UNIT, DIRECT SUPPORT, AND GENERAL SUPPORT MAINTENANCE MANUAL

FOR

SCRAPER, TRACTOR:
ELEVATING, SELF-PROPELLED,
11 CUBIC YARD,
SECTIONALIZED AND NONSECTIONALIZED
MODELS

613BSS
(NSN 3805-01-144-8837)

613BSS1
(NSN 3805-01-267-4177)

613BSNS
(NSN 3805-01-144-2992)

613BSNS1
(NSN 3805-01-267-4178)

HEADQUARTER, DEPARTMENT OF THE ARMY

MARCH 1991

WARNING

CARBON MONOXIDE

Carbon monoxide is colorless, odorless, DEADLY POISONOUS gas which, when breathed, deprives the body of oxygen and causes SUFFOCATION. Exposure to air contaminated with carbon monoxide pro- duces symptoms of headache, dizziness, loss of muscular control, apparent drowsiness, or coma. Permanent BRAIN DAMAGE or DEATH can result from severe exposure.

Carbon monoxide occurs in the exhaust fumes of fuel-burning heaters and internal-combustion engines and becomes DANGEROUSLY CONCENTRATED under conditions of INADEQUATE VENTILATION. The following precautions MUST be observed to insure the safety of personnel whenever the engine is operated for maintenance purposes.

- DO NOT operate the engine in an enclosed area unless it is ADEQUATELY VENTILATED.
- DO NOT operate the engine in an enclosed area such as a test cell without properly fitted and functioning exhaust ducts.
- BE ALERT at all times during engine operation for exhaust odors and exposure symptoms. If either are present, IMMEDIATELY VENTI LATE the work area. If symptoms persist, remove affected person- nel from the work area and treat as follows: expose to fresh air; keep warm; DO NOT PERMIT PHYSI- CAL EXERCISE; if necessary, administer artificial respiration as described in FM 21-11.

WARNING

HANDLING WEIGHTS

This manual considers short-term, non-repetitive lifts of equipment weighting up to 190 pounds to heights of about 3 feet. Under these conditions, this manual assigns one man for each 47-pound increment of weight up to a total of four men to accomplish the required lifts. If local conditions mandate higher lifts, repetitive lifts, or carries greater than 9 feet, refer to MIL-STD-1472 for a guideline on the number of personnel needed.

WARNING

MECHANICAL HAZARDS

Mechanical systems and components used on this equipment are energized, under pressure, or have sharp edges.

Use all precautions to de-energize a system, bleed pressure and to protect yourself from sharp edges when working on the equipment. Failure to do so may cause serious PERSONAL INJURY or DEATH.

WARNING

HIGH NOISE DANGER

Your hearing can be PERMANENTLY DAMAGED if you are exposed to constant high noise levels of 85 dB(A) or greater. Wear approved hearing protection devices when working in high noise level areas. Personnel exposed to high noise levels shall participate in a hearing conservation program in accordance with TB MED 501.

WARNING

USE OF COMPRESSED AIR TO DRY PARTS

DO NOT exceed 15 psig nozzle pressure when drying parts with compressed air. DO NOT direct compressed air against human skin. Failure to do so may result in SERIOUS INJURY or DEATH.

WARNING

FLAMMABLE LIQUIDS

Dry cleaning fluid, mineral spirits paint thinner, alcohol, acetone, methylethyl ketone and trichloroethylene are flammable solvents. Use these materials only in well-ventilated areas away from open flames and other heat sources that could cause ignition. The minimum safety measures described below must be observed in the handling and use of solvents:

- Fire extinguishers should be nearby when these materials are used.
- Cloths or rags saturated with cleaning solvents must be disposed of in accordance with authorized facilities procedures.
- The use of diesel fuel, oil, gasoline or benzine (benzol) is PROHIBITED for cleaning purposes.
- Fuel vapors can ignite and cause an explosion. Do not allow smoking or an open flame within 50 feet (16 meters).

WARNING

PROPER MACHINE OPERATION

This equipment must be operated only by authorized personnel who have satisfactorily completed a program of training which must include familiarity with safe operating procedures, characteristics, and a knowledge of applicable codes, regulations, and facilities directives. Untrained personnel subject themselves and others to the possibility of DEATH or SERIOUS INJURY from the improper operation of this machine. Understand the equipment, its function, and the controls before operations are begun.

WARNING

SHEARING PROTECTION

Shearing protection must be worn when working within 33 feet of the tractor-scraper.

WARNING

HANDLING CLEANING AGENTS

Toxic solvents are used in cleaning the equipment. Methyl-ethyl ketone TT-M-261 is a highly flammable solvent containing toxic characteristics that may irritate the skin and cause burns or internal disorders if fumes are repeatedly inhaled.

Trichloroethylene is a flammable solvent that has a chloroform odor. Inhaling concentrated fumes can cause unconsciousness. Inhaling fumes for a prolonged time can cause headache and drowsiness. Solvent absorbed by the skin can also result in internal disorders.

P-D-680 (Type II) is a flammable solvent that is potentially dangerous to personnel. Inhaling fumes for a prolonged time can cause headache and drowsiness. Solvent absorbed through the skin can also result in internal disorders.

The safety measures described below should be observed in the handling and use of solvents.

- Avoid prolonged or repeated breathing of vapors.
- Use only in a well-ventilated area.
- Keep away from heat, sparks, or open flames.
- Avoid contact with skin, eyes and clothing. The use of gloves is advised to prevent irritation or inflammation of the skin. If contact with the skin or eyes does occur, quickly wash the affected area with water for at least 15 minutes. For eyes, seek medical attention immediately after flushing eyes with water.

TECHNICAL MANUAL
No.5-3805-260-24

HEADQUARTERS
DEPARTMENT OF THE ARMY
Washington D.C., 15 March 1991

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REPORTING ERRORS AND RECOMMENDING IMPROVEMENTS

You can help improve this manual. If you find any mistakes or if you know of a way to improve the procedures, please let us know. Mail your letter, DA Form 2028 *(Recommended Changes to Publications and Blank Forms), or* DA Form 2028-2, located in the back of this manual, direct to: Commander, U.S. Army Tank-Automotive Command, ATTN: AMSTA-MB, Warren, Ml 48397-5000. A reply will be furnished to you.

This technical manual is an authentication of the manufacturer's commercial literature and does not conform with the format and content specified in AR 25-30, *Military Publications.* This technical manual does, however, contain available information that is essential to the operation and maintenance of the equipment.

Approved for public release; distribution is unlimited.

Table of Contents

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HOW TO USE THE TECHNICAL MANUAL

Introduction

The 613BS Series Tractor-Scraper is available in four configurations:

- 613BSNS and 613BSNS1 — Type I - Nonsectionalized
- 613BSS and 613BSS1 — Type II - Sectionalized

The Type I configurations are air transportable by three methods:

- Drive On/Drive Off*
- Low Altitude Parachute Extraction (LAPES)
- Low Velocity Air Drop (LVAD)
- Requires load transfer (weight distribution).

The Type II configurations, in addition to the three methods listed above, may be sectionalized (divided into two sections) and transported by helicopter.

Volume Identification

- Operation and Lubrication information, see TM 5-3805-260-10.
- Tractor Maintenance information, see Chapters 1-3 and Appendix B of this manual.
- Scraper Maintenance information, see Chapter 4 and Appendix B of this manual.
- Tractor-Scraper Parts information, see TM 5-3825-260-24P.
- Sectionalized Unique Information, see Chapter 5 of this manual.

There is a table of Contents located at the beginning of each Chapter/Appendix that provides the specific contents and location of what is covered in the Chapter/Appendix.

Part Number Identification

The part numbers identified in this manual may not always represent the most current RPSTL part numbers. ALWAYS verify given part numbers against the current RPSTL, TM 5-3805-260-24P.

REMEMBER!

This manual is a guide for the new mechanic and a reference for the experienced mechanic.

Illustrations will guide you through the procedures for maintaining the vehicle and attachments.

Your safety and the safety of others depend upon care and judgement in the maintenance of this vehicle. A careful mechanic is good insurance against an accident. Most accidents, no matter where they occur, are caused by someone's failure to observe and follow simple, fundamental rules or precautions. For this reason, most accidents can be avoided by recognizing hazards and taking steps to avoid them before an accident occurs.

CHAPTER 1
SPECIFICATIONS (TRACTOR)

INTRODUCTION

The specifications given in this chapter are on the basis of information available at the time the book was written. These specifications give the torques, operating pressure, measurements of new parts, adjustments and other items that will affect the service of the product.

When the words "use again" are in the description, the specification given can be used to determine if a part can be used again. If the part is equal to or within the specification given, use the part again. When the word "permissible" is in the description, is in the specification given is the "maximum or minimum" tolerance permitted before adjustment, repair and/or new parts are needed.

A comparison can be made between the measurements of a worn part, and the specifications of a new part to find the amount of wear. A part that is worn can be safe to use if an estimate of the remainder of its service life is good. If a short service life is expected, replace the part.

NOTE: The specifications given for "use again" and "permissible" are intended for guidance only and Caterpillar Tractor Co. hereby expressly denies and excludes any representation, warranty or implied warranty of the reuse of any component.

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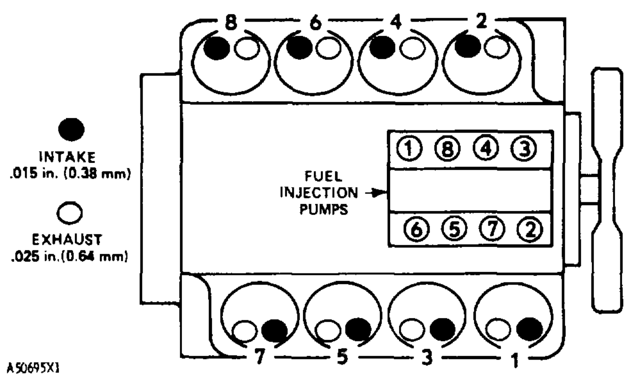
SECTION 1
SPECIFICATIONS
ENGINE

ENGINE DESIGN

Bore .... 4 5 in. (114 3 mm)
Stroke .... 0 in. (127 0 mm)
Number of Cylinders 8
Cylinder Arrangement 90V
Firing Order (Injection Sequence) 1, 2, 7, 3, 4, 5, 6, 8
Direction of Rotation (As Seen From
Flywheel End) .... Counterclockwise



CYLINDER, VALVE AND INJECTION PUMP LOCATION

ENGINE SETTINGS

Model Description Serial Number	Altitude (In Feet)	Brake Horsepower W/O Fan	W/Fan	Full Load RPM	High Idle Engine Only	In Vehicle	Static Fuel Setting (In mm.)	Rated Fuel Rate (Lb/Min)	In Vehicle BSFC	Torque Spring and Spacer (Thickness in Inches)	Torque Conv. Stall Speed
613Tractor Veh. S/N 38W1-Up	0- 2, 500	164	150	2200	2385	2340	*2A9* mm	1.027	.411	*5S2619(.010") **4N7777(.010")	2110
	2, 500- 5, 000	142	135	2200	2355	2310	2.14 mm				2035
	5, 000- 7, 500	131	125	2200	2335	2290	1.90 mm				1985
	7, 500-10, 000	121	115	2200	2315	2270	1.68mm				1940
	10, 000-12, 500	110	105	2200	2295	2250	1.44 mm				1880
	12, 500-15, 000	100	95	2200	2275	2230	1.22 mm-	1835			

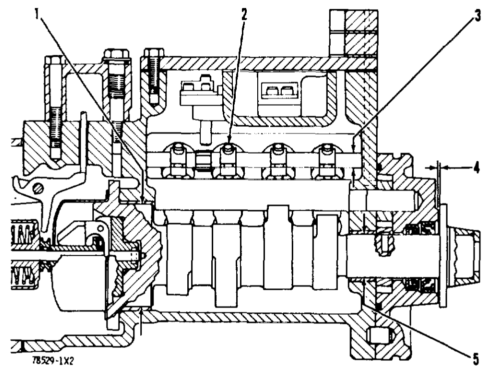
*Torque spring **Spacer

GENERAL NOTES:

Low idle in vehicle is 700 ± 10 RPM.
Fuel injection timing (static) is 16° BTC, .127 inch of piston travel.

FUEL INJECTION PUMP

Firing order (injection sequence) 1, 2, 7, 3, 4, 5, 6, 8
Injection timing before TC (top center): 16 ± 1°



Torque for the nuts that hold the fuel lines
(Use 5P144 Fuel Line Socket) ...30±5 lb ft (40 ± 7 N-m)

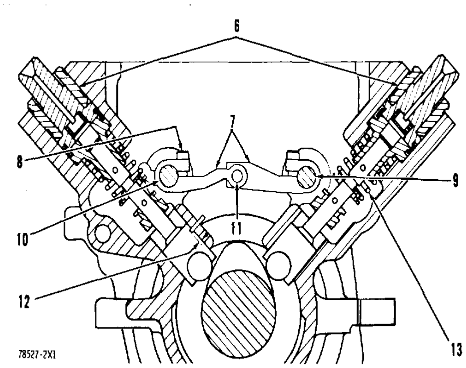
(1) Bore in the rear bearing for the camshaft (new) ....2 3750 ± 0005 in (60 325 ± 0 013 mm)
Diameter of rear bearing surface (journal) of the camshaft (new)...................2 3720 ± 0005 in (60 249 ± 0 013 mm)
Maximum permissible clearance between the bearing and the camshaft bearing surface (journal) (worn) ....006 in (15 mm)

(2) Torque for screws that hold sleeve control levers ....24 ± 2 lb in (2 8 ± 0 2 N-m)

(3) Bore in the housing for the fuel control shaft (new) ....3543 ± 0005 in (8 999 ± 0013 mm)
Diameter of sleeve control shaft (new) ....3530 ± 0003 in (8 966 ± 0 008 mm)
Maximum permissible clearance between the bore in the housing and the sleeve control shaft (worn)............. ....003 in (08 mm)

(4) End play for camshaft with sleeve installed (new) ....023 ± 018 in (0 58 ± 0 46 mm)

NOTE When installing sleeve on end of camshaft, support the camshaft to prevent damage to parts inside of injection pump and governor housing



(5) Bore in the front bearing for the camshaft (new)................ 1.0005±0005 in (25.413±0013 mm)
Diameter of front bearing surface (journal) of the camshaft (new) 9990±0005 in (25 375±0013 mm)
Maximum permissible clearance between the bearing and the camshaft bearing surface (journal) (worn)004 in (0.10 mm)

(6) Torque for bushing 60 ± 5 lb ft (80 ± 7 N.m)

(7) Crossover levers

NOTE: For adjustment of crossover levers, see the TESTING AND ADJUSTING SECTION

(8) Torque for screws that hold crossover levers .... 24 ± 2 lb in (2 8. ± 0 2 N m)

(9 and 10) Fuel control shafts

(11) Dowel pin (linkage between crossover levers)

(12) Distance guide pin extends into bore ....047 ± .004 in (1.20 ± 0.10 mm)

NOTE Install guide pin with slot towards the top of the lifter bore

(13) 9N5862 Spring for injection pump:
Length under test force ....1 348 in (34.24mm)
Test force ....12 5 ± 1 3 lb (55 5 ± 5 8 N)
Free length after test ....1.566 in (39.78mm)
Outside diameter ....728 ± 010 in (18 49 ± 0.25 mm)

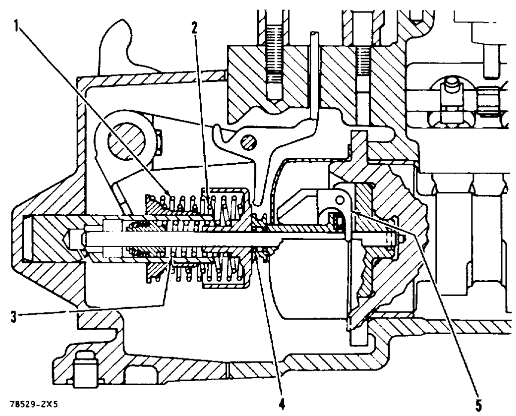
GOVERNOR

GOVERNOR SPRING CHART

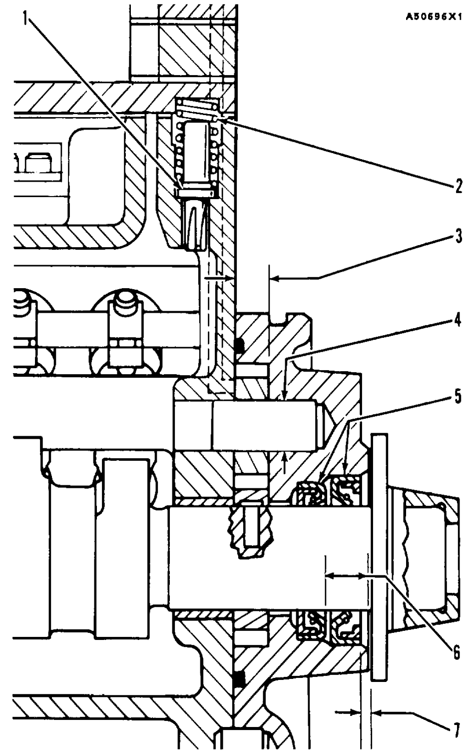
Part No.	(1) 4N6119	(2) 4N5663	(3) 6N2517
Color code (Stripes)	Three Green	One Pink	None
Put a force on spring of	3 0 lb (13 34 N)	1 0 lb (4 45 N)	20 lb (8 90 N)
Then add more force to make spring shorter by	700 In (17 78 mm)	700 in (17.78 mm)	200 in. (5 08 mm)
Total test force	11 40 ± 26 lb (50.71±1.16 N)	4.50 ± 12 lb (20 02± 53 N)	5.60±18 lb 124 91±80 N)
Free length after test	1 659± 021 in (42 14 ± 0 53 mm)	1.690±020 in (42 93±0 51 mm)	1.136±020 in (31.24 ± 0 51 mm)
Outside diameter	1.506 in (38 25 mm)	1 144 In. (29.06 mm)	.584 in. (14.83 mm)

(4) OVERFUELING SPRINGS	
Part No	6N6662
Length under test force	748 In. (19 00 mm)
Test force (0 84 * 008 N)	189 ± .02 lb
Free length after Test	1.126 in 128.60 mm)
Outside diameter	360 In. (9.14 mm)
Color code (Stripes)	One White

Torque for bolts that hold governor weight carrier to camshaft
90 ± 10 lb in (10 2 ± 1 1 N-m)

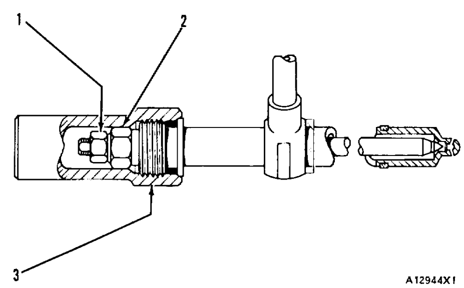


FUEL TRANSFER PUMP



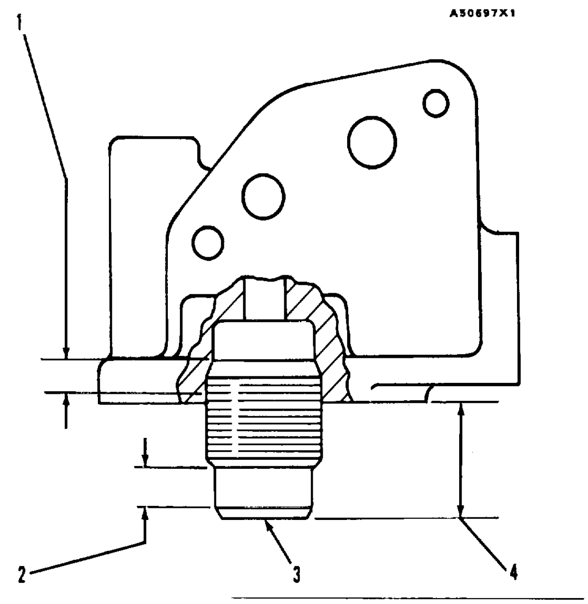
(1) Bypass valve.
Fuel pressure at FULL LOAD ....305 psi 1205 ± 35 kPa)
(2) 4N605 Spring for bypass valve-
Length under test force................. ....880 in (22.35 mm)
Test force ....3 53 .....18 lb (15 3 ± 0 80 N)
Free length after test ....1 729 in (43 92 mm)
Outside diameter........................... ....527 in(13 39 mm)
(3) Thickness of gears
(new) ....3736 ± 0003 in (9 489 ± 0 008 mm)
Depth of counterbore
(new) ....3750 ± 0005 in (9 525 ± 0 013 mm)
(4) Diameter of shaft for
Idler gear ....4914 ± 0003 in (12482 ± 0 008 mm)
Bore in idler gear ....4926 ± 0003 in (12 512 ± 008 mm)
(5) Put a thin layer of 5S1454 Sealing Compound on the outside diameter of the seals before installation Remove the extra sealing compound after assembly.
(6) Install inner seal from outside edge of body assembly
a distance of ....453 ± .010 in (11 51 ± 0.25 mm)
(7) Install outside seal from outside edge of body
assembly to a distance of ....030 ± .010 in (0.76 ± 0 25 mm)

INJECTION NOZZLE (9N3979)



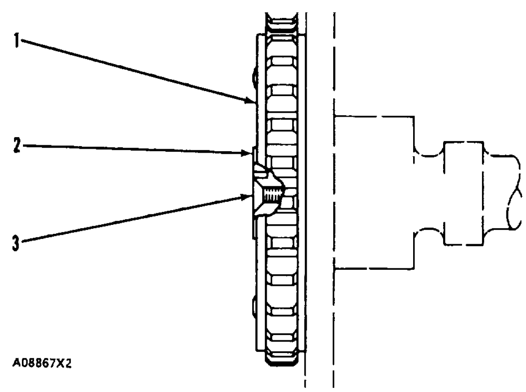
Bench test nozzles using clean SAE J967
Calibration Oil (Kent-Moore Corp J-26400
or Viscor Calibration Fluid 1487C-SAE J-967C)
at a temperature of ....65 to 70° F (18 to 20° C)
Nozzle setting pressures (valve lift adjustment screw turned 3/4 + 1/8 turn from closed position)
Used nozzle ....1500 to 2600 psi (10300 to 17690 kPa)
Used, adjusted
nozzle ....2400 to 2600 psi (16545 to 17690 kPa)
Return oil leakage test
pressure ....1400 to 1600 psi (9630 to 11 045 kPa)
Leakage in 15 seconds ....NO minimum or maximum
Maximum tip leakage Is 20 drops in 15 seconds with a pressure of 200 psi (1380 kPa) less than opening pressure
(1) Torque for valve lift
locknut ....35 to 45 lb in (4.0 to 5.1 N-m)
(2) Torque for pressure screw
locknut ....70 to 80 lb In (8.0 to 9.1 N-m)
(3) Torque for cap ......110 to 120 lb in (12.4 to 13.6 Nm)

FUEL FILTER BASE



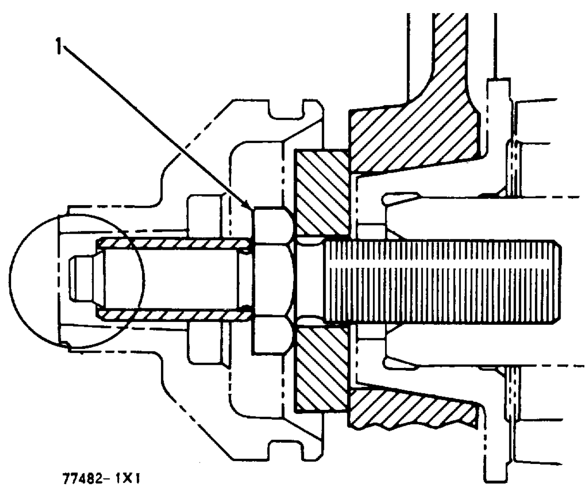
(1) Put 9S3263 Thread Lock Compound on the threads of the tapered end of the stud to a distance of ....30 in (7 6 mm)
(2) Sealing surface of stud.
NOTE Do not damage this surface
(3) Torque for stud ....50 ± 10 lb ft (70 ± 14 N-m)
(4) Distance from sealing surface of base to end of stud......................97 ± 05 in (24 61 ± 3 mm)

AUTOMATIC TIMING ADVANCE UNIT



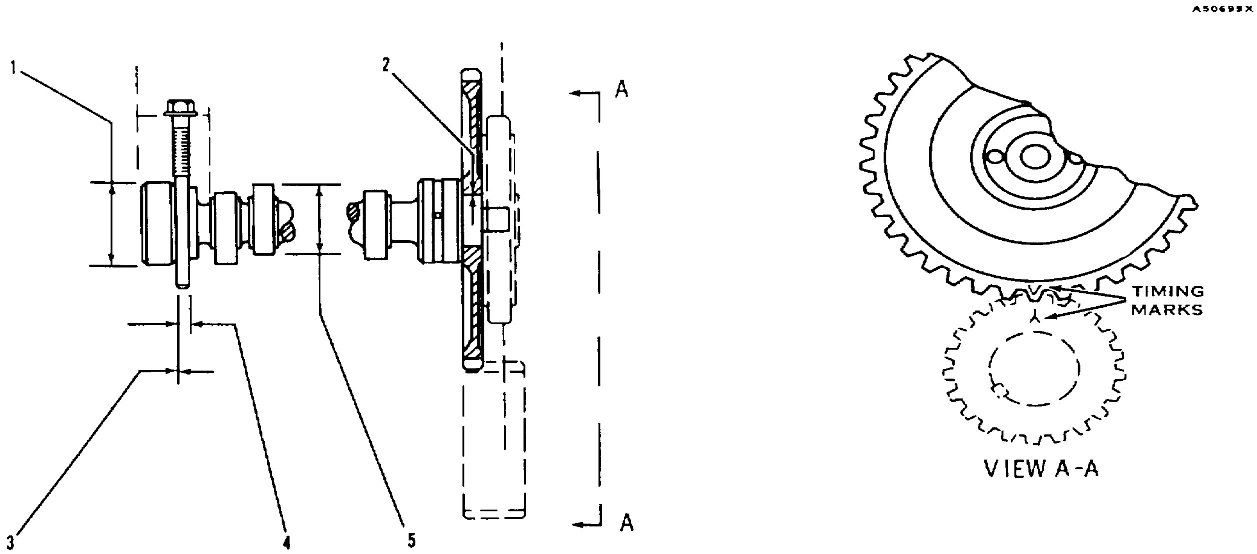
End play between washer (2) and timing advance unit (1)...............003 to 037 in (O 08 to O 94 mm)
(3) Torque for screw.................72 ± 5 lb In (8 2 ± 0.6 N m)
"Stake" (make a mark with a punch) screw (3) in two places

DRIVE GEAR FOR THE INJECTION PUMP



(1) Torque for the bolt that holds the drive gear to the camshaft of the injection pump ....110 ± 10 lb ft. (149 ± 14 N.m)

CAMSHAFT



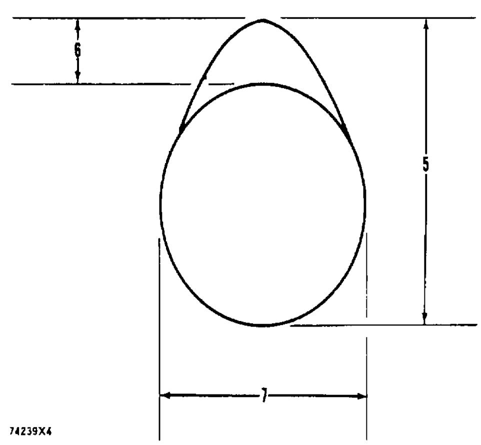
(1) Diameter of the surfaces (journals) for the camshaft bearings (new)..................... ....2 500 ± 0005 in (63 500 ± 0 013 mm)
Bore In the live bearings for the camshaft (new)......2.5035 ± 0015 in (63 589 ± 0 038 mm)
Maximum permissible clearance between bearing and bearing surface journal) (, worn).007 in (0 18 mm)

(2) Tight fit between the gear and camshaft.........0012 to 0028 in (0 030 to 0 071 mm)
Maximum permissible temperature of the gear for Installation on the camshaft (do not use a torch) 600° F (315° C)

(3) End play for the camshaft..007 ± 003 in (18 ± 08 mm)
Maximum permissible end play (worn) 020 In (0 51 mm)

(4) Width of thrust groove in camshaft (new)......360 ± 002 in (9 14 ± 0 05 mm)
Diameter of thrust pin (new) I.............. ....353 ± 001 in (8.97 ± 0 03 mm)
Torque for thrust pin-..........35 ± 5 lb ft (45 ± 7 N m)

NOTE For installation of camshaft. The timing mark or the camshaft gear tooth must be in alignment with the timing mark on the tooth space of the crankshaft gear

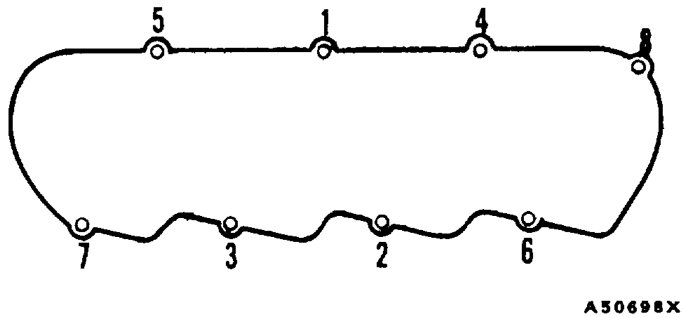


(5) Height of camshaft lobes
To find lobe lift, use the following procedure

A. Measure camshaft lobe height (5)
B. Measure base circle (7)
C. Subtract base circle (STEP 8) from lobe height (STEP A) The difference Is actual lobe lift (6)
D. Specified camshaft lobe lift (6) is
   a. Exhaust lobe..... ....3071 in (7 800 mm)
   b. Intake lobe........ ....3077 in (7.816 mm)

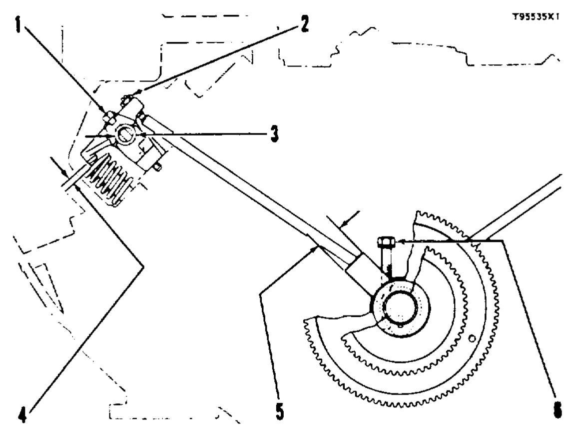
Maximum permissible difference between actual lobe lift (STEP C) and specified lobe lift (STEP D) is 010 in (0 25 mm)

VALVE COVERS



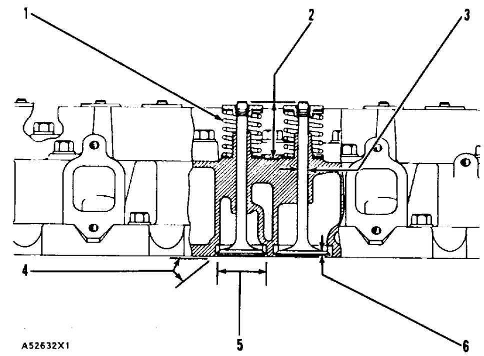
(1) Tighten bolts in sequence shown
to a torque of 10 ± 2 lb ft (14 ± 3 N m)

VALVE ROCKER ARMS AND CAM FOLLOWERS



(1) Torque for bolts holding
rocker arms ....18 ± 5 lb ft (24 ± 7 N m)
(2) Torque for lock nut for valve
adjustment screw ....24 ± 5 lb ft (30 ± 7 N m)
(3) Diameter of the shaft for
the rocker arms ....8580 to 8588 in (21 793 to 21 814 mm)
Minimum permissible diameter (worn) ....8570 in (21 768 mm)
Bore In bearings for the
rocker arms (new) ....8603 ± 0008 in (21 8520 ± 020 mm)
Maximum permissible bore (worn) ....8630 in (21 920 mm)
Maximum permissible clearance between bore
in bearing and shaft (worn) ....005 in (0.13 mm)
(4) Clearance for valves I intake valve)....015 in (0 38 mm)
Clearance for valves (exhaust valve) .....025 in (0 64 mm)
15) Diameter of cam
follower ....1.1589 ± 0004 n (29 436 ± 0.010 mm)
Minimum permissible diameter (worn) ....1.1575 in (29.401 mm)
Bore In block for cam
follower ....1.1624 ± 0010 in (29 525 ± 0 025 mm)
Maximum permissible bore (worn) ....1.1650 in (29 591 mm)
(6) Torque for the thrust pin for the
camshaft ....35 ± 5 lb ft (45 ± 7 N m

VALVES



(1) 9N3617 Spring for valves (new)
Length under test force 1 655 in (42 04 mm)
Test force .... 50 ± 5 lb (220 ± 22 N)
Use again minimum load at length under test force ..... 35 lb (155 N)
Length of spring at valve open position .... 1 167 in (29 64 mm)
Use again minimum load at valve open position ....154 5 lb (687 N)
Free length after test 1 855 in (47 12 mm)
Outside diameter .. 1 440 in (36 58 mm)
Spring must not be bent more than 065 In (1 65 mm)

(1) 9L91 90 Spring for valves (new)
Length under test force 1 715 in 43 56 mm)
Test force .... 35 ± 5 lb (155 ± 22 N)
Use again minimum load at length under test force ..... 23 lb (100 N)
Length of spring at valve open position ....1 215 in (30 86 mm)
Use again minimum load at valve open position .... 145 b (645 N)
Free length after test 1 855 in (47 12 mm)
Outside diameter .. 1 440 in (36 58 mm)
Spring must not be bent more than 065 in (1 65 mm)

(1) 1N4259 Spring for valve (new):
Length under test force ......1.334 in. (33.88 mm)
Test Force ....1.74b 774 ± 39 N m)
Use again minimum bad at length under test force .... 162 lbs. (720 N m)
Length of spring at valve open position ....1.802 in. (45.77 mm)
Use again minimum bad at valve open position ....44 lbs.(194 N m)
Free length after test ....1.996 in. (50.7 mm)
Outside diameter ... .1.560 n. (39.62 mm)
Spring must not be bent more than .065 in. (1.65 mm)

(2) Distance from the end of the valve to the valve spring spacer seat ....2 063 ± 015 in (52 40 ± 0 38 mm)

(3) Diameter of valve stem.
9L7682 Intake Valve...........3725 ±0005 in (9 462 ± 013 mm)
Use again minimum diameter of the valve stem ... .371 in (9 42 mm)
9L7683 Exhaust Valve (tapered stem)
Head end of valve stem ....3705±.0005 in (9 411 ± 0.013 mm)
Use again minimum diameter of the head end of valve stem ....369 in. (9 37 mm)
Lock end of valve stem ....3715±.0005 in (9.436±0013 mm)
Use again minimum diameter of the lock end of valve stem .. ..3704 in (9 408 mm)

Bore in the valve guides (intake and exhaust) ....3745 ± 0005 in (9 512 ± 0 013 mm)
Maximum permissible bore in the valve guides (worn)
Measure 75 in (190 mm) deep in valve guide bore from both ends of the valve guide 3760 in (9 550 mm)

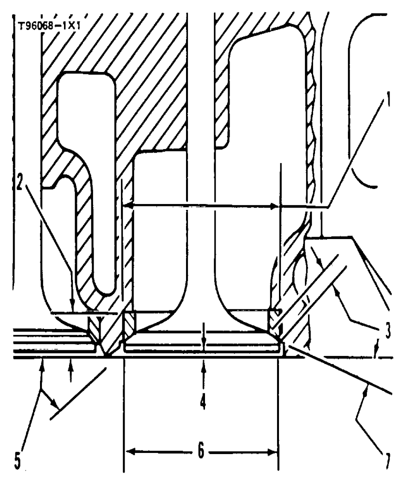
(4) Angle of valve face
Intake valve ....30°±15
Exhaust valve ....45°±15’

(5) Diameter of valve head (intake valve) .... 2.094±005 in (53.19 ± 0.13 mm)
Diameter of valve head (exhaust valve) ....1.804±005 in (45.82 ± 0 13 mm)

(6) Thickness of valve lip
Intake valve ....091 in (2 31 mm)
Use again minimum valve lip thickness . ----------070 in (1 78 mm)
Exhaust valve ....063 in (1 60 mm)
Use again minimum valve lip thickness . ...044 In (1 12 mm)

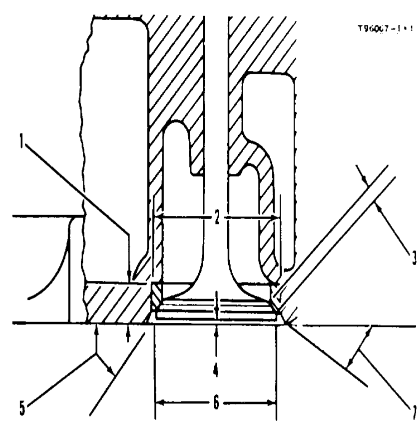
VALVE SEATS AND INSERTS

INTAKE VALVE (with valve seat insert)



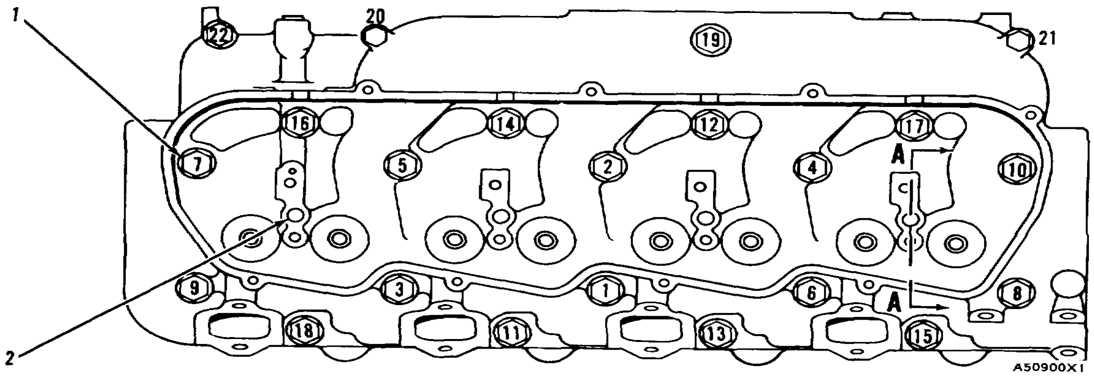
(1) Diameter of the valve seat insert......................2 1500±0005 in (54 610±0.013 mm)
(2) Bore In head for valve seat insert......................2 1470 ± 0005 In (54 534 ± 0.013 mm)
(2) Depth of bore in head for valve seat insert. .... .442 ± .002 in (11.23 ± 0.05 mm)
(3) Maximum permissible width of the face of the valve seat insert ....120 in (3 05 mm)
(4) Distance from head of valve to cylinder head face:
Maximum permissible (valve closed) ....068 in (1 73 mm)
Minimum permissible (valve closed) ....036 in (0 91 mm)
(5) Angle of the face of the valve seat insert ....301/2 ± 1/2°
(6) Outside diameter of the face of the valve seat insert...........................2.045 ± 005 in (52.23 ± 0.13 mm)
Maximum permissible ....2 065 in (52 45 mm)
(7) Angle to grind face of seat insert (to get a reduction of maximum seat diameter) ....15°

EXHAUST VALVE



(1) Depth of bore in head for valve seat insert............................442 ± .005 in (11 23 ± 0 13 mm)
(2) Diameter of valve seat insert .... 1.9120 ± 0005 in (48 565 ± 0.013 mm)
(3) Bore in head for valve seat insert ....1.9090 ± 0005 in (48 489 ± 0.013 mm)
Maximum permissible width of the face of the valve seat insert ....105 in (2 67 mm)
(4) Distance from head of valve to cylinder head face
Maximum permissible (valve closed) ....085 in. (2 16 mm)
Minimum permissible (valve closed) ....050 in (1 27 mm)
(5) Angle of the face of the valve seat insert ....451/2 ± 1/2°
(6) Outside diameter of the face of the valve seat insert ....1.735 ± .005 in (44.07 ± 0.13 mm)
Maximum permissible ....1.760 in (44 70 mm)
(7) Angle to grind face of seat insert (to get a reduction of maximum seat diameter) ....15°

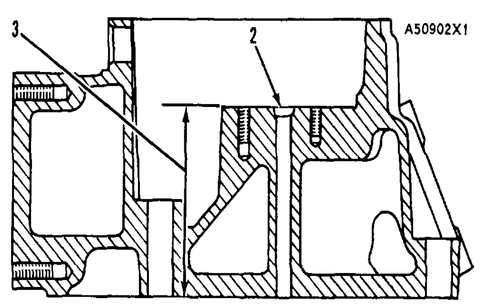
CYLINDER HEAD



(1) Put clean engine oil on bolt threads and tighten bolts according to the following HEAD BOLT CHART.

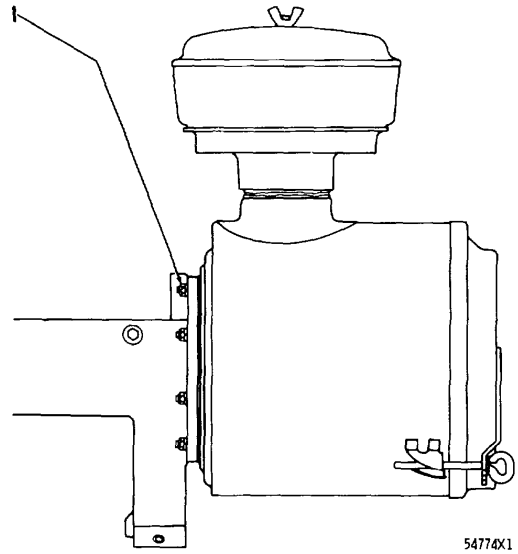
HEAD BOLT CHART	
Tightening Procedure	
Step 1. Tighten bolts 1 thru 18 in number sequence to:	60 ± 10 lb ft. (80 ± 14 N m)
Step 2. Tighten bolts 1 thru 18 in number sequence to:	110 ± 5 lb ft (150 ± 7 N m)
Step 3. Again tighten bolts 1 thru 18 in number sequence to:	1l0 ± 5 lb ft (150 ± 7 N m)
Torque for head bolts 19 thru 22 (tighten in number sequence to	32 ± 5 lb ft. (43 ± 7 N m)

(2) Holes for fuel Injection nozzles
(3) Thickness of cylinder head [measure through the fuel injection nozzle holes at each end of the cylinder head].
New....................... ....3.785 ± 006 in (96.14 ± 0.15 mm)
Minimum permissible thickness....................3.774 in (95.86 mm)



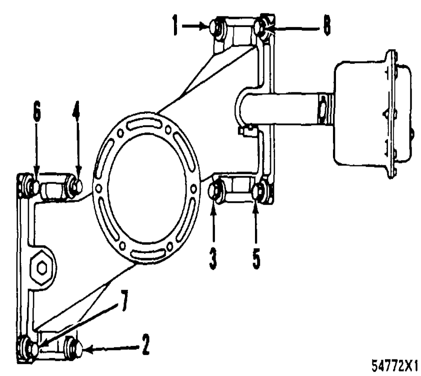
AIR CLEANER

(1) Torque for nuts ....20 ± 5 lb ft (25 ± 7 N m)



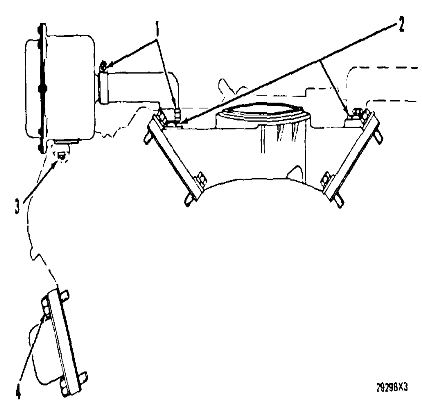
AIR INLET MANIFOLD

Tighten bolts (3) and (4) to ....15 ± 5 lb ft (20 ± 7 N m)
Tighten all bolts by number to ....32 ± 5 lb ft (43 ± 7 N m)

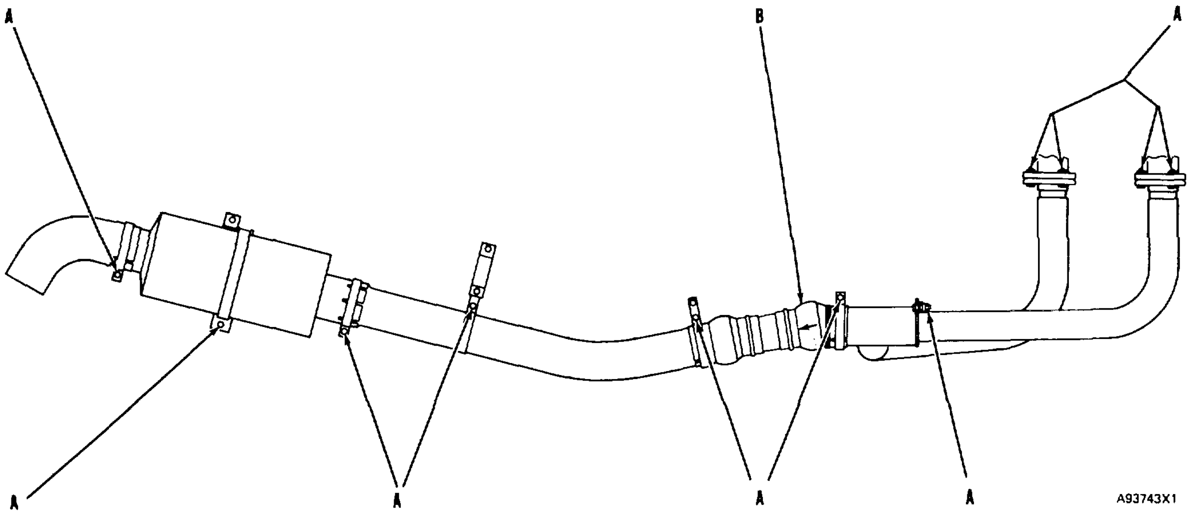


MANIFOLDS AND CRANKCASE VENTILATION VALVE

(1) Torque for hose clamps...................20 ± 2 lb in (2.3 ± O.2 N m)
(2) Torque for adapters.........................9 ± 3 lb ft (12 ± 4 N m)
Put 5P3413 Sealant on threads of adapter
(3) Torque for bolts ....30 ± 4 lb in (3.4 ± 0.5 N m)
(4) Torque for bolts holding
the exhaust manifold ....32 ± 5 lb ft. (43 ± 7 N m)
Put 5P3931 Anti-Seize Compound on bolt threads
Locks must be bent on a flat side of the bolt head Bolts must be turned no more than 30° (in the direction of increased torque only) for the alignment of locks with a flat side of the bolt head.

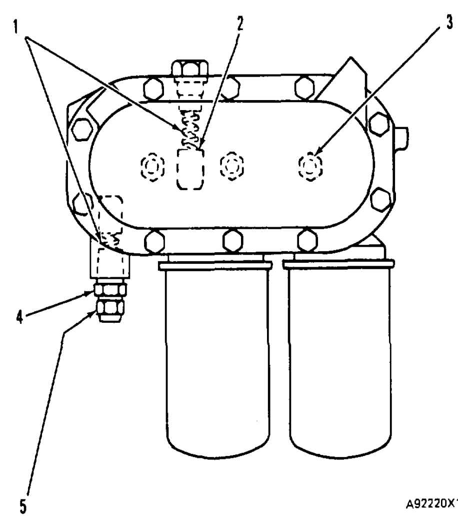


EXHAUST SYSTEM



Tighten bolts (A) to a
torque of ....18 ± 5 lb ft (24 ± 7 N m)
NOTE. Install swivel (B) with arrows in the direction of exhaust flow

ENGINE OIL COOLER AND FILTER



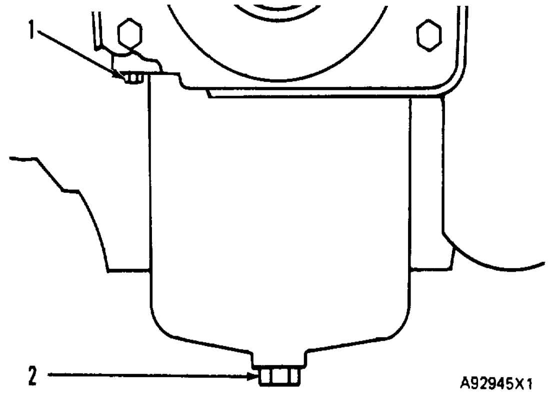
Oil pressure difference that makes the oil
filter bypass valve open 20 ± 4 psi (140 ± 25 kPa)
Oil pressure difference that makes the
oil cooler bypass valve open ....18 ± 4 psi (125 ± 25 kPa)

(1) 9L9188 Spring (oil cooler and oil filter bypass valve)
 Length under test force ....1 70 n (43 2 mm)
 Test force ....3 5 b (15 6 N)
 Free length after test ....2 28 in (57 9 mm)
 Outside diameter .. ..440 in (11 18 mm)
(2) Oil filter bypass valve
(3) Torque for nuts that hold oil
 cooler core to oil cooler base
 (hand torque only) . ...16 ± 2 lb ft (22 ± 3 N m)

NOTE Assemble gasket to oil cooler base with Indexing point toward the front of the engine and in the up position

(4) Torque for fitting ... .19 ± 4 lb ft (25 ± 5 N m)
(5) Torque for cap ....15 ± 4 lb ft (20 ± 5 N-m)

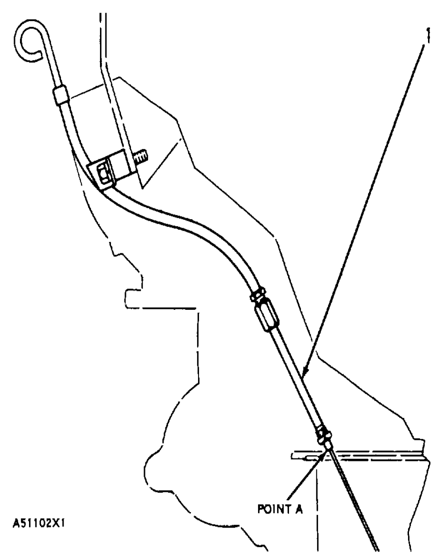
OIL PAN



(1) Torque for bolts that
hold oil pan ....17 ±3 lb ft (23 ± 4 N m)

(2) Torque for oil pan
drain plug............................50 ± 10 lb ft (70 ± 14 N m)

OIL LEVEL GAUGE



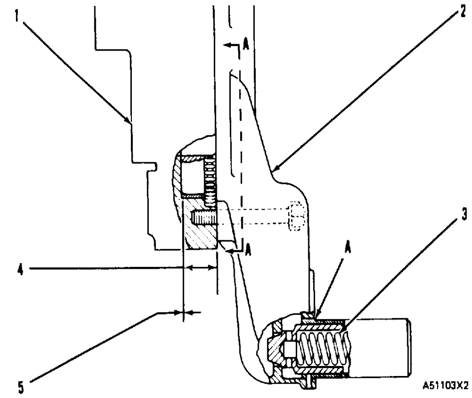
(1) Guide assembly
Assemble lower part of guide assembly (1) so that Point A is even with bottom surface of block within ± 03 in (0.8 mm)

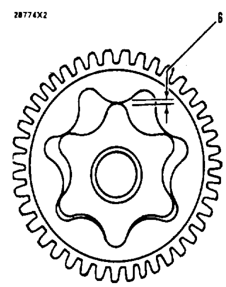
OIL PUMP

(A) Position of guide
Even with finished surface on cover to not more than 010 (0 25 mm) recessed

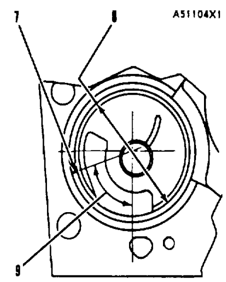
NOTE Make sure the flat surface on the guide is in alignment with the set screw

(1) Front housing assembly.
(2) Oil pump cover assembly
(3) 9L9243 Spring (pump pressure relief valve)
Length under test force....... ....2 579 in (65 51 mm)
Test force............... ....37 31 9 lb (166.5 8 5 N)
Free length after test ....3 50 in (88 9 mm)
Outside diameter ... .875 in (22 23 mm)
(4) Width of oil pump rotors
(new)..................... ....1 2480 + 0003 in (31 699 +- 0008 mm)
Depth of counterbore in front
housing (new) ....1.252 001 in (31 80 + 0 03 mm)
(5) Maximum permissible end clearance of oil pump rotors when measured with oil pump installed to front cover ....006 in (0 15 mm)
(6) Clearance of oil pump
rotor tip ....002 to 006 in (0.05 to 0.15 mm)
Maximum permissible clearance of oil pump
rotor tip.................. ....009 in (23 mm)
(7) Bearing junction
(8) Diameter of bearing for
rotor (new) ....2.8041 ± 0022 in (71.224 ± 0.056 mm)
(9) Position of main bearing junction from vertical
centerline ....75 ± 30°



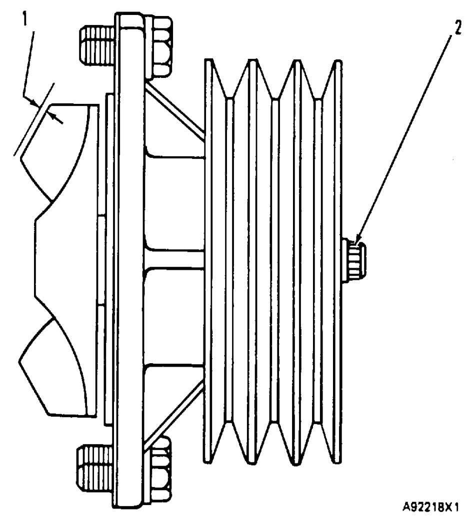


VIEW A-A OF
ROTOR OIL PUMP



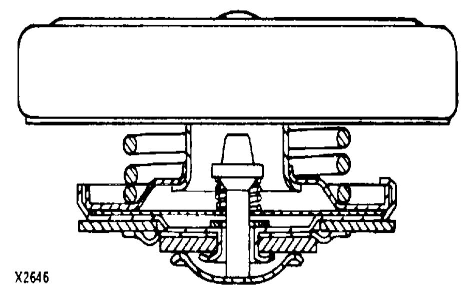
VIEW A-A OF
FRONT HOUSING

WATER PUMP



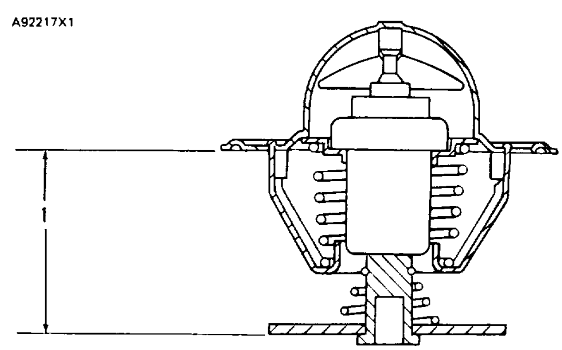
(1) Clearance between the water pump impeller face and front cover...................... ....011 to 033 in (O 28 to 0 84 mm)
(2) Torque for pulley.... ....55 ± 5 lb ft (75 ± 7 N m)

COOLING SYSTEM PRESSURE CAP (68865)



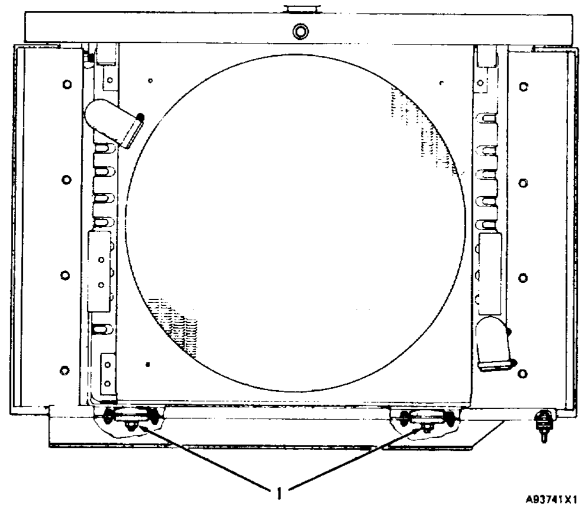
Relief valve opens at..... ....6 5 to 8 O psi (45 to 55 kPa)

WATER TEMPERATURE REGULATOR



9N5121 Regulators:
Temperature when completely open.......197 F (92 C)
(1) Distance at completely open temperature must not be more than ....1 170 n (29 72 mm)

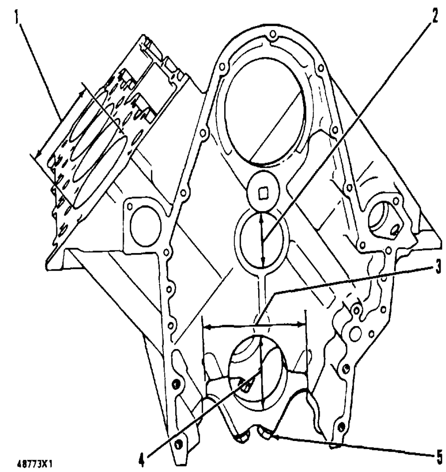
RADIATOR



(1) Torque for radiator mount bolts....................................47 ± 3 lb. ft (63 ± 4 N m)

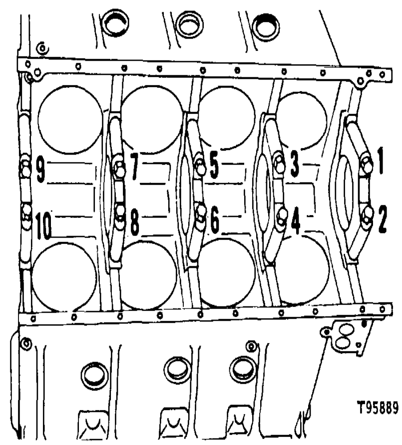
V-BELT TENSION CHART										
BELT SIZE	WIDTH BELT TOP		WIDTH TOP OF PULLEY GROOVE		BELT TENSION “INITIAL”* GAUGE READING		BELT TENSION “USED”** GAUGE READING		BORROUGHS GAUGE NUMBERS	
	in	mm	in	mm	lb.	N	lb.	N	OLD GUAGE NO.	NEW GUAGE NO.
3/8	.422	10.72	.380	9.65	100 ±5	445±22	90±5	400±22	BT-33-73F	BT-33-95
½	.547	13.89	.500	12.70	120±5	534±22	90±10	400±44	BT-33-96-4-16	BT-33-95
5V	.625	15.88	.600	15.24	120±5	534±22	90±10	400±44	BT-33-732-4-15	BT-33-72C
11/16	.688	17.48	.625	15.88	120±5	534±22	90±10	400±44	BT-33-72-4-15	BT-33-72C
¾	.750	19.05	.690	17.53	120±5	534±22	90±10	400±44	BT-33-72-4-15	BT-33-72C
15/16	.938	23.83	.878	22.30	120±5	534±22	90±10	400±44	BT-33-72-4-15	BT-33-72C
MEASURE TENSION OF BELT FARTHEST FROM THE ENGINE										
*”INITIAL” BELT TENSION is for a new belt **”USED” BELT TENSION is for a belt which has more than 30 minutes of operation at rated speed of engine. A10232X5										

CYLINDER BLOCK



Measure wear of the cylinder bore at the top and bottom of piston ring travel

(1) Cylinder bore [standard, original size] ....4.5000 to 4.5015 in (114.300 to 114.338 mm)
The recommendation is made to make the cylinder bore the next size larger when the size of the bore is ....4.5060 in (114.452 mm)
Cylinder bore must be made the next size larger when the size of the bore is ....4.5090 in (114 529 mm)
Cylinder bore [020 in (0 51 mm) larger than the original size] ....4.5205 ± 0005 in (114 821 ± 0.013 mm)
The recommendation is made to make the cylinder bore the next size larger when the size of the bore is ....4 5260 in (114 960 mm)
Cylinder bore must be made the next size larger when the size of the bore is............. ....4 5290 in (115 037 mm)
Cylinder bore [040 in (1 02 mm) larger than the original size]........... ....4 5405 + 0005 in (115.329 ± 0 013 mm)
Maximum permissible wear of cylinder bores (replacement of the cylinder block is necessary) ....4 5490 in (115 545 mm)

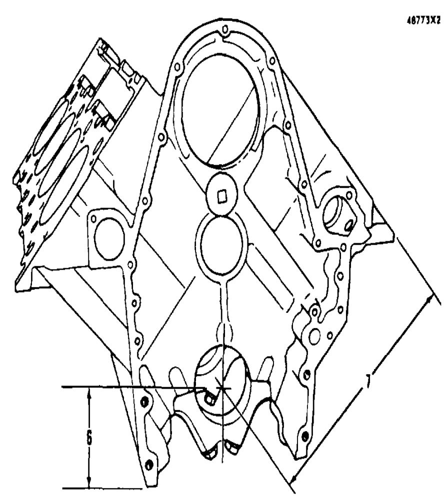


(2) Bore in block for camshaft bearing ....2 6525 ± 0005 in (67 374 ± 0.013 mm)

(3) Width of main bearing cap ....6 5600 ± 0007 in (166 624 ± 0 018 mm)
Minimum permissible width of main bearing cap... ....6.5580 in. (166.573 mm)
Width of main bearing cap guide (in cylinder block)... ....6 5590 ± 0005 in (166 599 ± 0013 mm)

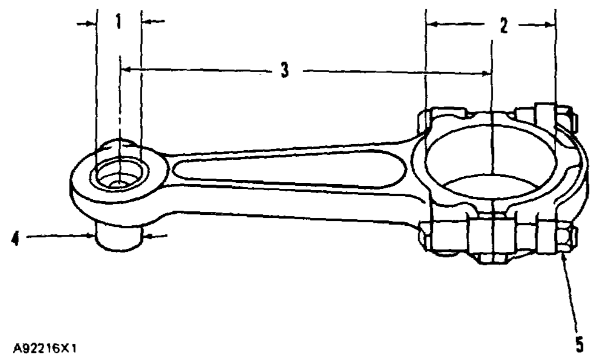
(4) Bore in block for main bearing.................. ....3 7075 ± 0005 in (94.171 ± 0.013 mm)
Permissible amount of distortion in bore ....3.706 to 3.709 in (94 13 to 94.21 mm)

(5) Torque for bolts holding caps for main bearings
1. Put crankcase oil on bolt threads and washer face
2. Tighten all bolts in number sequence ....to ....30 ± 3 lb ft. (40 ± 4 N-m)
3. Put a mark on each bolt and cap
4. Tighten all bolts in number sequence ....from mark .... 120° ± 5°

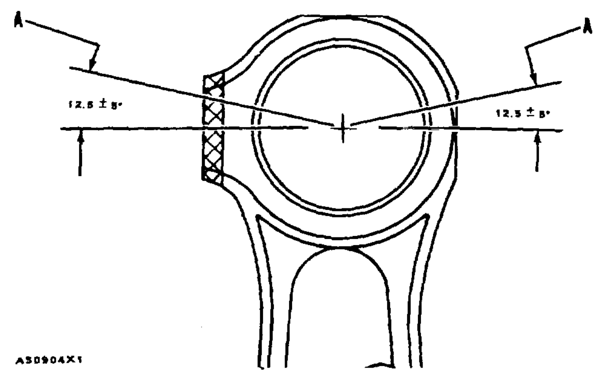


(6) Dimension (new) from centerline of crankshaft bearing bore to bottom of block (pan rails)............... ....3.7500 ± 0015 in (95 250 ± 0 038 mm)

(7) Dimension (new) from centerline of crankshaft bearing bore to the top of block (top deck)..................... ....12 703 ± 005 in (322 66 ± 0 13 mm)



CONNECTING ROD WITH



CONNECTING ROD

(1) Bore in bearing for
piston pin .... 1.5010 ± .0003 in. (38.125 ± 0.008 mm)

(2) Bore in connecting rod for bearing [when tightened according to procedure shown
in (5)] .... 2.9418 ± .0005 in. (74.721 ± 0.013 mm)

(3) Distance between center of bearing for piston pin and center of bearing for crankshaft. journal 7.900 ± .001 (200.66 ± 0.03 mm)

(4) Diameter of piston
pin...................... 1.4999 ± .0002 in. (38.097 ± 0.005 mm)
Maximum permissible clearance between bearing and piston .... pin

(5) Torque for nuts:
A. Put engine oil on bolt threads and seating faces of cap and nut.
B. Tighten both nuts to ....30 ± 3 lb. ft. (40 ± 4 N·m)
C. Put a mark on each nut and cap
D. Tighten each nut from mark...............................60 ± 5

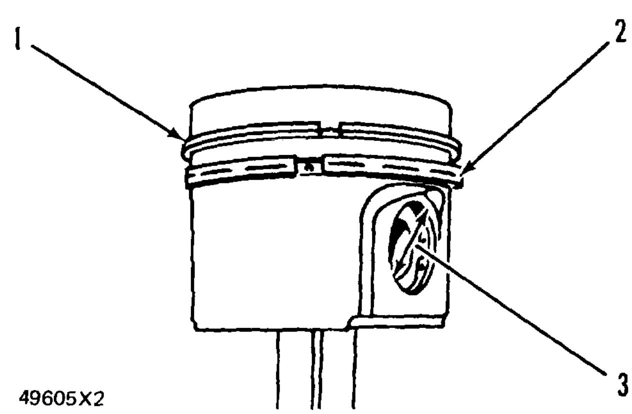
NOTE: Piston pin bearing junction and locating notch must be assembled in the top half of rod eye. Bearing junction can be located at either position "A" above centerline.

PISTONS AND RINGS

Make reference to GUIDELINE FOR REUSABLE PARTS, PISTONS AND CYLINDER LINERS.

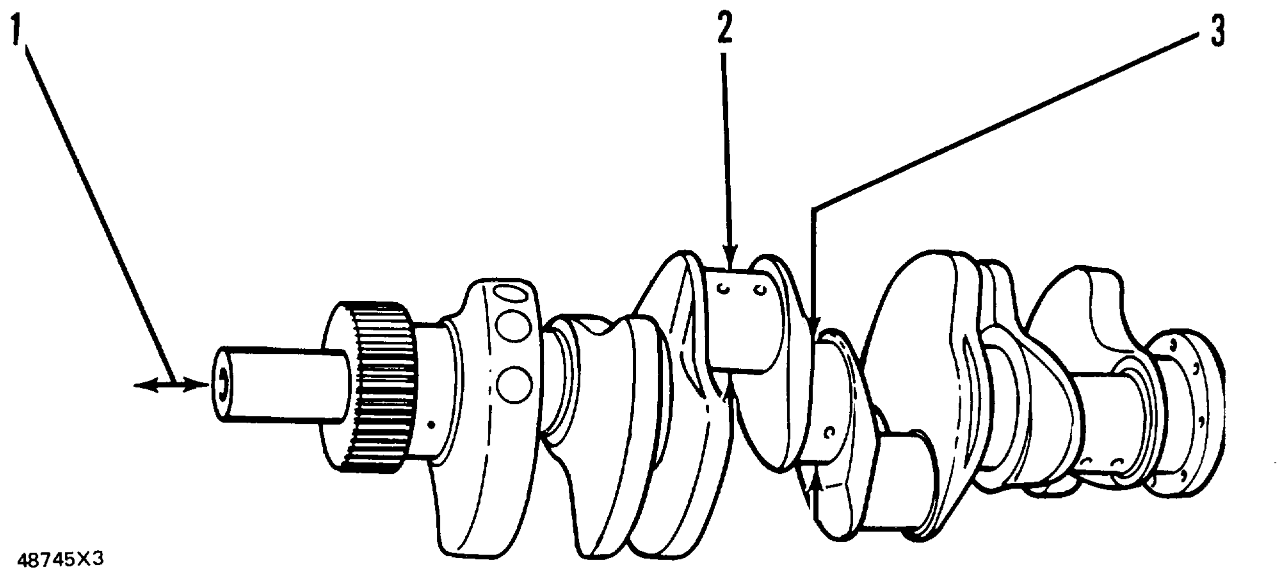
PISTONS AND PISTON RINGS		
	(1) TOP RING	(2) OIL CONTROL RING*
	9L6233	9L9316
Width of groove in piston for piston ring (new)	.1290 ± .0005 in. (3.276 ± 0.013 mm)	.11050 ± .0005 in (2.806 ± 0.013 mm)
. Thickness of piston ring (new)	.1240 ±. .0000 - .0015 In. (3.150 ± 0.000 - 0 038 mm)	.1085 ± .0005 in (2.756 ± 0.013 mm)
Clearance between groove and piston ring (new)	.0030 to .0055 in (0.076 to 0.140 mm)	.0010 to .0030 in (0.025 to 0.076 mm)
Clearance between ends of piston ring when installed in a cylinder with a bore size of 4.5000 in.(114.300 mm)	.0225 ± .0075 in (0.572 ± .0.190 mm).	.0200 ± .0100 in (0.508 ± 0.254 mm)
Increase in clearance between ends of piston ring for each .001 in.(0.03 mm) increase in cylinder bore size	.003 in. (0.08 mm)	

NOTE: 9L6233 Top Ring (1) has the mark "UP-1."
*Install 9L931 6 011 Control Ring (2) with the gap in the spring 1800 away from the gap in the ring.
NOTE: Use 5P3519 PISTON RING GROOVE GAUGE to check the top ring groove only



(3) Bore in piston
for pin .... 1.5005 to 1.5009 in (38.113 to 38.123 mm)
Clearance between pin and bore in
piston (new)......... .0004 to .0012 in (0.010 to 0.030 mm
Maximum permissible clearance between piston
pin and bore in piston (worn)............ .003 in (0.08 mm)

CRANKSHAFT.



Heat gear to Install Do not heat to a temperature of more than 500°F (260°C)

(1) End play for the crankshaft. .003 to .010 in. (0.08 to 0.25 mm)

Maximum permissible end play for the crankshaft. (worn).......... .014 in. 10.36 mm)

(2) Diameter of bearing surface (journals) for the connecting rods standard, original size] ..... 2.7496 ± .0006 in. (69.840 ± 0.015 mm)

Minimum permissible diameter (worn) .... 2.7486 in. (69.814 mm)

Diameter of bearing surfaces (journals) for the connecting rods .010 in. 0.25 mm) smaller than the original size]........2.7396 ± 0006 in. (69.586 ± 0015 mm)

Minimum permissible diameter (worn) .... 2.7386 in. (69.560 mm)

Diameter of bearing surfaces (journals) for the connecting rods [.020 in. (0.51 mm) smaller than the original size].......2.7296 ± .0006 in. (69.332 ± .0015 mm)
Minimum permissible diameter (worn) .... 2.7286 in. (69.306 mm)
Diameter of bearing surfaces (journals) for the connecting rods [.050 in (1.27 mm) smaller than the original size]........2.6996 ± 0006 in. (68.570 ± 0.015 mm)
Minimum permissible diameter (worn) .... 2.6986 in. (68.544 mm)

(3) Diameter of bearing surfaces (journals) for the main bearings [standard, original size]........3.4995 ± .0006 in (88.887 ± 0.015 mm)

Minimum permissible diameter (worn)..............................3.4980 in (88.749 mm)

Diameter of bearing surfaces (journals) for the main bearings .010 in (0.25 mm) smaller than the original size] .. 3.4895 ± .0006 in. (88.633 ± 0.015 mm)

Minimum permissible diameter (worn).............................3.4880 in. (88.595 mm)

Diameter of bearing surfaces (journals) for the main bearings [.020 in (0.51 mm) smaller than the original size] ...... 3.4795 ± .0006 in. (88.379 ± 0.015 mm)

Minimum permissible diameter (worn).............................3.4780 in. (88.341 mm)

Diameter of bearing surfaces (journals) for the main bearings [.050 in. (1.27 mm) smaller than the original size] ....3.4495 ± .0006 In (87.617 ± 0.015 mm)
Minimum permissible diameter (worn).............................3.4480 in. (87.579 mm)
Maximum permissible run out (axial eccentricity) of the crankshaft., measured at the center main bearing surface (journal) ...... .008 in. (0.20 mm)

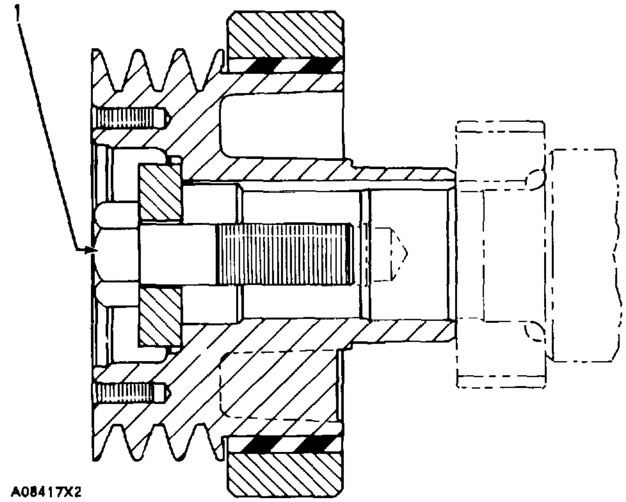
Maximum permissible run out (axial eccentricity) of the crankshaft., measured at No 2 and No 4 main bearing surfaces (journal) .... .004 in. (0.10 mm)

BEARINGS FOR CONNECTING RODS AND MAINS

	CONNECTING ROD BEARINGS			
	ORIGINAL SIZE JOURNAL	.010 in. (0.25 mm) UNDERSIZE (SMALLER) JOURNAL	.020 in. (0.51 mm) UNDERSIZE (SMALLER) JOURNAL	.050 in. (1.27 mm) UNDERSIZE (SMALLER) JOURNAL
Diameter of crankshaft. journal (bearing surface) for connect-ing rod.	2.7496 ± .0006 in. (69.840 ± 0.015 mm)	2.7396 ± .0006 in. (69.586 ± 0.015 mm)	2.7296 ± .0006 in. (69.332 ± 0.015 mm)	2.6996 ± .0006 in. (68.570 ± 0.015 mm)
Clearance between bearing and journal (new)	.0021 to .0055 in. (0.053 to 0.140 mm)			
Maximum permissible clear-ance between bearing and journal	.006 in. (0.15 mm)			

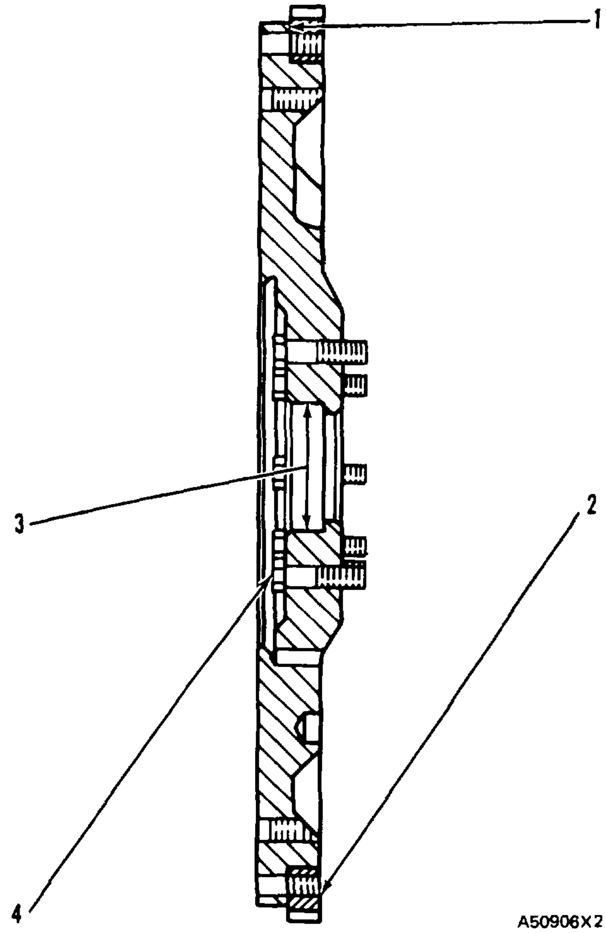
	MAIN BEARINGS			
	ORIGINAL SIZE JOURNAL	.010 in. (0.25 mm) UNDERSIZE (SMALLER) JOURNAL	.020 in. (0.51 mm) UNDERSIZE (SMALLER) JOURNAL	.050 in. (1.27 mm) UNDERSIZE (SMALLER) JOURNAL
(bearing surface) for main bear- Diameter of crankshaft. journal ings	3.4995 ± .0006 in. (88.887 ± 0.015 mm)	3.4895 ± .0006 in. (88.633 ± 0.015 mm)	3.4795 ± .0006 in. (88.379 ± 0015 mm)	3.4495 ± .0006 in. (87.617 ± 0.015mm)
Clearance between bearing and journal (new)	.0030 to .0066 in. (0.076 to 0.168 mm)			
Maximum permissible clear-ance between bearing and journal.	.007 in. (0.18 mm)			

PULLEY AND DAMPER



Install the damper assembly on the crankshaft. until the hub of the damper assembly comes in contact with the gear on the crankshaft.. DO NOT use the bolt and washer that holds the damper assembly on the crankshaft. to install the damper assembly

(1) Torque for bolt holding
the pulley .... 460 ± 60 lb. ft. (624 ± 80 N·m)



FLYWHEEL

(1) Flywheel shoulder.

(2) Install ring gear so that part No is on this side Ring gear must be assembled against shoulder of flywheel.

NOTE Do not heat ring gear to more than 400 °F (204°C) before installing on flywheel.

(3) Pilot bore.

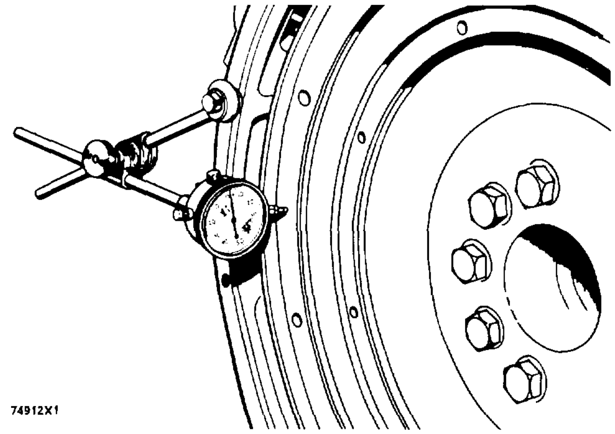
(4) Torque for bolts holding flywheel to crankshaft.................................55 ± 5 lb. ft. 175 - 7 N·m)
Put 5P3413 Sealant on the bolt threads.

NOTE: Dash mark on flywheel must be in alignment with dash mark on crankshaft..

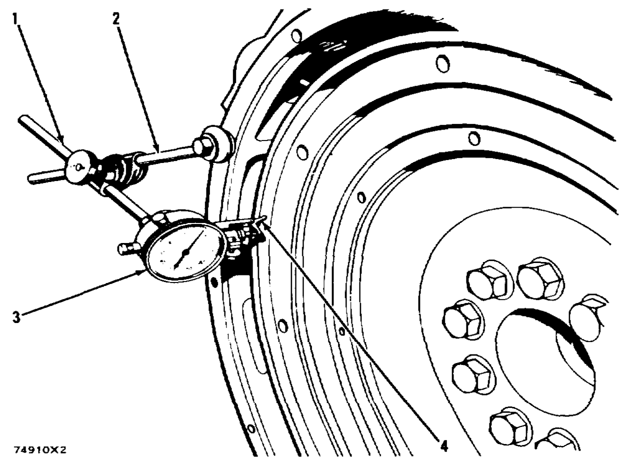
FLYWHEEL RUNOUT

Face Runout (axial eccentricity) of the Flywheel:

1. Install the dial indicator as shown Put a force on the flywheel toward the rear.
2. Set the dial indicator to read .000 in. (0.0 mm).
3. Turn the flywheel and read the indicator every 90° Put a force on the flywheel to the rear before each reading.
4. The difference between the lower and higher measurements taken at all four points must not be more than .006 in. (0.15 mm), which is the maximum permissible face runout (axial eccentricity) of the flywheel.



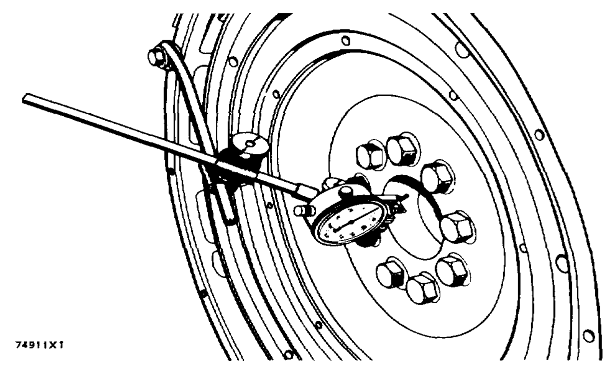
CHECKING FACE RUNOUT OF THE FLYWHEEL



CHECKING FLYWHEEL BORE

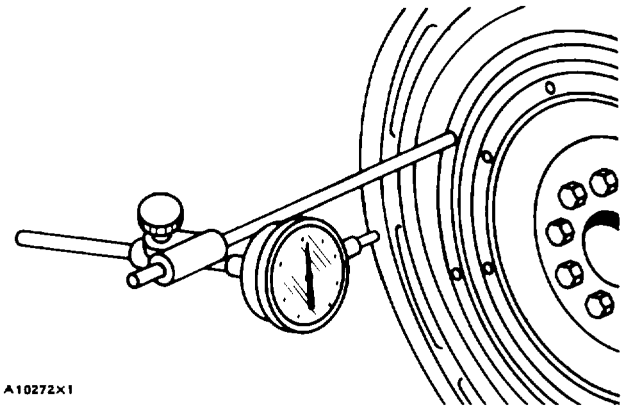
Bore Runout (radial eccentricity) of the Flywheel:

1. Install the dial Indicator (3) and make an adjustment of the universal attachment (4) so it makes contact as shown.
2. Set the dial indicator to read .000 in. (0.0 mm).
3. Turn the flywheel and read the indicator every 900.
4. The difference between the lower and higher measurements taken at all four points must not be more than .006 in. (0.15 mm), which Is the maximum permissible bore runout (radial eccentricity) of the flywheel.
5. Runout (eccentricity) of the bore for the pilot bearing for the flywheel clutch, must not exceed .005 in. (0.13 mm).



CHECKING FLYWHEEL CLUTCH PILOT BEARING BORE

FLYWHEEL HOUSING RUNOUT



8S2328 DIAL INDICATOR GROUP INSTALLED

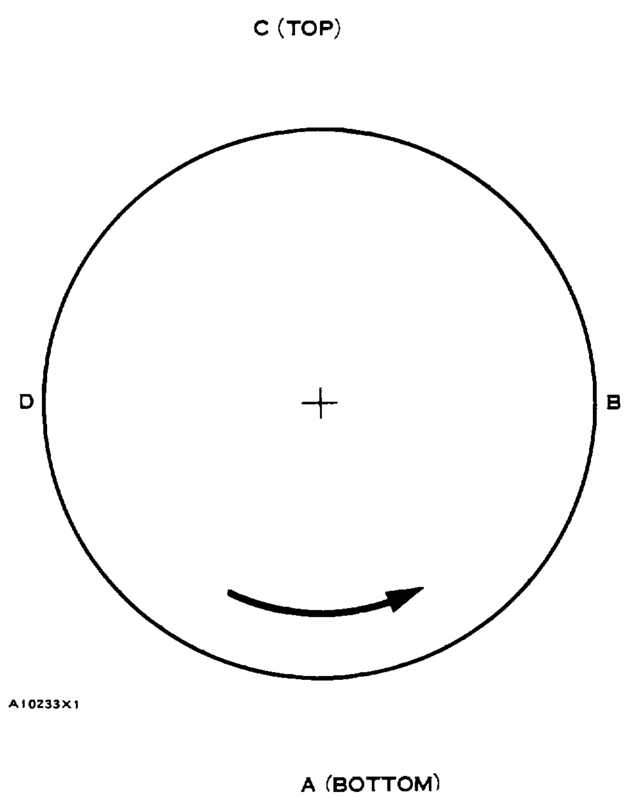
Face Runout (axial eccentricity) of the Flywheel Housing:

1. Fasten a dial indicator to the crankshaft. flange so the anvil of the indicator will touch the face of the flywheel housing.

2. Put a force on the crankshaft. toward the rear before reading the indicator at each point.

3. With dial indicator set at .000 in (0.0 mm) at location (A), turn the crankshaft. and read the indicator at locations (B), (C) and (D).

4. The difference between lower and higher measurements taken at all four points must not be more than .010 in. (0.25 mm), which is the maximum permissible face run out (axial eccentricity) of the flywheel housing.



FLYWHEEL HOUSING BORE

NOTE: Write the dial indicator measurements with their positive (+) and negative (-) notation (signs). This notation is necessary for making the calculations in the chart correctly.

1.With the dial indicator in position at (C), adjust the dial indicator to "0" (zero) Push the crankshaft. up against the top bearing Write the measurement for bearing clearance on line 1 in column (C).

2.Divide the measurement from Step 1 by 2 Write this number on line 1 In columns (B) & (D).

3.Turn the crankshaft. to put the dial Indicator at (A) Adjust the dial indicator to "0" (zero).

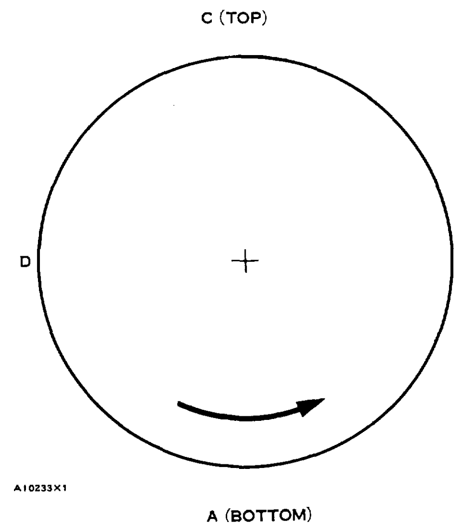
4.Turn the crankshaft. counterclockwise to put the dial indicator at (B). Write the measurement in the chart.

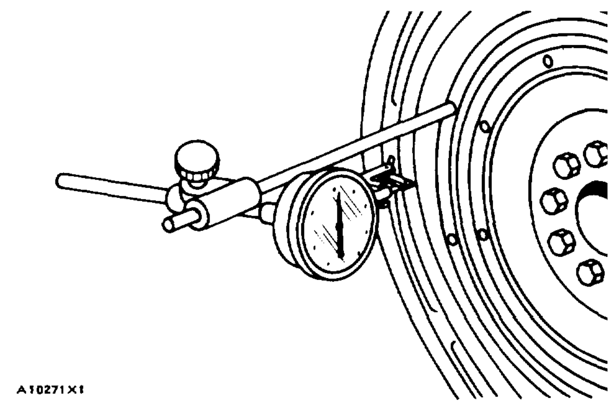
5.Turn the crankshaft. counterclockwise to put the dial indicator at (C). Write the measurement in the chart.

6.Turn the crankshaft. counterclockwise to put the dial indicator at (D). Write the measurement in the chart.

7.Add lines I & II by columns.

8.subtract the smaller number from the larger number in line III in columns (B) & (D) The result is the horizontal "eccentricity" (out of round) Line III, column (C) is the vertical eccentricity.



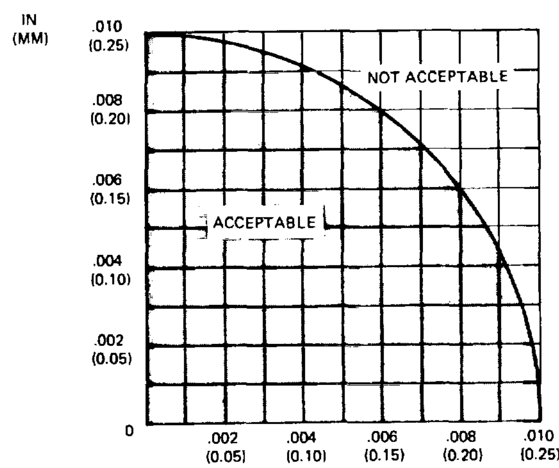


A92950X1

CHART FOR DIAL INDICATOR MEASUREMENTS

	Position of dial indicator				
	Line No.	**A**	**B**	**C**	**D**
Correction for bearing clearance	I	0			
Dial Indicator Reading	II	0			
Total of Line 1 & 2	III	0	**	*	**

*Total Vertical eccentricity (out of round).
**Subtract the smaller No. from the larger No. The difference is the total horizontal eccentricity

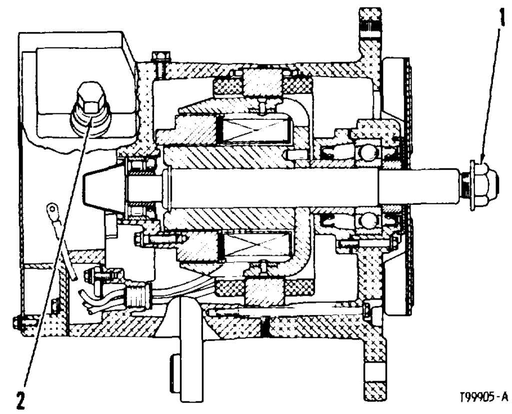


9. On the graph for total eccentricity find the point of Intersection of the lines for vertical eccentricity and horizontal eccentricity

10. If the point of intersection is in the range marked "Acceptable" the bore is in alignment If the point of intersection is in the range marked "Not Acceptable" the flywheel housing must be changed

ALTERNATOR

6N9294 24V-35A (Delco-Remy Number 1117640)



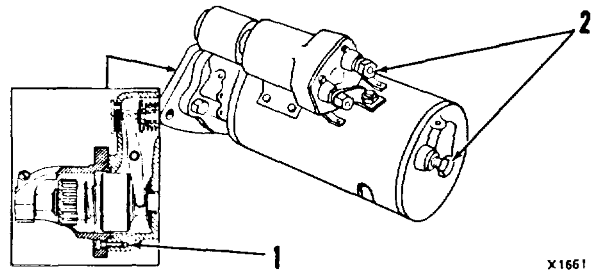
Circuit.. B
Polarity is negative ground
Speed for testing...6500 rpm
Rotation can be either direction
Output when cold
Fasten carbon pile to battery
to get maximum output .... 35 A
Rated output, hot .... 35 A
Field current at 80'- F (27- C)................................ 2.5 to 3.2 A
Voltage regulator (Not Adjustable)
Voltage range.. 26 to 30 V

(1) Torque for nut .... 75 ± 5 lb. ft. (100 ± 7 N·m)

(2) Torque for output terminal .... 5 ± .5 lb. ft. (7.1 ± 0.7 N·m)

STARTER MOTORS

3T2772 24V (Delco-Remy Number 1113540)

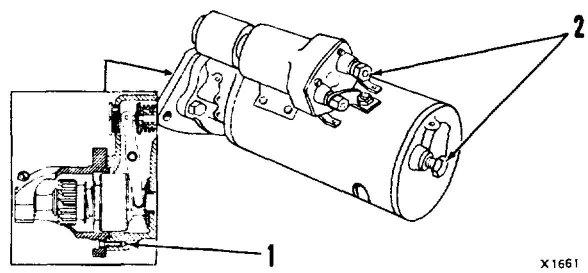


Rotation is clockwise when seen from drive end.
Minimum speed with no load..5500 rpm
Maximum speed with no load...7500 rpm
Current consumption (draw) at no load:
Minimum with solenoid at 20V.. 60 A
Maximum with solenoid at 20V... 80 A
Clearance between pinion and housing
(pinion clearance)... 33 to .39 in. (8.3 to 9.9 mm)

(1) Torque for screws holding nose housing
to lever housing...............................13 to 17 lb.. ft.. (18 to 23 N·m)

(2) Torque for terminal nuts ....20 to 25 lb.. ft.. (25 to 35 N·m)

9G4339 24V (Delco-Remy Number 1993814)

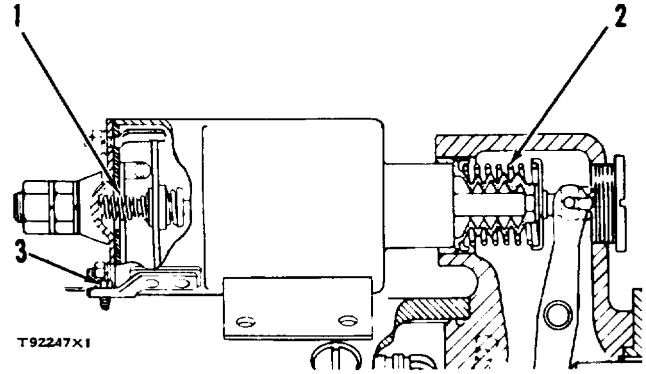


Rotation is clockwise when seen from drive end.
Minimum speed with no load...6500
Maximum speed with no load..7700
Current consumption (draw) at no load:
Minimum with solenoid at 20V.. 60 A
Maximum with solenoid at 20V... 75 A
Clearance between pinion and housing
(pinion clearance)... 33 to .39 in. (8.3 to 9.9 mm)
(1) Torque for screws holding nose housing
to lever housing.......... ....13 to 21 lb.. ft.. (18 to 30 N·m)

(2) Torque for terminal nuts ....20 to 25 lb.. ft.. (25 to 35 N·m)

STARTER SOLENOIDS

1P9181 24V (Delco-Remy Number 1115526)



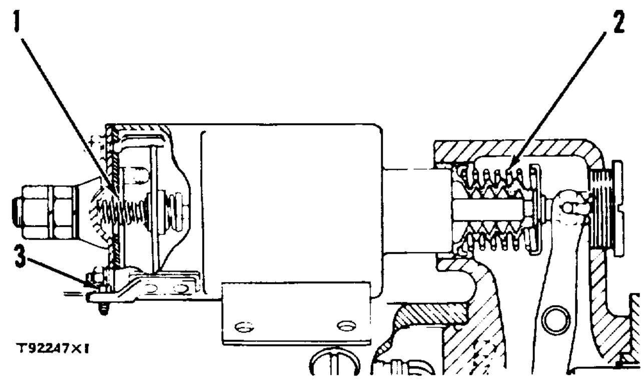
Current consumption (draw)'
Current pull in windings at 5V.......................... 9 to 11.5 A
Current hold in windings at 20V.................. max. of 6.8 A

(1) 4M1815 Spring for contact release:
Length under test force .... 42 in. (10.7 mm)
Test force .... 8.5 to 9.5 lb. (38.0 to 42.5 N)
Free length after test .... 83 ± .015 in. (21.1 ± 0.38 mm)
Outside diameter .... 375 ±.010 in. (9.53 0.25 mm)

(2) 9M7609 Spring to return the clutch lever:
Length under test force .... 1.56 in. (39.6 mm)
Test force .... 14 ± .5 lb.. (62 2.2 N)
Free length after test .... 2.79 in. (70.9 mm)
Outside diameter .... 1.393 ± .015 in. (35.38 ± 0.38 mm)

(3) Torque for terminal
screws .... 16 to 30 lb. in. (1.8 to 3.4 N·m)

7T258 24V (Delco-Remy Number 1115595)
lP9181 24V (Delco-Remy Number 1115526)



Current consumption (draw):
Current pull in windings at 8V.......................... 8.5 to 10 A
Current hold in windings at 20V................... max. of 15 A

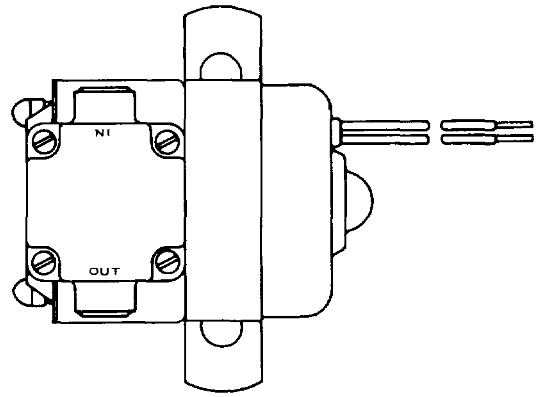
(1) 4M1815 Spring for contact release:
Length under test force .... 42 in. (10.7 mm)
Test force .... 8.5 to 9.5 lb.. (38.0 to 42.5 N)
Free length after test .... 83 to .015 in. (21.1 0.38 mm)
Outside diameter .... 375 ± .010 in. (9.53 +0.25 mm)

(2) 9M7609 Spring to return the clutch lever:
Length under test force .... 1.56 in. (39.6 mm)
Test force .... 14 ± 5 lb. (62 ± 2.2 N)
Free length after test .... 2.79 in, (70.9 mm)
Outside diameter .... 1.393 ± .015 in. (36.38 ± 0.38 mm)

(3) Torque for terminal
screws .... 16 to 30 lb. in. (1.8 to 3.4 N·m)

ELECTRIC FUEL PUMP

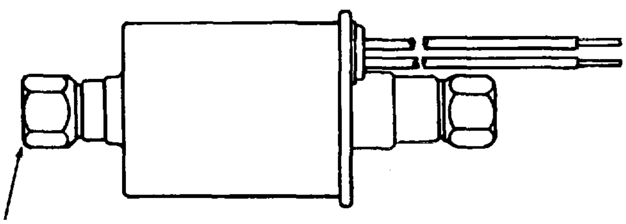
Models 613BSNS and 613BSS
6N6 24V (AC Spark Plug Division Number 6441067)



A18220X1

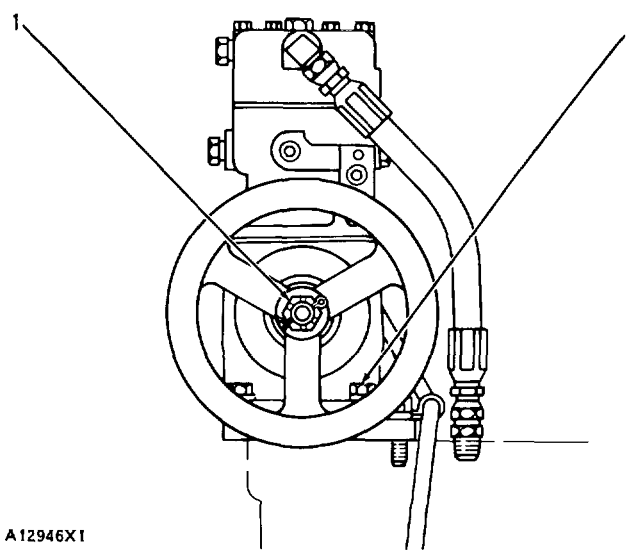
Current consumption (draw):
Current at 20V .... 8 A
Current at 20 to 32V .... 8 to 1.3 A
Pressure of fuel at pump outlet when pump is operated at 24V:
Minimum..5.0 psi (35 kPa)
Maximum...7.5 psi (52 kPa)

Models 613BSNS1 and 613BSS1
7W5668 24V (AC Spark Plug Division Number 6442514)



Current consumption (draw):
Current at 20V .... A
Current at 20 to 32V .... 8 to 1.3 A
Pressure of fuel at pump outlet when pump is operated at 24V:
Minimum..4.7 psi (33 kPa)
Maximum...8.8 psi (62 kPa)

AIR COMPRESSOR

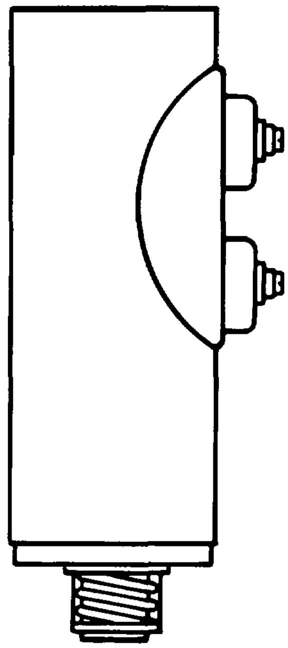


A12946X1

(1) Torque for nut that holds the drive pulley
Tighten farther to get alignment of
hole for cotter pin..................................50 lb. ft. (70 N·m)

(2) Torque for bolts holding the
air compressor..........................30 ± 5 lb. ft. (40 ± 7 N·m)

SHUTOFF SOLENOID

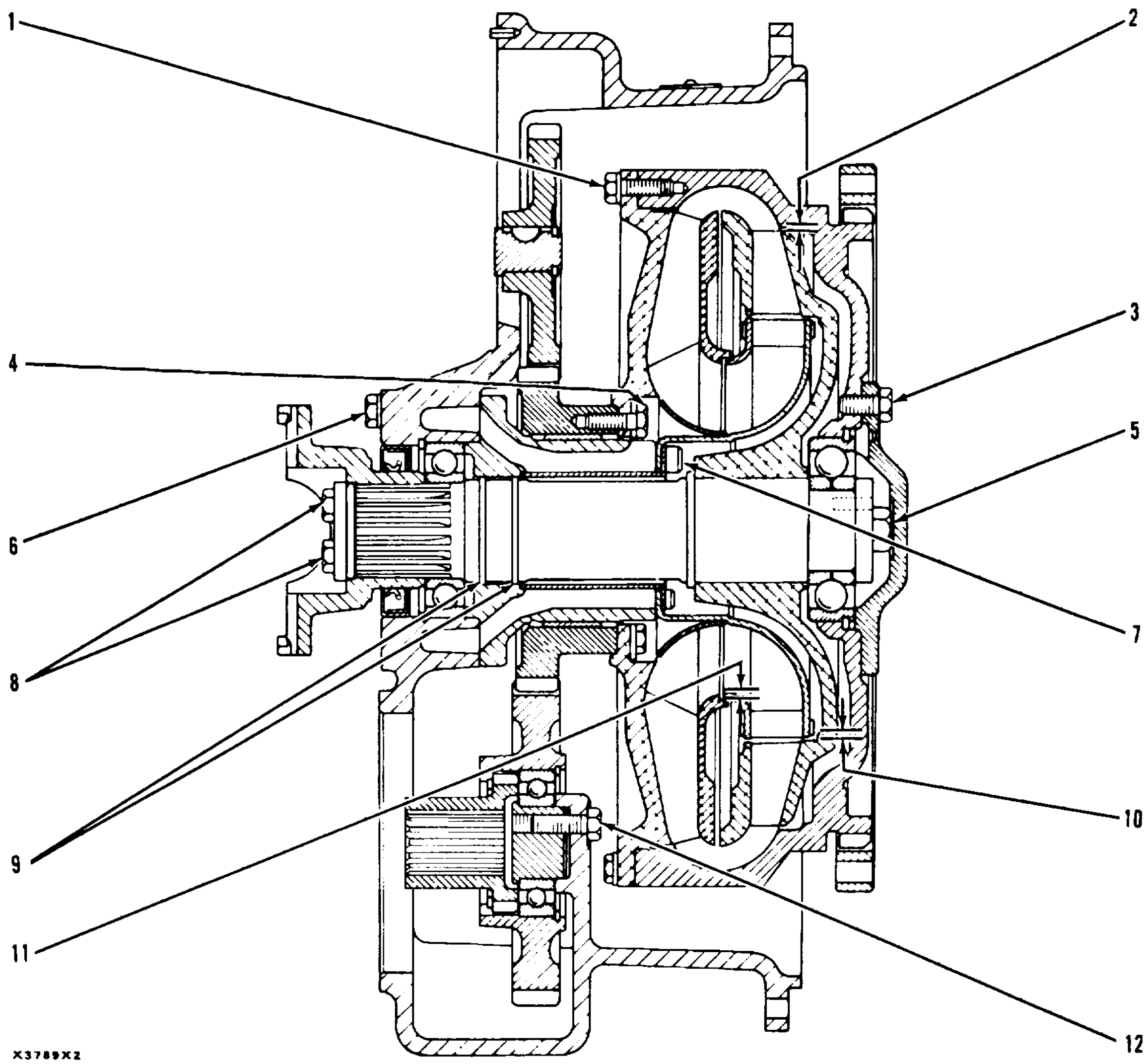


G. W. LISK
(2)

Coil resistance (ohms) at a temperature of 700°F (210°C) is 19.7 ± 2.0.

SECTION 2
SPECIFICATIONS
POWER TRAIN

TORQUE CONVERTER



(1) Torque for bolts that hold impeller to turning housing ....20 ± 1 lb. ft. (27 ± 1 N·m)

(2) **Clearance between turbine and turning housing:**
Across the diameter............ .020 to .040 in. (0.51 to 1.02 mm)
Maximum permissible clearance:
Across the diameter..................................... .045 in. (1.14 mm)
Running.................................... .0225 in. (0.57 mm)

(3) Torque for bolts that hold retainer to turning housing ....36 ± 2 lb. ft. (49 ± 3 N·m)

(4) Torque for bolts that hold drive gear for pump to impeller ....20 ± 1 lb.. ft.. (27 ± 1 N•m)

(5) Torque for bolt that holds bearing on output shaft ....81 ± 4 lb.. ft.. (110 ± 5 N·m)

(6) Torque for the bolts that hold stator to the converter housing ....362 lb.. ft.. (49 ± 3 N·m)

(7) Torque for the bolts that hold stator to the carrier......................20 ± 1 lb.. ft.. (27 ± 1 N·m)

(8) Torque for the bolts that hold flange to the output shaft 36 ± 2 lb. ft. (49 ±3 N•m)

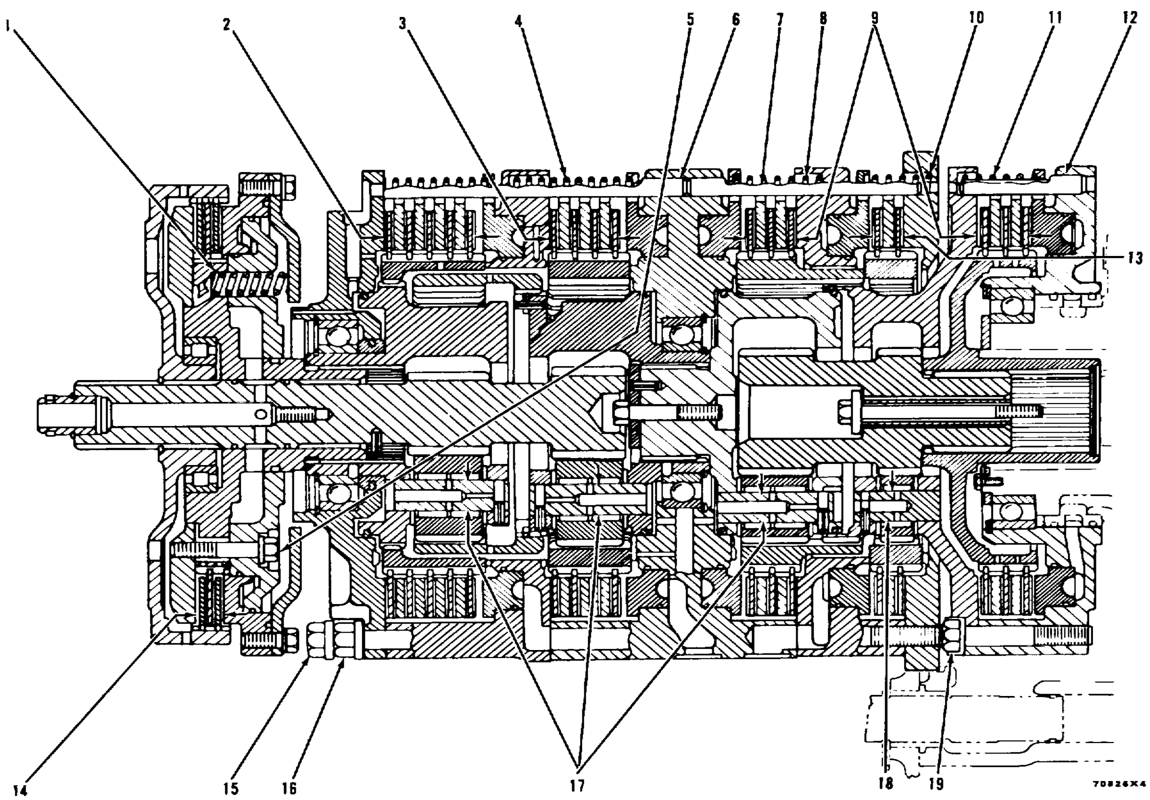
(9) Gap in seal rings. .005 to .015 in. (0.13 to 0.38 mm)

(10) **Clearance between stator and turbine:**
Across the diameter.. .012 to .018 in. (0.30 to 0.46 mm)
Running............... .006 to .009 in. (0.15 to 0.3 mm)
Maximum permissible clearance:
Across the diameter.................. .030 in. (0.76 mm)
Running.................................... .015 in. (0.38 mm)

(11) **Clearance between stator and impeller:**
Across the diameter. . .009 to .015 in. (0.23 to 0.38 mm)
Running......... .0045 to .0075 in. (0.11 to 0.19 mm)
Maximum permissible clearance:
Across the diameter.................. .024 in. (0.61 mm)
Running.................................... .012 in. (0.30 mm)

(12) Torque for bolts that hold retainer to converter housing .... 36 + 2 lb. ft. (49 + 3 N•m)

TRANSMISSION
(7S7008)



1) 4S5854 Springs for No. 1 clutch:
Length under test force................. 1.58 in. (40.1 mm)
Test force..74 lb.. (329 N)
Free length after test.......................... 1.83 (46.5 mm)
Outside diameter.............................. 60 in. (15.2 mm)

(2) Thickness of five new discs and four new plates for No. 2 clutch............. 1.888 to 1.942 in. (47.96 to 49.33 mm)

(3) Thickness of four new discs and three new plates for No. 3 clutch............. 1.461 to 1.503 in. (36.91 to 38.18 mm)
Thickness of one new
3P8393 Plate .... 250 .003 in. (6.35 0.08 mm)
Thickness of one new
3S7981 Disc............. 183 + .003 in. (4.65 0.08 mm)

(4) 4M5016 Springs for the No. 2 and No. 3 clutches:
Length under test force................. 2.68 in. (80.1 mm)
Test force...............28.00 + 2.24 lb.. (124.5 ± 9.97 N)
Free length after test..................... 3.28 in. (83.3 mm)
Outside diameter............................ 563 in. (14.3 mm)

(5)Torque for the bolts (nine) .34 ± 2 lb. ft. (46 ± 3 N·m)

(6) Length of pins (five) for No. 2 and No. 3 clutches.......................6.94 in. (176.3 mm)

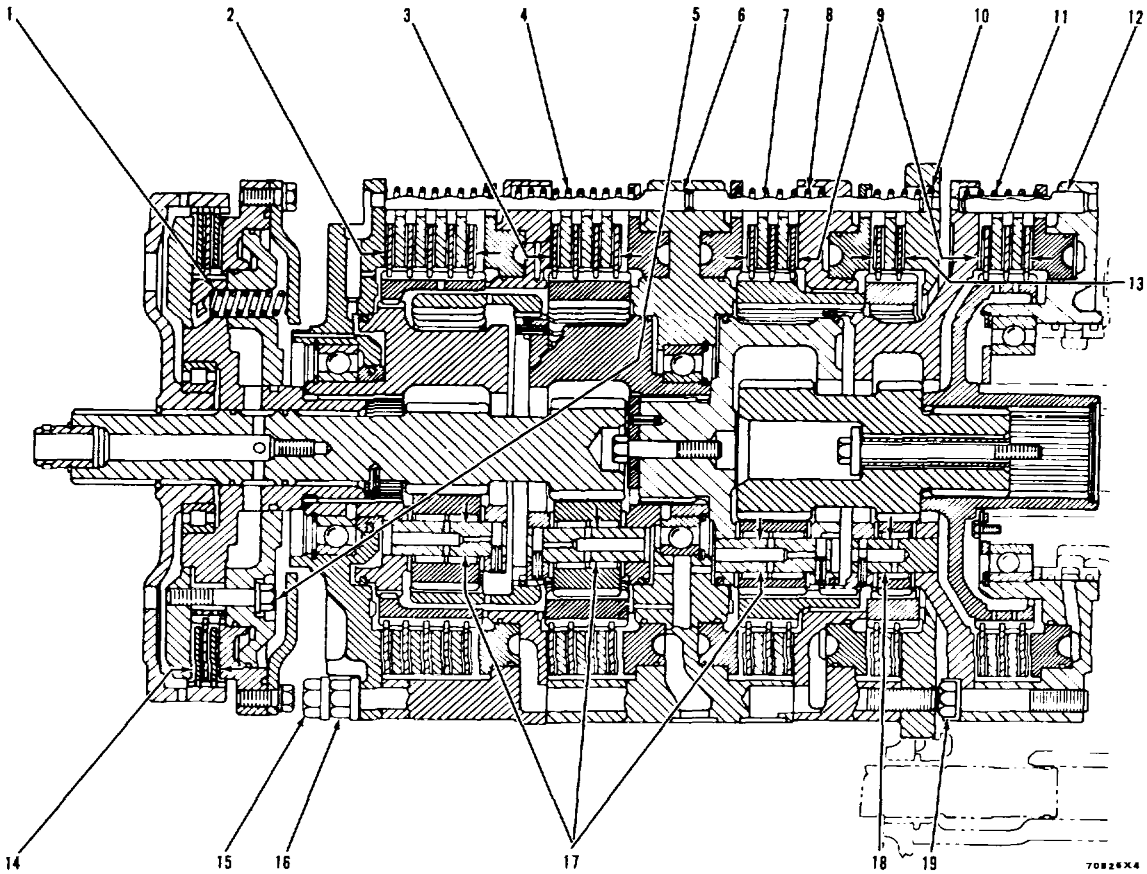
(7) Length of pins (five) for No. 4 and No. 5 clutches.......................5.00 in. (127.0 mm)

(8) 9H5537 Springs for No. 4 dutch:
Length under test force................1.84 in. (46.74 mm)
Test force.............. 28.75 ± 2.3 lb.. (127.88 ± 10.2 N)
Free length after test ....2.47 in. (62.74 mm)
Outside diameter .... .562 in. (14.27 mm)

(9) Thickness of three new discs and two new plates for No. 4 and No. 6 clutches ....1.034 to 1.064 in. (26.26 to 27.03 mm)

(10)4M9592 Springs for No. 5 clutch:
Length under test force..............1.375 in. (34.92 mm)
Test force.................... 26.2 ± 1.3 lb.. (116.5 ± 5.8 N)
Free length after test ....1.760 in. (44.70 mm)
Outside diameter .... .562 in. (14.27 mm)

Transmission (Cont.)



(11) 7S8553 Springs for No. 6 clutch:
Length under test force ...... 1.735 in. (44 07 mm)
Test force ....60.0 ± 4.8 lb. (267 + 21.4 N)
Free length after test .... 1.990 in. (50.55 mm)
Outside diameter .... 562 in. (14.27 mm)

(12) Length of pins (five) for No 6 clutch........ 2.688 in. (68.27 mm)

(13) Thickness of two new discs and one new plate for No 5 clutch .. .607 to .625 in. (15 42 to 15.87 mm)
Thickness of one new 3P8393
Plate .... .250 ± .003 in. (6.35 ± 0.08 mm)
Thickness of one new 3S7981
Disc .... .183 ± .003 in (4.65 + 0.08 mm)

(14) Thickness of two new discs and one new plate for No 1 clutch ... .491 to .509 in (12.47 to 12.93 mm)
Thickness of one new 4S5891
Plate .... .110 ± .003 in (2 79 + 9.08 mm)
Thickness of one new 2S4983
Disc .... .195 ± .003 in. (4.95 ± 0.08 mm)

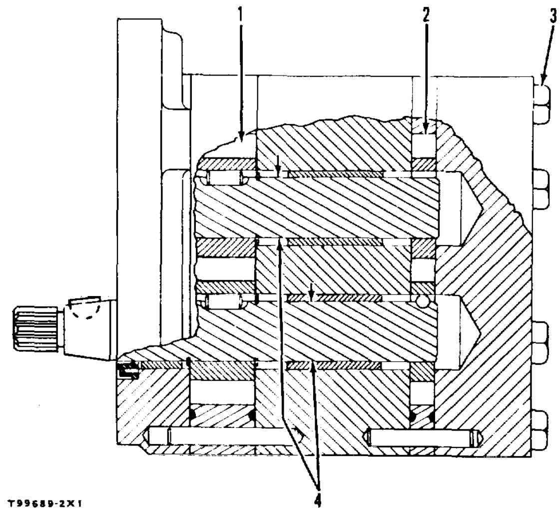
(15) Torque for the bolts
(two) ....80 ± 5 lb. ft. (109 ± 7 N•m)

(16) Torque for the bolts (nine) that hold transmission case
to clutch housing ....80 ± 5 lb. ft. (109 ± 7 N•m)

(17), (18) Diameter of shafts for planet gears in the No. 2, No. 3, No. 4 and No 5 clutches.....7930 to 7934 in. (20 14 to 20 15 mm)

(19) Torque for the bolts (ten) in
No. 6 clutch housing...85 ± 5 lb. ft. (116 ± 7 N•m)

TRANSMISSION AND SCAVENGE PUMP



Rotation is counterclockwise when seen from the drive gear. For bench test use SAE 10W oil at 120° F (49°C).

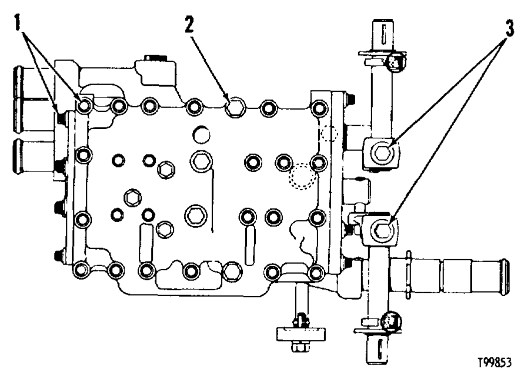
(1) Pressure section:
Output...............................24.3 U.S. gpm (91.97 litre/min)
with pump at...2855 rpm
at a pressure of .... 310 psi (21 8 kg/cm2) (2137 kPa)

(2) Scavenge section:
Output.................................9.7 U.S. gpm (36.73 litre/min)
with pump at...2855 rpm
at a pressure of .... 60 psi (4.2 kg/cm²) (414 kPa)

(3) Torque for bolts................................36 ± 2 lb. ft. (49 ± 3 N·m)

(4) Diameter of shafts .... .88 in (22.4 mm)

TRANSMISSION HYDRAULIC CONTROLS
(8S3437)



(1) Torque for the bolts
(12point head) ....22 ± 3 lb. ft. (30 ± 4 N·m)

(2) Torque for the bolts
(6 point head) ....35 ± 5 lb. ft. (48 ± 7 N·m)

(3) Torque for the bolts (two) that hold control levers
to the shaft.................................35 ± 5 lb. ft. (48 ± 7 N·m)

NOTE: Put 7M7260 Liquid Gasket on bore surface in transmission case for the lip-type seals and let dry. Do not let Liquid Gasket get on the case of the lip-type seals. Put a small amount of the lubricant being sealed on the lip of the seals before installation

PRESSURE CONTROL VALVE
9S8850

Plunger Springs:
(1), (6) 4M2381 Springs:
Length under test force .... .48 in. (12.19 mm)
Test force .... .517 ± .041 lb. (2.30 ± 0.18N)
Free length after test .... .89 in. (22.60 mm)
Outside diameter .... .30 in. (7.62 mm)

Modulation Relief Valve:
(2) 7S4596 Spring (outer):
FIRST TEST:
Length.. 3.19 in. (81.0 mm)
Test force .... 8.50 ± .60 lb. (37.81 ± 2.67 N)

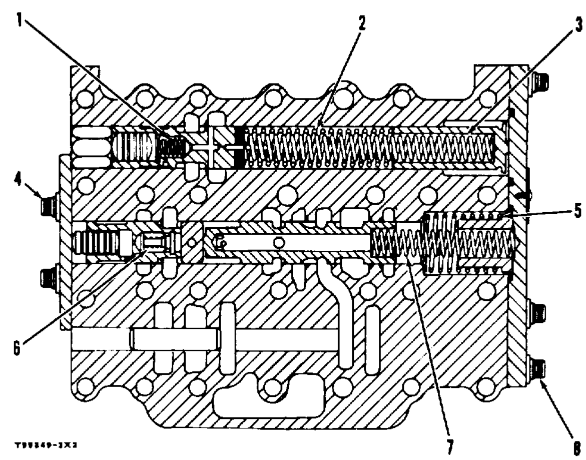
SECOND TEST:
Length under test force .... 1.94 in. (4.93 mm)
Test force .... 38.50 ± 1.15 lb. (171.25 ± 5.12 N)
Free length after test .... 3.45 in. (87.6 mm)
Outside diameter .... .830 in. (21.08 mm)

(3) 7S8495 Spring (inner, green stripe):
FIRST TEST:
Length.. 5.38 in. (136.7 mm)
Test force .... 12.71 ± 1.02 lb. (56.5 ± 4.5 N)

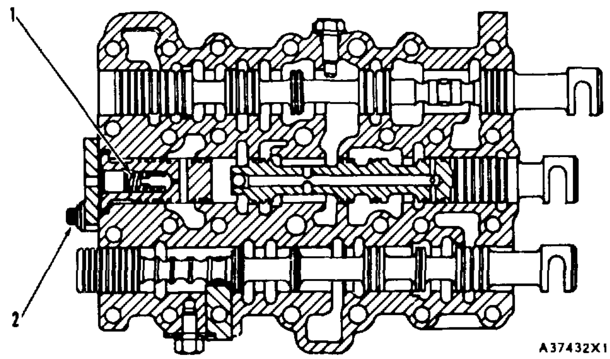
SECOND TEST:
Length under test force .... 4.16 in. (105.7 mm)
Test force .... 26.62 ± .80 lb. (118.5 ± 3.6 N)
Free length after test .... 5.96 n. (151.4 mm)
Outside diameter .... 579 in. (14.7 mm)
(4), (8) Torque for bolts................... 22 ± 3 lb. ft. (30 ± 4 N·m)

Differential and Safety Valve:
(5) 3S9950 Spring (outer):
Length under test force .... 1.375 in. (34.93 mm)
Test force .... 17.6 ± .7 lb. (78.28 ± 3.1 N)
Free length after test .... 3.44 in. (87.4 mm)
Outside diameter .... 1.250 in. (31.75 mm)

(7) 3S9949 Spring (inner):
Length under test force .... 2.28 in. (57.9 mm)
Test force .... 12.40 ± .50 lb. (55.16 ± 2.22 N)
Free length after test .... 4.50 in. (114.3 mm)
diameter .... .590 in. (14.99 mm)



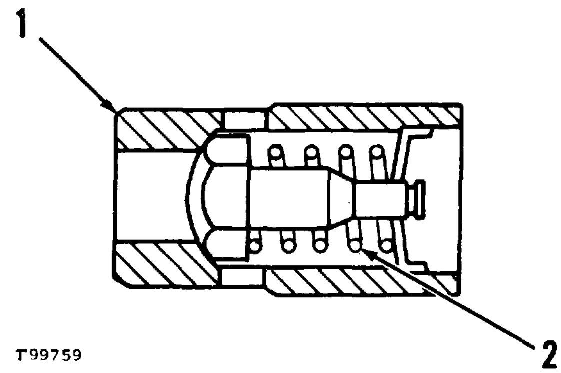
SELECTOR VALVE (8S3436)



(1) 8B3090 Spring:
Length under test force .... .594 in. (15.08 mm)
Test force ....12.3 to 14.4 lb.. (54.7 to 64.1 N)
Free length after test .... 1.05 in. (26.59 mm)
Outside diameter .... .33 in. (8.33 mm)

(2) Torque for bolts that hold cover..22 ± 3 b. ft. (30 ± 4 N·m)

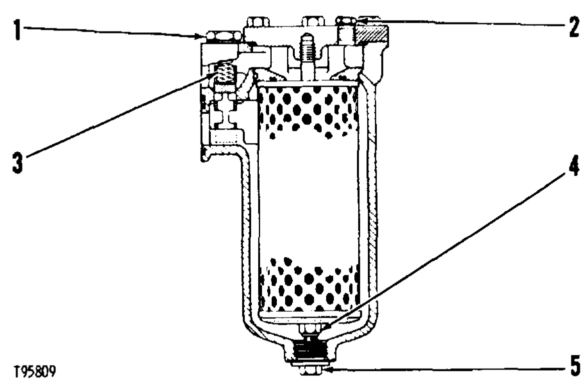
LUBRICATION RELIEF VALVE (7S8567)



(1) Value opens at........ 10 ± 3 psi (0.7 ± 0.2 kg/cm2) (69 ± 21 kPa)

(2) 7B3039 Spring for the plunger:
Length under test force .... 1.031 in. (26.2 mm)
Test force ....3.22 to 3.78 lb. (14.3 to 16.8 N)
Free length after test .... 1.438 in. (36.53 mm)
Outside diameter .... .781 in. (19 8 mm)

TRANSMISSION OIL FILTER (2S6457)



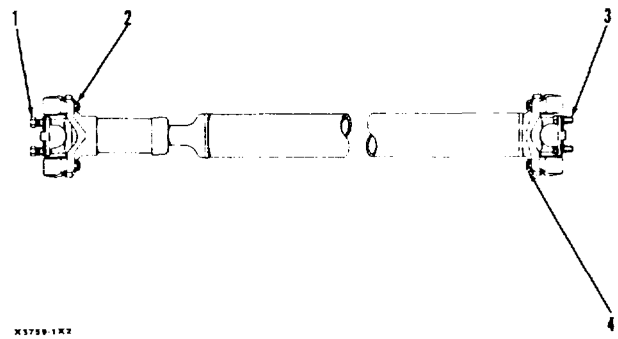
(1) Torque for plug (bypass valve) ....35 ± 5 lb.. ft.. (48 ± 7 N·m)

(2) Torque for plug.................................35 ± 5 lb. ft. (48 ± 7 N·m)

(3) 2S5816 Spring for bypass valve:
Length under test force .... 1.35 in. (34.3 mm)
Test force ....12.2 ± 98 lb. (54.3 ± 4.4 N)
Free length after test .... 1.86 in. (47.2 mm)
Outside diameter .... .562 in. (14.27 mm)

(4) Torque for nut that holds the filter element in position .... 120 ± 24 lb. in. (14 ± 3 N·m)

(5) Torque for the drain plug..35 ± 5 lb. ft. (48 ± 7 N·m)

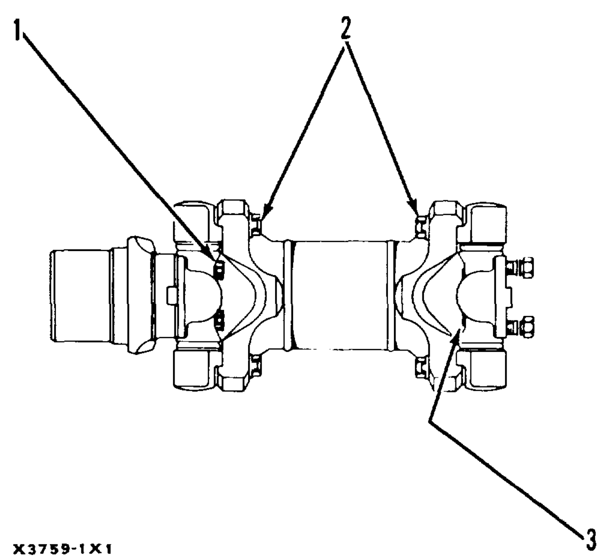


DRIVE SHAFT.S

Upper Drive Shaft.

(1) and (3) Torque for bolts .... 45 ± 5 lb. ft. (61 ± 7 N·m)

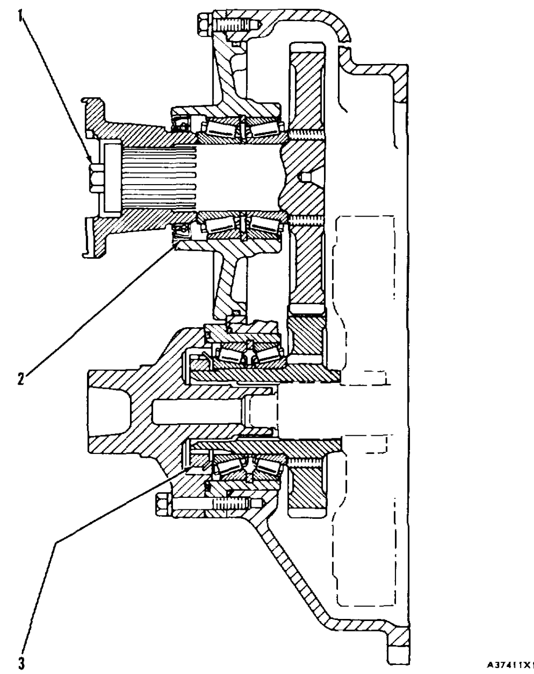
(2) and (4) Torque for bolts .... 50 to 55 lb. ft. (68 to 75 N·m)



Lower Drive Shaft.

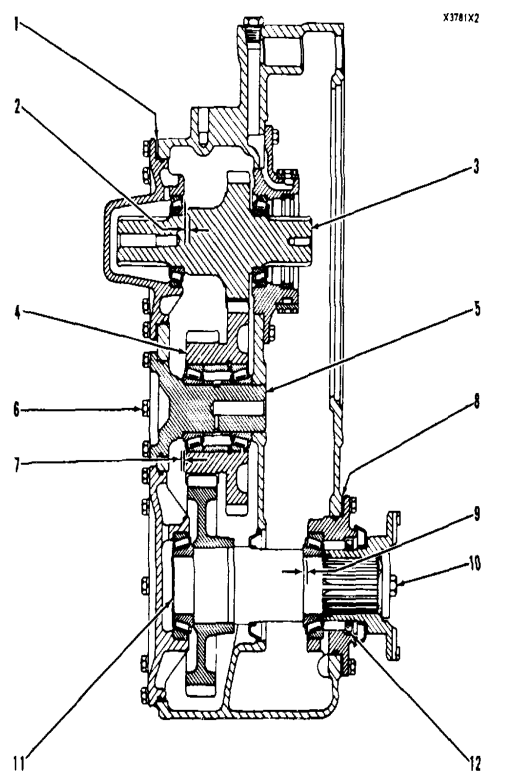
(1), (2) and (3) Torque for
bolts .... 120 ± 10 lb. ft. (163 ± 14 N·m)

TRANSFER GEARS (INPUT)



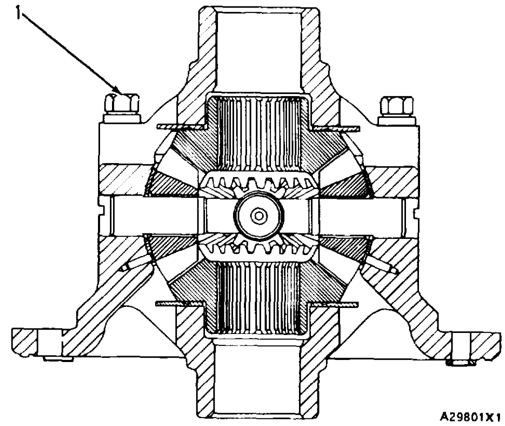
(1) Torque for bolt that holds flange to output gear 805 lb. ft. (1097 N M)
(2) Put a small amount of the lubricant being sealed on lip of seal. Install the seal with lip toward the bearing cup.
(3) Torque for the nut 150 t 10 lb. R. (204. 14 N m)

TRANSFER GEARS (OUTPUT)



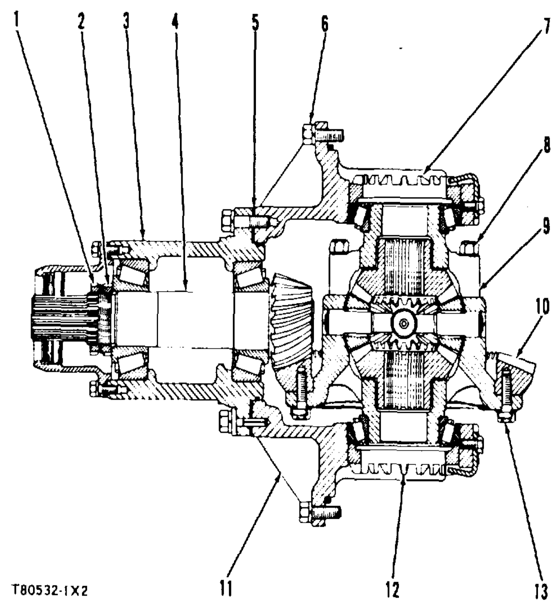
NOTE: Install idler gear (4) with bearing assembly and idler shaft (5) into the case assembly and tighten bolts (6) before checking end clearance of input gear (3) and output shaft (11).
(2) Add or remove shims (1) to get end clearance of input shaft of .003 to .005 in. (0.08 to 0.13 mm)
(7) End clearance after new bearing Is assembled (no adjustment possible) .003 to 0.013 in. (0.08 to 0.33 mm)
(9) Add or remove shims (8) to get end clearance of bearings on output shaft of 003 to .005 in. (0.08 to 0.13 mm)
(10) Torque for bolt that holds yoke to the output shaft 805 lb. ft. (109 . 7 N m)
(12) Put 7M7260 Liquid Gasket in bore of the cages for the seals and let dry before installing seals. Do not put Liquid Gasket on case of the seals. Put a small amount of the lubricant being sealed on lip of the seals. Install the seals with lip toward the bearing cup.

DIFFERENTIAL GROUP



(1) Torque for bolts 100 ± 15 lb. ft (13620 N m)

DIFFERENTIAL AND BEVEL GEAR WITH DIFFERENTIAL LOCK (8D2800) MODELS 613BSS AND 613BSNS

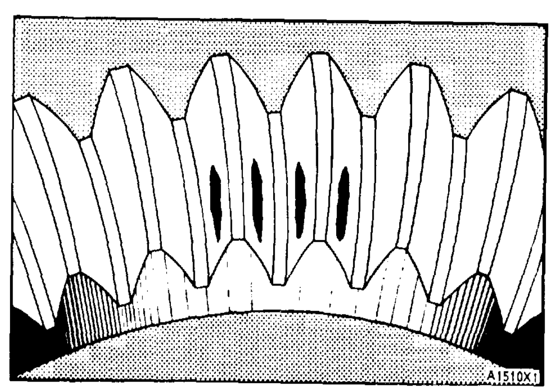


TYPICAL EXAMPLE

Torque for four bearing
cap bolts .... 35037 lb ft (47550 N M)
(6) Torque for 12 bolts that hold carrier
to axle housing .... 198 9 lb ft (269 - 12 N-m)
(8) Torque for 12 bolts that hold case
assemblies together .... 100 - 10 lb ft (135 + 14 N-m)
(13) Torque for 12 bolts .... 9818 lb ft (133 - 24 N-m)

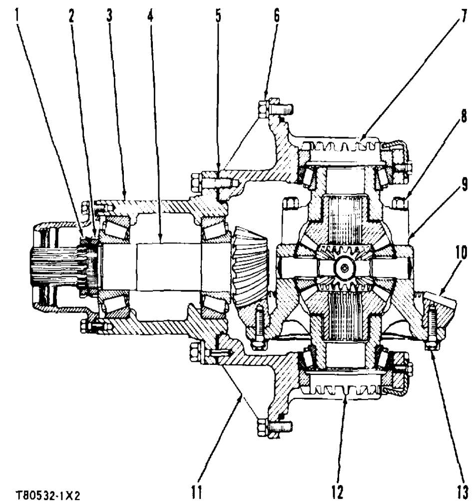
Adjustment Procedure:

1 Install pinion shaft (4) with bearings in housing (3)
2 Tighten nut (2) on pinion shaft (4), until torque needed to turn pinion shaft (4) is .... 8 , 2 lb In (O 9 _ 0 2 N-m)
3 Install lock and nut (1).
4 Install case (9) in carrier (11)
5 Install pinion shaft (4) and housing (3) into carrier (11) Use shims (5) to put pinion shaft (4) in alignment with bevel gear (10)
6 Make adjustments to nut (12) and nut (7) until free movement (backlash) between bevel gear (10) and pinion shaft (4) Is .... 008 to 017 in. (0 20 to 0 43 mm)
7 Tighten nut (12) and nut (7) the same amount until the torque needed to turn pinion shaft (4) is .... 30 to 50 lb in (3 to 6 N-m) If the nuts are turned the same amount, the free movement (back-lash) will not change
8 Check free movement (backlash), If an adjustment Is necessary, turn nut (12) and nut (7) the same amount, and in the same direction until the correct free movement (backlash) Is given. If the nuts are turned the same amount and in the same direction, the bearing preload will not change



CORRECT TOOTH CONTACT

**Differential and Bevel Gear
With Differential Lock (Cont.)**



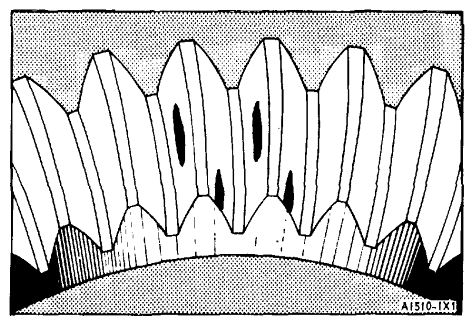


ILLUSTRATION A

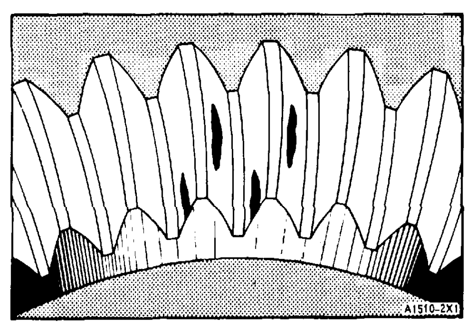
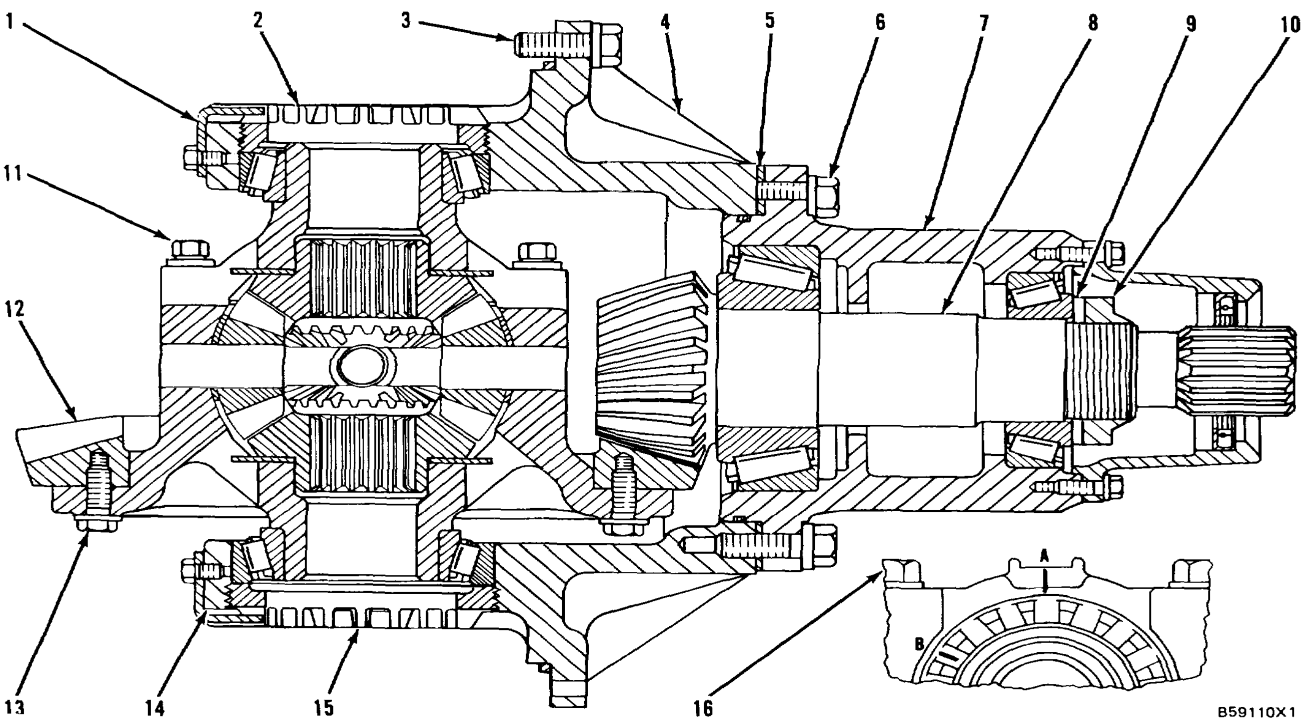


ILLUSTRATION B

9. Use the procedure that follows to check tooth contact.
   a. Put a small amount of Prussian blue, red lead, or paint on the bevel gear teeth.
   b. Turn the pinion shaft in both directions and check the marks made on the bevel gear teeth.
   c. See the illustration for the marks of the correct tooth contact.
10. If the marks on the bevel gear look like the marks in Illustration A, use the procedure that follows:
   a. Remove some of shims (5).
   b. After some of the shims are removed, do Steps 6, 7 and 8 again.
   c. Check tooth contact again.
11. If the marks on the bevel gear look like the marks in Illustration B, use the procedure that follows:
   a. Install more of shims (5).
   b. After more of the shims are installed, do Steps 6, 7, and 8 again.

NOTE: Several adjustments may be necessary before the tooth contact is correct. Free movement (backlash) must be correct before tooth contact can be checked.

DIFFERENTIAL AND BEVEL GEAR WITH DIFFERENTIAL LOCK
Models 613BSNS1 and 613BSS1



(3) Torque for ten bolts that fasten carrier (4) to the axle housing 270 ± 25 N m (200 ± 18 lb ft.)

(6) Torque for eight bolts that fasten pinion housing (7) to carrier (4) 270 ± 25 N-m (200 -+ 18 Ib.ft.) (11) Torque for 12 bolts that hold the differential group together 135 ± 20 N-m (100 + 15 Ib.ft)

(13) Apply 9S3263 Thread Lock to the internal threads in bevel gear (12) Torque 24 bolts that fasten bevel gear (12) to the differential group 135 ± 15 N M (100 ± 11 Ib.ft.)

(16) Torque for four bolts that fasten the caps to carrier (4) after the preload and backlash adjustments have been made 475 + 50 N-m (350 + 37 Ib.ft.) Adjustment Procedure: Pinion Preload Adjustment

1. Install bearing cups in housing (7) Bearing cups must be against (seated) the shoulders in housing (7).

2 Install the bearing cone next to the pinion teeth on pinion (8). Bearing cone must be against (seated) the shoulder on pinion (8).

3 Lubricate bearing and install pinion (8) in housing (7) Lubricate and install bearing cone, washer (9) and nut (10).

4. Position the assembly in a soft jawed vise. Tighten the vise against the teeth on pinion (8). While turning housing (7) tighten nut (10)

until the torque needed to turn the pinion is:

New bearings	0 7 to 1.1 N m (6 to 10 lb in.)
Used bearings	0.35 to 0.55 N M (3 to 5 lb in.)

Check to be sure that there is zero end play of pinion shaft (8).

5 When the torque needed to turn the pinion is correct, stake nut (10) by peening the collar on the nut into the key slot in pinion shaft (8), see Illustration A for the correct tooling and dimensions

NOTE. The nut may be reused if the collar is not cracked during removal or restaking.

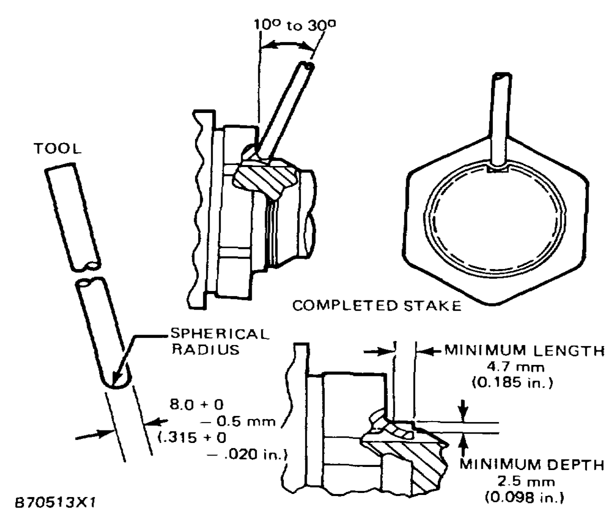


ILLUSTRATION A

Differential Backlash and Bearing Adjustment:
NOTE. The following procedure controls backlash and bearing preload. This procedure gives the same results for used and new bearings

1 Fasten pinion housing (7) to carrier (4). If original gears, carrier assembly and housing are used again, use the original thickness of shims (5) If any of these parts are replaced, install a shim pack thickness of 80% of a new full shim pack.
NOTE: Shim pack (5) thickness may have to be changed when adjusting the tooth contact pattern

2 Tighten eight bolts (6) to a torque of 270 + 25 N m(200 + 18 lb ft.)

3 With housing (7) fastened to carrier (4), position pinion (8) in the vertical position, downward.

4 Lubricate bearings and install bearing cups on the differential bearings to protect them.

5 Install differential in carrier (4) with bevel gear (12) on side opposite the pin hole in carrier (4)

6. Install caps (1) and (14) and adjustment rings (2) and (15). Adjustment rings (2) and (15) must turn freely.

7. Tighten one bolt (16) on caps (1) and (14) to a torque of 70 N m (50 lb ft.) and the other bolt on caps (1) and(14) to a torque of 5 N-m (4 lb ft)

8 Tighten adjustment rings (2) and (15) until there is a small amount of backlash and zero preload on differential bearings

9 Reposition the assembly so that pinion shaft (8) is In the horizontal position and measure the torque required to rotate pinion (8) Record this measurement.

10 Tighten adjustment ring (15) while turning bevel gear until there is zero backlash

11 Loosen adjustment ring (15) to the nearest lock position (maximum of one lug movement).

12. Tighten adjustment ring (2) until the torque required to rotate pinion (8) increases to 0.2 to 0.6 N-m (1 to 4 Ib.in.) over the torque reading in Step 9.

13 Put a mark (A) on cap (1). Put a mark (B) on adjustment ring (2) three lugs from mark (A). Tighten adjustment ring (2) until mark (B) is in alignment with mark (A).

14. If lock can not be installed, tighten adjustment nut (2) until lock can be installed.

15. Measure the backlash between the ring gear and pinion. The backlash must be 0.20 to 0.42 mm (.008 to .017 in.).

16 If backlash is too much, loosen adjustment ring (2) and tighten adjustment ring (15) the same amount.

17 If backlash is not enough, loosen adjustment ring (15) and tighten adjustment ring (2) the same amount.
NOTE The differential preload will be kept only if one adjustment ring is loosened and the other adjustment ring is tightened the same amount.

18. Tighten bolts(16) in caps (1)and (14) to a torque of 475 + 50 N m (350 + 37 Ib.ft.)

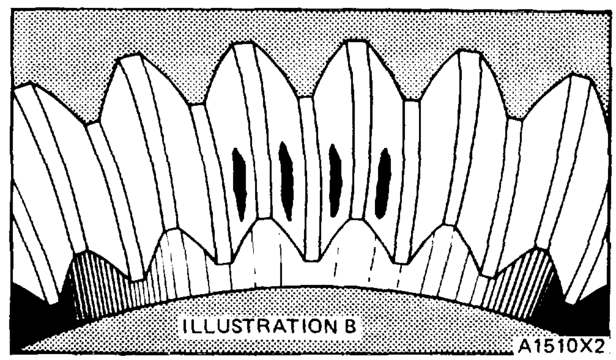
19. After the backlash and preload adjustments have been made, the tooth contact between pinion (8) and ring gear (12) must then be checked Do the procedure that follows:
a. Put a small amount of a mixture of paint pigment and oil on the teeth of ring gear (12)
b Turn pinion (8) In both directions.
c The correct area of tooth contact is located equally on both sides and starts near the inside end of the teeth of ring gear (12) See Illustration B for an example of the correct area of tooth contact.

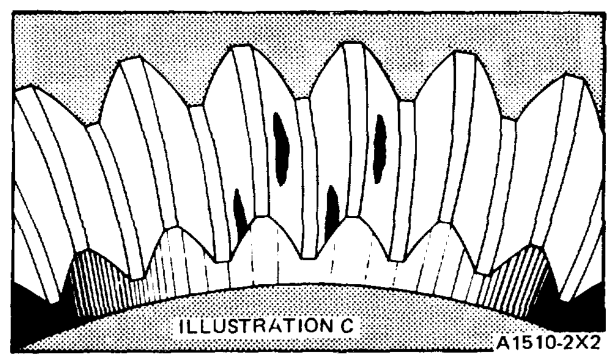
20. If the marks made on the teeth of ring gear (12) look like the marks in Illustration C, do the procedure that follows:
a. Add some of shims (5)
b. Loosen bolts (16) to the torque indicated in Step 7
c. Do Steps 15 through 19 again.

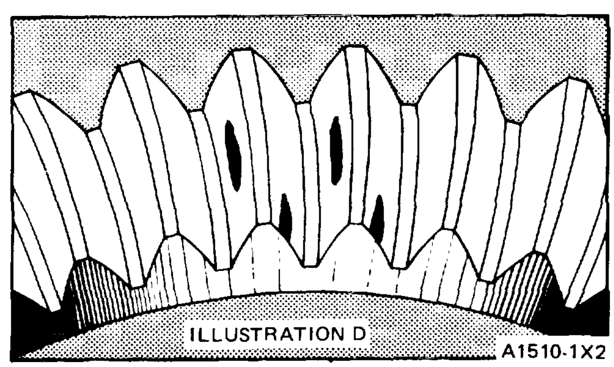
21 If the marks made on the teeth of ring gear (12) look like the marks in Illustration D, do the procedure that follows:
a. Remove some of shims (5).
b. Loosen bolts (16) to the torque indicated in Step 7
c. Do Steps 15 through 19 again.
NOTE: Always make sure the backlash adjustment is correct before an adjustment is made to the area of tooth contact Several adjustments to the backlash and tooth contact may be necessary to get the correct adjustments.

22. After adjustments are made, remove the paint from the gears.

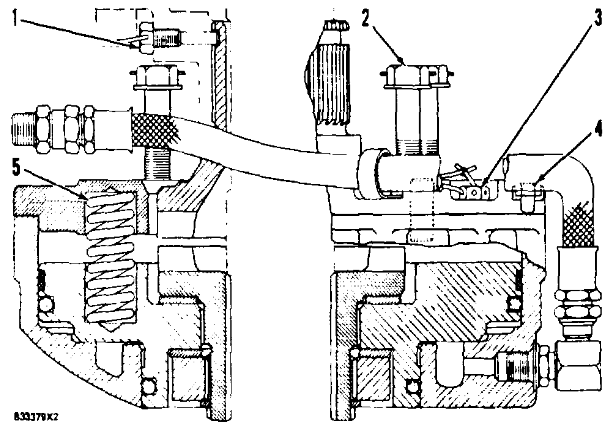
23 Install locks and bolts on caps (1) and (14).





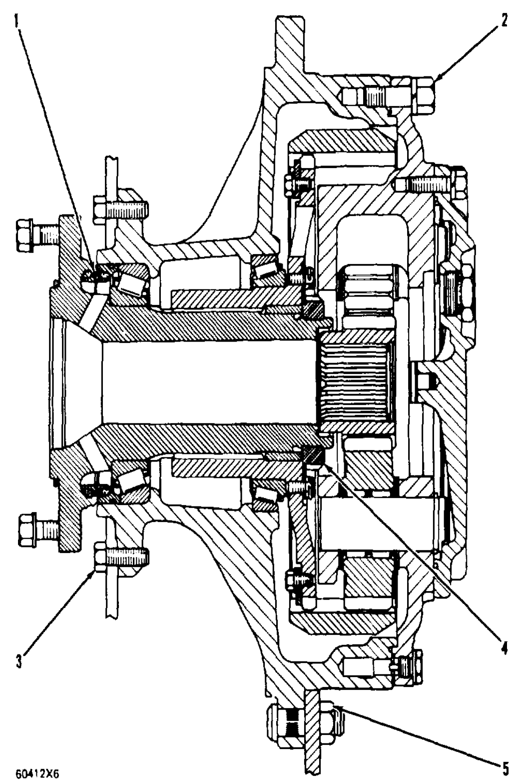


DIFFERENTIAL LOCK



(1) Torque for two bolts ....32 t 5 lb ft (43 ± 7 N-m)
(2) Torque for four bolts ....75 + 10 lb ft (100 ±14 N m)
(3) Torque for two bolts ....32 - 5 lb. ft (43 7 N-m)
Do not bend lock wire over top of bolts
(4) Torque for ten bolts ....325 lb ft (43 ± 7 N-m)
Bend locks against sides of heads of bolts (4) Not around corners.
(5) 8D2583 Springs (twelve).
Length under test force ....2 41 in (37 2 mm)
Test force ....7.75 ± 3.9 lb. (344.7 ± 17.4 N)
Free length after test ....2.96 in (75.1 mm)
Outside diameter ....927 in. (23.6 mm)

FINAL DRIVE



NOTE: Rubber toric seals (1) and all surfaces in contact with them must be clean and dry at assembly. Put a thin layer of oil on the surfaces of the metal seals that are in contact just before installation. Put lubricant on all other seals at assembly.
(2) Torque for the bolts that hold the carrier
to the wheel ....195 + 18 lb. ft. (265 + 25 N m)
(3) Torque for the bolts that hold the brake disc
to the wheel ....165 ± 20 lb. ft. (224 ± 27 N m)
(5) Torque for bolts that hold the rim
to the wheel .... 365 ± 50 lb. ft. (496 ± 68 N m)

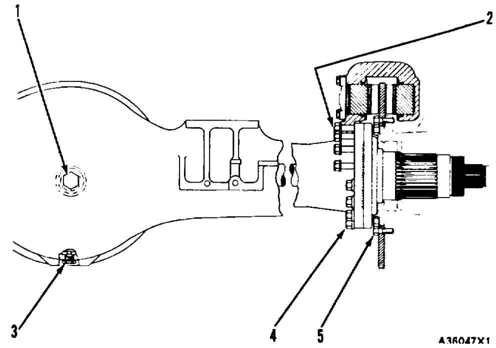
Adjustment Procedure for Wheel Bearings:
1. Tighten nut (4), while the wheel is turned slowly, until torque needed to turn wheel is 160 + 50 lb in. (18 ± 6 N m)

Procedure to Check Wheel Bearing Adjustment:
1. Install a torque wrench 6n nut (5), to check torque needed to turn wheel.
a. If an 8 in. (203 mm) long lb. in. (N m) 9S7354 Torque Wrench is used.
Torque read must be ....75 ± 25 lb. in. (9 . 3 N m)
b. If a 7 in. (178 mm) long lb in. (N-m) 9S6331 Torque Wrench is used.
Torque read must be .... 70 ± 22 lb. in. (83 N m)
c. Use this formula to get the correct torque reading for other lb. in. (N m) torque wrenches.

$$C = \frac{A*T}{A*B}$$

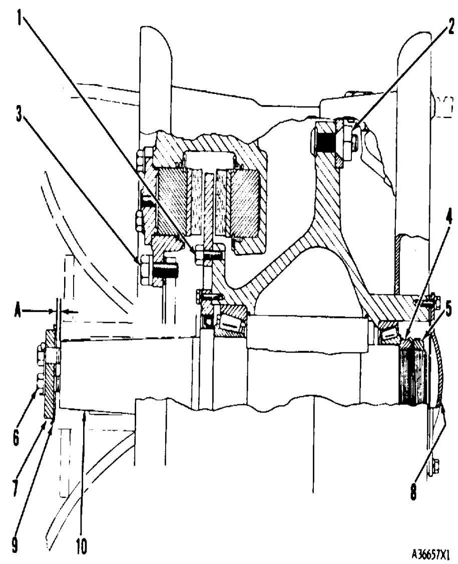
"C" is the reading on the torque wrench.
"A" is the length of the torque wrench.
"B" is the distance from the center of the wheel to nut (5).
"T" is the torque on bearings. [T = 160 t 50 lb. in. (18 - 6 N m)].
NOTE: Torque wrench must be installed on nut (5) so it is in line with the center of the wheel.
2.If torque read at nut (5) is not correct, make adjustments at nut (4).

BRAKE AND AXLE GROUP



(1) Torque for plug	45 ± 5 lb. ft. (61 ± 7 N m)
(2), (4) Torque for bolts	225 ± 25 lb. ft. (306 ± 34 N m)
(3) Torque for plug .	35 ± 5 lb. ft. (48 7 N m)
(5) Torque for bolts	195 ± 20 lb. ft. (265 ± 27 N m)

WHEEL AND BRAKE GROUP (SCRAPER)

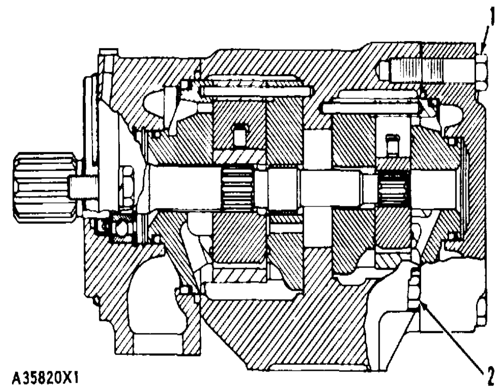


Adjustment Procedure for Wheel Bearings:

1. Fasten a rope to the studs for nuts (2) with at least two full wraps around the outside circumference.
2. Fasten a spring scale to the free end of the rope
3. While the wheel is turned, tighten nut (4) until a pull of 5 lbs. (2.3 kg) is the indication on the scale.
4. Install the lock, and outer nut (5).
5. While cover (8) is removed, hit the end of shaft (10) with a hammer until bolts (6) cannot be tightened to more than 200 to 220 lb. ft. (272 to 299 N m)
6. Install shims (9) to have dimension (A) of .125 in. (3.17 mm) minimum between plate (7) and end of shaft (10).

SECTION 3
SPECIFICATIONS
STEERING SYSTEM

HYDRAULIC PUMP
(3G7640)



Rotation is counterclockwise when seen from drive end
Type of pump: Vane
For test, use SAE 10W oil at 150'F (65°C).
LARGE SECTION OF PUMP (Drive end) (Steering)
Test at Full Speed:
- Output .... 23.0 U.S. gpm (87.1 litre/min)
  - at a pressure of ...... 100 psi (7 0 kg/cm^2) (690 kPa)
  - with pump at .... 2000 rpm
  - with engine at .... 2000 rpm
- Output .... 20.4 U.S. gpm (77.2 litre/min)
  - at a pressure of ..... 1000 psi (70 0 kg/cm^2) (6900 kPa)
  - with pump at .... 2000 rpm
  - with engine at .... 2000 rpm

Test at Half Speed
- Output .... 11.3 U S gpm (42 8 litre/min)
  - at a pressure of ..... 100 psi (7 0 kg/cm2) (690 kPa)
  - with pump at .... 1000 rpm
  - with engine at .... 1000 rpm
- Output .... 10.0 U S gpm (37.9 litre/min)
  - at a pressure of ..... 1000 psi (70.0 kg/cm^2) (6900 kPa)
  - with pump at .... 1000 rpm
  - with engine at .... 1000 rpm

SMALL SECTION OF PUMP (Cover end) (Implement)
Test at Full Speed.
- Output .... 23 7 U S gpm (89.7 litre/mn)
  - at a pressure of ...... 100 psi (7 0 kg/cm2) (690 kPa)
  - with pump at .... 2000 rpm
  - with engine at .... 2000 rpm
- Output .... 23.0 U.S. gpm (87.1 litre/min)
  - at a pressure of . .. 1000 psi (70 0 kg/cm^2) (6900 kPa)
  - with pump at .... 2000 rpm
  - with engine at .... 2000 rpm

Test at Half Speed.
- Output .... 11.7 U S. gpm (44 3 litre/min)
  - at a pressure of ..... 100 psi (7.0 kg/cm^2) (690 kPa)
  - with pump at .... 1000 rpm
  - with engine at .... 1000 rpm
- Output .... 10.8 U S. gpm (40 9 litre/min)
  - at a pressure of ..... 1000 psi (70 0 kg/cm2) (6900 kPa)
  - with pump at .... 1000 rpm
  - with engine at .... 1000 rpm

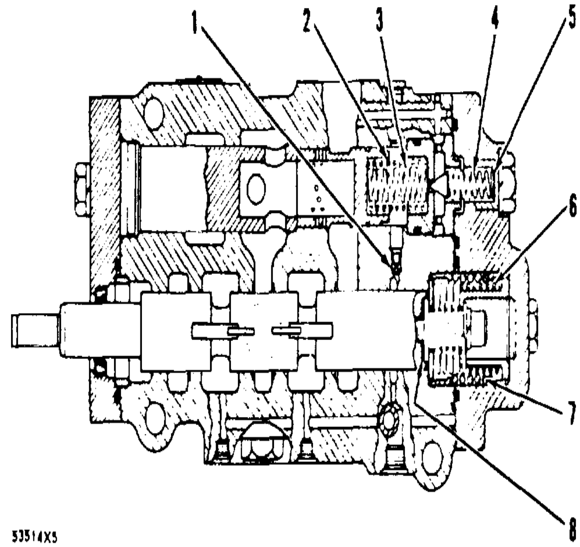
(1) Torque for four bolts ..... 45 ± 5 lb.ft. (61 ± 7 N m)
(2) Torque for four bolts ..... 70 ± 5 Ib.ft. (95 ± 7 N m)

STEERING CONTROL VALVE
(1 U327)

Pressure setting of relief valve with engine at high idle..........2000 ± 25 psi (140.6 ± 1.8 kg/cm2) (13 800 ± 172 kPa)

Pressure to each steering cylinder with valve In NEUTRAL position ..40 + 10 psi (2.8 ± 0.7 kg/cm^2) (276 ± 69 kPa)

Permissible difference in pressures (between steering cylinders) with valve in
NEUTRAL position ....10 ps (7 kg/cm^2) (69 kPa)



(1) Torque for plug (orifice). 120 - 24 lb, in. (13.6 - 2 7 N m)

(2) 2J6088 Spring (outer) for flow control valve'
Length under test force .... 1.53 in (38.9 mm)
Test force .... 22 1 11 lb (98.3 ± 4 9 N)
Free length after test .... 2.34 in. (59.4 mm)
Outside diameter .... .812 in. (20.62 mm)

(3) 4J7490 Spring (inner) for flow control valve:
Length under test force ... 1.63 in (41.4 mm)
Test force .... 13.3.7 lb (59.2 ± 3 1 N)
Free length after test .... 2.00 in (50.8 mm)
Outside diameter .... 60 in (15.2 mm)

(4) 4F7115 Spring for pilot valve:
Length under test force ... 1.43 in (36.3 mm)
Test force .... 67.6 ± 3.4 lb (300 7 + 15.1 N)
Free length after test .... 1.74 in (44.2 mm)
Outside diameter .... .49 in (12.4 mm)

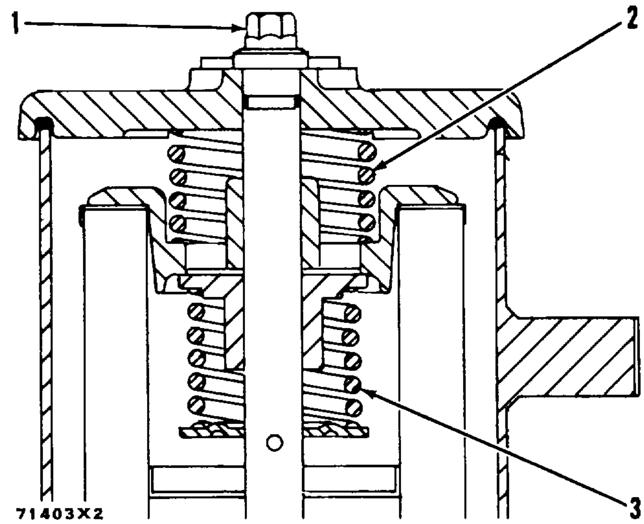
(5) 3H2549 Shims:
Thickness of one shim ....010 in (25 mm)
One shim changes
pressure .... 40 psi (2 8 kg/cm^2) (276 kPa)

(6) 7F9802 Spring (inner) for valve spool:
Length under test force ... 1.88 in. (47.8 mm)
Test force .... 23.91.9 lb. (106 3 - 8 5 N)
Free length after test .... 3 31 n. (84 1 mm)
Outside diameter .... 1.25 in (31.8 mm)

(7) 7H832 Spring (outer) for valve spool.
Length under test force ... 1 53 in. (38 9 mm)
Test force .... 403 lb (177.9133 N)
Free length after test .... 2.20 in. (55 9 mm)
Outside diameter .... 1.67 in. (42 4 mm)

(8) Thickness of 5J4776 Shim 005 in (13 mm)
Thickness of 4J8224 Shim .010 in (25 mm)

OIL FILTER
(8J4423)

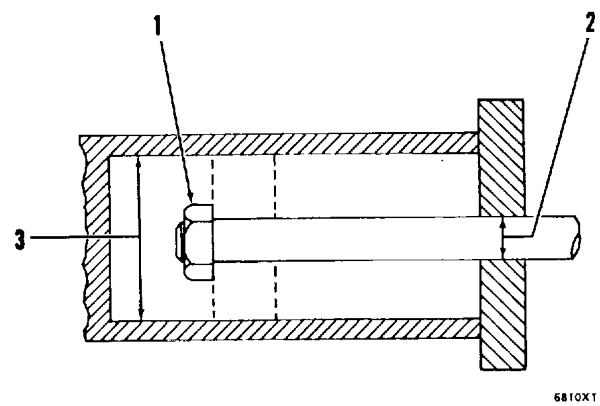


(1) Torque for bolt .... 60 ± 5 b ft. (827 N m)

(2) 6J2236 Spring:
Length under test force ... 1.38 in. (35.1 mm)
Test force .... 124.6 ± 7.4 lb (554.2 ± 32 9 N)
Free length after test .... 3.44 in. (87.4 mm)
Outside diameter .... 2.80 in. (71.1 mm)

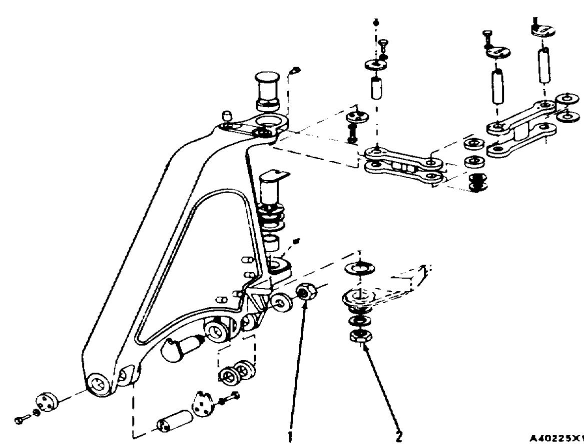
(3) 5J2926 Spring for bypass valve:
Length under test force ... 2.98 in. (75.7 mm)
Test force......................... 60.6 ± 4 3 lb. (269.6 ± 19.1 N)
Free length after test ...... 5.40 in. (137.2 mm)
Outside diameter .... 2.29 in (58.2 mm)

STEERING CYLINDERS



(1) Torque for nut with lubricant on
threads .... 1200 . 120 lb.ft. (1630 ± 163 N m)
(2) Bore in new
head .... 2.003 ± 001 in. (50 880 03 mm)
Diameter of new
rod .... 1.9980 ± 0015 in. (50.749- 0.038 mm)
(3) Bore in new cylinder
4.000 + .005 or - 002 in. (101 60 + 0.13 or - 0.05 mm)

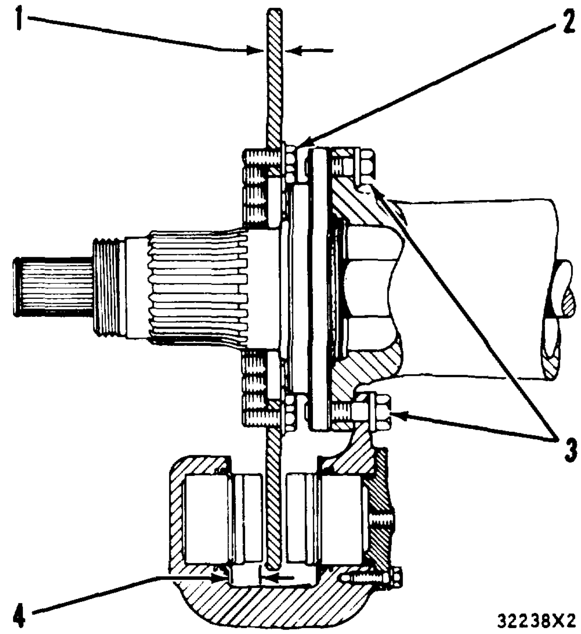
HITCH GROUP



(1) Torque for nut (horizontal
pin) .... 375 to 425 lb.f. (510 to 580 N m)
(2) Torque for nut
(vertical pin)............................ 700 to 900 b.ft. (950 to 1220 N m)

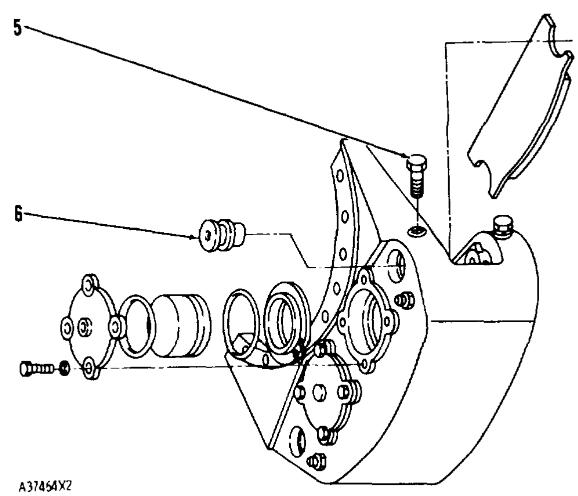
SECTION 4
SPECIFICATIONS
AIR SYSTEM AND BRAKES

WHEEL BRAKE ASSEMBLY



(1) Thickness of disc:
New..50 in (127 mm)
Minimum permissible thickness (worn) (in area where pad and disc make contact) ...44 in (11 2 mm)
(2) Torque for bolts with lubricant on threads ....195 ± 20 lb ft (265 ± 25 N-m)
(3) Torque for bolts with lubricant on threads ....159 to 175 lb ft (217 to 240 N m)
(4) Thickness of lining assembly (including plate)
New ....88 in (224 mm)
Minimum permissible thickness (worn) ....38 in (9 6 mm)
(Measure the lining at both ends because it can wear more at one ....end than the other.)

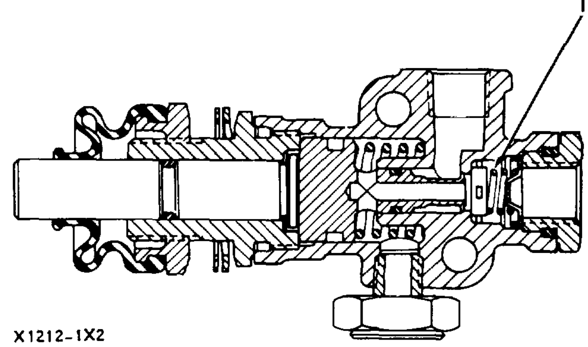
(5) (6) Clearance between pin (6) and brake disc must not be less than 010 in (0 25 mm) If clearance is less than 010 in (0 25 mm), turn bolt (5) counterclockwise one turn, slide pin (6) to get 010 in (O 25 mm) clearance and tighten bolt (5) again



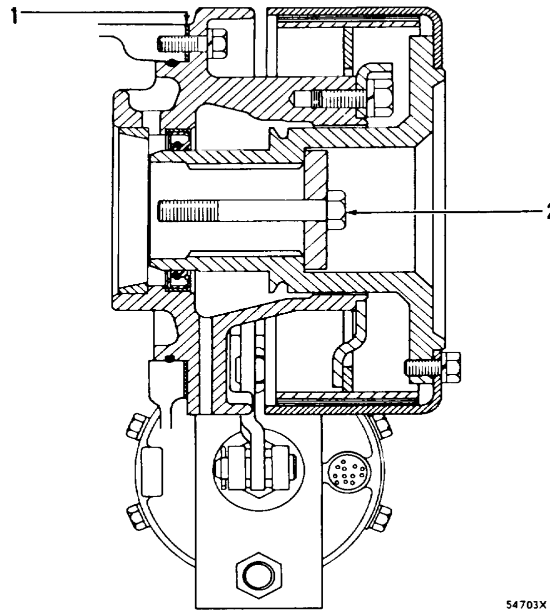
DIFFERENTIAL LOCK CONTROL VALVE (6D856)

Valve has a normally closed position

Maximum operating pressure ....150 psi (1030 kPa)
(1) 4J3957 Spring:
Free length .... .67 in (17 0 mm)
Inside diameter .... .42 in (10.7 mm)



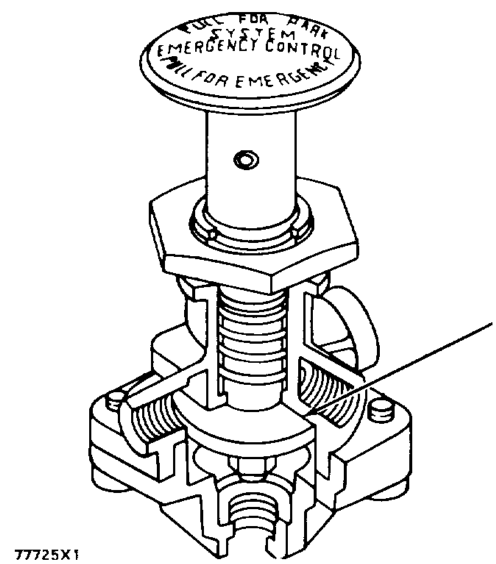
EMERGENCY AND PARKING BRAKE



(1) Use shims as necessary to get end play of tapered roller bearing .... .003 to 005 in (0 08 to 0 13 mm)

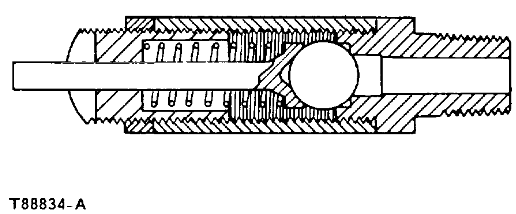
(2) Torque for bolt ....80 ± 5 lb ft (110 ± 7 N m)

CONTROL VALVE FOR EMERGENCY AND PARKING BRAKE (7D2316 and 7J9568)



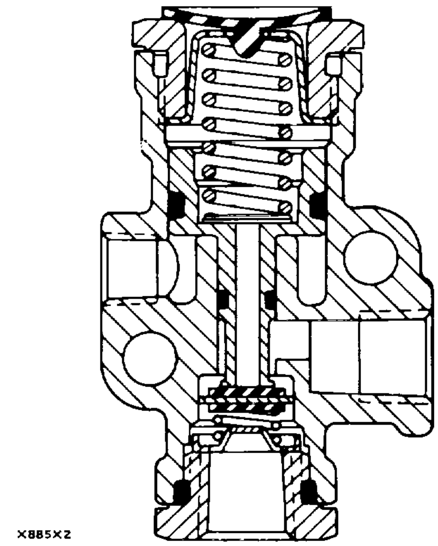
(1) Valve
Opens at ....40 ± 5 psi (280 ± 35 kPa)
Closes at ....55 ± 5 psi (380 ± 35 kPa)

RELIEF VALVE



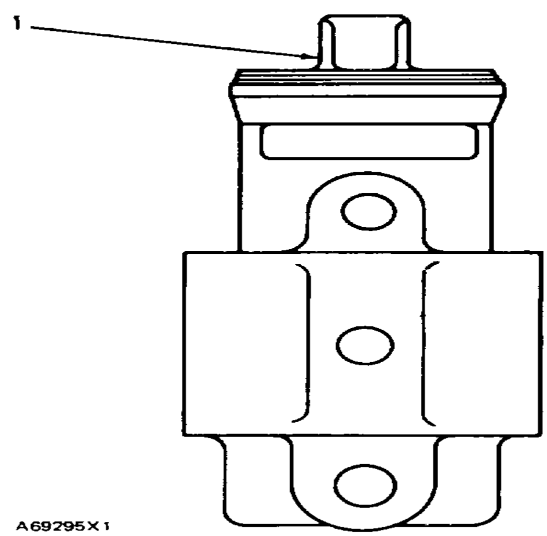
Pressure (bench test) at which relief valve opens ....150 psi (1030 kPa)

EMERGENCY CONTROL VALVE
(6D1039)



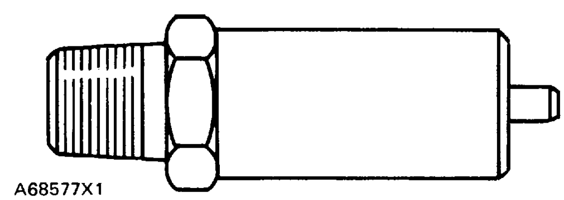
Inlet opening pressure ....45 psi (310 kPa)
Exhaust opening pressure ....60 psi (415 kPa)

AIR COMPRESSOR GOVERNOR



Governor settings:
Cut-in pressure 100 to 105 psi (690 to 725 kPa)
Cutout pressure 125 ± 5 psi (860 + 35 kPa)
(1) Pressure change (when screw is turned
one revolution) 20 psi (140 kPa)

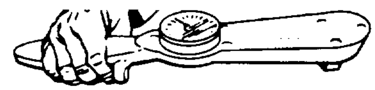
RELIEF VALVE
(2G 1034)



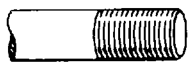
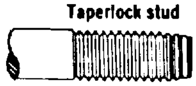
On side of air dryer housing
pressure needed to open valve . 175 ± 8 psi (1200 ± 55 kPa)

SECTION 5
SPECIFICATIONS
MISCELLANEOUS

GENERAL TIGHTENING TORQUE FOR BOLTS, NUTS AND TAPERLOCK STUDS



The following charts give the standard torque values for bolts, nuts and taperlock studs of SAE Grade 5 or better quality. Exceptions are given in other sections of the Service Manual where needed.

THREAD DIAMETER		STANDARD TORQUE	
inches	**millimeters**	**lb. ft.**	**N·m***
Standard thread 		Use these torques for bolts and nuts with standard threads (conversions are approximate).	
1/4	6.35	9 ± 3	12 ± 4
5/16	7.94	18 ± 5	25 ± 7
3/8	9.53	32 ± 5	45 ± 7
7/16	11.11	50 ± 10	70 ± 15
1/2	12.70	75 ± 10	100 ± 15
9/16	14.29	110 ± 15	150 ± 20
5/8	15.88	150 ± 20	200 ± 25
3/4	19.05	265 ± 35	360 ± 50
7/8	22.23	420 ± 60	570 ± 80
1	25.40	640 ± 80	875 ± 100
1 1/8	28.58	800 ± 100	1100 ± 150
1 1/4	31.75	1000 ± 120	1350 ± 175
1 3/8	34.93	1200 ± 150	1600 ± 200
1 1/2	38.10	1500 ± 200	2000 ± 275
		Use these torques for bolts and nuts on hydraulic valve bodies.	
5/16	7.94	13 ± 2	20 ± 3
3/8	9.53	24 ± 2	35 ± 3
7/16	11.11	39 ± 2	50 ± 3
1/2	12.70	60 ± 3	80 ± 4
5/8	15.88	118 ± 4	160 ± 6
Taperlock stud 		Use these torques for studs with Taperlock threads.	
1/4	6.35	5 ± 2	7 ± 3
5/16	7.94	10 ± 3	15 ± 5
3/8	9.53	20 ± 3	30 ± 5
7/16	11.11	30 ± 5	40 ± 10
1/2	12.70	40 ± 5	55 ± 10
9/16	14.29	60 ± 10	80 ± 15
5/8	15.88	75 ± 10	100 ± 15
3/4	19.05	110 ± 15	150 ± 20
7/8	22.23	170 ± 20	230 ± 30
1	25.40	260 ± 30	350 ± 40
1 1/8	28.58	320 ± 30	400 ± 40
1 1/4	31.75	400 ± 40	550 ± 50
1 3/8	34.93	480 ± 40	650 ± 50
1 1/2	38.10	550 ± 50	750 ± 70

*1 newton meter (N·m) is approximately the same as 0.1 mkg.

T95416-7

LINES, PLUGS AND FITTINGS

HYDRAULIC LINE INSTALLATION

1. For a metal tube to hose installation, install the tube and tighten all bolts finger tight.

2. Tighten the bolts at the rigid end.

3. Install the hose and tighten all bolts finger tight.

4. Put the hose in a position so that it does not make contact with the machine or another hose.

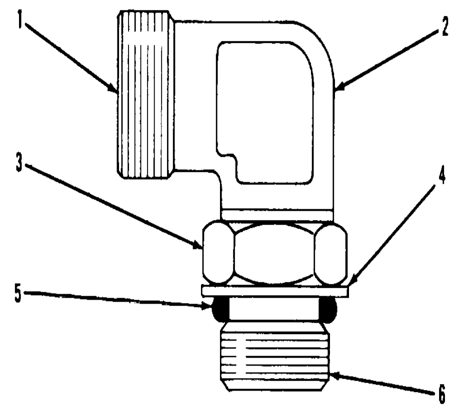
5. Tighten the bolts on both connections.

6. Start the engine.
7. Move the implement control levers to all positions.
8. Look at the hose during movement of the implement. Make sure hose is not in contact with the machine or other hoses.
9. Shut off the engine.

10. If necessary, put the hose in a new position where it will not make contact when the implement is moved.

ASSEMBLY OF FITTINGS WITH STRAIGHT THREADS AND O-RING SEALS

This type of fitting is used in many applications. The tube end of the fitting will be different in design so that it can be used in many different applications. However, the installation procedure of the fitting is the same. If the tube end of the fitting body is the same as in the illustration (either an elbow or a straight body) it will be necessary to assemble the sleeve on the tube before connecting the tube to the end.



ELBOW BODY ASSEMBLY

1. End of fitting body (connects to tube). 2. Fitting body. 3. Locknut. 4. Backup washer. 5. O-ring seal. 6. End of fitting that goes into other part.

1. Put locknut (3), backup washer (4) and O-ring seal (5) as far back on fitting body (2) as possible. Hold these components in this position. Turn the fitting into the part it is used on, until backup washer (4) just makes contact .with the face of the part it is used on.

2. To put the fitting assembly in its correct position turn the fitting body (2) out (counterclockwise) a maximum of 359°. Tighten locknut (3) finger tight.

NOTE: If the fitting is a connector (straight fitting) the hex on the body takes the place of the locknut. To install this type fitting tighten the hex against the face of the part it goes into.

TORQUES FOR FLARED AND O-RING FITTINGS

The torques shown in the chart that follows are to be used on the nut part of 37° Flared, 45° Flared and Inverted Flared fittings (when used with steel tubing), O-ring plugs, O-ring fittings and swivel nuts when used in applications to 3000 psi (20700 kPa).

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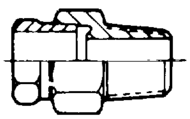
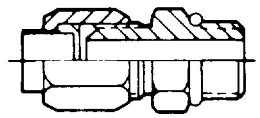
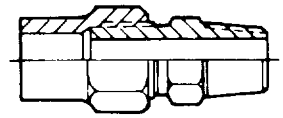
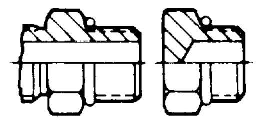
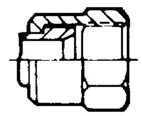

INVERTED 45° FLARED


37° FLARED


45° FLARED


O-RING FITTING – PLUG

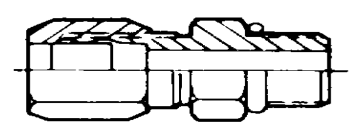

SWIVEL NUTS

TUBE SIZE (O.D)						
	mm	3.18	4.78	6.35	7.92	9.52
	in.	.125	.188	.250	.312	.375
THREAD SIZE (in.)		5/16	3/8	7/16	1/2	9/16 5/8
TORQUE N·m		5 ±1	9 ±1	16 ±2	18 ±2	21 ±2
TORQUE lb.in.		45 ±10	80 ±10	145 ±20	155 ±20	190 ±20

TUBE SIZE (O.D.)									
	mm	12.70	15.88	19.05	22.22	25.40	31.75	38.10	50.80
	in.	.500	.625	.750	.875	1.000	1.250	1.500	2.000
THREAD SIZE (in.)		3/4	7/8	1 1/16	1 3/16 1 1/4	1 5/16	1 5/8	1 7/8	2 1/2
TORQUE N·m		40 ±7	55 ±7	75 ±7	90 ±7	110 ±7	135 ±15	160 ±15	310 ±30
TORQUE lb.ft.		30 ±5	40 ±5	55 ±5	65 ±5	80 ±5	100 ±10	120 ±10	230 ±20

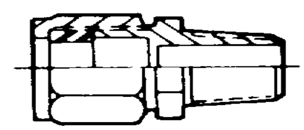
TORQUES FOR OTHER FITTINGS

Ermeto Tube Fittings



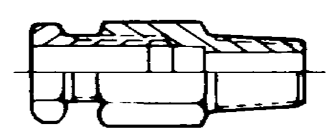
Put nut and sleeve over the tube with head or shoulder end of sleeve next to nut. Push tube into counterbore of fitting body as far as possible. Turn nut clockwise until sleeve holds tube and prevents movement. Tighten the nut I ’ turns more to seat sleeve and give a locking action. When necessary to assemble again, put sleeve over tube and tighten nut until a sudden increase in torque is felt. Then tighten 1/6 to 1/3 turn more to seat the sleeve.

Flex Fittings



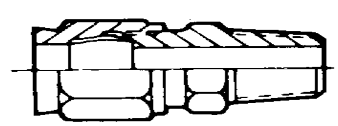
Put nut and sleeve’ over tubing and push tube into counterbore of fitting body as far as possible. Tighten the nut until it is against the hex part of the fitting body.

Hi Duty (shear sleeve) Tube Fittings



After tube has been put through the nut and makes contact against the tube shoulder in the fitting body, turn the nut with a wrench until a small decrease in torque is felt. This is an indication that the sleeve has been broken off of the nut. Hold the tube to prevent turning and tighten the nut I and 1/2 turns.

Hi Seal Fittings



Put nut and sleeve over the tubing with the short heavy end of the sleeve facing the end of tubing. Put the tube end against the counterbore in the body of the fitting and tighten until nut is over the last thread on the body. The remainder of space is used whenever the fitting is removed and installed again.

CHAPTER 2
SYSTEMS OPERATION, TESTING, AND ADJUSTING (TRACTOR)

Table of Contents

Table of Contents (Con't)

SECTION 1
SYSTEMS OPERATION, TESTING, AND ADJUSTING
3208 VEHICULAR ENGINE

INTRODUCTION

Correct operation, maintenance, test and repair procedures will give this product a long service life. Before starting a test, repair or rebuild job, the serviceman must read the respective sections of the Maintenance Manual, and know all the components he will work on.

Your safety, and the safety of others, is at all times very important. When you see this symbol ⊕ or this symbol ⚠ in the manual, you must know that caution is needed for the procedure next to it. The symbols are warnings. To work safely, you must understand the job you do. Read all instructions to know what is safe and what is not safe.

It is very important to know the weight of parts. Do not lift heavy parts by hand. Use a hoist. Make sure heavy parts have a good stability on the ground. A sudden fall can cause an accident. When lifting part of a machine, make sure the machine has blocks at front and rear. Never let the machine hang on a hoist, put blocks or stands under the weight.

When using a hoist, follow the recommendation in the manual. Use correct lift tools as shown in illustrations to get the correct balance of the component you lift. This makes your work safer at all times.

Fuel System

The sleeve metering fuel system is a pressure type fuel system. The name for the fuel system is from the method used to control the amount of fuel sent to the cylinders. This fuel system has an Injection pump for each cylinder of the engine. It also has a fuel transfer pump on the front of the injection pump housing. The governor is on the rear of the injection pump housing.

The drive gear for the fuel transfer pump is on the front of the camshaft for the injection pumps. The carrier for the governor weights is bolted to the rear of the camshaft for the injection pumps. The injection pump housing has a bearing at each end to support the camshaft. The camshaft for the sleeve metering fuel system is driven by the timing gears at the front of the engine.

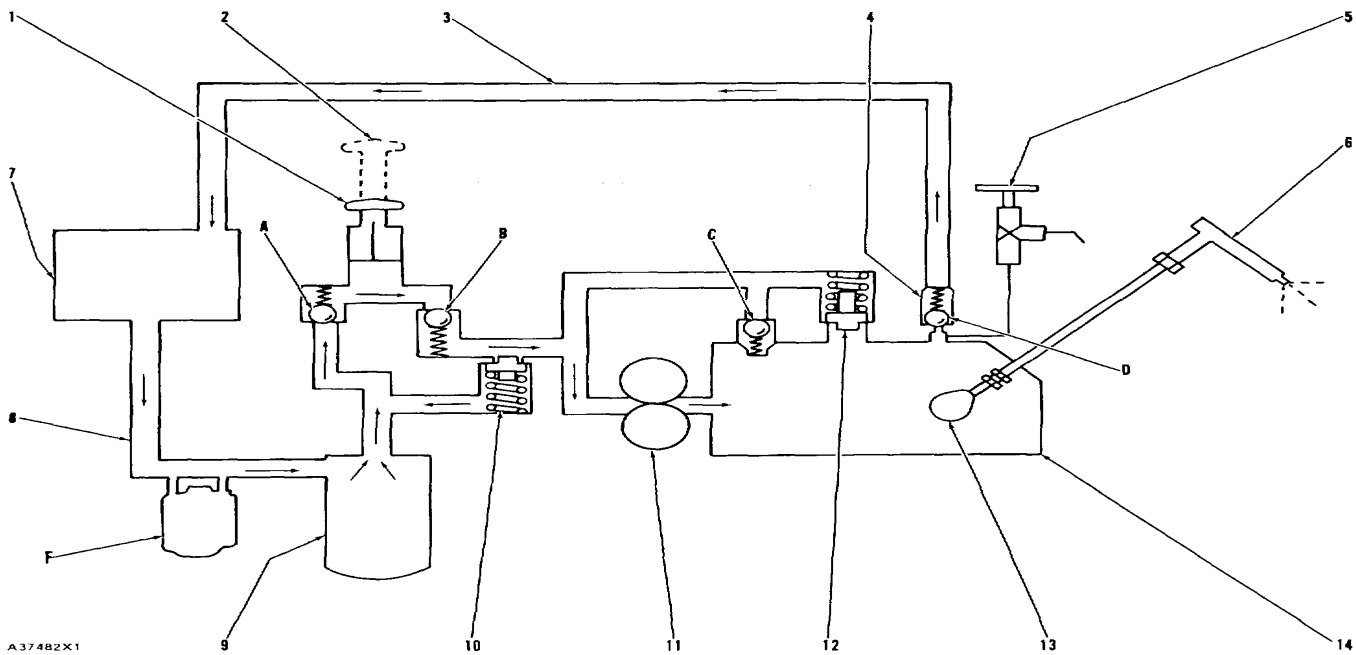
The injection pumps, lifters and rollers, and the camshaft are all inside of the pump housing. The pump housing and the governor housing are full of fuel at transfer pump pressure (fuel system pressure).

CAUTION

Diesel fuel is the only lubrication for the moving parts in the transfer pump, injection pump housing, and the governor. The injection pump housing must be full of fuel before turning the camshaft.

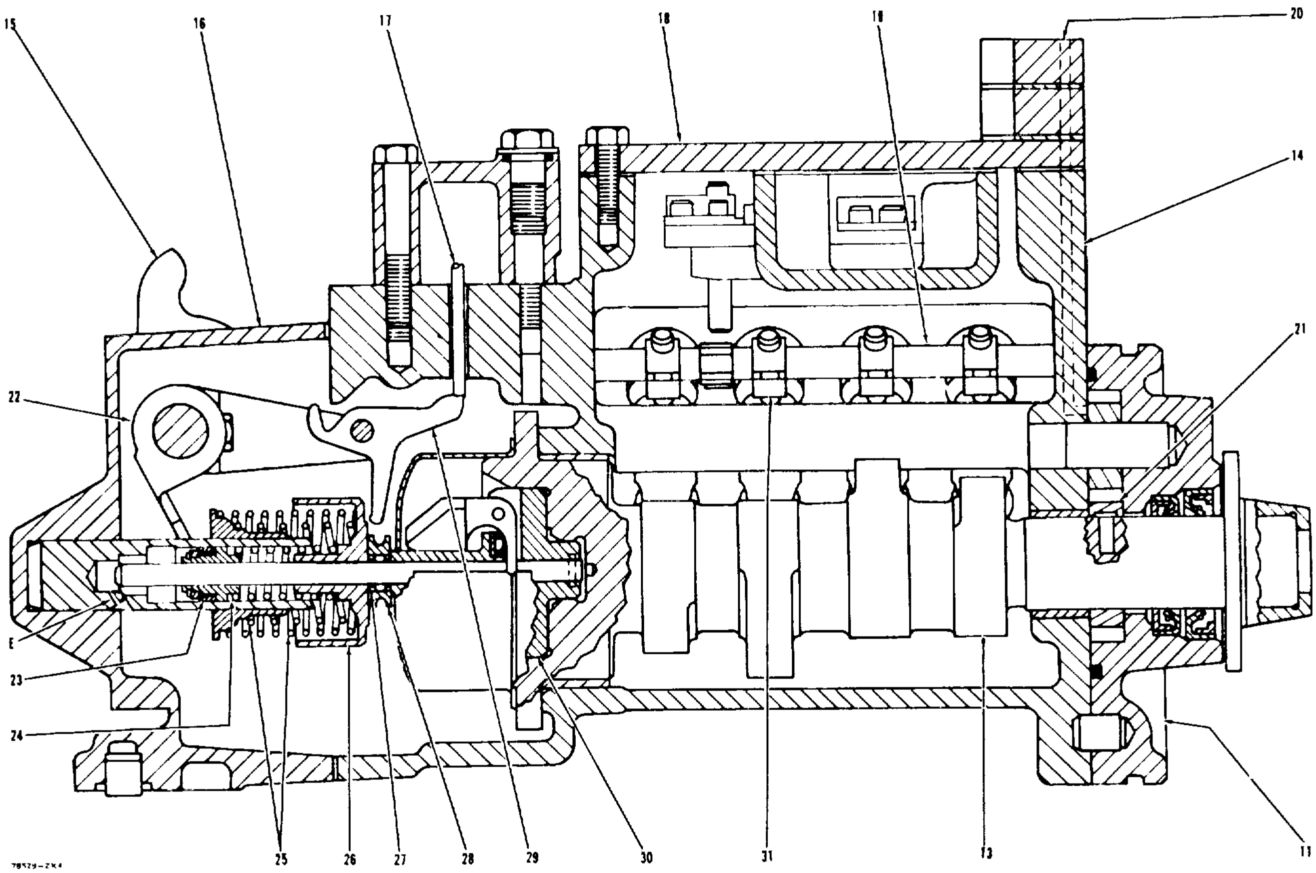
This fuel system has governor weights, a thrust collar and two governor springs. One governor spring is for high idle and the other governor spring is for low idle. Rotation of the shaft for governor control, compression of the governor springs, movement of connecting linkage in the governor and injection pump housing controls the amount of fuel sent to the engine cylinders.

Fuel from fuel tank (7) is pulled by fuel transfer pump (11) through water separator (F) and fuel filter (9). From fuel filter (9) the fuel goes to housing for fuel injection pumps (14). The fuel goes in housing (14) at the top and goes through inside passage (20) to fuel transfer pump (11).



SCHEMATIC OF FUEL SYSTEM

1. Fuel priming pump (closed position). 2. Fuel priming pump (open position). 3. Return line for constant bleed valve. 4. Constant bleed valve. 5. Manual bleed valve. 6. Fuel injection nozzle. 7. Fuel tank. 8. Fuel inlet line. 9. Fuel filter. 10. Bypass valve for fuel priming pump. 11. Fuel transfer pump. 12. Fuel bypass valve. 13. Camshaft. 14. Housing for fuel injection pumps. A. Check valve. B. Check valve. C. Check valve. D. Check valve. F. Water Separator.



CROSS SECTION OF FUEL SYSTEM WITH DASHPOT GOVERNOR

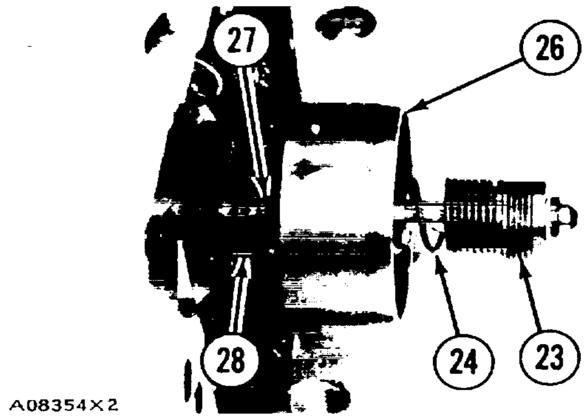
11. Fuel transfer pump.13. Camshaft14. Housing for fuel Injection pumps.15. Lever.16. Governor housing 17. Load stop pin 18. Cover.19. Sleeve control shafts (two) 20. Inside fuel passage.21 Drive gear for fuel transfer pump22. Lever on governor shaft.23. Piston for dashpot governor 24. Spring for dashpot governor 25. Governor springs (inner spring Is for low idle. Outer spring Is for high idle).26. Spring seat 27. Over fueling spring.28. Thrust collar29. Load stop lever.30. Carrier and governor weights. 31 Sleeve levers. E. Orifice for dashpot.

From fuel transfer pump (I 1), fuel under pressure, fills the housing for the fuel injection pumps (14). Pressure of the fuel in housing (14) is controlled by bypass valve (12). Pressure of the fuel at FULL LOAD is 30 $^{+}$ 5 psi (205 + 35 kPa). If the pressure of the fuel in housing (14) gets too high, bypass valve (12) will move (open) to let some of the fuel return to the inlet of fuel transfer pump (II).

Lever (15) for the governor is connected by linkage and governor springs (25) to the sleeve control shafts (19). Any movement of lever (22) will cause a change in the position of sleeve control shafts (19).

When lever (15) is moved to give more fuel to the engine, lever (22) will put governor springs (25) in compression and move thrust collar ('28) forward. As thrust collar (28) moves forward, the connecting linkage will cause sleeve control shafts t19) to turn. With this movement of the sleeve control shafts, levers (31) will lift sleeves (32) to make an increase in the amount of fuel sent to the engine cylinders.

When starting the engine, the force of over fueling spring (27) is enough to push thrust collar (28) to the full fuel position. This lets the engine have the maximum amount of fuel for injection when starting. At approximately 400 rpm, governor weights (30) make enough force to push spring (27) together. Thrust collar (28) and spring seat (26) come into contact. From this time on, the governor works to control the speed of the engine.

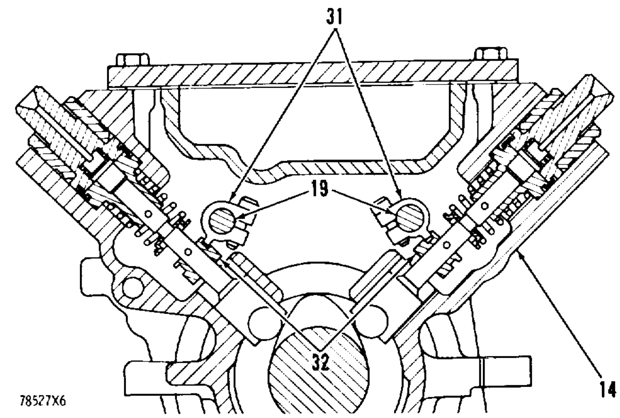


GOVERNOR PARTS

23. Piston for dashpot governor. 24. Spring for dashpot governor. 26. Spring seat. 27. Over fueling spring. 28. Thrust collar.

When governor springs (25i are put in compression, the spring seat at the front of the governor springs will make contact with load stop lever (2). Rotation of the load stop lever moves load stop pin (17) up until the load stop pin comes in contact with the stop bar or stop screw. This stops the movement of thrust collar (28), the connecting levers, and sleeve control shafts (19). At this position, the maximum amount of fuel per stroke is being injected by each injection pump.

The carrier for governor weights (30) is held on the rear of camshaft (13) by bolts. Engine rpm goes up, injection pump camshaft (13) turns faster. Any change of camshaft rpm will change the rpm and position of governor weights (30). Any change of governor weight position will cause thrust collar (28) to move. As governor weights (30) turn faster, thrust collar (28) is pushed toward governor springs (25). When the force of governor springs (25) is balanced by the centrifugal force of the governor weights, sleeves (32) of the injection pumps are held at a specific position to send a specific amount of fuel to the engine cylinders. When the governor control lever is turned toward the FUEL-OFF position with the engine running, there is a reduction of force on governor springs ('5). The movement of the linkage in the governor will cause fuel control shafts (19) to move sleeves (321 down, anti less fuel will be injected in the engine cylinders. To stop the engine, turn the ignition switch to the "OFF" position. This will cause the slut-off solenoid to move linkage in the fuel pump housing. Movement of the linkage will cause sleeve levers (3 1) to move sleeves (32) down, and no fuel is sent to the engine cylinders. With no fuel going to the engine cylinders, the engine will stop.



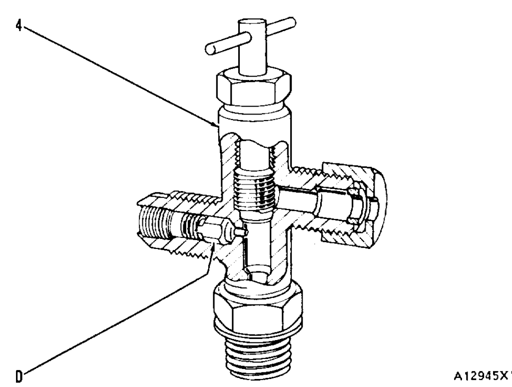
FUEL SYSTEM COMPONENTS

14. Housing for fuel injection pumps. 19. Sleeve control shafts. 31. Sleeve levers. 32. Sleeves.

FLOW OF FUEL USING THE PRIMING PUMP

When the handle of priming pump (2) is pulled out, negative air pressure in priming pump (2) opens check valve (A) and pulls fuel from fuel tank (7). Pushing the handle in closes check valve (A) and opens check valve (B). This pushes air and/or fuel into housing (14) through the fuel passages and check valve (C). More operation of priming pump (2) will pull fuel from fuel tank (7) until the fuel lines, fuel filter (9) and housing (14) are full of fuel. Do this until the flow of fuel from manual bleed valve (5) is free of air bubbles. Relief valve (10) will open and let the fuel go to the inlet for fuel priming pump (2) if the pressure gets higher than 20 psi (140 kPa) when using priming pump (2).

CONSTANT BLEED VALVE



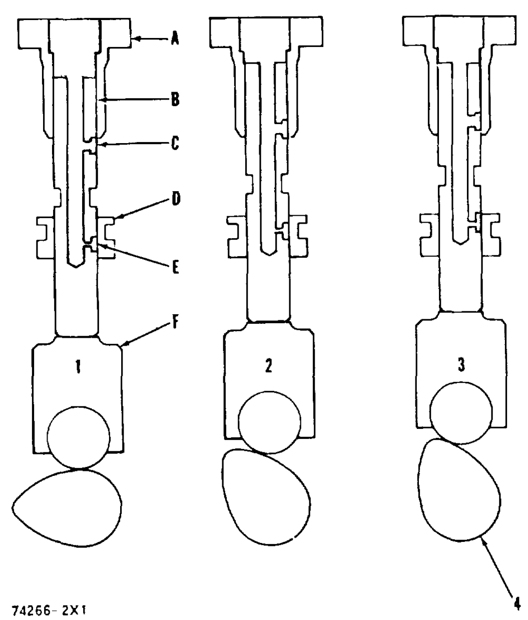
CONSTANT BLEED VALVE

4. CONSTANT BLEED VALVE. D. Check valve

Constant bleed valve (4) lets approximately 9 gallons of fuel per hour go back to fuel tank (7). This fuel goes back to fuel tank (7) through return line for constant bleed valve (3). This flow of fuel removes air from housing (14) and also helps to cool the fuel injection pump. Check valve (D) makes a restriction in this flow of fuel until the pressure in housing (14) is 8 ± 3 psi (55 ± 20 kPa).

OPERATION OF FUEL INJECTION PUMPS

The main components of a fuel injection pump in the sleeve metering fuel system are barrel (A), plunger (B), and sleeve (D). Plunger (B) moves up and down inside the barrel (A) and sleeve (D). Barrel (A) is stationary while sleeve (D) is moved up and down on plunger (B) to make a change in the amount of fuel for injection. When the engine is running, fuel under pressure from the fuel transfer pump goes in the center of plunger (B) through fuel inlet (C) during the down stroke of plunger (B). Fuel can not go through fuel outlet (E) at this time because it is stopped by sleeve (D), (see position 1). Fuel injection starts (see position 2) when plunger (B) is lifted up in barrel (A) enough to close fuel inlet (C). There is an increase in fuel pressure above plunger (B), when the plunger is lifted by camshaft (4). The fuel above plunger (B) is injected in to the engine cylinder.



FUEL INJECTION SEQUENCE

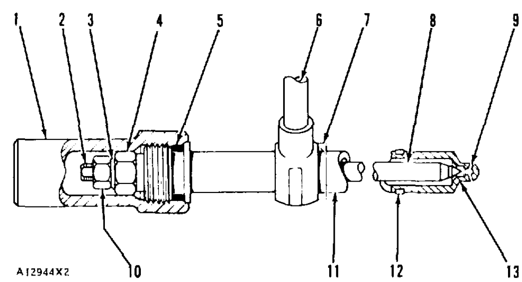
1, 2, 3. Injection stroke (positions) of a fuel injection pump. 4. Injection pump camshaft. A. Barrel. B. Plunger. C. Fuel inlet. D. Sleeve. E. Fuel outlet. F. Lifter.

Injection will stop (see position 3) when fuel outlet (E) is lifted above the top edge of sleeve (D) by camshaft (4). This movement lets the fuel that is above, and In, plunger (B) go through fuel outlet (E) and return to the fuel injection pump housing.

When the sleeve (D) is raised on plunger (B), fuel outlet (E) is covered for a longer time, causing more fuel to be injected in the engine cylinders. If sleeve (D) is low on plunger (B), fuel outlet (F.) is covered for a shorter time, causing less fuel to be injected.

OPERATION OF FUEL INJECTION NOZZLE

The fuel inlet (6) and nozzle tip (13)re parts of the nozzle body, (11). Valve (8) is held in position by spring force Force of the spring is controlled by pressure adjustment screw (3). Locknut (4-) holds pressure adjustment screw (3) in position. The lift of value (8) is controlled 1b lift adjustment screw (2).Locknut (10) holds lift adjustment screw (2) in position. Compression seal (7) goes on nozzle body (11). The compression seal goes against inlet fitting (6) and prevents the leakage of compression from the cylinder. Carbon dam (12), at the lower end of nozzle body (11), prevents the deposit of carbon in the bore in the cylinder head.



FUEL INJECTION NOZZLE

1. Cap. 2. Lift adjustment screw. 3. Pressure adjustment screw. 4. Locknut for pressure adjustment screw. 5. O-ring seal. 6. Fuel inlet. 7. Compression seal. 8. Valve. 9. Orifices (four). 10. Locknut for lift adjustment screw. 11. Nozzle body. 12. Carbon dam. 13. Nozzle tip.

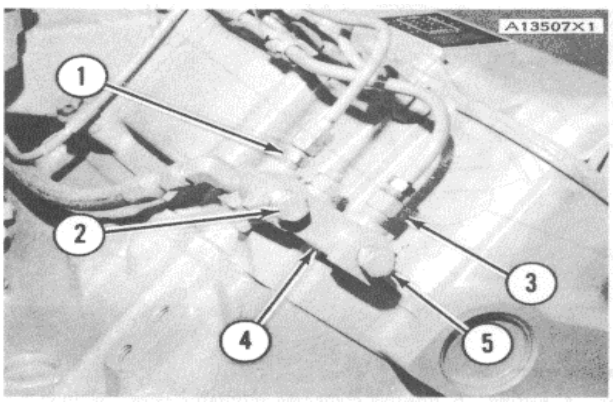
Fuel, under high pressure from the fuel injection pump goes through the hole in fuel inlet (6). Tile fuel then goes around valve (8), fills the inside of nozzle body (11) and pushes against the valve guide. When the force made by the pressure of the fuel is more than the force of the spring, valve (8) will lift. When valve (8) lifts, fuel under light pressure will go through the four .0128 in. (0.325 mm) orifices (9) into the cylinder. When the fuel is sent to the cylinder, the force made by the pressure of the fuel in the nozzle body will become less. The force of the spring will then be more than the force of the pressure of the fuel in the nozzle body. Valve (8) will move to the closed position.

Valve (8) is a close fit with the inside of nozzle tip (13), this makes a positive seal for the valve.

When the fuel is sent to the cylinder, a very small quantity of fuel will leak by the valve guide. This fuel gives lubrication to the moving parts of the fuel injection nozzle.

FUNCTION OF FUEL JUNCTION BLOCK

The location of the fuel junction block (4) is at the right rear of the engine. The fuel lines from the fuel tank and the engine connect at fuel junction block (4).



CONNECTIONS FOR FUEL LINES AT THE FUEL JUNCTION BLOCK

1. Connection for constant bleed line to housing for fuel injection pumps. 2. Connection for constant bleed line to fuel tank. 3. Connection for fuel supply line to fuel filter. 4. Fuel junction block. 5. Connection for fuel supply line to fuel tank.

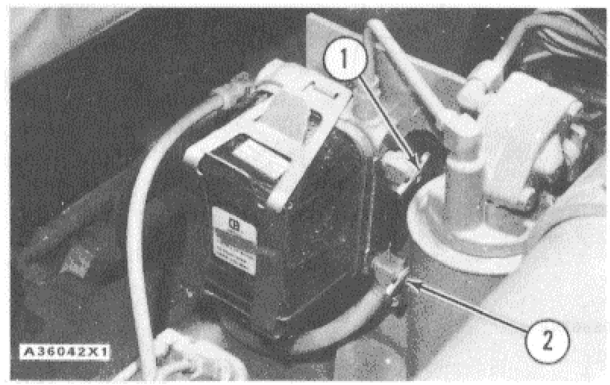
WATER SEPARATOR

The water separator is installed between the fuel tank and the rest of the fuel system. For efficiency in the action of the water separator the fuel flow must come directly from the fuel tank and through the water separator. This is because the action of going through a pump or valves before the water separator lowers the efficiency of the water separator.

The water separator can remove 95% of the water in a fuel flow of up to 33 gph (125 liter/hr) if the concentration of the water in the fuel is 10% or less. It is important to check the water level in the water separator frequently. The maximum amount of water which the water separator can hold is 0.8 pt. (0.4 liter). At this point the water fills the glass to 3/4 full. Do not let the water separator have this much water before draining the water. After the water level is at 3/4 full, the water separator loses its efficiency and the water in the fuel can go through the separator and cause damage to the fuel injection pump.

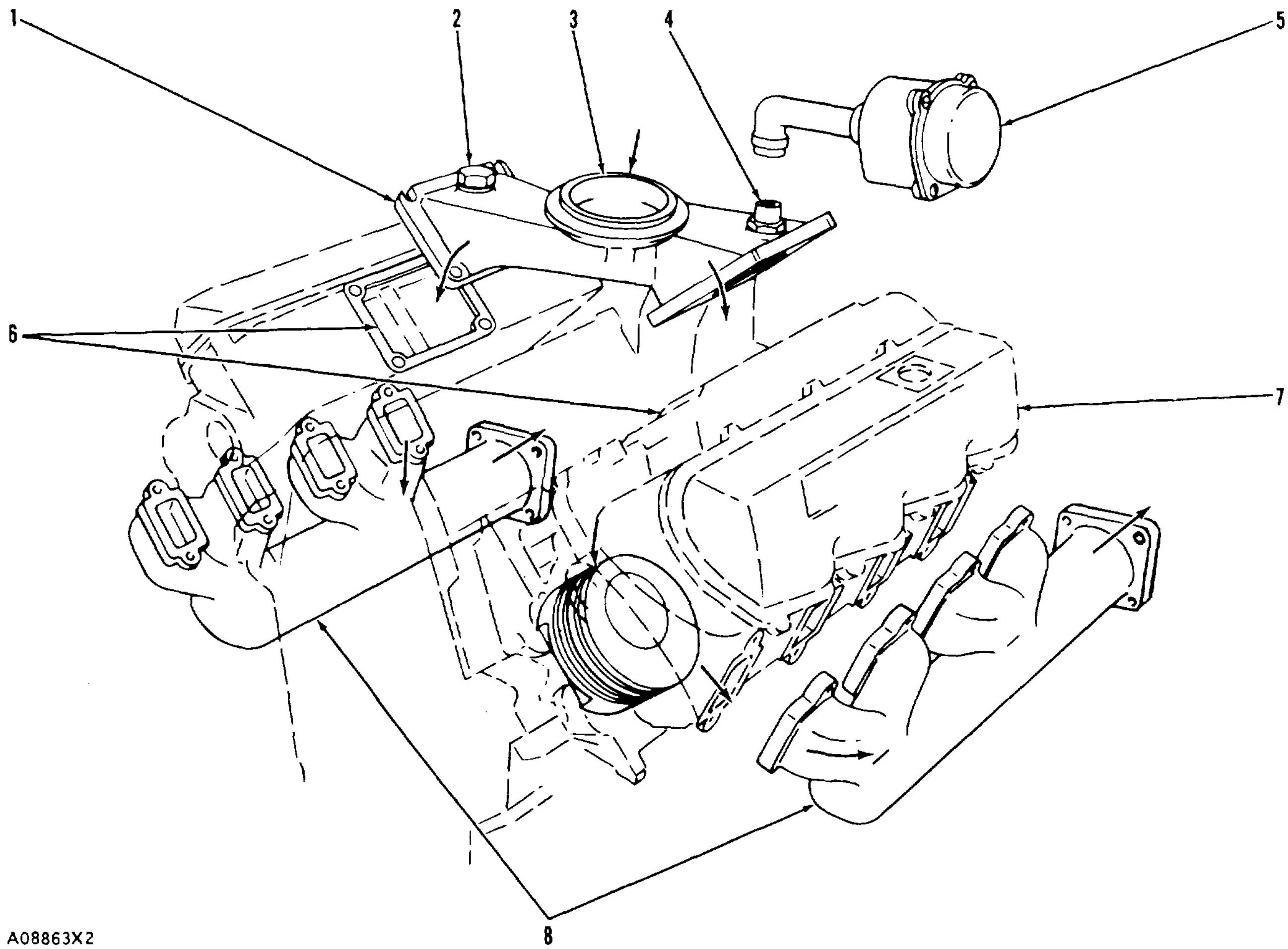
Drain the water from the water separator every day or when the water level gets to 1/' full. This gives the system protection from water in the fuel. If the fuel has a high concentration of water, or if the flow rate of fuel through the water separator is high, the water separator fills with water faster and must be drained more often.

To drain the water separator, open drain valve (2) in the drain line and vent valve (1) at the top of the water separator. Let the water drain until it is all out of the water separator. Close both valves.



WATER SEPARATOR

1 Vent Valve 2. Drain Valve



AIR INLET AND EXHAUST SYSTEM

1. Air inlet pipe. 2. Pipe plug. 3. Mounting flange for the air cleaner. 4. Fitting. 5. Positive crankcase ventilator valve. 6. Inlet manifolds. 7. Valve cover. 8. Exhaust manifolds.

The air inlet system is on the top side of the engine. The air cleaner goes on air inlet pipe (1). The air inlet pipe sends air to both cylinder heads.

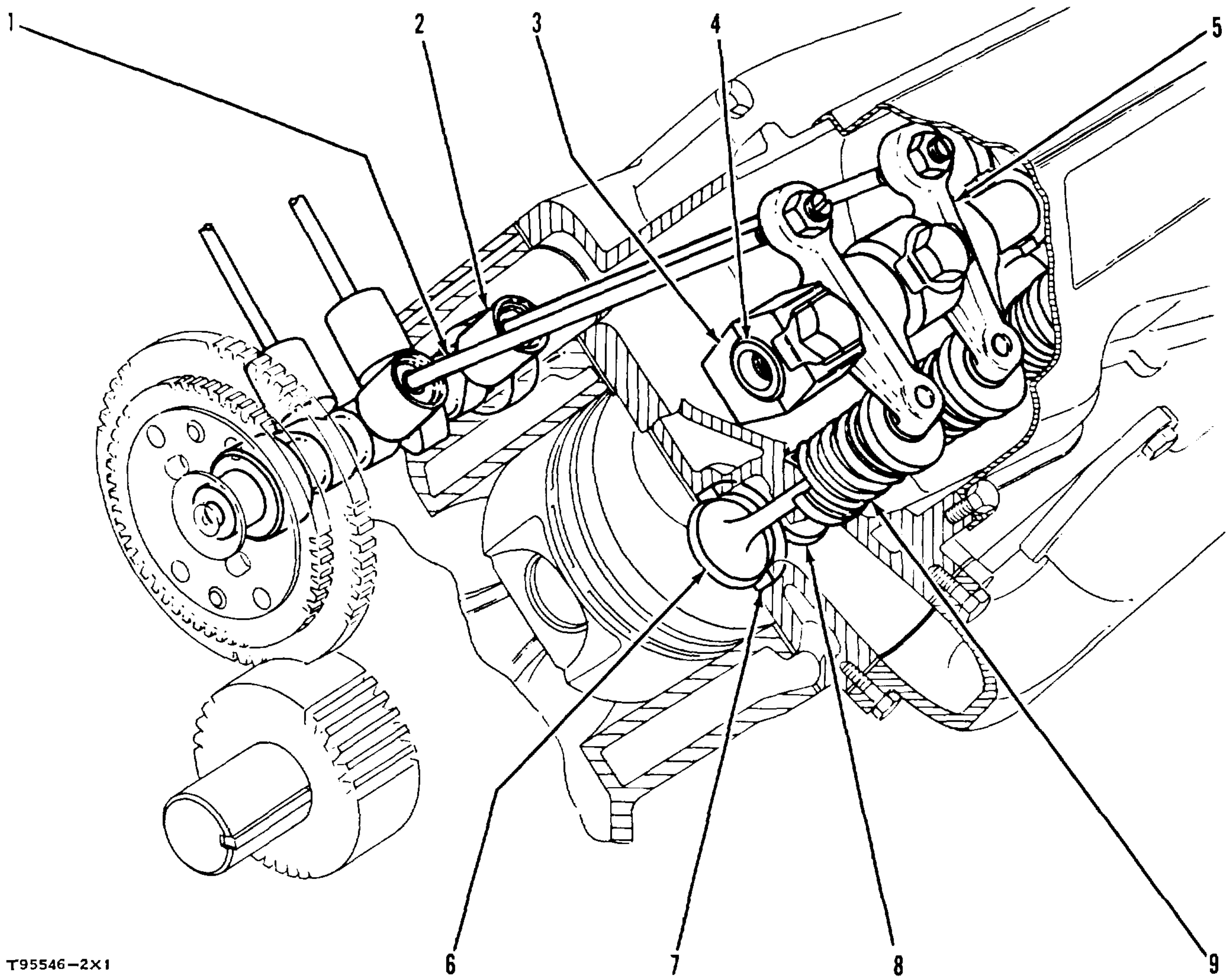
The air inlet pipe can not be turned end for end because the mounting flange for the air cleaner (3) has a small angle toward the front of the engine. The air inlet manifolds (6) are made as a part of the cylinder heads. The air inlet openings and the design of the combustion chamber give the air needed for complete combustion.

The exhaust system is on each side of the engine. The exhaust manifolds (8) are along the outside of the cylinder heads. The exhaust manifold for the right side of the engine will not go on the left side of the engine. The exhaust manifold for the left side of the engine will not go on the right side of the engine.

A positive crankcase ventilator valve (5) goes on valve cover (7). Valve (5) will return crankcase fumes to the engine through air inlet pipe (1).

Valve cover (7) can also be put on the other cylinder head. When valve cover (7) is put on the other cylinder head, fitting (4) must be exchanged with pipe plug (2) in the air inlet pipe (1).

CYLINDER HEAD AND VALVES



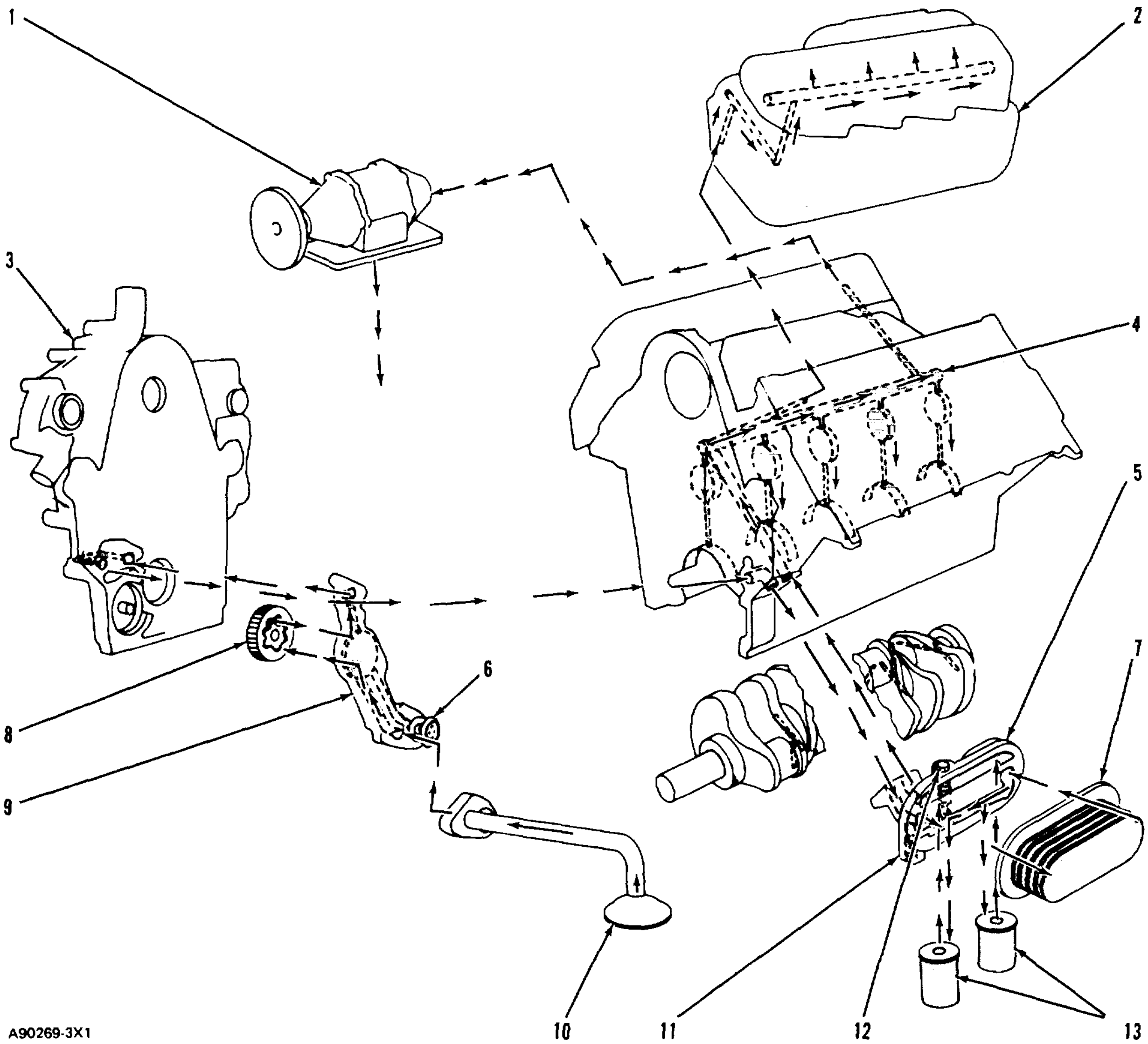
1. Push rod.2. Cam follower.3. Guide support.4. Rocker arm shaft. 5. Rocker arm.6. Exhaust valve. 7. Valve seat insert. 8. Intake valve. 9. Valve spring.

The valves and valve system components control the flow of inlet air and exhaust gases into and out of the cylinder during engine operation.

The intake and exhaust valves are opened and closed by movement of these components; crank-shaft, camshaft, cam followers, push rods, rocker arms, and valve springs. Rotation of the crankshaft causes rotation of the camshaft. The camshaft gear is driven by, and timed to, a gear on the front of the crankshaft. When the camshaft turns, the cams on the camshaft also turn and cause the cam followers to go up and down. This movement makes the push rods move the rocker arms. The movement of the rocker arms will make the intake and exhaust valves in the cylinder head open and close according to the firing order (injection sequence) of the engine. One valve spring for each valve helps to hold the valves in the closed position.

There is one intake and one exhaust valve for each cylinder. The valve seat insert for the exhaust valve can have replacement. The valve seat for the intake valve is machined in and is a part of the cylinder head. When the seat for the intake valve has been machined to the limits given in the SPECIFICATIONS, it can be bored (machined) for a valve seat insert. The valve guide bore is machined in and is a part of the cylinder head.

LUBRICATION SYSTEM



SCHEMATIC OF LUBRICATION SYSTEM

1. Vacuum pump or air compressor. 2. Cylinder head. 3. Front cover for the engine. 4. Oil manifold. 5. Base for the oil cooler. 6. Oil pump bypass valve. 7. Oil cooler. 8. Oil pump. 9. Cover for oil pump. 10. Suction bell for oil pump. 11. Oil cooler bypass valve. 12. Oil filter bypass valve. 13. Oil filters.

The lubrication system uses a six lobe, rotor type oil pump (8). Bolts hold the cover for the oil pump (9) on the front cover for the engine (3). The gear on the crankshaft drives the outer rotor. The outer rotor has rotation in a bearing in the front cover for the engine. The inner rotor goes on a short shaft in the front cover for the engine. The inner rotor is driven by the outer rotor.

Oil pump bypass valve (6), in the cover for the oil pump (9), controls the pressure of the oil coming from oil pump (8). The pump can put more oil into the system than needed. When the pressure of the oil going into the engine is more than 75 to 85 psi (520 to 590 kPa), the bypass valve (6) will open. This permits the oil that is not needed to bypass the system.

Oil from the oil pan is pulled through the suction bell for the oil pump (10) by oil pump (8). The oil is sent by the pump to an oil passage in the front cover for the engine (3). Oil from this passage goes to the cylinder block and on to base for the oil cooler (5). The base for the oil cooler is on the left side of the engine, near the front of the engine. Bypass salve (I), in the base for the oil cooler, will let the oil go around the oil cooler (7) when the oil is cold or if the restriction in the oil cooler is more than the other parts of the system. A difference in pressure of 12 to 15 psi (85 to 105 kPa) between the oil inlet and the oil outlet will open the bypass valve.

Oil from the oil cooler goes to the oil filters. Bypass valve (12), in the base for the oil cooler will let oil go around oil filters (13) if there is a restriction in the oil filters.

There are two pressure outlets in the base for the oil cooler. The pressure outlets are on the outlet side of the oil cooler and oil filters. The pressure outlets are for the sending unit and switch for the oil pressure.

Oil from the oil filters (13) goes through a passage in the cylinder block to oil manifold (4). The oil manifold is in the center of the cylinder block, above the camshaft, and goes the full length of the cylinder block. Oil goes from the oil manifold to the bearings for the camshaft. There are grooves in the bores in the cylinder block around the bearings for the camshaft. The bearing surfaces (journals) on the camshaft get lubrication from these grooves through a hole in the bearings for the camshaft.

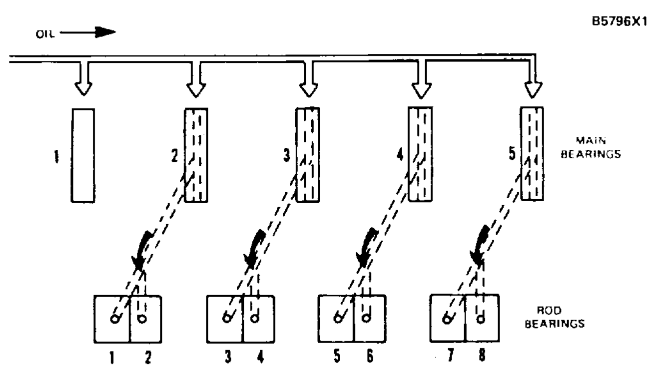
Some of the oil goes around the grooves and down through a passage to a hole and groove in the top half of the main bearing. Oil from the hole and groove gives lubrication to the bearing surfaces (journals) of the crankshaft for the main bearings.

Oil gets into the crankshaft through holes in the bearing surfaces (journals) for the main bearings. Passages connect the bearing surface (journal) for the main bearing with the bearing surface (journal) for the connecting rod. The piston pins get lubrication from oil thrown by other parts.

Oil for the rocker arms comes from the oil manifold (4) through passages in the cylinder block. The passages in the cylinder block are in alignment with a passage in each cylinder head. The passage to the cylinder head on the left side is near the front of the cylinder block. The passage to the cylinder head on the right side is near the rear of the cylinder block.

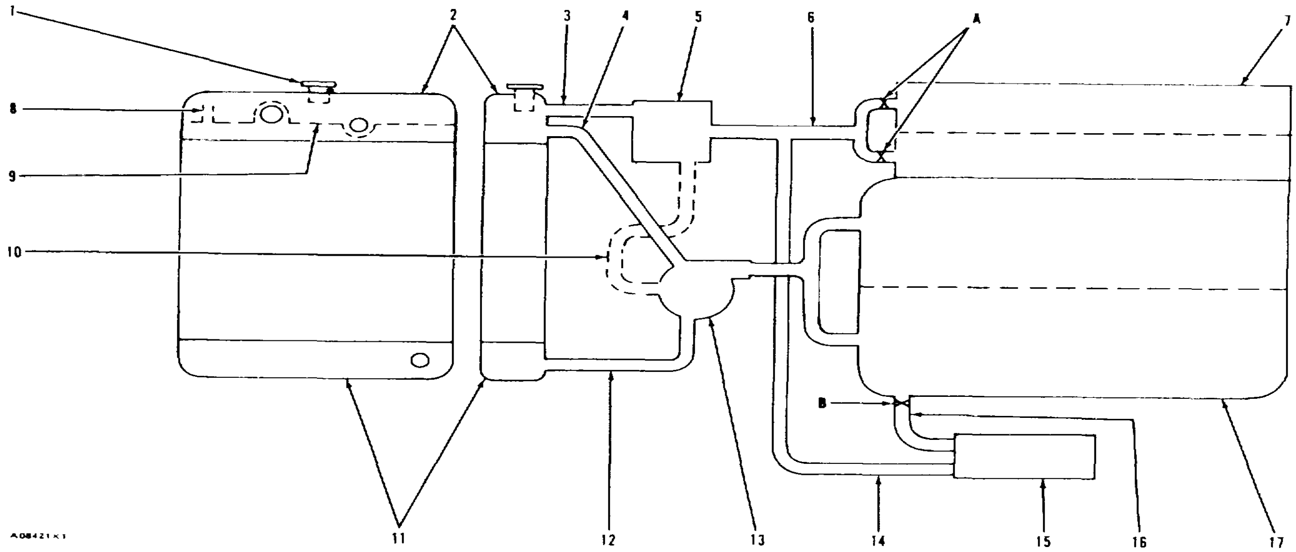
The passage in each cylinder head sends the oil into an oil hole in the bottom of the mounting surface of the bracket that holds the shaft for the rocker arms. The oil hole is in the front bracket on the left side and in the rear bracket on the right side. The oil then goes up through the bracket and into the center of the shaft for the rocker arms. Oil goes along the center of the shaft to the bearings for the rocker arms. From the rocker arms, the oil is pushed through small holes to give lubrication to the valves, push rods, cam followers, and cam - shaft lobes.

After the lubrication oil has done its work, it will return to the oil pan for the engine.



SCHEMATIC OF OIL PASSAGES IN CRANKSHAFT

COOLING SYSTEM



COOLING SYSTEM WITH STANDARD VERTICAL RADIATOR

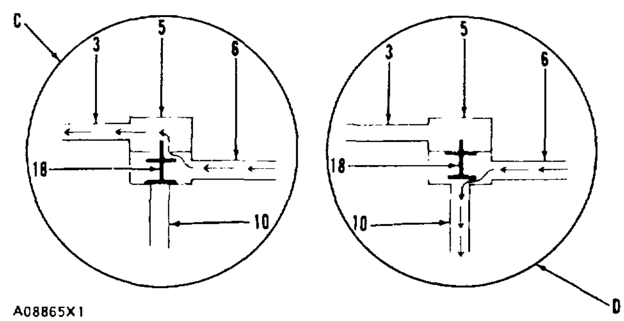
1. Radiator cap. 2. Radiator top tank. 3. Radiator top hose. 4. Shunt line. 5. Housing for water temperature regulators. 6 Coolant to housing for water temperature regulators. 7. Cylinder heads (two). 8. Vent tube. 9. Surge tank. 10. Inside bypass. 11. Radiator bottom tank. 12. Radiator bottom hose. 13. Water pump.14. Outlet line for oil cooler. 15. 011 cooler. 16. Inlet line for oil cooler. 17. Cylinder block. A. Orifices between cylinder heads and front cover. B. Orifice in oil cooler inlet.

Water pump (13) is installed on the front face of the front cover for the engine and is driven by V belts from the crankshaft pulley. The inlet opening of water pump (13) is connected to radiator bottom hose (12). The outlet flow of coolant from water pump (13) goes through inside passages in the front cover for the engine.

As the coolant goes from the water pump, it divides and goes through the inside passages in the front cover for the engine to cylinder block (17). Most of the coolant goes through cylinder block (17) and up to cylinder heads (7). From cylinder heads (7) the coolant goes forward through orifices (A) to the front cover for the engine.

Part of the coolant going to the left side (as seen from the flywheel) of cylinder block (17) goes through orifice (B) to inlet line (16) and on to oil cooler (15), to cool the oil for lubrication of the engine, and back to the front cover for the engine through outlet line (14).

From the front cover for the engine, the coolant either goes to the inlet for water pump (13) or to the radiator. If the coolant is cold (cool), the water temperature regulators (18) will be closed. The coolant will go through inside bypass (10) to water pump (13). If the coolant is warm, the water temperature regulators (18) will be open. When the water temperature regulators (18) are open, they make a restriction in the inside bypass (10) and the coolant goes through radiator top hose (3) and into radiator top tank (2). Coolant then goes through the core of the radiator to the radiator bottom tank (11) where it is again sent through the cool-



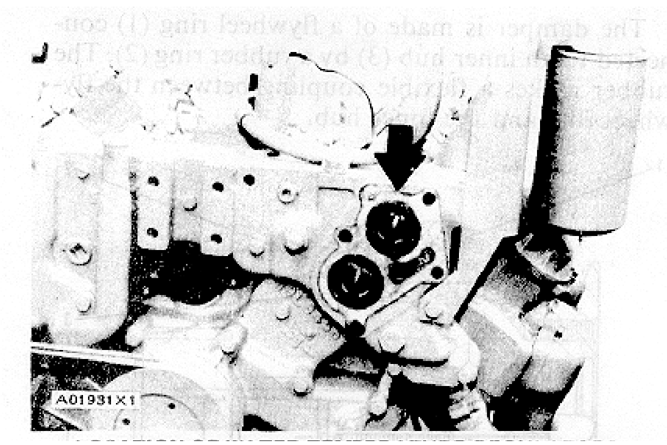
FLOW OF COOLANT

3. Radiator top hoses. 5. Housing (water temperature regulators). 6. Coolant to housing for water regulators. 10. Inside bypass. 18. Water temperature regulators (two). C. Flow with warm coolant. D. Flow with cold coolant.

ing system. A small part of the coolant goes through inside bypass (10) when temperature regulators (18) are open.

CAUTION

Never run an engine unless the water temperature regulators are installed. With no water temperature regulators in the system, the coolant will continually bypass the radiator and the engine will get too hot.



LOCATION OF WATER TEMPERATURE REGULATORS

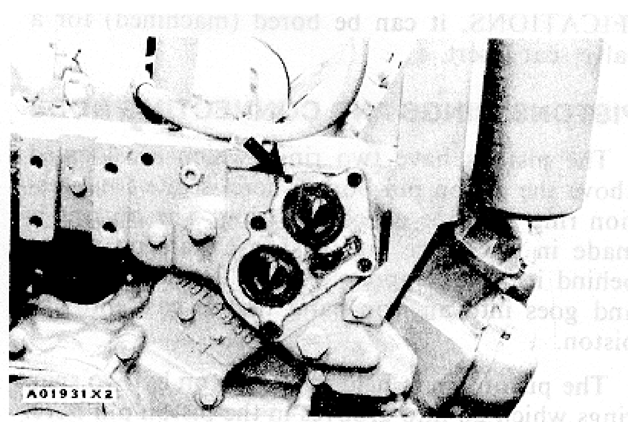
The vertical radiator is made with a top tank (2) above the core and a surge tank (9) above the top tank. Vent tube (8) connects radiator top tank (2) and surge tank (9).

Surge tank (9) has a shunt line (4) that connects to the inlet of water pump (13). This shunt type system keeps a positive pressure on the inlet of water pump (13) at all times. When putting coolant in the cooling system, coolant from surge tank (9) goes through shunt line (4) to the inlet of water pump (13) and fills cylinder block (17) from the bottom. By filling the system from the bottom, any air in the system is pushed out through radiator top tank (2), through vent tube (8) into surge tank (9).

Radiator cap (1) is used to keep the correct pressure in the cooling system. This pressure keeps a constant supply of coolant to water pump (13). If this pressure goes too high, a valve in radiator cap (1) moves (opens) to get a reduction of pressure. When the correct pressure is in the cooling system, the valve in radiator cap (1) moves down (to the closed position).

A vent valve is installed in the vent hole located in the front housing and the outlet elbow is used to let the air out of the cylinder block and head when filling the cooling system with coolant.

The vent valve is open when the cooling system is being filled. When the engine is in operation, the vent valve will close and not let the coolant go through. This will help increase the temperature of the coolant at low engine speeds.



LOCATION OF VENT HOLE

It is important to keep the vent hole clean and open. If the vent hole is not open it will keep the engine from completely filling with coolant.

BASIC BLOCK

CYLINDER BLOCK

The cylinders are a part of the cylinder block. There are no replaceable cylinder liners. The cylinders can be machined (bored) up to .040 in. (1.02 mm) oversize for reconditioning. The cylinders in the block are at a 900 angle to each other. There are fire main bearings in the block to support the crankshaft.

CYLINDER HEAD

There is one cylinder head for each side (bank) of the engine. One intake and one exhaust valve is used for each cylinder. The valve guides are a part of the cylinder head and can not be replaced. A valve seat insert is used for the exhaust valve and can be replaced. When the seat for the intake valve has been machined to the limits given in the SPECIFICATIONS, it can be bored (machined) for a valve seat insert.

PISTONS, RINGS AND CONNECTING RODS

The pistons have two rings which are located above the piston pin bore. There is one compression ring and one oil control ring. The oil ring is made in one piece and has an expansion spring behind it. The compression ring is also one piece and goes into an iron band that is cast into the piston.

The piston pin is held in the piston by two snap rings which go into grooves in the piston pin bore.

The connecting rod is installed on the piston with the boss on the connecting rod on the same side as the crater in the piston. The connecting rod bearings are held in location with a tab that goes into a groove in the connecting rod.

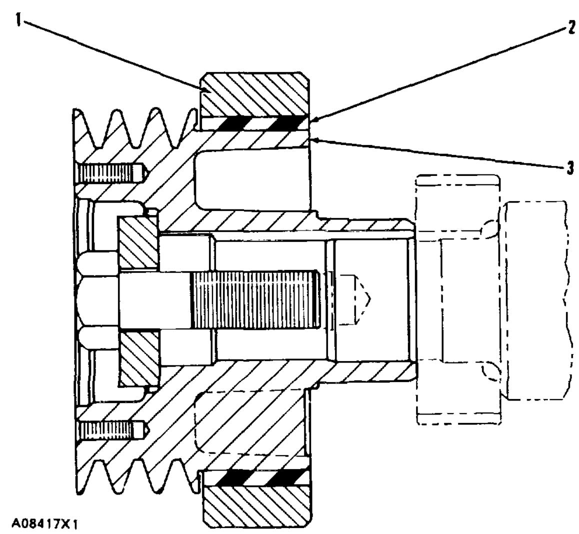
CRANKSHAFT

The force of combustion in the cylinders is changed to usable rotating power by the crank - shaft. The crankshaft can have either six or eight counterweights. A gear on the front of the crank - shaft turns the engine camshaft gear and the engine oil pump. The end play of the crankshaft is controlled by the thrust bearing on No. 4 main bearing.

VIBRATION DAMPER

The twisting of the crankshaft, due to the regular power impacts along its length, is called twisting (torsional) vibration. The vibration damper is installed on the front end of the crankshaft. It is used for reduction of torsional vibrations and stops the vibration from building up to amounts that cause damage.

The damper is made of a flywheel ring (1) connected to an inner hub (3) by a rubber ring (2). The rubber makes a flexible coupling between the fly-wheel ring and the inner hub.



CROSS SECTION OF VIBRATION DAMPER
1. Flywheel ring. 2. Rubber ring. 3. Inner hub.

ELECTICAL SYSTEM

The electrical system has three separate circuits: the charging circuit, the starting circuit and the low amperage circuit. Some of the electrical system components are used in more than one circuit. The battery (batteries), circuit breaker, ammeter, cables and wires from the battery are all common in each of the circuits.

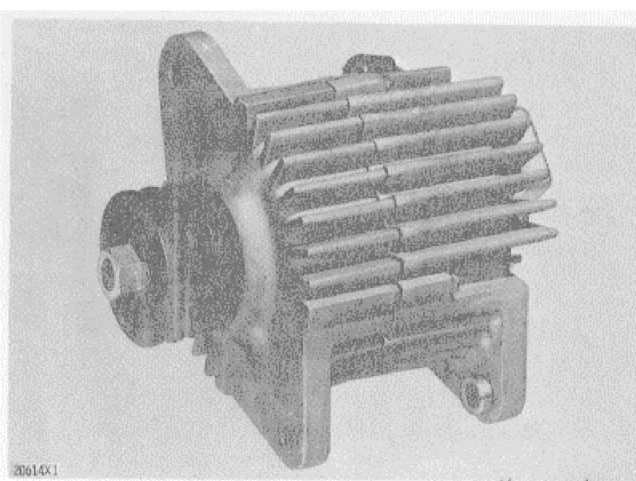
The charging circuit is in operation when the engine is running. An alternator makes electricity for the charging circuit. A voltage regulator in the circuit controls the electrical output to keep the battery at full charge. The starting circuit is in operation only when the start switch is activated.

The low amperage circuit and the charging circuit are both connected to the same side of the ammeter. The starting circuit connects to the opposite side of the ammeter.

SYSTEM COMPONENTS

Alternator (Prestolite) 2P1204

The alternator is driven by V type belts from the crankshaft pulley. It is a 24 volt, 19 ampere unit with a regulator which has no moving parts (solid state) installed on the side opposite the pulley. The alternator is made up of the following parts: head assembly on the drive end, rotor assembly, stator assembly, rectifier and heat removal assemblies, brush and holder assembly, head assembly on the ring end, and regulator.



The alternator has diodes which change the alternating current (AC) made by the alternator to direct current (DC). This direct current is used to make magnet like lines of force in a space around the stator assembly (field current). The field current is controlled by the regulator.

Alternator (Delco-Remy)

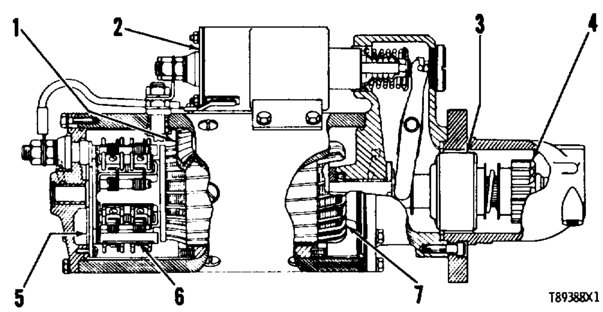
The alternator is a three phase, self rectifying charging unit. The regulator for the alternator is part of the alternator. The alternator is driven from the crankshaft pulley by two V type belts.

The only part in the alternator which has movement is the rotor. The rotor is held in position by a ball bearing at the drive end and a roller bearing at the rectifier end.

The compartment for the regulator is sealed. The regulator controls the alternator output according to the needs of the battery and the other components in the electrical system.

Starting Motor

The starting motor is used to turn the engine flywheel fast enough to get the engine running.

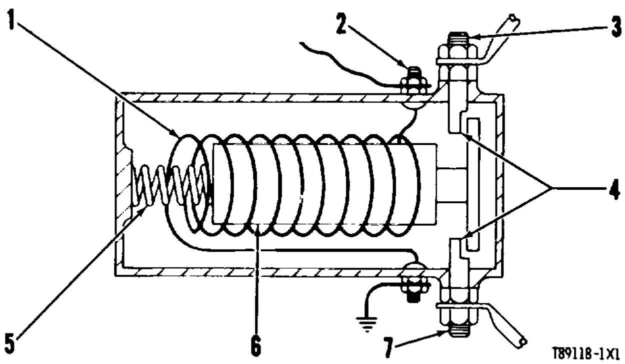


STARTING MOTOR
1. Field. 2. Solenoid. 3. Clutch. 4. Pinion. 5. Commutator. 6. Brush assembly. 7. Armature.

The starting motor has a solenoid. When the start switch is activated, electricity from the electrical system will cause the solenoid to move the starter pinion to engage with the ring gear on the flywheel of the engine. The starter pinion will engage with the ring gear before the electric contacts in the solenoid close the circuit between the battery and the starting motor. When the start switch is released, the starter pinion will move away from the ring gear of the flywheel.

Solenoid

A solenoid is a magnetic switch that uses low current to close a high current circuit. The solenoid has an electromagnet with a core (6) which moves.



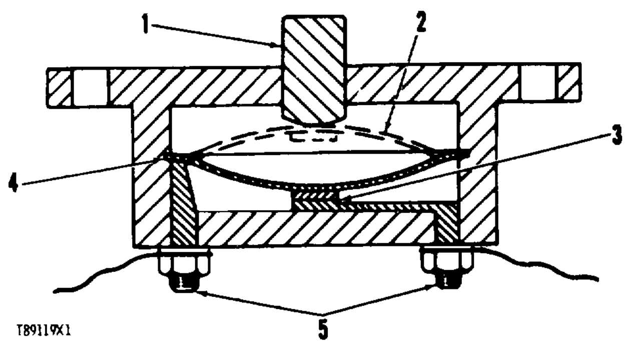
SCHEMATIC OF A SOLENOID
1. Coil. 2. Switch terminal. 3. Battery terminal. 4. Contacts. 5.Spring. 6.Core. 7. Component terminal.

There are contacts (4) on the end of core (6). The contacts are held in the open position by spring (5) that pushes core (6) from the magnetic center of coil (1). Low current will energize coil (1) and make a magnetic field. The magnetic field pulls core (6) to the center of coil (1) and the contacts close.

Circuit Breaker

The circuit breaker is a safety switch that opens the battery circuit if the current in the electrical system goes higher than the rating of the circuit breaker.

A heat activated metal disc with a contact point completes the electric circuit through the circuit breaker. If the current in the electrical system gets too high, it causes the metal disc to get hot. This heat causes a distortion of the metal disc which opens the contacts and breaks the circuit. A circuit breaker that is open can be reset after it cools. Push the reset button to close the contacts and reset the circuit breaker.



CIRCUIT BREAKER SCHEMATIC
1. Reset button. 2. Disc in open position. 3. Contacts. 4. Disc. 5. Battery circuit terminals.

AIR COMPRESSOR

GENERAL

The function of the air compressor is to build up and maintain the air pressure required to operate air powered devices in air brake or air auxiliary systems.

DESCRIPTION

The Tu Flo Type 400 is a two cylinder, single stage, air cooled, reciprocating piston type compressor. The rated capacity of all Bendix compressors is their piston displacement in cubic feet per minute when operating at 1250 RPM. The rated capacity of the Tu Flo 400 compressor is 7-1/4 cubic feet per minute. SEE FIG. 1.

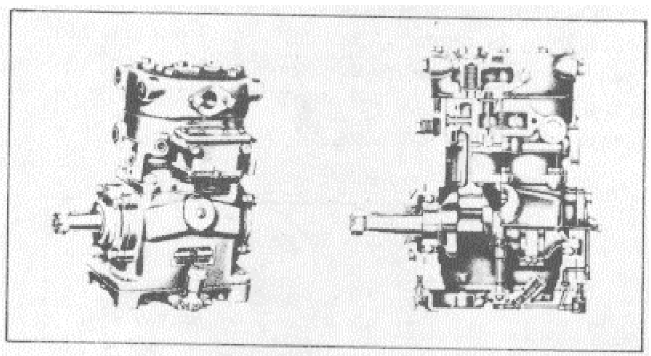


FIGURE 1 - TU FLO 400

Tu Flo type compressors have automatic type inlet valves. Their unloading mechanisms are located in the cylinder block and they have no external moving parts.

The compressor is engine lubricated. Oil under pressure from the Diesel engine is forced through the oil passage in the crankshaft and out around each connecting rod journal. The turning motion of the crankshaft throws the oil that is forced out at the journals, against the cylinder bores and crankcase walls, lubricating the bores and crankshaft bearings.

The wrist pins and bushings are lubricated by oil dripping from a drip-boss on the piston into a "catch-funnel" at the top of the rod and through the drilled passage to the bushings and pins.
SEE FIG. 2

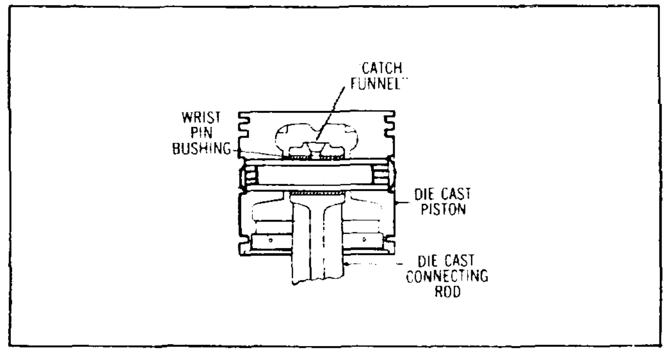


FIGURE 2 - PISTONS & CONNECTING RODS

A nameplate is attached to the crankcase of the compressor. It shows the piece number, type and serial number (Fig. 3). A nameplate with a black background denotes a new compressor, whereas a nameplate with a red back-ground designates that the compressor is a factory reconditioned unit. The compressor is identified by the piece number which is the number to use when reference is made to a particular compressor. The type and serial number is supplementary information.

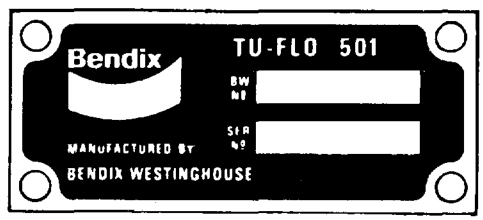


FIGURE 3 - TYPICAL COMPRESSOR NAMEPLATE

OPERATION

GENERAL

The compressor runs continuously while the engine is running but actual compression of air is controlled by a governor which stops or starts the compression of air by loading or unloading thelcompressor in conjunction with its unloading mechanism. This is done when the air pressure in the system reaches the desired maximum or minimum pressures.

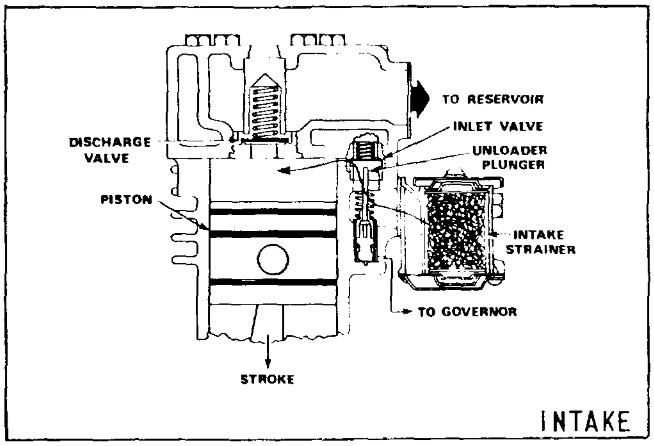


FIGURE 4

INTAKE AND COMPRESSION (Loaded)

During the down stroke of the piston, a slight vacuum created above the piston causes the inlet valve to move off its seat. Atmospheric air is drawn in through the compressor intake, by the open inlet valve, and on top of the piston (Fig. 4). As the piston starts its upward stroke, the air that was drawn in on the down stroke is being compresses.

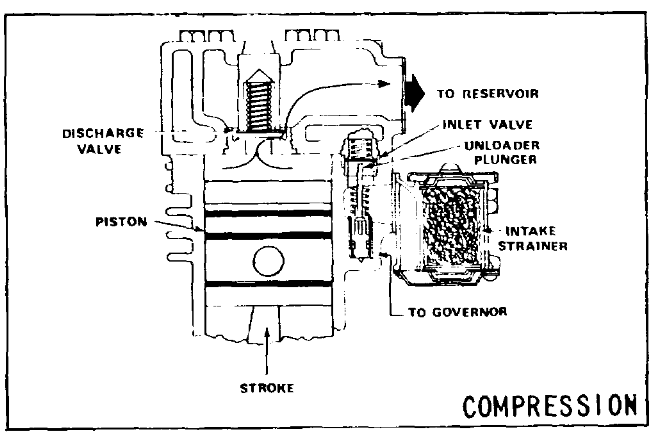


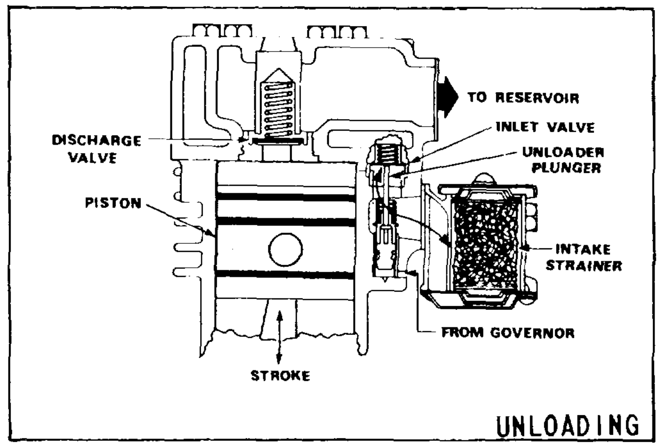
Figure 5

Now, air pressure on top of the inlet valve plus the force of its spring, returns the inlet valve to its seat. The piston continues the upward stroke and compresses the air sufficiently to overcome the discharge valve spring and unseat the discharge valve. The compressed air then flows by the open discharge valve, into the discharge line and on to the reservoirs (Fig. 5).

As the piston reaches the top of its stroke and starts down, the discharge valve spring returns the discharge valve to its seat. This prevents the compressed air in the discharge line from returning to the cylinder bore as the intake and compression cycle is repeated.

NON-COMPRESSION (Unloaded)

When the air pressure in the reservoir reaches the high pressure setting of the governor, the governor opens, allowing air to pass from the reservoir through the governor and into the cavity beneath the unloader pistons. This lifts the unloader pistons and plungers. The plungers move up and hold the inlet valves off their seats (Fig. 6).



With the inlet valves held off their seats by the unloader pistons and plungers, air is merely pumped back and forth between the two cylinders. When air is used from the reservoir and the pressure drops to low pressure setting of the governor, the governor closes and in doing so exhausts the air from beneath the unloader pistons. The unloader saddle spring forces the saddle, pistons and plungers down and the inlet valves return to their seats. Compression is then resumed.

TROUBLESHOOTING

Troubleshooting can be difficult. On the following pages there is a list of possible problems. To make a repair to a problem, make reference to the cause and correction.

This list of problems, causes, and corrections, will only give an indication of where a possible problem can be, and what repairs are needed. Normally, more or other repair work is needed beyond the recommendations in the list. Remember that a problem is not normally caused only by one part, but by the relation of one part with other parts. This list can not give all possible problems and corrections. The serviceman must find the problem and its source, then make the necessary repairs.

TROUBLESHOOTING SYMPTOM INDEX

Item	Problem
1.	Engine Will Not Start.
2.	Misfiring or Running Rough.
3.	Stall at Low rpm.
4.	Sudden Changes in Engine rpm.
5.	Not Enough Power.
6.	Too Much Vibration.
7.	Loud Combustion Noise
8.	Loud Noise (Clicking) From Valve Compartment.
9.	Oil in Cooling System.
10.	Mechanical Noise (Knock) in Engine.
11.	Fuel Consumption Too High.
12.	Loud Noise From Valves or Valve Drive Components.
13.	Little Movement of Rocker Arm and Too Much Valve Clearance.
14.	Valve Spring Lock is Free.
15.	Oil at the Exhaust.
16.	Little or No Valve Clearance.
17.	Engine Has Early Wear.
18.	Coolant in Lubrication Oil.
19.	Too Much Black or Gray Smoke.
20.	Too Much White or Blue Smoke.
21.	Engine Has Low Oil Pressure.
22.	Engine Uses Too Much Lubrication Oil.
23.	Engine Coolant is Too Hot.
24.	Starting Motor Does Not Turn.
25.	Alternator Gives No Charge.
26.	Alternator Charge Rate is Low or Not Regular.
27.	Alternator Charge Too High.
27.	Alternator Charge Too High.
28.	Alternator Has Noise.
29.	Exhaust Temperature is Too High.
30.	Compressor Passes Excessive Oil
31.	Noisy Compressor Operations
32.	Excessive Buildup and Recovery Time
33.	Compressor Fails to Unload
34.	Compressor Leaks Oil
35.	Compressor Constantly Cycles
36.	Compressor Head Gasket Failure

1. ENGINE WILL NOT START

Cause	Correction
Empty Fuel Tank	Put fuel in fuel tank.
Bad Quality Fuel	Remove the fuel from the fuel tank. Install a new fuel filter element. Put a good grade of clean fuel in the fuel tank.
Dirty Fuel Filter	Install new fuel filter.
Dirty or Broken Fuel Lines	Clean or install new fuel lines as necessary.
Linkage to Sleeve Control Shaft is Held in Shutoff Position	Check the operation of the shut-off solenoid and the shut-off linkage. Solenoid must pull up to compress spring for fuel turn on. Check governor linkage for free movement. Sleeves must turn freely on pump plungers in all positions of sleeve control shaft. The thrust collar must turn freely on the governor shaft at all positions between shut-off and full load. If linkage does not move freely under these conditions, clean all parts thoroughly. Inspect all parts for wear and make replacement where needed.
Fuel Pressure is Too Low	Replace the fuel filter. Inspect the bypass valve for free movement. Install a new bypass valve if necessary.
Air In The Fuel System	Find the air leak in the fuel system and correct it. Loosen each fuel line nut at the injection pumps and open the manual bleed valve. Loosen the bolts that hold the torque spring or stop bar cover. This will let out any air that is in the governor housing. After all air is out of fuel system, tighten bolts that hold torque spring or stop bar cover. Tighten fuel line nuts according to the SPECIFICATIONS. Close manual bleed valve.
Fuel System Not Timed	Make adjustment to timing if necessary. Correctly to Engine
Constant Bleed Valve Stays	Replace constant bleed valve. Open (Not enough fuel pressure for starting)
No Over Fueling Spring	Install an over fueling spring.

2. MISFIRING OR RUNNING ROUGH

Cause	Correction
Fuel Pressure is Low	Make sure there is enough fuel in the fuel tank. Look for leaks or bad bends in the fuel line between fuel tank and fuel transfer pump. Look for air in the fuel system. Check fuel pressure. The outlet pressure of the fuel transfer pump at full load speed is 30 + 5 psi (205 $\pm$ 35 kPa). If fuel pressure is lower than above pressure, install a new fuel filter element. Inspect the fuel bypass valve for free movement. Install a new fuel bypass valve if necessary.

2. MISFIRING OR RUNNING ROUGH (CONT.)

Cause	Correction
Air In The Fuel System	Find the air leak in the fuel system and correct it. Loosen each fuel line nut at the injection pumps and open the manual bleed valve. Loosen the bolts that hold the torque spring or stop bar cover. This will let out any air that is in the governor housing. After all air is out of fuel system, tighten bolts that hold torque spring or stop bar cover. Tighten fuel line nuts according to the SPECIFICATIONS. Close manual bleed valve.
Leak or Break in Fuel Line Between Injection Pump and Injection Valve	Install a new fuel line.
Wrong Valve Clearance	Make adjustment according to Testing and Adjusting.
Defect in Fuel Injection Nozzle	Run engine at rpm that gives maximum misfiring or rough run ning. Then loosen a fuel line nut on the injection line for each cylinder, one at a time. Find the cylinder where loosening the fuel line nut does not change the way the engine runs. Test the fuel injection nozzle for that cylinder. Install new parts where needed.
Wrong Fuel Injection Timing	Make adjustment to timing.

3. STALL AT LOW RPM

Cause	Correction
Fuel Pressure is Low	Make sure there is enough fuel in the fuel tank. LIook for leaks or bad bends in the fuel line between fuel tank and fuel transfer pump. Look for air in the fuel system. Check fuel pressure. The outlet pressure of the fuel transfer pump at full load speed is 30 $\pm$ 5 psi (205 $\pm$ 35 kPa). If fuel pressure is lower than above pressure, install a new fuel filter element. Inspect the bypass valve for free movement. Install a new bypass valve if necessary.
Idle rpm Too Low	Make adjustment to governor so idle rpm is the same as given in the RACK SETTING INFORMATION.
Defect in Fuel Injection Nozzle	Install a new fuel injection nozzle.
Wrong Valve Clearance	Make adjustment according to Testing and Adjusting.
Spring for Dashpot Governor Installed Wrong	Install spring correctly.

(Cont. next page)

4. SUDDEN CHANGES IN ENGINE RPM

Cause	Correction
Air In The Fuel System	Find the air leak in the fuel system and correct it. Iloosen each fuel line nut at the injection pumps and open the manual bleed Nalec. Loosen the bolts that hold the torque spring or stop bar cover. This will let out any air that is in the governor housing. After all air is out of fuel system, tighten bolts that hold torque spring or stop bar cover. Tighten fuel line nuts according to the SPECIFICATIONS. Close manual bleed valve.
Broken Torsion Spring on Sleeve Control Shaft	Install new parts as needed.
Linkage In Governor Does Not Move Freely	Clean all linkage and inside of governor housing. Install new parts for those parts that have damage.
Governor Springs Not Completely on Spring Seat	Put springs completely on spring seat.
Spring for Dashpot Governor Installed Wrong	Install spring correctly.

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5. NOT ENOUGH POWER

Cause	Correction
Bad Quality Fuel	Remove the fuel from the fuel tank. Install a new fuel filter element. Put a good grade of clean fuel in the fuel tank.
Fuel Pressure is Low	Make sure there is fuel in the fuel tank. Look for leaks or bad bends in the fuel line between fuel tank and fuel transfer pump. Look for air in the fuel system. Check fuel pressure. The outlet pressure of the fuel transfer pump at full load speed is 30 $\pm$ 5 psi (205 + 35 kPa). If fuel pressure is lower than above pressure, install a new fuel filter element. Inspect the fuel bypass salve for free movement. Install a new fuel bypass valve if necessary.
Air In The Fuel System	Find the air leak in the fuel system and correct it. Loosen each fuel line nut at the injection pumps and open the manual bleed valve. Loosen the bolts that hold the torque spring or stop bar cover. This will let out any air that is in the governor housing. After all air is out of fuel system, tighten bolts that hold torque spring or stop bar cover. Tighten fuel line nuts according to the SPECIFICATIONS. Close manual bleed valve.
Air Inlet Has A Restriction	Check air inlet pipes and air cleaner for restrictions.
Wrong Fuel Setting	Make adjustments as necessary.
Governor Linkage	Make adjustment to get full travel of linkage. Install new parts for those that have damage or defects.
Defect in Timing Advance Unit	Replacement of timing advance unit is needed.

5. NOT ENOUGH POWER (CONT.)

Cause	Correction
Wrong Valve Clearance	Make adjustment according to Testing and Adjusting.
Defect in Fuel Injection Nozzle	Run engine at rpm that gives maximum misfiring or rough running. Then loosen a fuel line nut on the injection line for each cylinder, one at a time. Tighten each fuel line nut before loosening the next one. Find the cylinder where loosening the fuel line nut does not change the way the engine runs. Test the fuel injection nozzle for that cylinder. Install new parts where needed.
Wrong Fuel Injection Timing	Make adjustment to timing.
Fuel Shut-off Solenoid or Shut-off Linkage Causing a Restriction in the Travel of the Shaft for the Sleeves	Check for correct full power with solenoid removed. If the engine has full power with the solenoid removed, the problem is in the solenoid or the shut-off linkage. Check for free travel of the linkage.
Constant Bleed Valve Stays Closed	Replace constant bleed valve.
Exhaust System Has A Restriction	Check exhaust pipe and muffler for restrictions.

6. TOO MUCH VIBRATION

Cause	Correction
Loose Bolt or Nut Holding Pulley or Damper	Tighten bolt or nut.
Pulley or Damper Has A Defect	Install a new pulley or damper.
Engine Supports Are Loose, Worn, or Have a Defect	Tighten all mounting bolts. Install new components if necessary.
Misfiring or Running Rough	Make Reference to Item 2.

7. LOUD COMBUSTION NOISE (SOUND)

Cause	Correction
Bad Quality Fuel	Remove the fuel from the fuel tank. Install a new fuel filter element. Put a good grade of clean fuel in the fuel tank.
Defect in Fuel Injection Nozzle	Install a new fuel injection nozzle.
Wrong Fuel Injection Timing	Make adjustment to timing.

8. LOUD NOISE (CLICKING) FROM VALVE COMPARTMENT

Cause	**Correction**
Broken Valve Spring(s) or Locks	Install new parts where necessary. Broken locks can cause the valve to slide into the cylinder. This will cause much damage.
Loose Bolts Holding Rocker Arm Assembly	Tighten to 18 + 5 lb. ft. (24 + 7 N-m).
Too Much Valve Clearance	Make adjustment according to Testing and Adjusting.

9. OIL IN COOLING SYSTEM

Cause	Correction
Defect in Core of Oil Cooler	Install a new core in the oil cooler.
Defect in Head Gasket	Install a new head gasket.

10. MECHANICAL NOISE (KNOCK) IN ENGINE

Cause	**Correction**
Failure of Bearing For Connecting Rod	Inspect the bearing for the connecting rod and the bearing surface on the crankshaft. Install new parts where necessary.
Damage to Crankshaft	Make replacement of the crankshaft.
Defect in Attachment	Repair or install new components.

11. FUEL CONSUMPTION TOO HIGH

Cause	**Correction**
Fuel System Leaks	Replacement of parts is needed at points of leakage.
Defect in Timing Advance Unit	Replacement of timing advance unit is needed.
Wrong Fuel Injection Timing	Make adjustment to timing.

12. LOUD NOISE FROM VALVES OR VALVE DRIVE COMPONENTS

Cause	**Correction**
Broken Valve Spring(s)	Make replacement of parts with damage.
Broken Camshaft	Make replacement of parts with damage. Clean engine thoroughly.
Broken Timing Advance Gear	Make replacement of timing advance unit.

13. LITTLE MOVEMENT OF ROCKER ARM AND TOO MUCH VALVE CLEARANCE

Cause	Correction
Not Enough Lubrication	Check lubrication in valve compartment. There must be a strong flow of oil at engine rpm, but only a small flow at low rpm. Oil passages must be clean, especially those sending oil to the cylinder head.
Rocker Arm Parts Worn	If there is too much wear, install new parts or rocker arms. Make adjustment of valve clearance according to Testing and Adjusting.
End of Valve Stem Worn	If there is too much wear, install new valves. Make adjustment of valve clearance according to Testing and Adjusting.
Too Much Valve Clearance	Make adjustment according to Testing and Adjusting.
Worn Push Rods	If there is too much wear, install new push rods. Make adjustment of valve clearance according to Testing and Adjusting.
Cam Followers Worn	If there is too much wear, install new cam followers. Make adjustment of valve clearance according to Testing and Adjusting.
Worn Cams on Camshaft	Check valve clearance. Check for free movement of valves or bent valve stems. Check for cam follower wear. Install a new camshaft. Make adjustment of valve clearance according to Testing and Adjusting.
Loose Bolts Holding Rocker Arm Assembly	Tighten to 18 $\pm$ 5 lb. ft. (24 $\pm$ 7 N.m).

14. VALVE SPRING LOCK IS FREE

Cause	Correction
Broken Locks	Broken locks can cause the valve to slide into the cylinder. This will cause much damage.
Broken Valve Spring(s)	Install new valve spring(s).

15. OIL AT THE EXHAUST

Cause	Correction
Too Much Oil in the Valve Compartment	Look at both ends of the rocker arm shaft. Be sure that there is a plug in each end.
Worn Valve Guides	Reconditioning of the cylinder head is needed.
Worn Piston Rings	Inspect and install new parts as needed.

16. LITTLE OR NO VALVE CLEARANCE

Cause	Correction
Worn Valve Seat or Face of Valve	Reconditioning of cylinder head is needed. Make adjustment of valve clearance according to Testing and Adjusting.

(Cont. next page)

17. ENGINE HAS EARLY WEAR

Cause	Correction
Dirt in Lubrication Oil	Remove dirty lubrication oil. Install a new oil filter element. Put clean oil in the engine.
Air Inlet Leaks	Inspect all gaskets and connections. Make repairs if leaks are found.
Fuel Leakage Into	This will cause high fuel consumption and low engine oil pressure.
Lubrication Oil	Make repairs if leaks are found. Install new parts where needed.

18. COOLANT IN LUBRICATION OIL

Cause	Correction
Failure of Oil Cooler Core	Install a new core for the oil cooler.
Failure of Cylinder Head Gasket	Install a new cylinder head gasket. Tighten the bolts holding the cylinder head, according to the Specifications.
Crack or Defect in Cylinder Head	Install a new cylinder head.
Crack or Defect in Cylinder Block	Install a new cylinder block.
Failure of Front Cover Gasket	Install a new front cover gasket.

19. TOO MUCH BLACK OR GRAY SMOKE

Cause	Correction
Not Enough Air For Combustion	Check air cleaner for restrictions. [Max. 25 in. (635 mm) of water].
Bad Fuel Injection Nozzle(s)	Install new fuel injection nozzle(s).
Wrong Fuel Injection Timing	Make adjustment to timing.

20. TOO MUCH WHITE OR BLUE SMOKE

Cause	Correction
Too Much Lubrication Oil in Engine	Remove extra oil. Find where extra oil comes from. Put correct amount of oil in engine. Do not put too much oil in engine.
Misfiring or Running Rough	Make reference to ITEM 2.
Wrong Fuel Injection Timing	Make adjustment to timing.
Worn Valve Guides	Reconditioning of cylinder head is needed.
Worn Piston Rings	Install new parts as necessary.
Defect in Timing Advance Unit	Replacement of timing advance unit is needed.

21. ENGINE HAS LOW OIL PRESSURE

Cause	Correction
Defect in Oil Pressure Gauge	Install new gauge.
Dirty Oil Filter or Oil Cooler	Check the operation of bypass valve for the filter. Install new oil filter elements if needed. Clean or install new oil cooler core. Remove dirty oil from engine. Put lean oil in engine.
Diesel Fuel in Lubrication Oil	Find the place where diesel fuel gets into the lubrication oil. Make repairs as needed. Remove the lubrication oil that has diesel fuel in it. Install a new oil filter element. Put clean oil in the engine.
Too Much Clearance Between Rocker Arm Shaft and Rocker Arms	Check lubrication in valve compartment. Install new parts as necessary.
Oil Pump Suction Pipe Has A Defect	Replacement of pipe is needed.
Relief Valve for Oil Pump Does Not Operate Correctly	Clean valve and housing. Install new parts as necessary.
Oil Pump Has A Defect	Make repair or replacement of oil pump if necessary.
Too Much Clearance Between Crankshaft and Crankshaft Bearings	Check the oil filter for correct operation. Install new parts if necessary.
Too Much Clearance Between Camshaft and Camshaft Bearings	Install new camshaft and camshaft bearings if necessary.

22. ENGINE USES TOO MUCH LUBRICATION OIL

Cause	Correction
Too Much Lubrication Oil in Engine	Remove extra oil. Find where extra oil comes from. Put correct amount of oil in engine. Do not put too much oil in engine.
Oil Leaks	Find all oil leaks. Make repairs as needed.
Oil Temperature is Too High	Check operation of oil cooler. Install new parts if necessary. Clean the core of the oil cooler. Check oil cooler bypass valve.
Too Much Oil To Intake Valve Guides	Make reference to ITEM 15.
Worn Valve Guides	Make reference to ITEM 15.
Worn Piston Rings	Install new parts as necessary.

23. ENGINE COOLANT IS TOO HOT

Cause	Correction
Restriction To Air Flow Through Radiator or Restriction To Flow Of Coolant Through the Radiator	Remove all restrictions of flow.
Not Enough Coolant in System	Add coolant to cooling system.
Pressure Cap Has A Defect	Check operation of pressure cap. Install a new pressure cap if necessary.
Combustion Gases in Coolant	Find out where gases get into the cooling system. Make repairs as needed.
Water Temperature Regulators (Thermostats) or Temperature Gauge Has A Defect	Check water temperature regulators for correct operation. Check temperature gauge operation. Install new parts as necessary.
Water Pump Has A Defect	Install a new water pump.
Too Much Load On The System	Make a reduction to the load.
Wrong Fuel Injection Timing	Make adjustment to timing.
Shunt Line Has A Defect	Make repairs as needed.
Drive Belts Loose	Adjust drive belts.

24. STARTING MOTOR DOES NOT TURN

Cause	Correction
Battery Has Low Output	Check condition of battery. Charge battery or make replacement as necessary.
Wiring or Switch Has A Defect	Make repairs or replacement as necessary.
Starting Motor Solenoid Has A Defect	Install a new solenoid.
Starting Motor Has A Defect	Make repair or replacement of starting motor.

25. ALTERNATOR GIVES NO CHARGE

Cause	Correction
Loose Drive Belt For Alternator	Make an adjustment to put the correct tension on the drive belt.
Charging or Ground Return Circuit or Battery Connections Have A Defect	Inspect all cables and connections. Clean and tighten all connections. Make replacement of parts that have a defect.
Alternator Brushes Have A Defect	Install new brushes.
Rotor (Field Coil) Has A Defect	Install a new rotor.

26. ALTERNATOR CHARGE RATE IS LOW OR NOT REGULAR

Cause	Correction
Loose Drive Belt For Alternator	Make an adjustment to put the correct tension on the drive belt.
Charging or Ground Return Circuit or Battery) Connections Have A Defect	Inspect all cables and connections. Clean and tighten all connections. Make replacement of parts that have a defect.
Alternator Regulator Has A Defect	Make repair or replacement of alternator regulator.
Alternator Brushes Have A Defect	Install new brushes.
Rectifier Diodes Have A Defect	Make replacement of rectifier diode that has a defect.
Rotor (Field Coil) Has A Defect	Install a new rotor.

27. ALTERNATOR CHARGE TOO HIGH

Cause	Correction
Alternator or Alternator Regulator Has Loose Connections	Tighten all connections to alternator or alternator regulator.
Alternator Regulator Has A Defect	Install a new alternator regulator.

28. ALTERNATOR HAS NOISE

Cause	Correction
Drive Belt For Alternator is Worn or Has A Defect	Install a new drive belt for the alternator.
Loose Alternator Drive Pulley	Check key groove in pulley for wear. If groove is worn, install a new pulley. Tighten pulley nut according to Specifications.
Drive Belt and Drive Pulley For Alternator Are Not in Alignment	Make an adjustment to put drive belt and drive pulley in correct alignment.
Worn Alternator Bearings	Install new bearings in the alternator.

29. EXHAUST TEMPERTATURE IS TOO HIGH

Cause	Correction
Air Inlet or Exhaust System Has A Restriction	Remove restriction.
Wrong Fuel Injection Timing	Make an adjustment to the timing.

COMPRESSOR TROUBLESHOOTING CHART

SYMPTOMS	CAUSE	REMEDY
30. Compressor passes excessive oil as evidenced by presence of oil at exhaust ports of valving or seeping from air strainer.	A. Restricted air intake.	A. Check engine air cleaner and replace if necessary. Check compressor air inlet line for kinks, excessive bends and be certain inlet lines have the minimum specified inside diameter. Recommended minimum inlet line inside diameter is 5/8". Recommended maximum air inlet restriction is 25" of water.
	B. Restricted oil return (to engine).	B. Oil return to the engine should not be in any way restricted. Check for excessive bends, kinks, and restrictions in the oil return line. Minimum recommended oil return line size is 5/8" O.D. tubing or equivalent I.D. (1/2" minimum). Return line must CONSTANTLY DESCEND from the compressor to the engine crankcase. Make certain oil drain passages in the compressor and mating engine surfaces are unobstructed and aligned. Special care must be taken when sealants are used with, or instead of, gaskets.

SYMPTOMS	CAUSE	REMEDY
	C. Poorly filtered inlet air.	C. Check for damaged, defective or dirty air filter on engine. Check for leaking, damaged or defective compressor air intake components (i.e., induction line, fittings, gaskets, filter bodies, etc).
	D. Insufficient compressor cooling (compressor runs hot).	D. For air-cooled portions of the compressor: 1. Remove accumulated grease, grime, or dirt from the cooling fins. Replace components found damaged. 2. Check for damaged cooling fins. Replace components found damaged.
	E. Contaminants not being regularly drained from system reservoirs.	E. Check reservoir drain valves to insure that they are functioning properly. It is recommended that the vehicle should be equipped with functioning automatic drain valves, or have all reservoirs drained to zero (0) psi daily, 'or optimally to be equipped with a desiccant-type air dryer prior to the reservoir system.
	F. Compressor runs loaded an excessive amount of time.	F. Vehicle system leakage should not exceed industry standards of 1 psi pressure drop per minute without brakes applied, and 3 psi pressure drop per minute with brakes applied. If leakage is excessive, check for system leaks and repair.
	G. Excessive engine crankcase pressure.	G. Test for excessive engine crankcase pressure and replace or repair crankcase ventilation components as necessary. (An indication of crankcase pressure is a loose or partially lifted dipstick.)
	H. Excessive engine oil pressure.	H. Check the engine oil pressure with a test gauge and compare the reading to the engine specifications. Bendix does not recommend restricting the compressor oil supply line because of the possibility of plugging the restriction with oil contaminants. Minimum oil supply line size is 1/4" O.D. tubing.
	I. Faulty compressor.	I. Replace or repair the compressor only after making certain none of the preceding installation defects exist.
31. Noisy compressor operations.	A. Loose pulley.	A. Inspect the fit of pulley on the compressor crank shaft. The pulley must be completely seated and the crankshaft nut must be tight. If the compressor crankshaft surface or its keyway are damaged, it is an indication of loose drive components. If damage to the compressor crankshaft is detected, replace the compressor or the crankshaft. When installing pulley, torque the crankshaft nut to 100 foot pounds. DO NOT BACK OFF THE CRANKSHAFT NUT TO ALIGN THE COTTER PIN AND CASTELLATED NUT. DO NOT USE IMPACT WRENCHES.

SYMPTOMS	CAUSE	REMEDY
	B. Compressor cylinder head head discharge line restrictions.	B. Inspect the compressor discharge port and discharge line for carbon build-up. If carbon is detected, check for proper cooling to the compressor. (See Cause and Remedy (D) under Symptom #30.) Inspect the discharge line for kinks and restrictions. Replace dischage line as necessary.
	C. Worn or burned out bearings.	C. Check for proper oil pressure in the compressor. Minimum required oil pressure; 5 psi engine idling, 15 psi maximum governed engine rpm. Check for excessive oil temperature-should not exceed 240° F.
	D. Faulty compressor.	D. Replace or repair the compressor after determining none of the preceding installation defects exist.
32. Excessive build-up and recovery time. Compressor should be capable of building air system from 85-100 psi in 40 seconds with engine at full governed rpm. Minimum compressor performance is certified to meet Federal requirements by the vehicle manufacturer. Do not down size the original equipment compressor.	A. Dirty induction air filter.	A. Inspect engine or compressor air filter and replace if necessary.
	B. Restricted induction line.	B. Inspect the compressor air induction line for for kinks and restrictions and replace as necessary.
	C. Restricted discharge line or compressor discharge activity.	C. Inspect the compressor discharge port and line for restrictions and carbon build-up. If a carbon build-up is found, check for proper compressor cooling. Replace faulty sections of the discharge line.
	D. Slipping drive components.	D. Check the condition of drive belts and replace or tighten, whichever is appropriate.
	E. Excessive air system leakage.	E. Test for excessive system leakage and repair as necessary. Use the following as a guide: Build system pressure to governor cutout and allow the pressure to stabilize for one minute. Using the dash guage, note the system pressure and the pressure drop after two minutes. The pressure drop should not exceed: 1. 2 psi in each reservoir for a single vehicle. 2. 6 psi in each reservoir for a tractor and trailer. 3. 8 psi in each reservoir for a tractor and 2 trailers.
	F. Sticking unloader pistons and plungers.	F. Check the operation of the unloading pistons in the inlet cavity of the compressor. Both pistons should have the plunger flanges resting on the inlet cavity floor when the compressor is loaded (pumping air). If the pistons and plunger are not fully retracted, check for proper operation of the compressor air governor. If the

SYMPTOMS	CAUSE	REMEDY
		governor is operating properly, replace the unloader pistons and plungers and inspect their bores in the cylinder block. Clean lubricate as necessary. Inspect for bent, kinked or blocked tubing leading to or from the governor.
	G. Faulty compressor.	G. Replace or repair the compressor after determining none of the preceding installation defects exist.
33. Compressor fails to unload.	A. Faulty governor or governor installation.	A. Test the governor for proper operation and inspect air lines to and from the governor for kinks or restrictions. Replace or repair the governor or its connecting air lines.
	B. Faulty or worn unloader.	B. Inspect for worn, dirty or corroded unloader pistons or bores pistons and their cylinder block bores. Replace as necessary.
34. Compressor leaks oil.	A. Damaged mounting gasket.	A. Check the compressor mounting bolt torque. If the mounting bolt torque is low, replace the compressor mounting gasket before retorquing the mounting bolts.
	B. Cracked crankcase, cylinder block or end cover.	B. Visually inspect the compressor exterior for cracked or broken components. Cracked or broken crankcases or mounting flanges can be caused by loose mounting bolts. The end cover can be cracked by over-torquing fitting or plugs installed in the end cover. Replace or repair the compressor as necessary.
	C. Loose end cover or cylinder block cap screws.	C. Check the cap screw torques and tighten as necessary.
	D. Loose oil supply or return line fittings.	D. Check the torque of external oil line fittings and tighten as necessary.
	E. Porous compressor casting.	E. Replace the compressor if porosity is found.
	F. Mounting flange or end cover, O-Ring or gasket-missing, cut, or damaged.	F. Replace as necessary.
35. Compressor constantly cycles (compressor remains unloaded for a very short time.)	A. Leaking compressor unloader pistons.	A. Remove the compressor inlet air strainer or fitting. With the compressor unloaded (not compressing air), check for air leakage around the unloader pistons. Replace as necessary.
	B. Faulty governor.	B. Test the governor for proper operation and repair or replace as necessary.
	C. Excessive system. leakage.	C. Test for excessive system leakage as instructed in Symptom 32, Remedy E. Reduce leakage wherever possible.
	D. Excessive reservoir contaminants.	D. Drain reservoirs.

SYMPTOMS	CAUSE	REMEDY
36. Compressor head gasket failure.	A. Restricted discharge line.	A. Clear restriction or replace line.
	B. Loose head bolts.	B. Tighten evenly to a torque of 25-30 foot pounds.
	C. Faulty compressor or head gasket.	C. Check for rough or poorly machined head or block surfaces. Replace necessary components.

FUEL SYSTEM

Either too much fuel or not enough fuel for combustion can be the cause of a problem in the fuel system.

Many times work is done on the fuel system when the problem is really with some other part of the engine. The source of the problem is difficult to find, especially when smoke comes from the exhaust. Smoke that comes from the exhaust can be caused by a bad fuel injection valve, but it can also be caused by one or more of the reasons that follow:

a. Not enough air for good combustion.
b. An overload at high altitude.
c. Oil leakage into combustion chamber.
d. Not enough compression.

FUEL SYSTEM INSPECTION

A problem with the components that send fuel to the engine can cause low fuel pressure. This can decrease engine performance.

1. Check the fuel level in the fuel tank. Look at the cap for the fuel tank to make sure the vent is not filled with dirt.
2. Check the fuel lines for fuel leakage. Be sure the fuel supply line does not have a restriction or a bad bend.
3. Install a new fuel filter. Clean the fuel screen located in the inlet valve of the fuel transfer pump.
4. Remove any air that may be in the fuel system. If there is air in the fuel system, use the priming pump and loosen the nuts holding the fuel lines tor the outside of the cylinder head, one at a time. Do this until fuel, without air, comes from the fuel line connection.

CHECK ENGINE CYLINDERS SEPARATELY

An easy check can be made to find the cylinder that runs rough (misfires) and causes black smoke to come out of the exhaust pipe.

Run the engine at the speed that is the roughest. Loosen the fuel line nut at a fuel injection pump. This will stop the flow of fuel to that cylinder. Do this for each cylinder until a loosened fuel line is found that makes no difference in engine performance. Be sure to tighten each fuel line nut after the test before the next fuel line nut is loosened. Check each cylinder by this method. When a cylinder is found where the loosened fuel line nut does not make a difference in engine performance, test the injection pump and fuel injection nozzle for that cylinder.

Temperature of an exhaust manifold port, when the engine runs at low idle speed, can also be an indication of the condition of a fuel injection nozzle. Low temperature at an exhaust manifold port is an indication of no fuel to the cylinder. This can possibly be an indication of a nozzle with a defect. Extra high temperature at an exhaust manifold port can be an indication of too much fuel to the cylinder, also caused by a nozzle with a defect.

The most common defects found with the fuel injection valves are:

1. Carbon on tip of the nozzle or in the nozzle orifice.
2. Orifice wear.

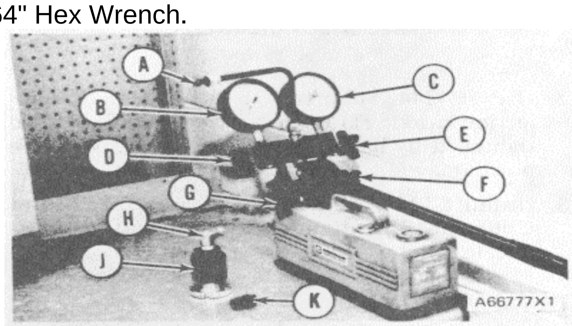
CAUTION

Do not test or disassemble nozzles unless you have the correct service tools.

NOTE: Do not disassemble fuel nozzles before they have been tested. See TESTING PENCIL-TYPE FUEL INJECTION NOZZLES.

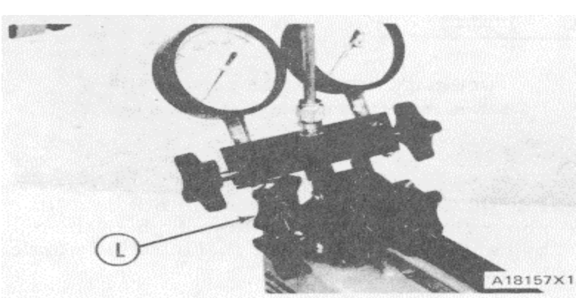
TESTING 9N3979 PENCIL-TYPE FUEL INJECTION NOZZLES

Tools Needed:
*5P4150 Nozzle Testing Group.
5P4244 Adapter.
8S2270 Fuel Collector.
FT1384 Extension.
8S2245 Cleaning Tool Group.
    8S2258 Brass Wire Brush.
    8S2250 Nozzle Holding Tool.
    8S2252 Carbon Seal Installation Tool.
1F1153 Needle Nose Pliers.
8H8505 Combination Wrench.
8H8502 Combination Wrench.
8S2274 Socket.
8S1589 Socket.
9S5031 Socket.
5P4813 Socket.
5/64" Hex Wrench.



5P4150 NOZZLE TESTING GROUP

A. 5P4721 Tube. B. 5P4146 Gauge, 0 to 1000 psi (O to 6900 kPa) used to test PC capsule valves. C. 2P2324 Gauge, 0 to 5000 psi (O to 34 500 kPa) used to test DI capsule valves and pencil-type nozzles. D. Gauge protector valve for 5P4146 Gauge (B). E. Gauge protector valve for 2P2324 Gauge (C). F. On-off valve. G. Pump isolator valve. H. 5P4720 Fitting. J. 5P8744 Adapter for capsule nozzles. K. 5P4244 Adapter for pencil-type nozzles.



EXTRA VALVE
L. Gauge protector valve (must be In open position at all times).

CAUTION

Be sure to use clean SAE J967 Calibration oil when tests are made. Dirty test oil will damage components of fuel injection nozzles. The temperature of the test oil must be 65 to 750 F (18 to 240 C) for good test results.

Order calibration oil by part number, in the quantities needed, according to the information that follows:
Kent-Moore Corp.
1501 South Jackson St.
Jackson, MI 49203
    Order:
    J-26400-5 [5 U.S. gal. (18.9 liter)]
    J-26400-15 [15 U.S. gal. (56.7 liter)]
    J-26400-30 [30 U.S. gal. (113.5 liter)]
    J-26400-55 [55 U.S. gal. (208.2 liter)]

Viscosity Oil Company
3200 South Western Ave.
Chicago, IL 60608
    Order:
    Viscor Calibration Fluid
    1487C-SAE J-967C
    Available in 30 U.S. gal (113.5 liter) or 55 U.S. gal. (208.2 liter) drums.

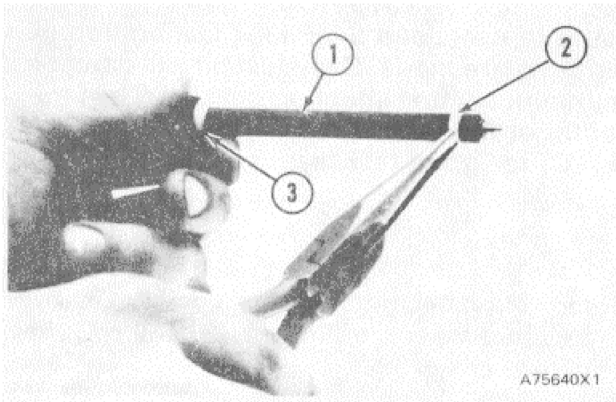
To test a pencil-type fuel injection nozzle, all six steps of the test procedure must be completed, and the step sequence must be as follows:

I. Return Leakage Test. (This test is not needed with the 9N3979 Nozzle).
II. Valve Opening Pressure Test.
III. Flush the Nozzle.
IV. Tip Leakage Test.
V. Orifice Restriction Test.
VI. Cap Leakage Test.

NOTE: Do all tests before the nozzle is disassembled for cleaning, or before any adjustments are made to a nozzle. A test can show that the nozzle must not be used again.

Nozzle Preparation for Test

Before fuel injection nozzle (I) can be tested, all loose carbon around the tip of the nozzle must be removed with the 8S2258 Brass Wire Brush (M).



REMOVING CARBON DAM

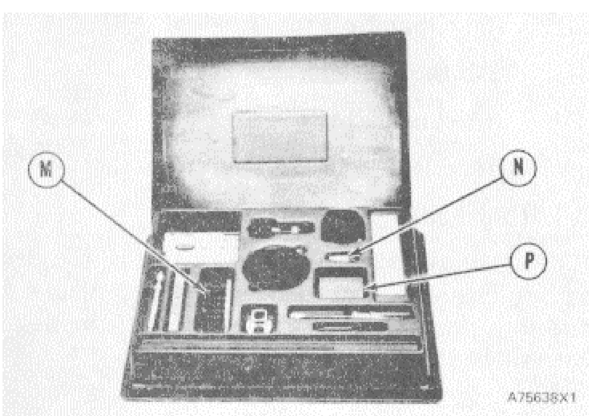
1. Fuel injection nozzle. 2. Csrbon dam. 3. Seal. Remove carbon dam (2) with needle nose pliers and remove seal (3) from the nozzle.

CAUTION

Do not use a steel brush or a wire wheel to clean the nozzle body or the nozzle tip. Use of these tools can cause a small reduction of orifice size, and this will cause a large reduction in engine horsepower. Too much use of the 8S2258 Brass Wire Brush will also remove the coating that is on the nozzle for protection.

Clean the groove for carbon seal dam (2) and the body of the nozzle below the groove with the 8S2258 Brass Wire brush (M). Remove the carbon, but be sure not to use the brush enough to cause damage to the body of the nozzle.

NOTE: A change in color in the area below the groove is normal and does not affect the body of the nozzle.

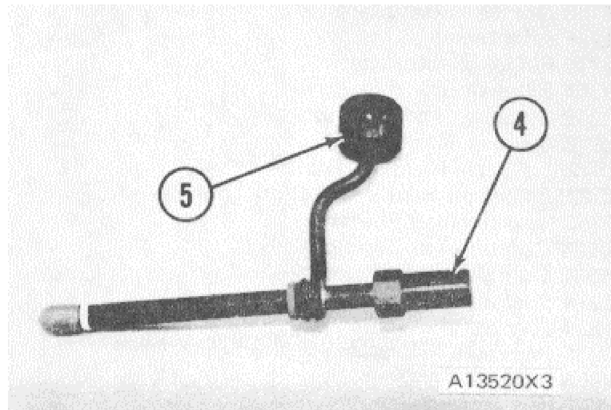


8S2245 CLEANING KIT

(M) 8S2258 Brass Wire Brush. (N) 8S2252 Carbon Seal Tool. (P) 8S2250 Nozzle Holding Tool.

I. Return Leakage Test

1. Put nozzle (I) and 8S2250 Nozzle Holding Tool (P) in a vise and remove cap (4).

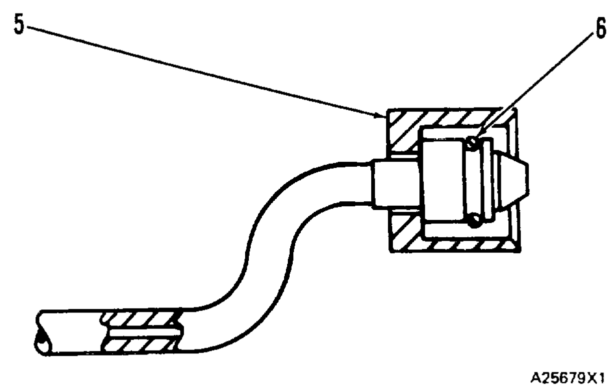


FUEL INJECTION NOZZLE

4. Cap. 5. Nut.

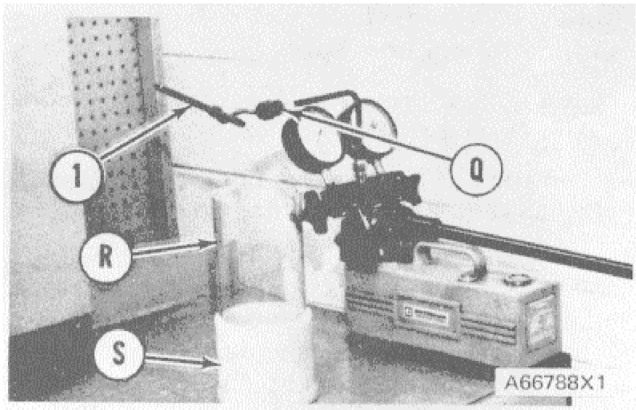
2. Use 5P4244 Adapter (Q) to connect fuel injection nozzle (I) to the tester. Nut (5) can be tightened by hand if IH1023 O-ring Seal (6) is not damaged.

3. Install FT1384 Extension (R) in 8S2270 Fuel Collector (S) and put parts into position under nozzle.



FUEL INJECTION NOZZLE CONNECTOR 5. Nut. 6. 1H1023 O-ring Seal for fuel line.

4. Put the tip of the fuel injection nozzle a little above the horizontal position. Tighten the nut by hand that connects the fuel injection nozzle to the tester.



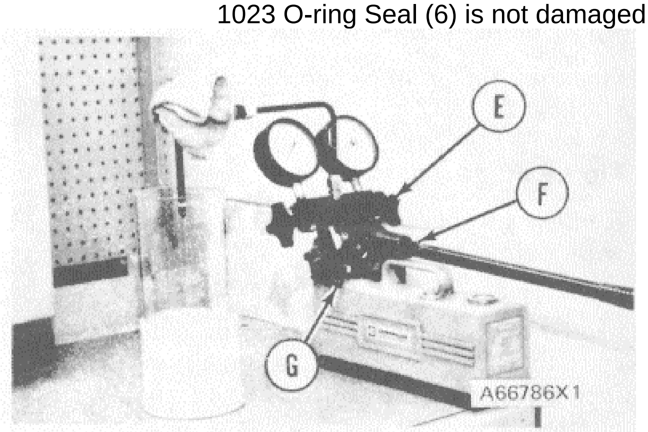
NOZZLE POSITION FOR RETURN LEAKAGE TEST
1. Fuel injection nozzle. Q. 5P4244 Adapter. R. FT1384 Extension. S. 8S2270 Fuel Collector.

5. Close on-off valve (F). Open pump isolator valve (G).
6. Open gauge protector valve (E) and operate the tester slowly until the pressure is at 1400 to 1600 psi (9630 to I 1 045 kPa).
7. Look at the leakage from the return at the top (pressure screw end) of the fuel injection nozzle.

RETURN LEAKAGE SPECIFICATION		
	Minimum	Maximum
After the first drop falls:	No Minimum	No Maximum

II. Valve Opening Pressure Test (VOP)

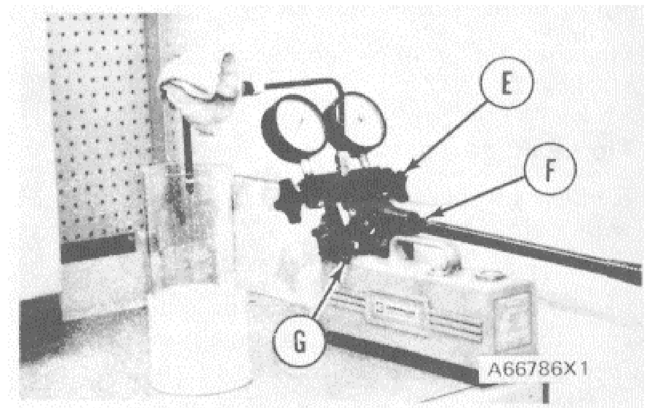
1. Loosen nut (5) and turn nozzle tip down so that it extends into FT1384 Extension (R) as shown.
2. Tighten nut (5) to 5P4244 Adapter (Q). Nut (5) can be tightened by hand if 1 1023 O-ring Seal (6) is not damaged.



NOZZLE CONNECTED TO 5P4150 NOZZLE TESTER

⚠WARNING

When fuel injection nozzles are tested, be sure to wear eye protection. Fuel comes from the orifices in the nozzle tip with high pressure. The fuel can pierce (go thru) the skin and cause serious injury to the operator. Keep the tip of the nozzle pointed away from the operator and into the 8S2270 Fuel Collector and FT1384 Extension.



NOZZLE READY FOR TEST
E. Gauge protector valve. F. On-off valve. G. Pump isolator valve.

CAUTION

Put a shop towel around the top of the nozzle (pressure screw end) to take in any fuel leakage.

3. Close on-off valve (F). Open pump isolator valve (G).
4. Open gauge protector valve (E). Operate the pump to make a slow increase in pressure until the valve in the fuel injection nozzle just starts to open. Read the maximum gauge pressure at the instant fluid flows from the tip.

NOTE: It is possible for the pressure reading of the gauge to go down fast if the valve makes a noise (chatters) when it opens. It is also possible for the pressure reading of the gauge to be almost constant when the valve in the fuel injection nozzle opens.

NOTE: The salve in the fuel injection nozzle can be good and still not make a noise (chatter). or not have a very fine vapor (spray) from the orifices in the tip of the fuel injection nozzle during Step 4.

If the opening pressure is less than 1500 psi 10300 kPa), do not use the fuel injection nozzle again.

VALVE OPENING PRESSURE (VOP) SPECIFICATIONS
1500 to 2600 psi (10, 300 to 17, 690 kPa)

III. Flush the Nozzle

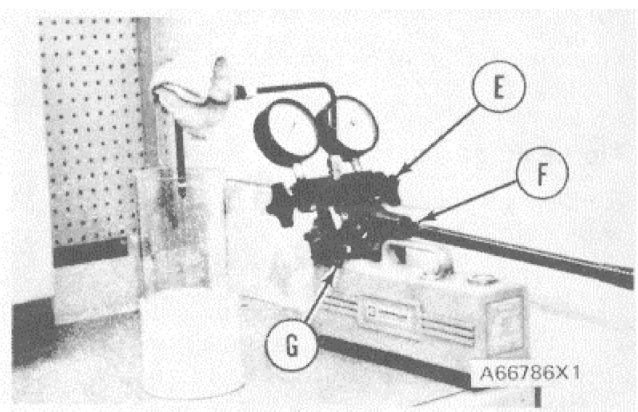
1. Close gauge protector valve (E). Close on-of valve (F). Open pump isolator valve (G)

NOTE: Make sure nozzle extends inside and below the top of FT1384 Extension (R).

2. Operate the pump rapidly for three full strokes.

IV. Tip Leakage Test

1. Remove all fuel from the nozzle tip and body with a cloth.
2. Put a clean cloth around the top of the body of the fuel injection nozzle (pressure screw end) to take in the leakage and prevent any fuel leakage to drain down to the tip of the nozzle.



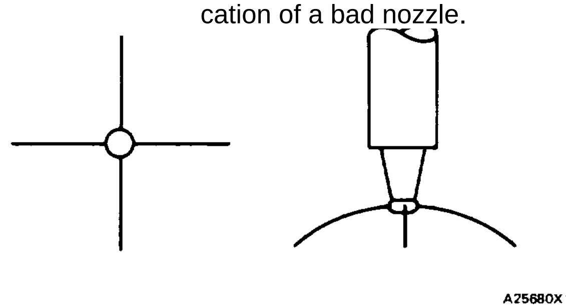
CLOTH ON TOP OF NOZZLE
E. Gauge protector valve. F. On-otff valve.
G. Pump Isolator valve.

3. Open gauge protector valve (E). Be sure the nozzle tip is completely dry.
4. Make and hold for 15 seconds a pressure of 200 psi (1380 kPa) less than the opening pressure measured in VOP Test II.
5. If nozzle is not within specification, DO NOT USE THE NOZZLE.

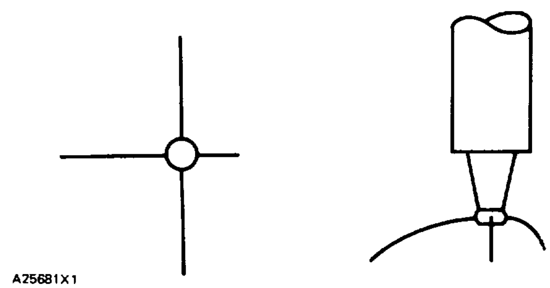
TIP LEAKAGE SPECIFICATION
No more than 20 drops can fall in 15 seconds

V. Orifice Restriction Test

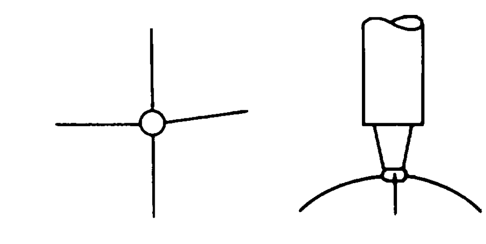
1. Close gauge protector valve (E) and on-off valve (F). Open pump isolator valve (G).
2. Point the tip of the fuel injection nozzle into the 8S2270 Fuel Collector and FT1384 Extension.
3. Make a slow increase in pressure and look at the orifice discharge pattern (shape of discharge) when fluid begins to flow through the fuel injection nozzle. The discharge must be the same through all four orifices. Any change, either vertically or horizontally, is an indication of a bad nozzle.



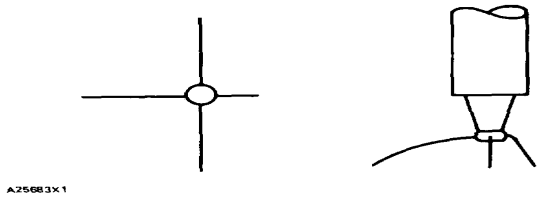
GOOD NAZZLE
(USE AGAIN)



TYPICAL DISCHARGE PATTER FOR ORIFICE WITH A RESTRICTION (RECONDITIONING OR REPLACEMENT NECESSARY)



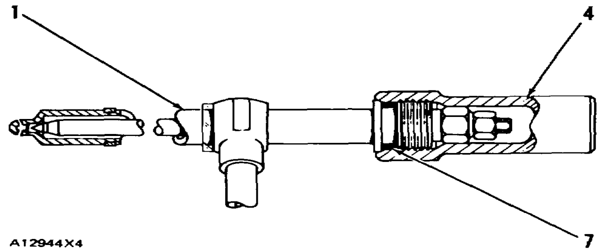
TYPICAL DISCHARGE PATTERN WITH HORIZONTAL DISTORTION (RECONDITIONED OR REPLACEMENT NECESSARY)



TYPICAL DISCHARGE PATTERN WITH VERTICAL DISTORTION (RECONDITIONING OR REPLACEMENT NECESSARY)

VI. Cap Leakage Test

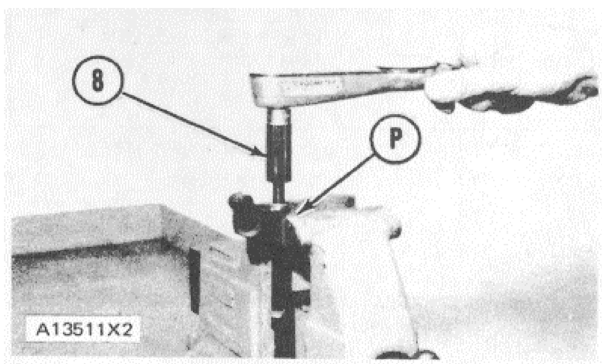
1.move fuel injection nozzle (I) from the P4150 Nozzle Tester and put it in 8S2250 Nozzle Holding Tool (P).



NOZZLE CAP INSTALLATION

1.Fuel injection nozzle4. Cap. 7. 1H1023 O-ring seal.

2. Install new IH1023 O-ring Seal (7). 3. Install cap (4) and tighten to 110 to 120 lb. in. (12.4 to 13.6 N.m).



TIGHTENING CAP

8. 9S5031 Socket.P. 8S2250 Nozzle Holding Tool.

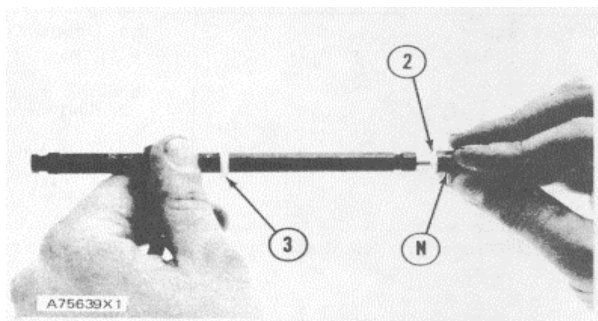
CAUTION

Do not tighten the cap more than torque shown or the new O-ring seal will be damaged.

4. Put fuel injection nozzle (1) on the 5P4150 Nozzle Tester with the nozzle tip in the 8S2270 Fuel Collector and FT1384 Extension.
5. With gauge protector valve (E) open, pump the tester until cap (4) is completely full of fuel and the pressure on the gauge is 4000 psi
27 500 kPa).
NOTE: 15 to 20 strokes of the pump can be necessary for the pressure to reach 4000 psi (27 500 kPa).

CAP LEAKAGE SPECIFICATION
There must be no leakage between the cap and the body of fuel injection nozzle

There must be no leakage between the cap and the body of fuel injection nozzle. 6. If there is leakage, make a replacement of I H 1023 Seal (7) and inspect cap (4) for cracks. Test the nozzle again. If there is still leakage, replacement of fuel injection nozzle is neces-sary.



INSTALLING CARBON DAM

2. Carbon dam. 3. Seal. N. 8S2252 Carbon Seal Tool.

7. If no fuel leakage is found, fuel injection nozzle is acceptable. Slide new seal (3) into position over the nozzle. Install new carbon dam (2) in nozzle groove with 8S2252 Carbon Seal Tool (N).

TROUBLESHOOTING OF 9N3979 FUEL INJECTION NOZZLES

Use the guide that follows to troubleshoot for problems with the pencil-type fuel injection nozzles

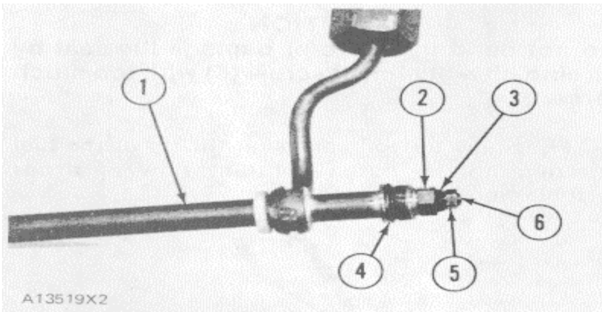
NOZZLE ASSEMBLY TROUBLESHOOTING GUIDE

PROBLEM	CAUSE	CORRECTION
Return Leakage High	1. 1.Too much wear or scratches at guide 2.Parts are bad	1 Make replacement of nozzle assembly 2 Make replacement of nozzle assembly
Return Leakage Low	1 Foreign material on valve 2.Not enough clearance	1 Clean area with solvent 2 Make replacement of nozzle assembly
opening Pressure Not Correct	1 Adjustment wrong 2.Parts are bad	1 Make adjustment See ADJUST-MENT OF 9N3979 FUEL NOZZLES 2 Make replacement of nozzle assembly
Tip Leakage	1 Deposits in seat area 2.Seat for valve bad 3.Parts have failed 4.Crack at tip of nozzle	1. Disassemble and clean nozzle 2 Make replacement of nozzle 3 Make replacement of nozzle 4 Make replacement of nozzle make replacement of nozzle assembly
Orifice Discharge Is Not Correct	1 Orifices have a restriction or are 2.Crack at tip of nozzle 3 Debris inside nozzle at bottom of tip 4.Adjustment of lift screw not correct	1 Clean orifices, if office are bad, 2 Make replacement of nozzle 3 Clean nozzle See Special In-structlon Form No. SEHS7292 for cleaning procedures 4. Make adjustment See ADJUST-MENT OF 9N3979 FUIEL NOZZLES

ADJUSTMENT AND CLEANING OF 9N3979 FUEL INJECTION NOZZLES

NOTE: Do not clean or adjust a nozzle with a valve opening pressure (VOP) less than 1500 psi (10300 kPa).

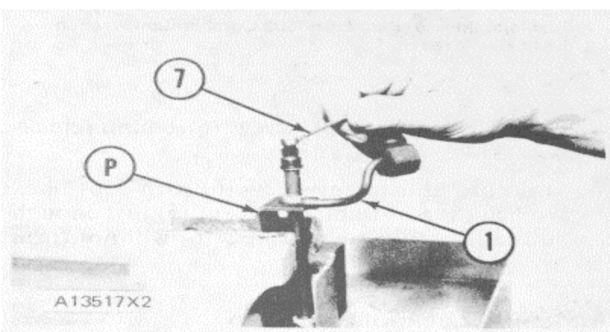
Valve Opening Pressure (VOP) Adjustment



FUEL INJECTION NOZZLE

1. Fuel injection nozzle. 2.Locknut (for pressure adjust- m., 'lt screw). 3. Pressure adjustment screw. 4. 1H1023 O-ring Seal for cap. 5. Locknut (for lift adjustment screw). 6. Lift adjustment screw.

1. Remove fuel injection nozzle (I) from the5P4150 Nozzle Tester and put it in the 8S2250 No771e Holding Tool (P).



LOOSENING LOCKNUT

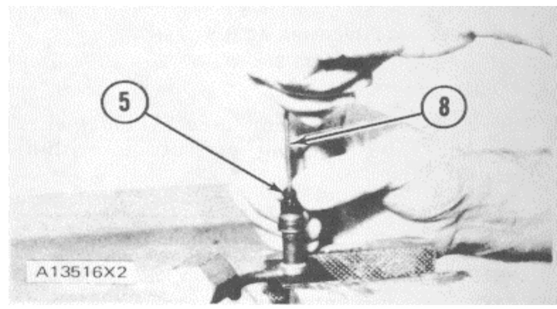
1. Fuel injection nozzle. 7.8H8502 Combination Wrench.
P. 8S2250 Nozzle Holding Tool.

2..Loosen locknut (5) that holds lift adjustment screw (6). Turn lift adjustment screw (6) counter clock wise two turns.

CAUTION

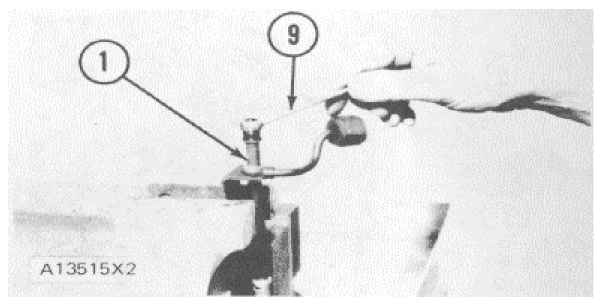
If the lift adjustment screw is not turned counter clock wise two turns, the valve can be bent or the seat for the valve can be damaged when the pressure adjustment screw is turned.

3. Hold lift adjustment screw (6) with a 5, 64" hex wrench (8) and remove lock nut (5).



REMOVING LOCKNUT

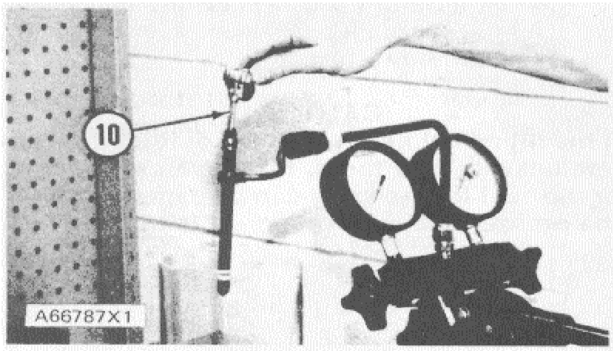
5. Locknut (for lift adjustment screw). 8. 5/64" hex wrench.



LOOSENING LOCKNUT

1. Fuel injection nozzle. 9. 8H8505 Combination Wrench.

4. Loosen lock nut (2) that holds pressure adjustment screw (3).
5. Put fuel injection nozzle (I) on the nozzle tester. Turn pressure adjustment screw (3) clockwise with 5P4813 Socket (10). Each one- fourth of a turn will increase the opening pressure approximately 250 psi (1720 kPa)

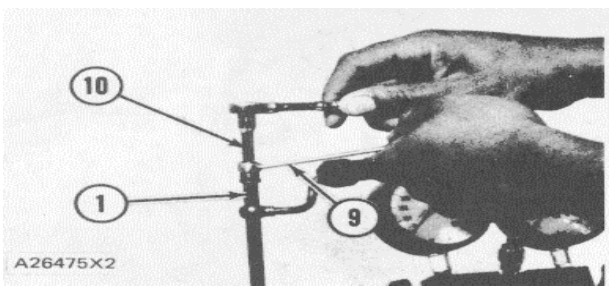


OPENING PRESSURE ADJUSTMENT
10. 5P4813 Socket

6. Turn pressure adjustment screw (3) clockwise until the valve opening pressure is within specifications.

SPECIFICATIONS	**VOP2400 to 2600 psi (16545 to 17690 kPa)**

NOTE: If nozzle can not be adjusted to specifications, make a replacement of the nozzle.



TIGHTENING LOCKNUT
1. Fuel Injection nozzle. 9. 8H8505 Combination Wrench.10. 5P4813 Socket.

7. Hold pressure adjustment screw (3) and tighten lock nut (2) just enough so that pressure adjustment screw (3) will not turn.

8. After the opening pressure adjustment is made, install lock nut (5) that holds lift adjustment screw (6). Make the valve lift adjustment. See VALVE LIFT ADJUSTMENT

Valve Lift Adjustment

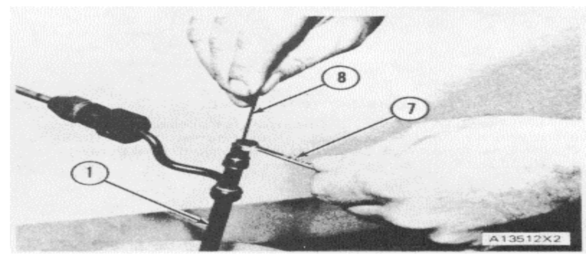
1. With the valve opening pressure correct, pump test oil through the fuel injection nozzle. At the same time, hold locknut (5) and slowly turn lift adjustment screw (6) clockwise until the pressure starts to increase above the opening pressure.

2. To be sure the valve is on the seat, increase the pressure 200 to 500 psi (1380 to 3450 kP a) more than the opening pressure.

CAUTION

Do not bend the valve or damage the seat by turning lift adjustment screw (6) with too much force.

NOTE: Some test oil can be at the tip of the fuel injection nozzle, but a constant flow of drops (dribble) must not be seen.



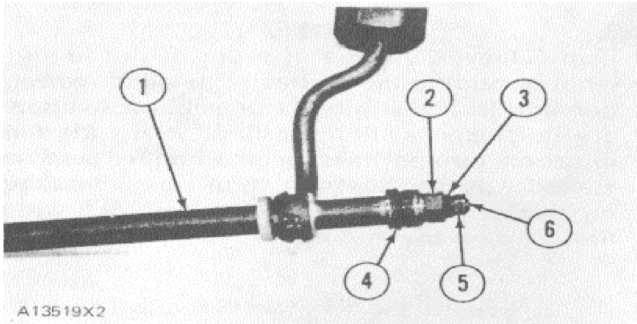
TIGHTENING LOCKNUT
1. Fuel Injection nozzle. 7. 8H8502 Combination Wrench. 8. 5/64" Hex Wrench.

3. Turn lift adjustment screw (6) counter clock wise 3, 4 ± 1/8 of a turn.

4. Hold lift adjustment screw (6) with 5/64" hex wrench (8) and tighten lock nut (5) just enough so that lift adjustment screw (6) will not turn.

Tightening Lock nuts and Cap

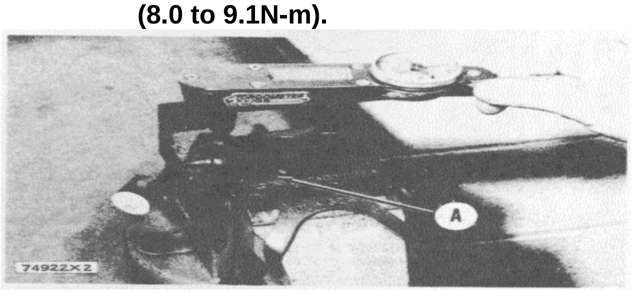
1. Remove fuel injection nozzle (1) from 5P4150 Nozzle Tester and put it in 8S2250 Nozzle Holding Tool (P).



FUEL INJECTION NOZZLE

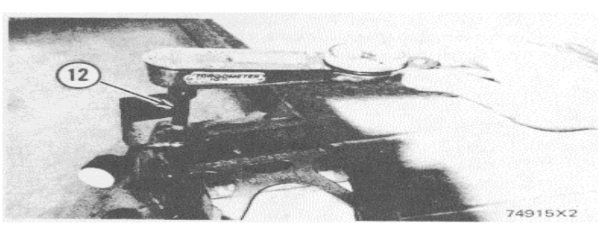
1. Fuel Injection nozzle. 2. Lock nut (for pressure adjustment screw). 3. Pressure adjustment screw. 4. 1H102 O-ring Seal for cap. 5. Lock nut (for lift adjustment screw). 6. Lift adjustment screw.

2. Tighten lock nut (2) that holds pressure adjustment screw (3) to 70 to 80 lb. in. (8.0 to 9.1N-m).



TIGHTENING PRESSURE SCREW LOCKNUT
(Typical Example)
11. BS2274 Socket. P. 8S2250 Nozzle Holding Tool.

3Tighten lock nut (5) that holds lift adjustment screw (6) to 35 to 45 lb. in. (4.0 to 5.1 N.m).

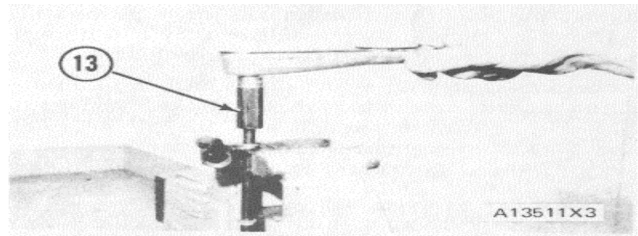


TIGHTENING VALVE LIFT SCREW LOCKNUT
(Typical Example)
12. 8S1589 Socket.

4. Install new IH1023 O-ring seal (4).

5. Install the cap and tighten to 110 to 120 lb. in. (12.4 to 13.6 N-m).

CAUTION
Do not tighten the cap more than torque shown or the new O-ring seal will be damaged.



TIGHTENING CAP
13. 9S5031 Socket

With adjustments and tests complete, check for leakage between the cap and the body of the fuel injection nozzle. See Cap Leakage Test in section TESTING 9N3979 PENCIL-TYPE FUEL INJECTION NOZZLES.

FUEL INJECTION LINES

Fuel from the fuel injection pump is sent through the fuel injection lines to the fuel injection no77les.

Each fuel injection line of an engine has a special design and must be inT stilled in a certain location. _n fuel injection lines are removed from an engine, put identification marks or tags on the fuel lines as they are removed, so they can be put in the correct location when they are installed.

The nuts that hold a fuel injection line to an injection nozzle and injection pump must be kept tight. Use a torque wrench and the 5P144 Fuel line Socket to tighten the fuel line nuts to 30 + 5 lb. ft. (40 ± 7 Nhm).

FUEL INJECTION PUMPS

When injection pumps, sleeves and lifters are removed from the injection pump housing, keep the parts of each pump together so they can be installed back in their original location.

Be careful when disassembling injection pumps. Do not damage the surface on the plunger. The plunger, sleeve and barrel for each pump are made as a set. Do not put the plunger of one pump in the barrel or sleeve of another pump. If one part is sworn, install a complete new pump assembly. Be careful when putting the plunger in the bore of the barrel or sleeve.

When an injection pump is installed correctly, the plunger is through the sleeve and the adjustment lever is engaged with the groove on the sleeve. The bushing that holds the injection pump in the pump housing must be kept tight. Tighten the bushing to 60 + 5 lb. ft. (80 + 7 N.m). Damage to the housing will result if the bushing it too tight. If the bushing is not tight enough, the pump *will leak.

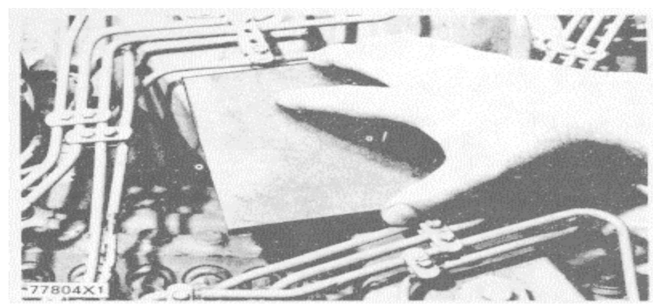
AIR INLET PIPE
(Typical Example)

CAUTION

If the sleeves on one or more of the fuel injection pumps have been installed wrong, damage to the engine is possible if cautions are not taken at first starting. When the fuel injection pumps have been removed and installed with the fuel injection pump housing on engine, take the following cautions when first starting the engine.

a. Remove air cleaner leaving the air inlet pipe open as shown.

b. If the sleeve on a pump has been installed *wrong and the engine starts to run too fast, put a steel plate over the air inlet opening as show n to stop the engine.



STOPPING THE ENGINE
(Typical Example)

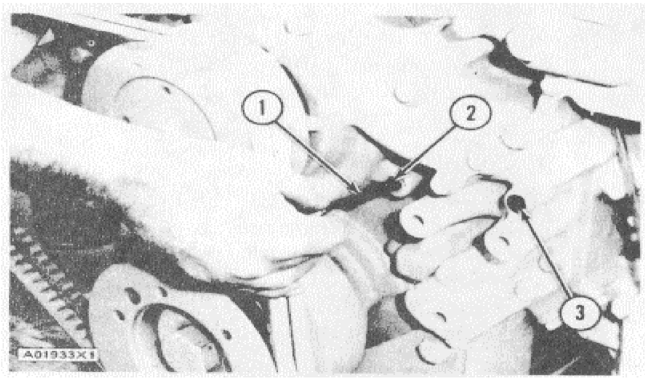
FINDING TOP CENTER COMPRESSION POSITION FOR NO. 1 PISTON

No. 1 piston at top center (TDC) on the compression stroke is the starting point for all timing procedures.

1. Remove the plug from the timing hole (2) in the front cover. Put bolt (I) in timing hole (2). The bolt from hole (3) can be used.

2. Turn the crankshaft COUNTERCLOCK-WISE (as seen from rear of engine) until bolt (I) will go into the hole in the drive gear for the camshaft.

3. Remove the valve cover on the right side of the engine (as seen from rear of engine). The two valves at the right front of the engine are the intake and exhaust Valves for No. I cylinder.



INSTALLING BOLT
1. 1D4539 Bolt, 5/16 in.-18NC, 2.5 in. (63.5 mm) long.
2. Timing hole. 3. Hole.

4. The intake and exhaust valves for No. I cylinder must now be closed and the timing pointer will be in alignment with the TDC-I on the damper assembly. The No. I piston is now at top center on the compression stroke.

FUEL SYSTEM ADJUSTMENTS

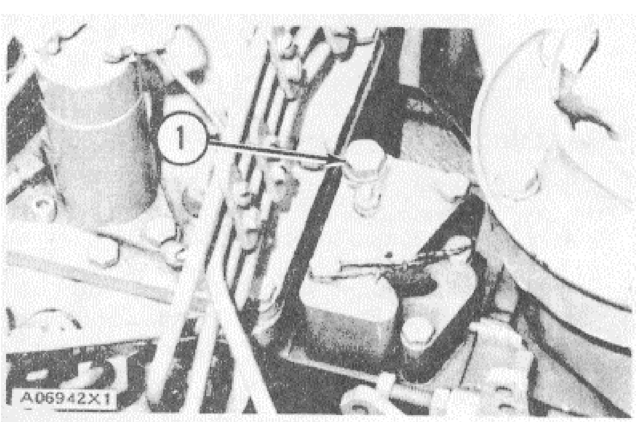
Checking Fuel Injection Pump Timing; On Engine

The timing of the fuel injection pump can be checked and changed if necessary, to make compensation for movement in the taper sleeve drive or worn timing gears. The timing can be checked and if necessary, changed using the following method.

Checking Timing by Timing Pin Method

Tools Needed:
5P2371 Puller.
3P1544 Timing Pin.

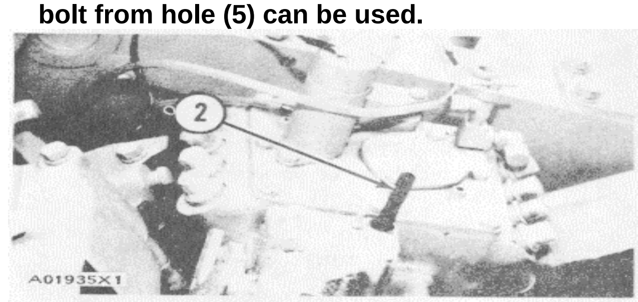
I. Remove bolt (I! from the timing pin hole.



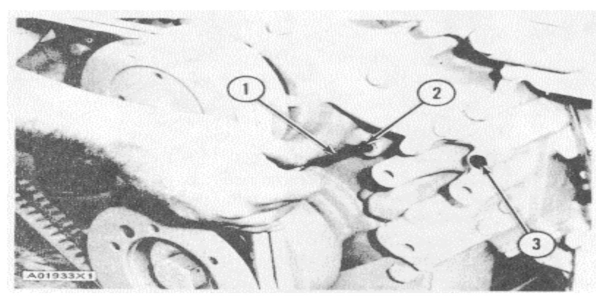
TIMING HOLE BOLT
1. BOLT

2. Turn the crankshaft COUNTERCLOCK- WISE (as seen from rear of engine) until timing pin (2) goes into the notch in the camshaft for the fuel injection pumps.

3. Remove the plug from timing hole (4) in the front cover. Put bolt (3) through the front cover and into the hole with threads in the timing gear. The bolt from hole (5) can be used.



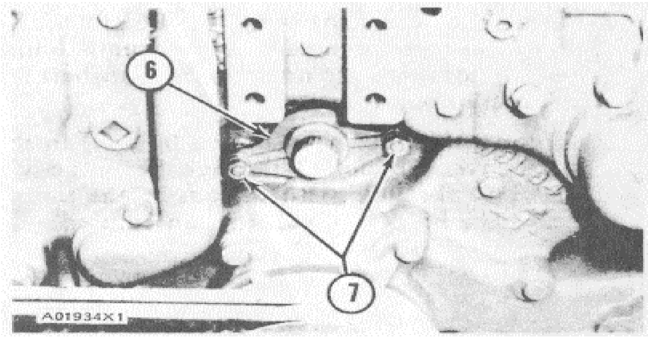
TIMING PIN INSTALLED
(Typical Example)
2. 3P1544 Timing Pin.



INSTALLING BOLT
3.1D4539 Bolt, 5/16 in.-18 NC, 2.5 in. (63.5 mm) long.
4. Timing hole. 5. Hole.

4. If the timing pin is in the notch in the camshaft for the fuel injection pumps, and bolt (3) goes into the hole in the timing gear through timing hole (4), the timing of the fuel injection pump is correct.

NOTE: If bolt (3) does not go in the hole in the timing gear with timing pin (2) in the notch in the camshaft, use the following procedure.



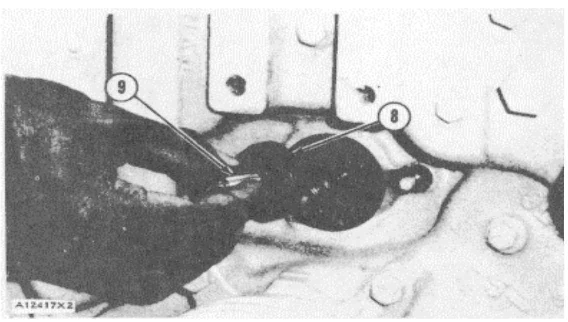
LOCATION OF COVER

6. Cover for the tachometer drive assembly. 7.Nuts.

a. Remove nuts (7) and the cover for the tachometer drive assembly (6).

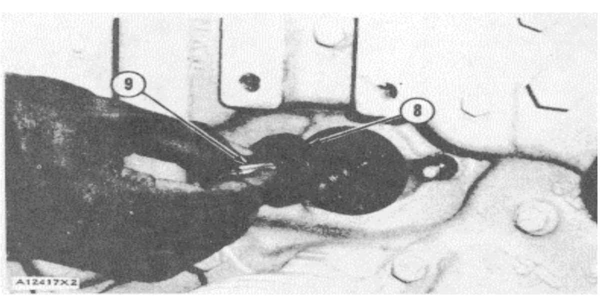
b. Remove the tachometer drive shaft (9) and washer (8) from the camshaft for the fuel injection pumps.

NOTE: Tachometer drive shaft (9) and washer (8) Ire removed as an assembly.



LOCATION OF BOLT

8. Washer. 9. Tachometer drive shaft**.**



LOOSENING DRIVE GEAR

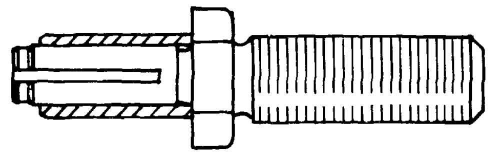
10. 5P2371 Puller. 11. Bolts**.**

c. Put 5P2371 Puller (10) on the camshaft for the fuel injection pumps. Tighten bolts (I I) until the drive gear on the camshaft for the fuel injection pumps comes loose,

d. Remove the 5P2371 Puller.

e. Turn the crankshaft COUNTERCLOCK- WISE (as seen from rear of engine) until bolt (3) goes into the hole in the timing gear. With timing pin (2) in the notch in the cam- shaft for the fuel injection pumps, and bolt (3) in the hole in the timing gear, the timing for the engine is correct.

f. Install washer (8) and tachometer drive shaft (9). Tighten tachometer drive shaft to 110+ 10 lb. ft. (149 ± 14 Nm). Then remove timing pin (2).



TACHOMETER DRIVE SHAFT

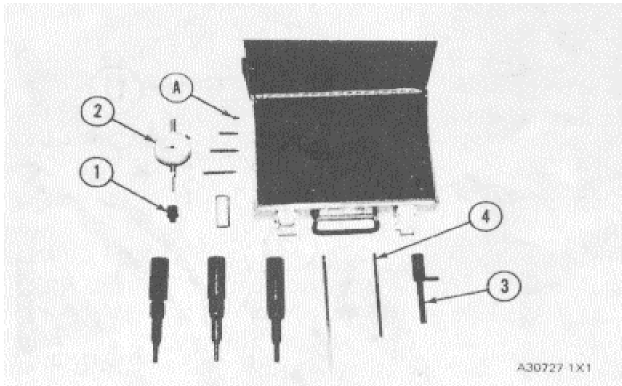
g. Turn the crankshaft two complete revolutions COUNTERCLOCKWISE (as seen from rear of engine) and put timing pin (2) and bolt (3) in again. If timing pin (2) and bolt (3) can not be installed do Steps a through f again.

h. Remove bolt (3) from the timing gear and install in hole (5). Install the plug in timing hole (4). Remove timing pin (2) and install bolt (I). Install cover for the tachometer drive assembly (6).

Checking Timing By Fuel Flow Method

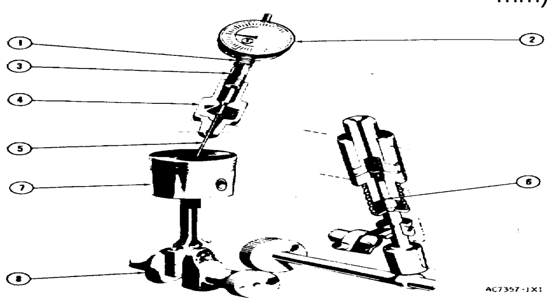
Tools Needed:
1P540 Flow Checking Tool Group.
5P6524 Engine Timing Indicator Group.
9S215 Dial Indicator.
9S8883 Contact point .50 in. (12.7 mm) long.
8S2296 Rod 5.25 in. (133.4 mm) long.
5P7266 Adapter.
3P1565 Collet.
7M1999 Tube Assembly

T



5P6524 ENGINE TIMING INDICATOR GROUP

1. 3P1565 Collet Clamp. 2. 9S215 Dial Indicator. 3. 5P7266 Adapter. 4. 8S2296 Rod, 5.25 in. (133.4 mm) long. A. 3S8883 Contact Point, .50 In. (12.7 mm) long.



MEASUREMENT OF PISTON TRAVEL

1. 3P1565 Collet Clamp. 2. 9S215 Dial Indicator and 9S8883 Contact Point (A). 3. 5P7266 Adapter. 4.8S2296 Rod, 5.25 in. (133.4 mm) long. 5. Cylinder head. 6. Inlet port. 7. Piston.

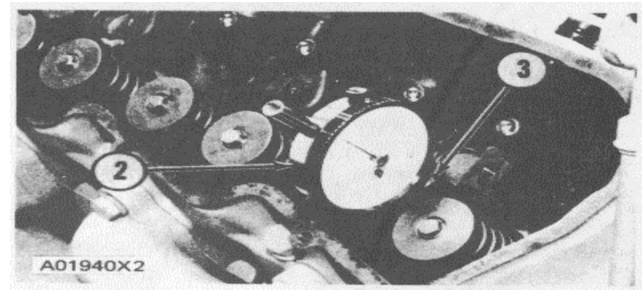
Travel of piston (7), from the point of closing inlet port (6) to top center, can be found by using the procedure that follows:

NOTE: The fuel system timing has a tolerance of ±1.°

NOTE: When reference is made to crankshaft rotation, the engine is seen from the flywheel end.

1. No. 1 piston at top center (TC) on the compression-stroke. Make reference to FINDING TOP CENTER COMPRESSION POSITION FOR NO. 1 PISTON.

2. Remove timing bolt from front cover.
3. Remove the valve cover from the right side of the engine. Remove the rocker arm assembly-bly, and the fuel injection nozzle for No. I cylinder.



DIAL INDICATOR INSTALLED
2. 9S215 Dial Indicator. 3. 5P7266 Adapter.

4. Put a small amount of clean oil on 8S2296 Rod (4) and put the rod in 5P7266 Adapter (3).
5. Put adapter (3) in same hole that No. I fuel nozzle was removed from. Fasten adapter (3) to head with bolt and spacer from fuel nozzle. 6. Install 3P1565 Collet Clamp (I) in the top of adapter (3).
7. Install 9S8883 Contact Point (A) on 9S215 Dial Indicator (2) and put indicator (2) in adapter (3) thru collet (1).
8. Position the dial indicator (up or down) so small pointer is on "O" (zero) and tighten collet (I).

CAUTION
Do not tighten collet too much or damage to the dial indicator can result.

9. Loosen the screw that locks the dial face. Move the dial face until the large pointer is on "O" (zero) and tighten the lock screw.

10. Turn the crankshaft a minimum of 45 degrees in a clockwise direction. Slowly turn the crank-shaft in a counterclockwise direction until a maximum reading is seen on the dial indicator. Adjust the indicator up or down in the collet until the resolution counter is at + .300 in. (Black Numbers). Tighten the collet to hold the indicator in this position. Loosen the bezel lock and turn the bezel until the zero on the face of the dial is in alignment with the hand. Tighten the bezel lock.

11. Slowly turn the crankshaft in a counter clockwise direction until the dial indicator moves beyond .020 in. Now turn the crankshaft the opposite direction until the dial indicator is at .020 in

12. Make a temporary mark on the \fs20 vibration damper ill relation to the pointer on the front Cover.

CAUTION

Do not use a hammer and punch to mark a vibration damper.

13. Turn the crankshaft in a clockwise direction beyond the maximum indicator reading and beyond .020 in. Now turn the crankshaft in a counter clock indirection until the dial indicator is .020 in.

14. Make a second temporary mark on the tion damper in relation to the pointer. Now, make a mark on the vibration damper that is one-half the distance between the two temporary marks. This mark is the point of most accuracy for top center No. I piston.

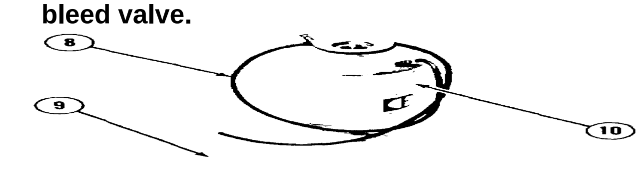
15. Turn the crankshaft in a clock vise direction approximately 45 degrees and then turn the crankshaft in a counter clock wise direction to the top center mark that was made in Step 14. If needed, adjust the dial indicator as in Step 10.

16. Turn the crankshaft in a clockwise direction approximately 45 degrees.

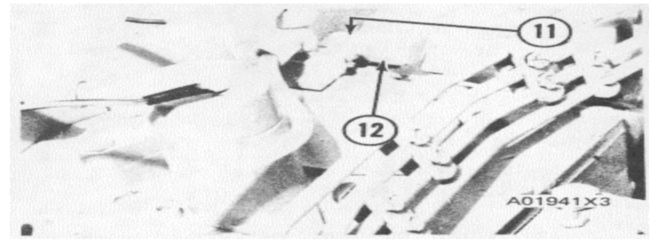
17. Put 7Ml999 Tube Assembly (9) on No. I injection pump and tighten the nut. The free end of tube assembly (9) must be in a position above horizontal and higher than the end on the injection pump.

18. Disconnect the fuel line at the fuel filter. Use an adapter to connect 5J4634 Hose Assembly (X) to the fuel line.

19. Disconnect the fuel return line from constant bleed valve (I I). Put cap (12) on the constant bleed valve.



1p540 Flow Checking Tool Group
8. 5j4634 Hose Assembly. 9. 7M1999 Tube Assembly
10. Tank Assembly



CONSTANT BLEED VALVE

11. Constant bleed valve. 12. Cap.

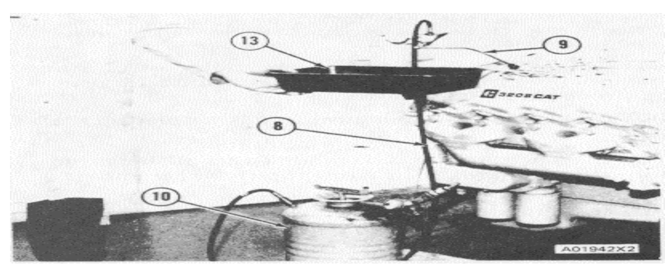
20. Put 1 gal. (4 liters) of clean fuel in the tank assembly (10). Move the governor lever to full FUEI.-ON position. Put 15 psi (105 kPa) of air pressure in the tank. Use the hand pump or shop air.

NOTE: Solenoid must be activated (ignition switch turned on) or solenoid must be removed before governor lever can be moved to FUEL-ON position.

CAUTION

If shop air is used, make an adjustment to the regulator so the air pressure in the tank is a maximum of 15 psi (105 kPa).

21. Put pan (13) under the end of tube assembly (9) for the fuel that comes out of the tube.



FUEL FLOW CHECK OF TIMING

8. 5J4634 Hose Assembly. 9. 7M1999 Tube Assembly. 10. Pressure Tank. 13. Pan.

22. Turn the crankshaft. slow, in a counter clockwise direction. Do this until the]low, of fuel from the end of tube assembly (9) is 12 to 18 drops per minute.

23. Stop rotation of the crankshaft *when the flow of fuel is 12 to 18 drops per minute. Take a reading of the measurement on dial indicator (3).

24. To check for correct timing of the fuel system, make a comparison of the reading on dial indicator (3) with the correct measurement in the chart. Timing must be set within - I" of correct timing angle.

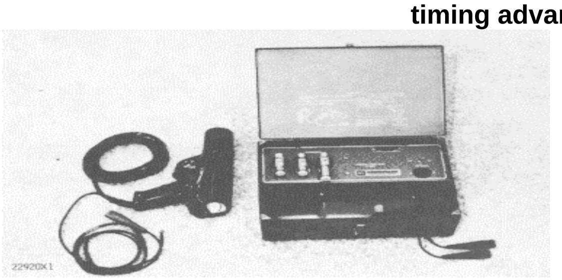
ANGLE	TIMING INDICATOR READING	
16’	**127 In.**	**3 23 mm**

NOTE: If the timing of the fuel system is different than the correct timing dimension given in the chart, see the subject CHECKING TIMING BY TIMING PIN METHOD.

Checking Automatic Timing Advance Unit By Timing Light Method

Tools Needed:
1P3500 Injection Timing Group or
2P8280 Injection Timing Group

Either group can be used to check the automatic timing advance.



1P3500 INJECTION TIMING GROUP

NOTE: When either of these injection timing groups is used, the cap from the 9N3979 Nozzle Assembly must be removed. This will let fuel bleed from the cap end of the nozzle, and will maintain line pressure in the normal range.

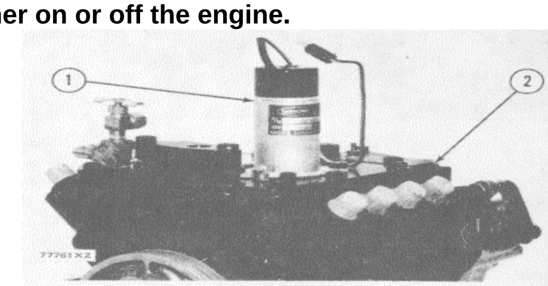
CAUTION

Do not use the engine in service with the cap removed from the nozzle. The fuel will drain into the crankcase and the result will be thin oil (oil dilution). Also a new 1H1023 Seal must be used when the cap is installed.

FUEL SETTING

Tools Needed:
5P4203 Field Service Tool Group

The procedure that follows for fuel setting can be done with the housing for the fuel injection pumps either on or off the engine.



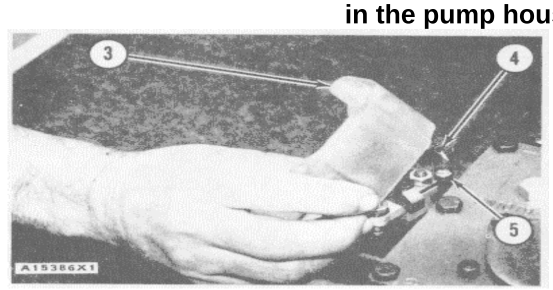
REMOVAL OF COVER
1. Shut-off solenoid. 2. Cover.

CAUTION

Before any service work is done on this fuel system, the outside of the housing for the fuel injection pumps and all parts connected to it must be especially clean.

1Remove shut-off solenoid (1) and cover (2).

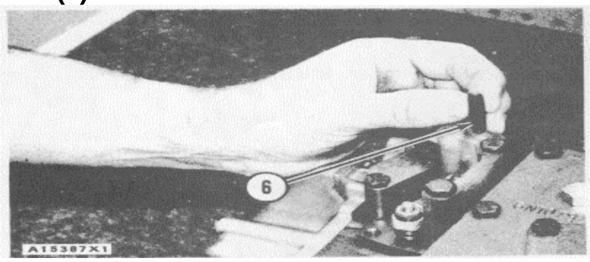
2. Put the 5P298 Zero Set Pin (5), with 17.8507 on it, in the pump housing.



INSTALLATION OF COVER
3. 5P4226 Adapter. 4. 3J6956 Spring. 5. 5P298 Zero Set Pin, with 17.8507 on it.

3. Put adapter (3) and spring (4) over zero set pin (5). Use a I D4533 Bolt and a ID4538 Bolt to fasten adapter (3) to the housing for the fuel injection pumps.

4. Put screw (6) in the hole over pin (5) and spring (4).

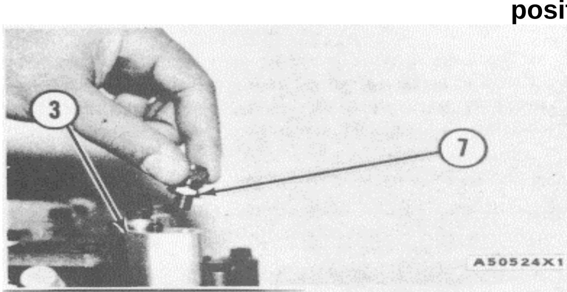


INSTALLATION OF SCREW
6. 8S7271 Screw.

5. Turn screw (6) clockwise until pin (5) is held against the housing for the fuel injection pump. DO NOT tighten screw (6) too tight.

6. Put clamp (7) in adapter (3).

7. Move the governor control lever to FULL. LOAD position.



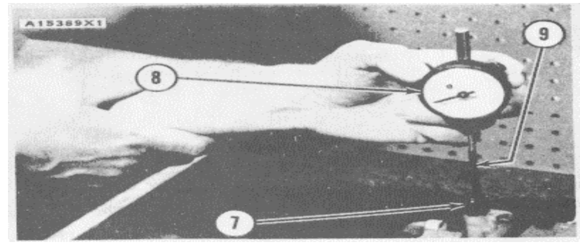
INSTALLATION OF CLAMP
3. Adapter. 7. 3P1565 Collet clamp.

8. Put 5P6531 Point (9) on dial indicator (8). Put the indicator assembly in clamp (7).

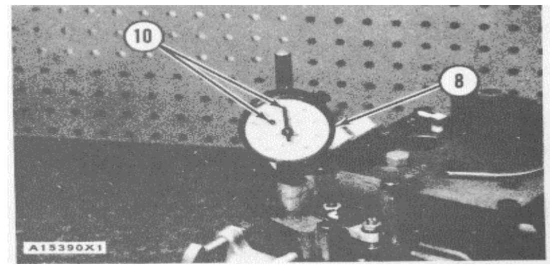
9. Adjust dial indicator (8) so both pointers (10) are on "O" (zero).

10. Use French (11) to turn the 8S7271 Screws (6) counter clockwise. Turn screws (6) six or more turns.

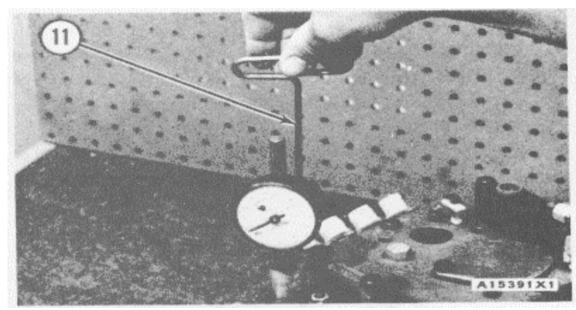
11. Put the clip end of the 8S4627 Circuit Tester to a good ground. Put the other end of the 8S4627 Circuit Tester on the load stop contact.



INSTALLATION OF DIAL INDICATOR
7. 3P1565 Collet Clamp.8. 3P1567 Dial Indicator.9. 5P6531 Contact Point, 2.25 In. (57.2 mm) long.



INDICATOR SET ON ZERO
8. 3P1567 Dial Indicator. 10. Pointers**.**

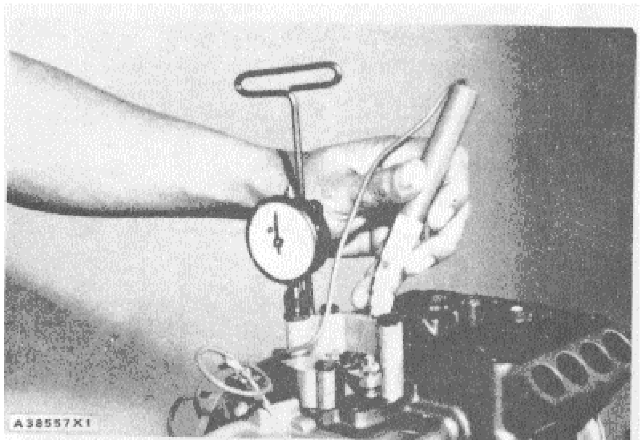


LOOSENING SCREW (6**)**

11. 5P4205 Wrench.

12. Move the governor control lever to the LOW IDLE position.

13. Move the governor control lever slowly toward the HIGH IDLE position until the continuity light just comes on. Make a note of the reading on dial indicator (8). Do this step several times to make sure the reading is correct.

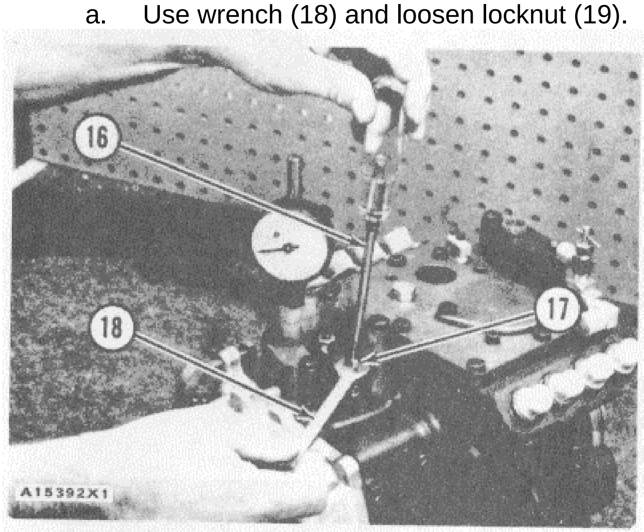


8S4627 CIRCUIT TESTER

14. Make a comparison of this reading and the fuel setting in the RACK SETTING INFORMATION.
15. If the reading on dial indicator (8) is not correct, do the following.

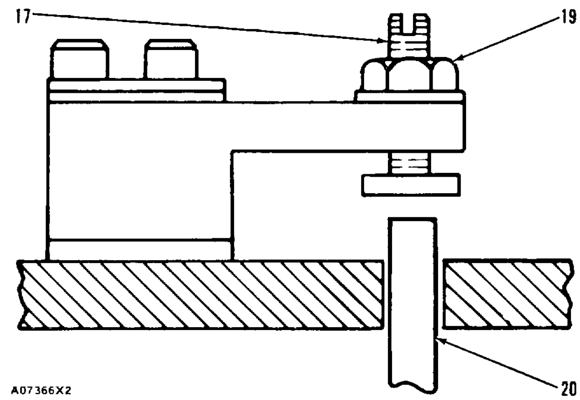
Load Stop Adjustment

a. Use wrench (18) and loosen locknut (19).



ADJUSTMENT OF FUEL SETTING
16. Screwdriver. 17. Adjustment screw. 18. Wrench.

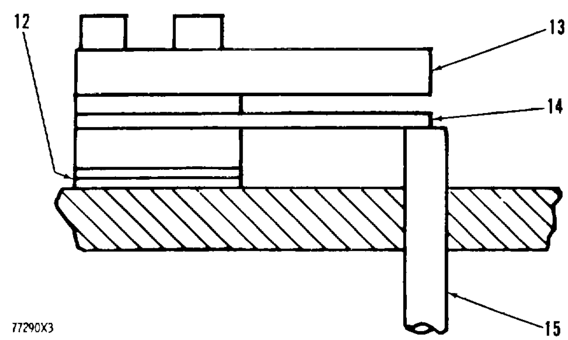
b. Use screwdriver (16) to turn adjustment screw (17) until the reading on dial indicator (8) is the same as the dimension given in the RACK SETTING INFORMATION.
c. When the adjustment is correct, tighten locknut (19). Check the adjustment again by doing Steps II through 15 again.
d. Remove the test tools. Install cover (2) and shut-off solenoid (1).



ADJUST I MNT SCREW FOR FUEL SETTING
17. Adjustment screw. 19. Locknut. 20 Load stop pin.

Leaf Type Torque Spring

a. Write down the dimension that is on dial indicator (8).
b. Write down the dimension given in the RACK SETTING IN'FORMATION.
c. Remove the test tools [adapter (3), spring (4), and dial indicator (8)] from the housing for fuel injection pumps.



LEAF TYPE TORQUE SPRING
12. Location of shims. 13. Stop bar. 14. Leaf type torque spring. 15. Load stop pin.

d. Install or remove shims at location (12) to get the correct dimension as given in the RACK SETTING INFORMATION. The difference between the dimensions in (a) and (b) is the thickness and amount of shims to remove or install to get the correct setting.
e. Install the correct amount of shims (12) torque spring (14), and stop bar (13) on the housing for the fuel injection pumps.

f. Install the test tools and do the test procedure again. Do this until the dimension on the dial indictor is the same as the dimension given in the RACK SETTING INFORMATION. After the fuel setting is correct, remove the test tools. Install cover (2) and shut-off solenoid (1).

CROSSOVER LEVERS

Tools Needed:

3P1546 Calibration Pin, 5P4206 Wrench,
5P4209 Gauge, 5P7253 Socket Assembly.

Checking Crossover Levers

NOTE**:** The cross over levers normally do not need checking unless one or more of the following conditions exist (after the timing is checked and the other corrections shown in TROUBLESHOOTING GUIDE have been made):

A. The engine produces too much black smoke.

B. The engine runs rough because fuel delivery is not even.

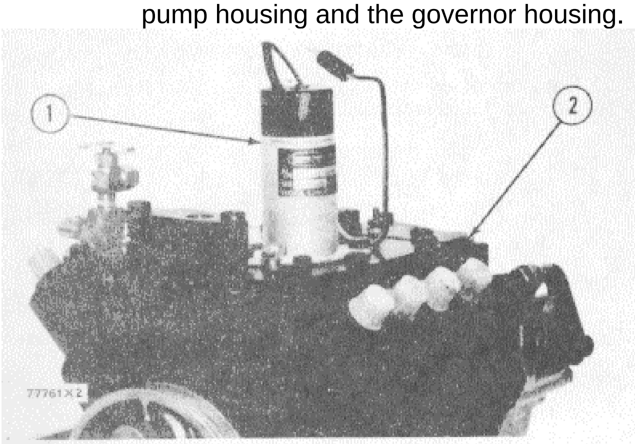
C. Some cylinders continue to fire at fuel shut off position.

D. The complete injection group is being reconditioned.

CAUTION

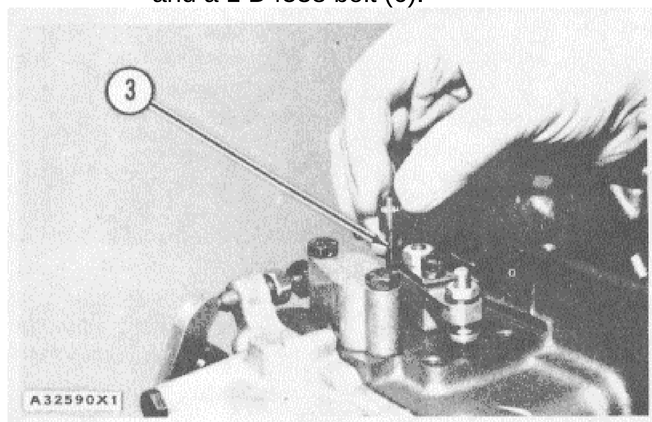
Before any service work is done on this fuel system, the outside of the injection pump housing and all parts connected to it must be clean.

1. Remove the fuel shutoff solenoid (l), top cover (2) of the fuel pump housing and the cover over the torque control group.
2. Remove the fuel that is in the injection pump housing and the governor housing.

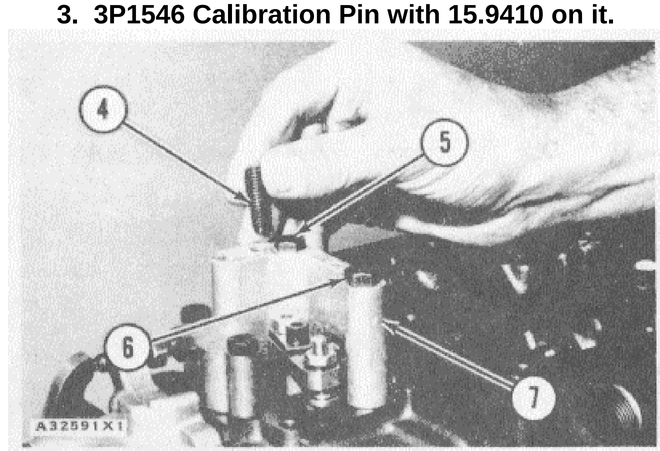


REMOVAL OF COVERS
1. Shut-off solenoid. 2. Top cover.

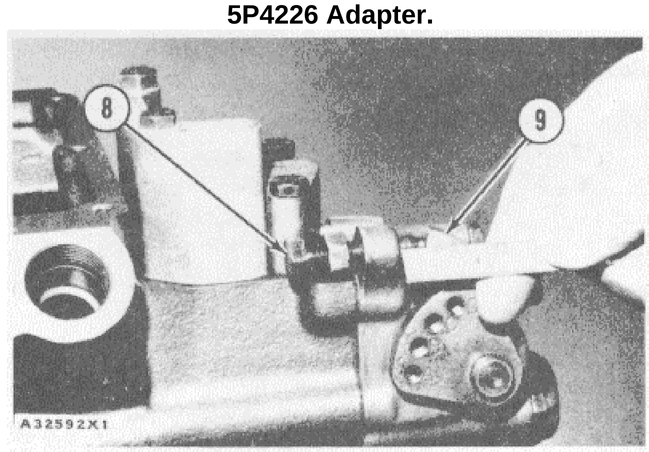
3. Put the 3P1546 Calibration Pin (3) in calibration hole as shown.
4. Install the 5P4226 Adapter (7) as shown. Fasten it in position with a 1 D4533 bolt (5) and a 1 D4538 bolt (6).



INSTALLING CALIBRATION PIN
3. 3P1546 Calibration Pin with 15.9410 on it.

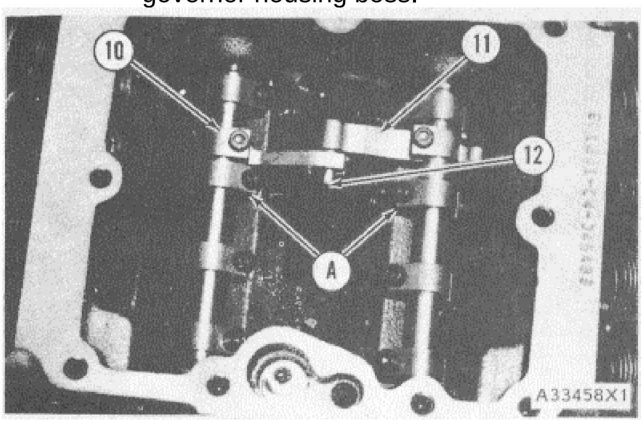


INSTALLING 5P4226 ADAPTER AND 8S7271 SCREW
4. Screw. 5. 1D4533 Bolt. 6. 1D4538 Boll. 7. 5P4226 Adapter.



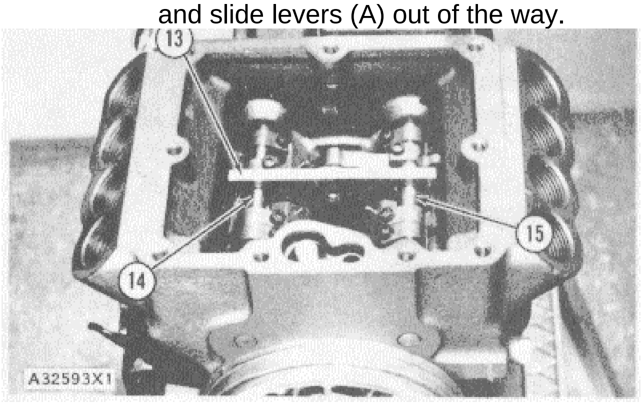
ADJUSTMENT OF LOW IDLE SCREW
8. **Low idle screw. 9. Lever.**

5. Putt the 8S7271 Screw (4) (Setscrew) in the hole over calibration pin (3). Tighten the setscrew (4) to 20 to 25 lb. in. (2.3 to 2.8 N m) with the 2P8264 Socket.
6. Adjust low idle screw (8) to position lever (9) to .35 ± .04 in. (8.0 ± 1.0 mm) from governor housing boss.



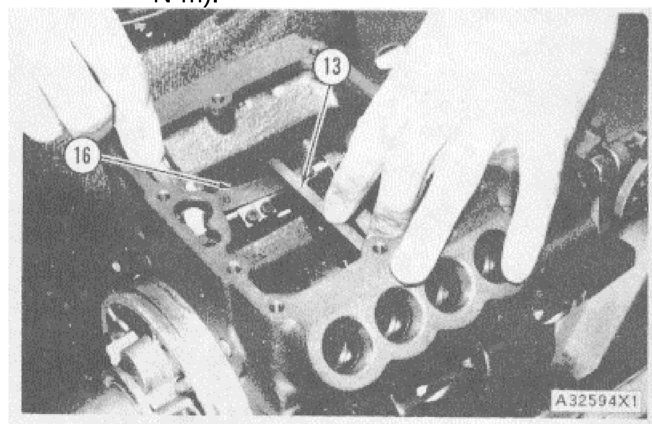
CROSSOVER LEVERS
10. Crossover lever. 11. Crossover lever. 12. Dowel pin. A. Sleeve levers.

7. Loosen the bolts that hold sleeve levers (A) and slide levers (A) out of the way.



INSTALLING 5P4209 GAUGE
13. 5P4209 Gauge. 14. Shaft. 15. Shaft.

8. Put gauge (13) on shafts (14) and (15). Slide gauge (13) toward crossover levers (10) and (II) until dowel pin (12) goes into hole in gauge (13).
9. If dowel pin (12) must be lifted to go into the hole in gauge (13), the levers must be adjusted. See ADJUSTMENT OF CROSSOVER LEVERS.
10. If gauge (13) must be lifted more than .008 in. (0.20 mm) to let dowel pin (12) go into the hole in gauge (13), see ADJUSTMENT OF CROSSOVER LEVERS.
11. To check the maximum clearance of .008 in. (.020 mm) that is acceptable under one side of gauge (13), hold the center and one side of gauge (13) against sleeve lever shaft (15). Use a feeler gauge to check clearance. Torque for bolts that hold sleeve levers (A) is 24 + 2 lb. in. (2.8 + 0.2 N-m).

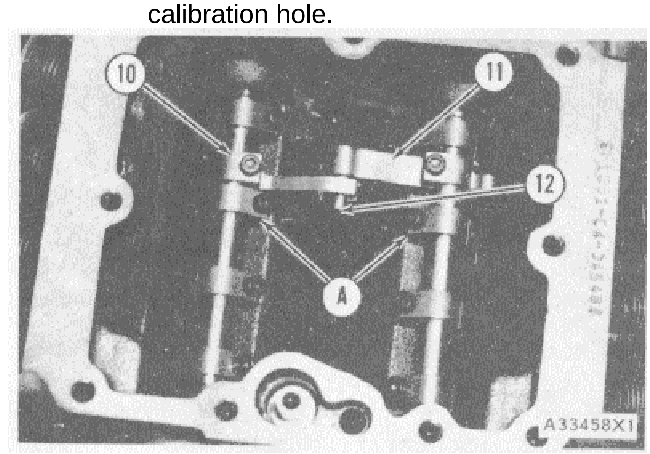


CHECKING CLEARANCE OF CROSSOVER LEVER
13. 5P4209 Gauge. 16. Feeler gauge.

NOTE: .After the checking of the crossover levers is complete, the trio fuel injection pumps must be calibrated where sleeve levers been moved to install 5P4209 Gauge. See FUEL PUMP CALIBRATION.

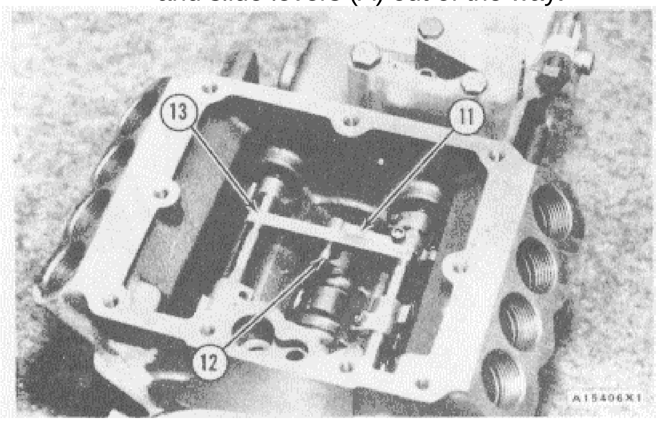
Adjustment of Crossover Levers

1. Remote the fuel shutoff solenoid ( ) top cover (2) of the fuel pump housing and the cover over the torque control group.
2. Remote the fuel that is in the injection pump housing and the governor housing.
3. Put the 3P1546 Calibration Pin (3) in calibration hole.



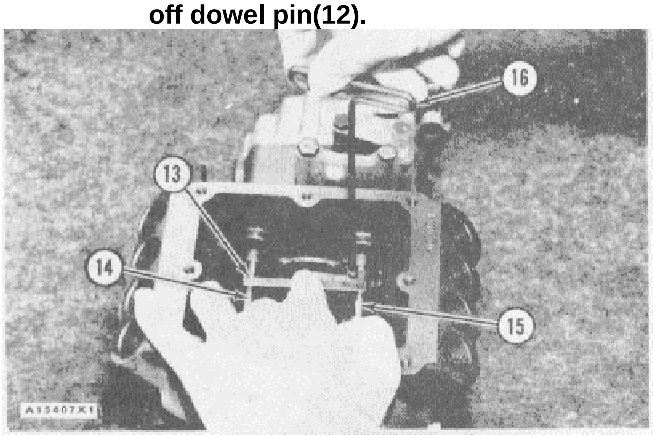
CROSSOVER LEVERS
10. Crossover lever.11. Crossover lever.12. Dowel pin.
A. **Sleeve levers.**

4. Install the 5P4226 Adapter (7). Fasten it in position with a 11D4533 Bolt (5) and a 1D4538 Bolt (6).
5. Adjust lows idle screw (8) to position lever (9) to .35 + .04 in. (8.0 + 1.0 mm) from governor housing boss.
6. Loosen the bolts that hold sleeve levers (A) and slide levers (A) out of the way.



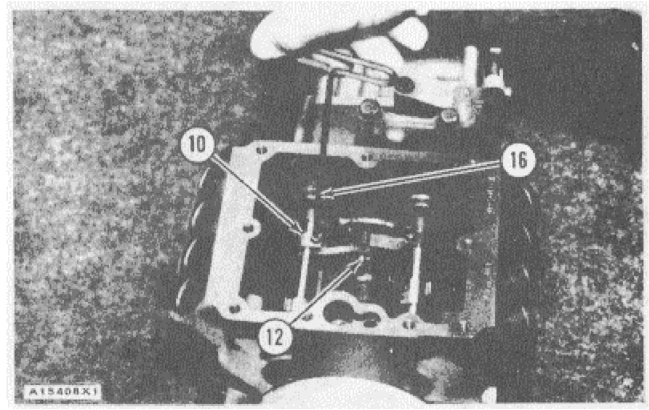
5P4209 GAUGE INSTALLED
11. Crossover lever. 12. Dowel pin. 13. 5P4209 Gauge.

7. **Loosen the bolts that hold crossover lever (10) and (11) and move lever (10) off dowel pin(12).**



ADJUSTMENT OF CROSSOVER LEVERS
13. Gauge. 14. Shall. 15. Shaft. 16. 5P4206 Wrench.

8. Put gauge (13) on shafts (14) and (15), put crossover lever (11) in a position so dowel pin (12) will fit in gauge hole. Hold gauge (13) down and torque the bolt that holds crossover lever (1) to 24 $\pm$ 2 lb. in. (2.8 $\pm$ 0.2 N•m).
9. Check adjustment again with the 5P4209 Gauge (13). Put gauge (13) on shafts (14 and 15), slide gauge toward crossover lever (11) to engage dowel pin (12) into hole in gauge (13).
10. If dowel pin (12) must be lifted to go into gauge, the lever must be adjusted again. If gauge (13) is lifted, a maximum of .008 in. (0.20 mm). clearance is acceptable under one side of gauge (13). Use a feeler gauge to check clearance.
11. Slide crossover lever (10) on to dowel pin (12). Torque the bolt that holds crossover lever (10) to 24 $\pm$ 2 lb. in. (2.8 $\pm$ 0.2 N•m).



TIGHTENING BOLT
10. Crossover lever. 12. Dowel pin. 16. Wrench.

12. **Check the adjustment again with the 5P4209 Gauge.**

NOTE: After the adjustment of the crossover levers is completed, all of the fuel injection pumps must be calibrated. See FUEL PUMP .

FUEL PUMP CALIBRATION

Tools Needed:
Tool Group.

8S2243 Wrench*.
5P4226 Adapter'
5P4205 Wrench'
5P4206 Wrench"*
1D4533 Bolt
1D4538 Bolt*
8S7271 Screw*
5P7253 Socket Assembly*
6V190 Clamp**

*Part of 5P4203 Tool Group
**Not part of a Tool Group

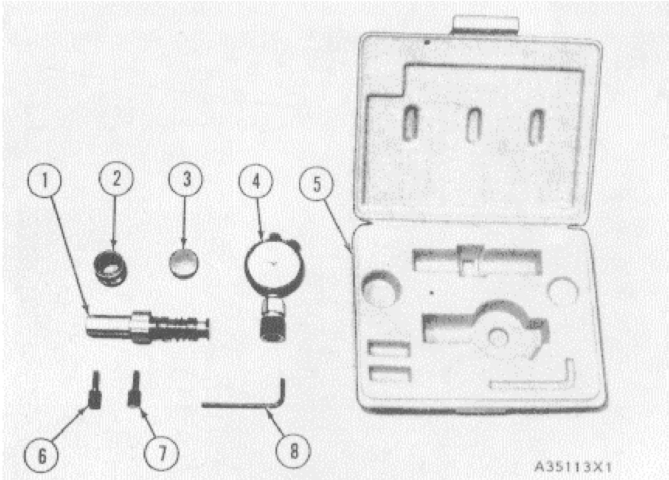
NOTE: 3P1540 Calibration pump must have the 5P6557 Spring installed instead of the IP7377 Spring.

Checking Fuel Pump Calibration

The following procedure for fuel pump calibration can be done with the housing for the fuel injection pumps either on or off the engine.

CAUTION

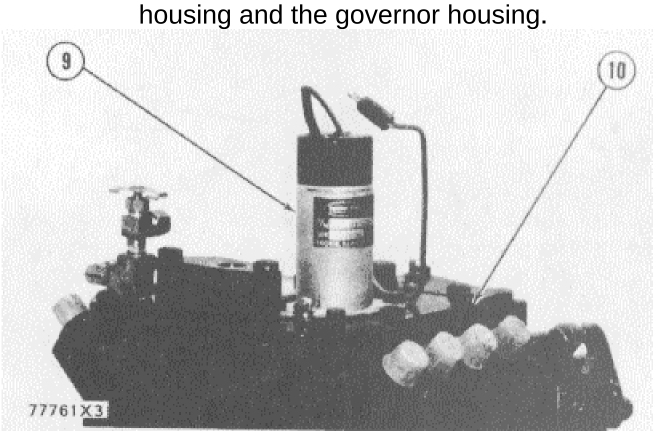
Before any service work is done on this fuel system, the outside of the injection pump housing and all parts connected to it must be clean.



3P2200 TOOL GROUP

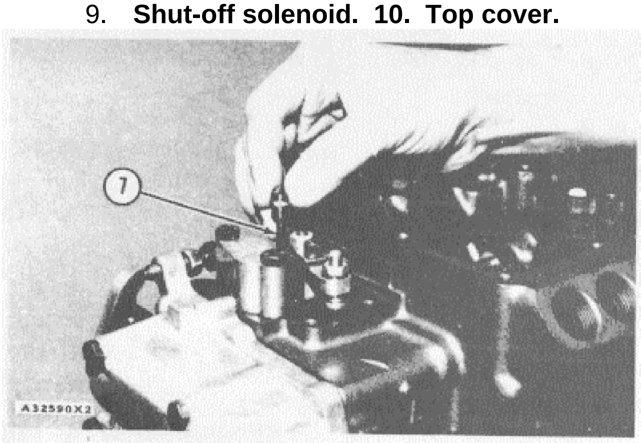
1. 3P1540 Calibration Pump. 2. 4N218 Bushing. 3.1P7379 Microgage. 4. 3P1568 Dial Indicator with 3P2226 Collet. 5. 5P6510 Box. 6 3P1545 Calibration Pin with 17.3734 on it, (in-line engines). 7. 3P1546 Calibration Pin with 15.9410 on it. (Vee engines). 8. 1S9836 Wrench.

1. Remove the fuel shut-off solenoid (9), top cover (1) of the fuel pump housing and the cover over the torque control group.
2. Remove the fuel that is in the injection pump housing and the governor housing.



REMOVAL OF COVERS

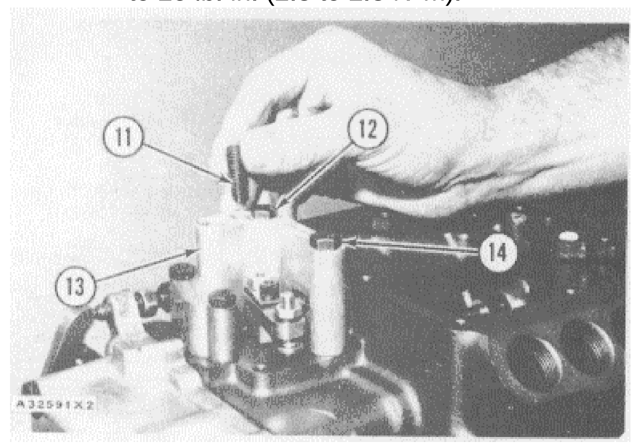
9. **Shut-off solenoid. 10. Top cover.**



INSTALLING CALIBRATION PIN

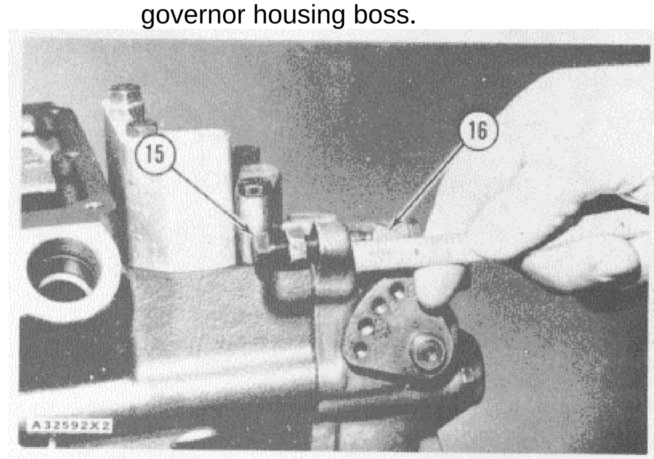
7. **3P1546 Calibration Pin with 15.9410 on it.**

8.
3. Install 3p1546 Calibration pin (7) in the calibration hole.
4. Install 5P4226 Adapter (13) as shown. Fasten it in position on the injection pump housing with a ID4533 bolt (12 and a ID4538 bolt(14).
5. Put XS7271 Screw (11) in the hole over calibration pin (7). Tighten screw (11) to 20 to 25 lb. in. (2.3 to 2.8 N•m).



INSTALLING 5P4226 ADAPTER AND 8S7271 SCREW
11. Screw. 12 1D4533 Bolt. 13. 5P4226 Adapter. 14. 1D4538 Bolt.

6. Adjust low idle screw (15) to position lever (16) to .35 ± .04 in. (8.0 ± 1.0 mm) from governor housing boss.



ADJUSTMENT OF LOW IDLE SCREW
15. Low idle screw. 16. Lever.

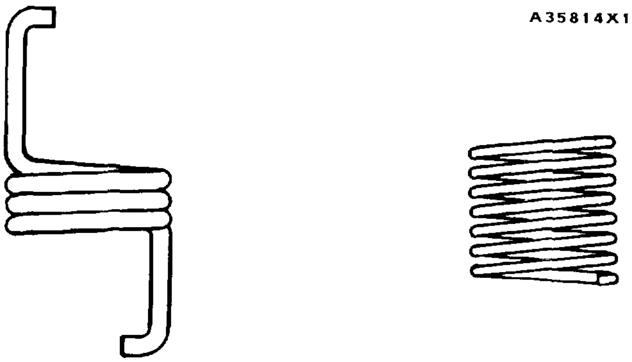
7. Use the 8S2243 Wrench and remote the fuel injection pumps to be checked.

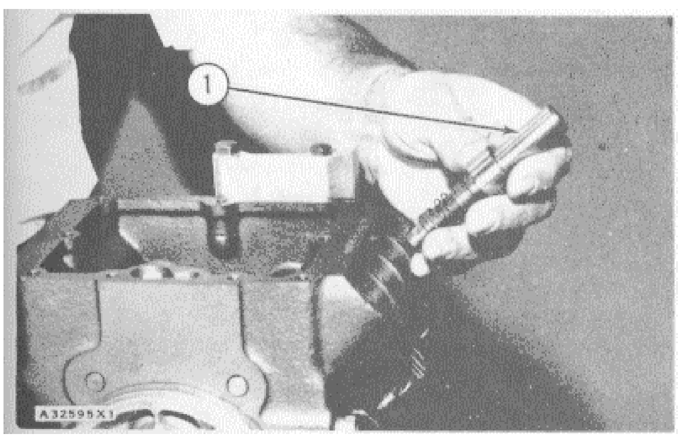
NOTE: If pump is removed carefull3y, the sleeve will remain on the plunger. If the sleeve falls off the pump plunger during removal, find it immediately and replace it on the pump plunger before removal of another pump. The original sleeve must remain with the same pump plunger.

NOTE: When sleeve is installed on pump plunger, the narrower of the two lands on the sleeve must be toward top of pump (nearest the pump spring).

8 Clean the barrel and plunger of calibration pump (1). Put clean diesel fuel on the calibration pump fox lubrication.

NOTE: Be sure that the spring on calibration pump (1) is the 5P6557 Spring instead of the 1 P7377 Spring which was installed on earlier calibration pumps.

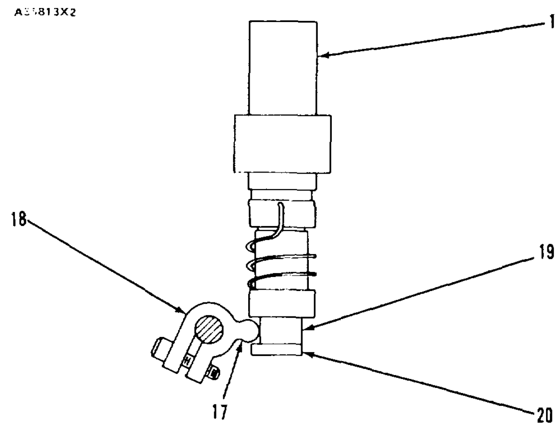




INSTALLING CALIBRATION PUMP
1. 3P1540 Calibration Pump.

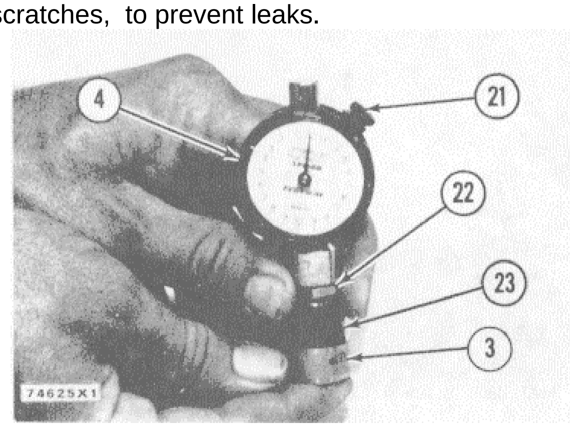
9. Put calibration pump (1) in the place of the pump to be checked with the flat place (20) on the plunger toward tang (17) on lever (18). When the calibration pump (1) is all the way in the bore, turn it 180° in either clockwise or counterclockwise direction. Tang (17) on lever (18) is now in groove (19) of calibration pump (1). Then install 4N218 Bushing (2) use the 8S2243 Wrench and a torque to tighten the bushing to 60 ± 5 lb. ft. (80 ± 7 N•m).

NOTE: Turning calibration pump (1) 1800 gives the same reference point for all measurements.



CALIBRATION PUMP INSTALLED
1. 3P1540Calibration Pump. 17. Tang on lever. 18. Lever. 19. Groove of calibration pump. 20. Flat on plunger.

NOTE: Use 4N218 Bushing (2) and calibration pump (1) together. The contact surfaces of the standard bushing, fuel injection pump and the housing for the fuel injection pumps are sealing surfaces. Keep them clean and free of scratches, to prevent leaks.

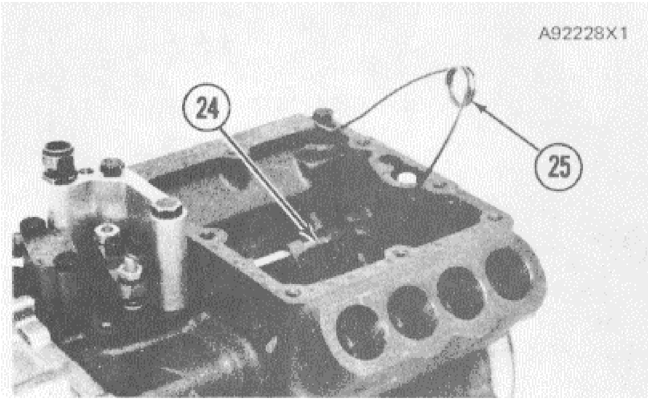


PUTTING DIAL INDICATOR ON ZERO
3. Microgage. 4. 3P1568 Dial Indicator with 3P2226 Collet. 21. Lockscrew. 22. Locknut. 23.3P2226 Collet.

10. Put dial indicator (4) on microgage (3) and hold them together tightly. Loosen lockscrew (21) and turn the face of dial indicator (4) to put the pointer at "0". Tighten lockscrew (21).

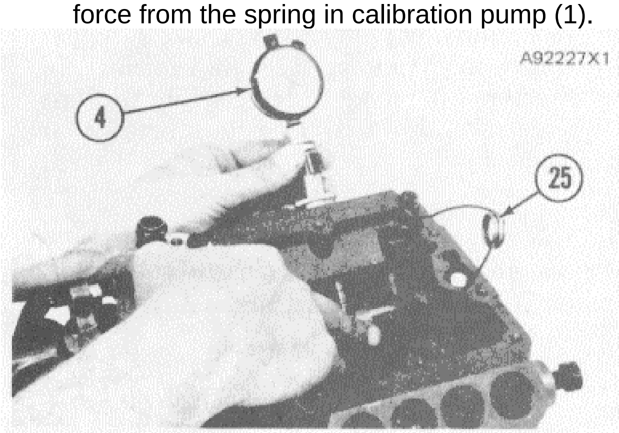
Remove dial indicator (4) from microgage (3). Look at the face of dial indicator (4) and put dial indicator (4) on microgage (3) again. The pointer must move through one to one and one half revolutions before stopping at exactly "0". If the number of revolutions is not correct, loosen the locknut on 3P2226 Collet (23), and adjust the position of the dial indicator until the adjustment is correct do Step 11.

NOTE: If locknut (22) on the 3P2226 Collet is too tight, it can cause interference in the operation of the dial indicator.



6V190 CLAMP INSTALLED
24. Shaft. 25. 6V190 Clamp.

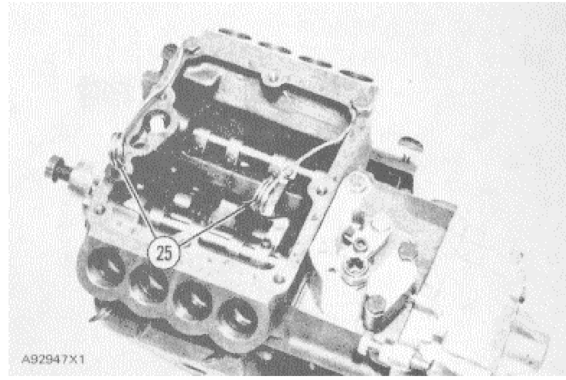
Put 6V190 Clamp (25) in the position shown, next to the transfer pump end. Clamp (25) pushes shaft (24) down against the bottom of its bearing. The other end of shaft (24) is held down against its bearing by 3P1546 Calibration Pin (7) which is held b) 8S7271 Screw (11). The combination of forces from clamp (25) and calibration pin (7) is necessary to hold shaft (24) in its normal operating position against the lifting force from the spring in calibration pump (1).



DIAL INDICATOR POSITION

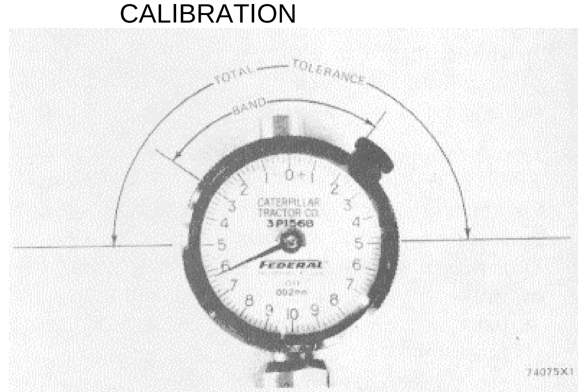
4. **3P1568 Dial Indicator with 3P2226 Collet. 25 Clamp.**

NOTE: When checking pumps on the "slave" side [side opposite from governor control lever (16)], put clamp (25) on both ends of sleeve shaft as shown. Put dial indicator (4) on the calibration pump (1) as shown. Hold it tightly in place. Move shaft (24) toward the governor end to remove end play. To remove any clearance in the link- age, lift the crossover lever dowel and rapidly let it go. Do this several times. Then look at the reading on the dial indicator (4).



INSTALLING CLAMP ON "SLAVE" SIDE
25. 6V190 Clamps.

13. If the dial indicator (4) reading is more than ± 0.050 mm from "0.000" (outside the TOTAL TOLERANCE).do steps 17 through 20, ADJUSTING FUEL, PUMP CALIBRATION



DIAL INDICATOR READING
Desired reading for all pumps is "0.000"

Maximum permissible tolerance for pump readings in any FUEL INJECTION PUMP GROUP is 0.100 mm(-0.050 to -0.050 mm on dial indicator).

Maximum permissible differences between any two pumps in the same FUEL INJECTION PUMP GROUP is 0.050 mm.

TOTAL TOLERANCE shows the maximum permissible range of pointer positions which are acceptable. If any reading Is outside the range of TOTAL TOLERANCE, do ADJUSTING FUEL PUMP CALIBRATION for all pumps.

BAND is an example only. It shows a 0.050 mm range. This range shows the maximum permissible difference between any two readings for all the pumps. If any two readings are farther apart than the 0.050 mm range, do ADJUSTING FUEL PUMP CALIBRATION for all pumps.

If the dial indicator (4) reading is near either end of the TOTAL TOLERANCE, check another pump. If the next reading is outside the TOTAL TOLERENCE or if the two readings have a difference of 0.050 mm or more, do the Steps 15 through 19, .ADJUSTING FUEL PUMP CALIBRATION.

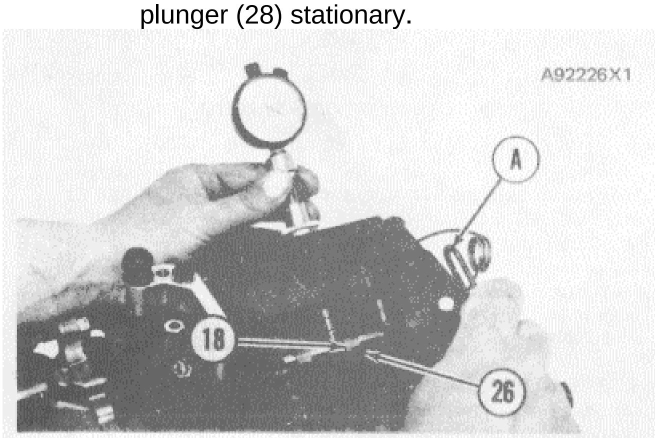
NOTE: The mechanic doing the checking must make the decisions of which and how many pumps to check according to the symptoms of the fuel injection pump being tested.

14. If dial indicator (4) readings for all the pumps are within the limits in Step 13, the calibration is acceptable. Remove the tooling, and install the parts which were removed.

NOTE: For troubleshooting purposes, if the dial indicator (4) reading is "0" or near "0", the calibration of the other pumps is probably in the tolerance.

Adjustment of Fuel Pump Calibration

15. Remove all pumps with 8S2243 Wrench.
16. Clean the barrel and plunger of calibration pump (1). Put clean diesel fuel on the calibration pump (1) for lubrication.
17. Install calibration pump (1) in the place of one of the pumps according to the procedure in Step 9.
18. Loosen bolt (26) with 1S9836 Wrench (8) or 5P4206 Wrench. Turn the lever (18) on shaft (24) enough to move the top of plunger (28) of calibration pump (1) below top surface (27) of calibration pump (1).Tighten bolt (26) just enough for lever (18) to hold plunger (28) stationary.

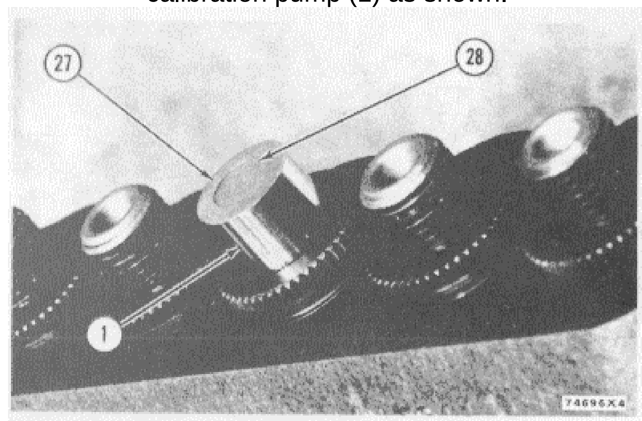


5P4206 WRENCH
18. Lever. 26. Bolt. A. 5P4206 Wrench.

NOTE: When bolt (26) has the correct torque, pushing with a small amount of force on lever (18) through the wrench moves plunger (28) up in calibration pump (1).

19. Move shaft (24) toward the governor to remove end play. Then push down on lever (18).

through the wrench until top of plunger (28) is almost even with top surface (27) of calibration pump (1) as shown.

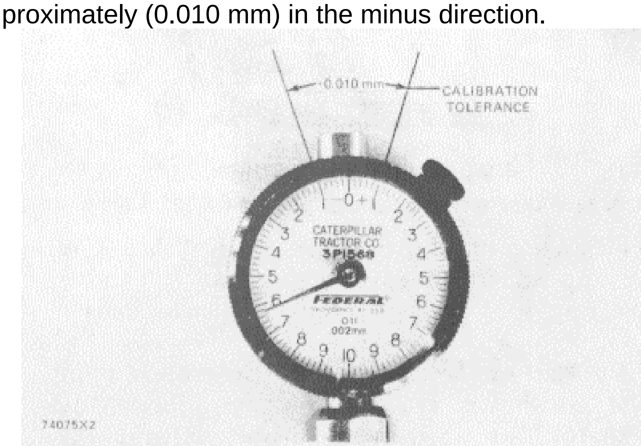


PLUNGER POSITION
1. Calibration pump. 27. Top surface of calibration pump.28. Plunger.

20. Check dial indicator (4) according to Step 10. Then put dial indicator (4) in place over the center of calibration pump (1) and hold it there tightl5. Now move plunger (28) of calibration pump (1) by pushing on lever (18) through the wrench. Stop moving the plunger when the dial indicator is at approximately 0.009 mm past "0.000". Tighten bolt (26) to 24 ± 2 lb. in. (2.8 ± 0.2 N•m).

NOTE: When Moving plunger (28), make sure that the last direction of plunger (28) movement is in the up direction. If plunger (28) goes up too far, move plunger (28) down to a position below that desired. Then move plunger (28) up to the desired position

NOTE: The action of tightening bolt (26) usually changes the reading on dial indicator (4) by approximately (0.010 mm) in the minus direction.

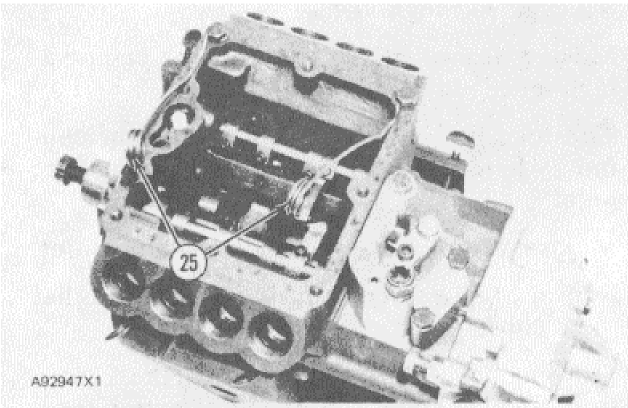


+ 0.010 mm CALIBRATION TOLERANCE

Move shaft (24) toward shutoff several times to remove clearance in the linkage. Dial indicator (4) reading must be (0.000 ± 0.010 mm) as shown.

When the pump calibration is correct make a record and then do the same procedure for all the other pumps.

NOTE: When calibrating pumps on the "slave" side [side opposite from governor control lever (16)], put clamp (25) on both ends of the sleeve shaft as shown in picture number A92947X1.



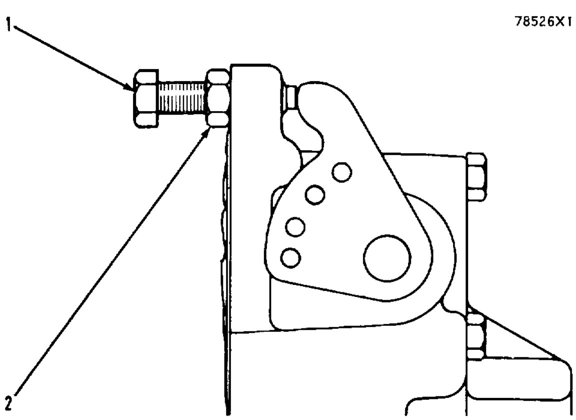
INSTALLING CLAMP ON "SLAVE" SIDE
25. 6V190 Clamps.

GOVERNOR ADJUSTMENTS

CAUTION

A mechanic that has the correct training is the only one to make the adjustment of low idle and high idle rpm. The correct low idle and high idle rpm, and the measurements for adjustment of fuel setting are given in the RACK SETTING INFORMATION.

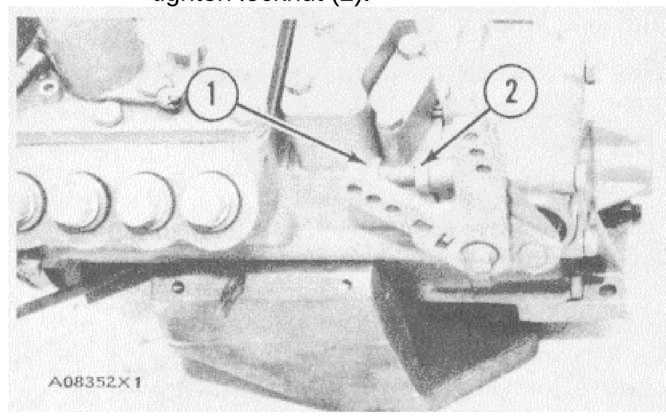
Check engine rpm with a tachometer that has good accuracy. If the low idle or high idle rpm needs an adjustment, use the following procedure:



ADJUSTMENT OF LOW IDLE RPM
1. **Adjustment boll for low idle. 2. Locknut.**

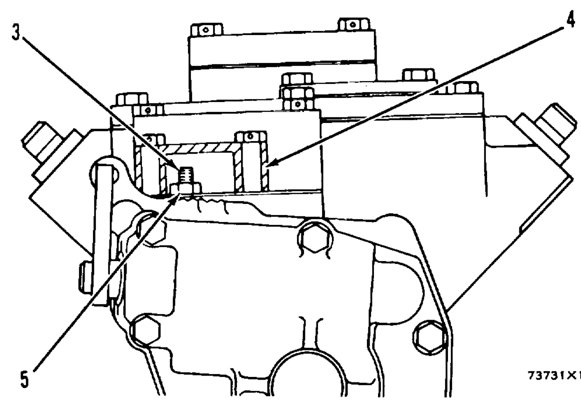
1. For adjustment of loss idle, loosen lock nut (2) and turn adjustment bolt (1) to get as near as possible to the correct low idle rpm.

2. After the low idle adjustment is correct, tighten locknut (2).



ADJUSTMENT OF LOW IDLE RPM
1. Adjustment bolt for low idle. 2. Locknut.

3. To make an adjustment to the high idle rpm, remove the small cover (4) at the top rear of the fuel system.
4. Loosen locknut (5) and turn adjustment screw (3) to get as near as possible to the correct high idle r m.



ADJUSTMENT OF HIGH IDLE RPM
3. Adjustment screw. 4. Cover. 5 Locknut.

5. After each idle adjustment is made, move, the governor lever to change the rpm of the engine. Now move the governor lever back to the point of first adjustment to check the idle adjustment. Keep doing the adjustment procedure until the low idle and high idle rpm are the same as given in the RACK SETTING INFORMATION.
6. After adjustment of high idle rpm is correct, tighten locknut (5) and install cover (4).

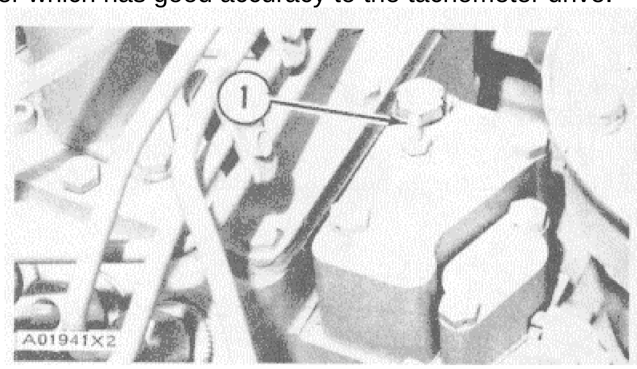
Checking Balance Point (Full Load Speed)

The balance point for the engine is:

1. At full load speed.
2. The point the load stop pin is against the load , top.
3. The point where the engine gets the maximum amount of fuel per stroke.
4. The point where the engine has the most horse- power output.
5. The point where an increase in load on the engine puts the engine in a lug condition (a condition in which a small increase in load makes the engine speed get much less).

Procedure for Checking Balance Point

1. Connect a tachometer which has good accuracy to the tachometer drive.



TERMINAL LOCATION

1. **Brass terminal screw.**

2. Connect a continuity light to the brass ter-minal screw (1) on the cover for the load stop. Connect the other end of the light to a place on the fuel system which is a good electrical connection.
3. Start the engine.
4. With the engine at operating conditions, run the engine at high idle.
5. Make a record of the speed of the engine at high idle.
6. Add load on the engine slowly until the con-tinuity light just comes on. This is the balance point.
7. Make a record of the speed at the balance point.
8. Repeat Step 6 several times to make sure that the recording is correct.
9. Stop engine. Make a comparison of the records from Steps 5 and 7 with the information from the ENGINE INFORMATION plates on the side of the engine or with the information given in the RACK SETTING INFORMATION.
10. If the full load speed is not correct, adjust the HIGH IDLE speed to make a change in the full load speed.
11. If the high idle speed is out of tolerance and the full load speed is correct, look for a weak governor spring or the wrong governor spring. Both the full load speed and the high idle speed must be in the tolerance given in the RACK SETTING INFORMATION.

AIR INLET INLET AND EXHAUST SYSTEM

RESTRICTION OF AIR INLET AND EXHAUST

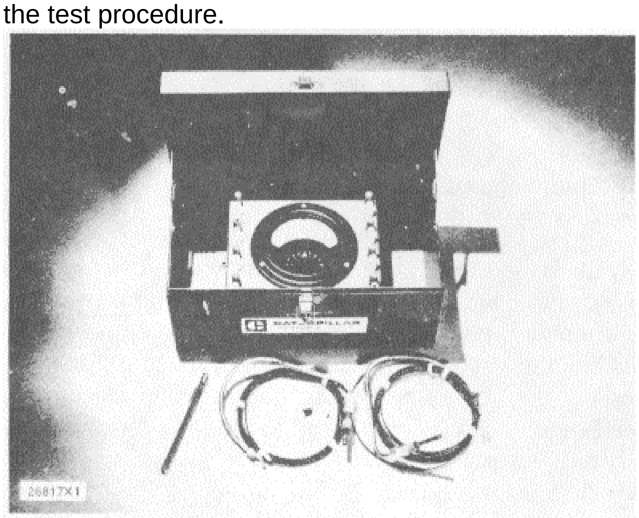
There will be a reduction of horsepower and efficiency of the engine if there is a restriction in the air inlet or exhaust system.

Air flow through the air cleaner must not have a restriction of more than 25 in. (635 mm) of water difference in pressure.

Back pressure from the exhaust (pressure difference measurement between exhaust outlet elbow and atmosphere) must not be more than 34 in. (864 mm) of water.

MEASUREMENT OF EXHAUST TEMPERATURES

Use the lP3060 Pyrometer Group to check exhaust temperature. Special Instruction Form No. SMHS7179 is the tool group and gives instructions for the test procedure.



1P3060 PYROMETER GROUP

CYLINDER COMPRESSION

An engine that runs rough can have a leak at valves, or valves that need adjustment. Run the en{ at the speed that gives rough running. To find a cylinder that has low compression or does not have good ignition, loosen a fuel line nut at a fuel injection pump. This will stop the flow of fuel to that cylinder. Do for each cylinder until a loosened fuel line is found makes no difference in engine rough running. Be sure to tighten each fuel line nut after the test before the next fuel line nut is loosened. This test can also be indication that the fuel injection is wrong, so more checking of the cylinder will be needed.

An analysis of the engine cylinder condition can be done with controlled pressure air through the cylinder head. Special Instruction GMG00694 explains the procedure.

1. Remove the fuel injection nozzle.
2. Adapt an air hose to 1P5564 Adapter. Install 1P5564 Adapter in the fuel injection nozzle opening in the cylinder head.
3. Start crankshaft rotation until the piston in the cylinder being inspected is at TC on the compression stroke. In this position the valves of this cylinder will be against their seats.
4. Force the air into the cylinder and then check air leakage. An air leak from the exhaust opening is an indication of exhaust valve leakage and leak from the air cleaner inlet is an indication of intake valve leakage. If the air leakage is into crankcase during this test, the piston or piston rings can be the cause.

VALVE CLEARANCE SETTING

Check and adjust valve clearance with engine stopped.

Valve clearance is measured with a thickness gauge between the top of the valve stem and the rocker arm.

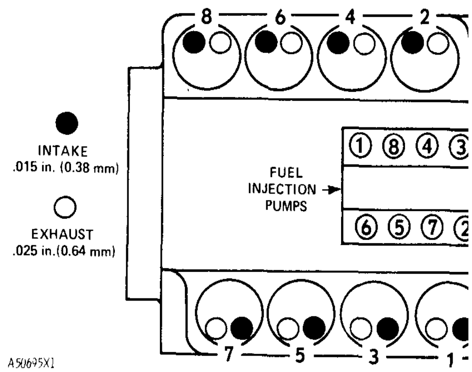
VALVE CLEARANCE CHECK: ENGINE STOPPED	
Exhaust......	.022 to .028 In.(0.56 to .71mm)
Intake.........	.012 to .018 in.(0.30 to 0.46mm)

NOTE: When the valve lash (clearance) is checked adjustment is NOT NECESSARY if the measure is in the range given in the chart for VALVE CLEARANCE CHECK: ENGINE STOPPED. If the measurement is outside this range, adjustment is necessary. See the chart for VALVE CLEARANCE SETTING ENGINE STOPPED, and make the setting to the nominal (desired) specifications in this chart.

VALVE CLEARANCE SETTING: ENGINE STOPPED	
Exhaust......	.025in. (0.64 mm)
Intake.........	.015 in. (0.38 mm)

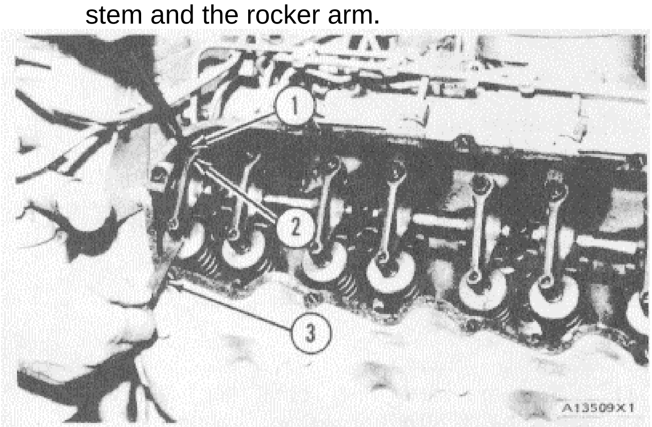
To check and make adjustment to the valve lash the procedure that follows:

1. Remove the valve covers.



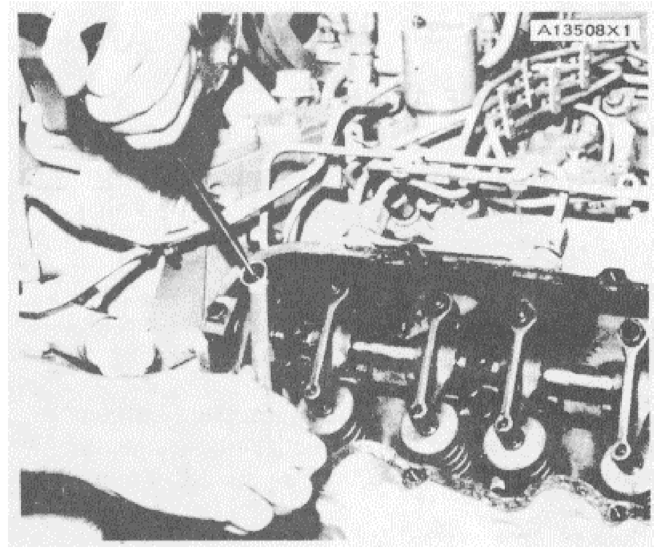
CYLINDER, VALVE, AND PUMP LOCATION

2. Turn the crankshaft COUNTERCLOCKWISE (as seen from rear of engine) until No. 1 Piston is at top center on the compression stroke. The TDC-I mark on the damper assembly will be in alignment with the timing pointer.
3. Make adjustment to the valves for No. 1 and No 2. cylinders. To make the adjustment, loose nut (2). Turn the adjustment screw (1) until the feeler gauge (3) will go between the end valve stem and the rocker arm.



VALVE LASH ADJUSTMENT
1. Adjustment screw. 2. Locknut. 3. Feeler gauge.

4 .After the adjustment is complete, hold adjustment screw (1) and tighten locknut (2) to 24 + (32 + 7 N.m). After the locknut is tightened check the adjustment again.
5. Turn the crankshaft 180° COUNTERCLOCKWISE (as seen from rear of engine). The VS mark on the damper assembly will be in alignment with the timing pointer. Make adjustment to the for No. 3 and No. 7 cylinders.
6. Turn the crankshaft 1800 COUNTERCLOCKWISE (as seen from rear of engine). The mark on the damper assembly will be in alignment with the timing pointer. Make adjustment valves for No. 4 and No. 5 cylinders.



TIGHTENING LOCKNUT

7. Turn the crankshaft 180° COUNTERCLOCKWISE (as seen from rear of engine). The VS mark on damper assembly will be in alignment with the timing pointer. Make adjustment to the vale No. 6 and No. 8 cylinders.

When the adjustment of the valve lash needs done several times in a short period of time, it car indication of wear in a different part of the engine the problem and make any necessary repairs to prevent more damage to the engine.

Not enough valve lash, if not corrected, can be the cause of rapid wear of the camshaft and cam followers. Not enough valve lash can also be an indication of the seats for the valves being bad. Some reasons for the seats for the valves becoming bad are fuel injection nozzles with defects, restriction to the inlet air or air filters, wrong fuel setting, or using the engine loads that are too large for the engine.

Too much valve lash, if not corrected, can be the cause for broken valve stems, push rods, or retainers. A fast increase in valve lash can be an indication of any of the following:

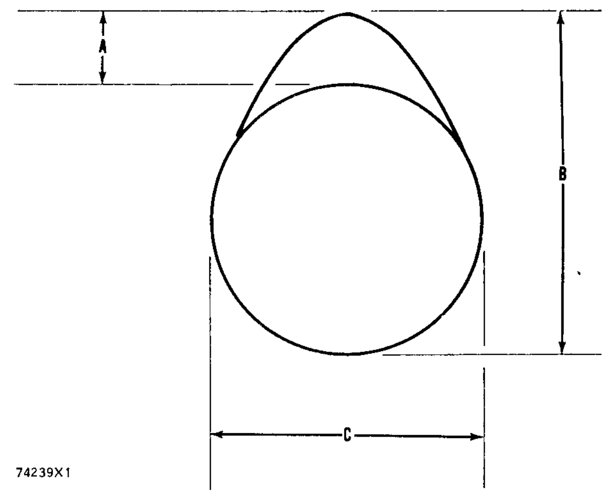
a. Camshaft and cam follower with wear.
b. Rocker arms with wear.
c. Push rot's that are bent.
d. Loose adjustment screw for the valve 1a
e. Broken socket on the upper end of a push

If the camshaft and cam followers show signs of rapid wear, look for fuel in the lubrication oil or dirty lubrication oil as a possible cause when making necessary repairs.

PROCEDURE FOR MEASURING CAMSHAFT LOBES

To find lobe lift (A) of camshaft, use the following procedure:

1. Measure lobe height (B) of one exhaust and one intake lobe.
2. Measure base circle (C) of one exhaust and one intake lobe.
3. Subtract base circle (C) dimension (STEP 2) from lobe height (B) dimension (STEP 1). The difference is actual lobe lift (A).
4. The specified (new) lobe lift (A) is: -
   (a) Exhaust lobe ...... .3071 in. (7.800 mm
   (b) Intake lobe .... .3077 in. (7.816 mm
5. The maximum permissible difference between actual lobe lift (STEIP 3) and specified lobe lif't (STEP 4) is .010 in. (0.25 mm).



CAMSHAFT LOBE

A. Lobe lift. B. Lobe height. C. Base circle.

LUBRICATION SYSTEM

One of the problems in the following list will generally be an indication of a problem in the lubrication system for the engine.

TOO MUCH OIL CONSUMPTION

OIL PRESSURE IS LOW

OIL PRESSURE IS HIGH

TOO MUCH COMPONENT WEAR

TOO MUCH OIL CONSUMPTION

Oil Leakage on Outside of Engine

Check for leakage at the seals at each end of the crankshaft. Look for leakage at the oil pan gasket an all lubrication system connections. Check to see if oil is coming out of the crankcase breather. This can be caused by combustion gas leakage around the pistons. A dirty crankcase breather will cause high pressure is the crankcase, and this will cause gasket and sea leakage.

Oil Leakage Into Combustion Area of Cylinders of Cylinders

Oil leakage into the combustion area of the cylinders can be the cause of blue smoke. There are three possible ways for oil leakage into the combustion area of the cylinders:

1. Oil leakage between worn valve guides and valve stems.
2. Worn or damaged piston rings or dirty oil return holes.
3. Compression ring not installed correctly.

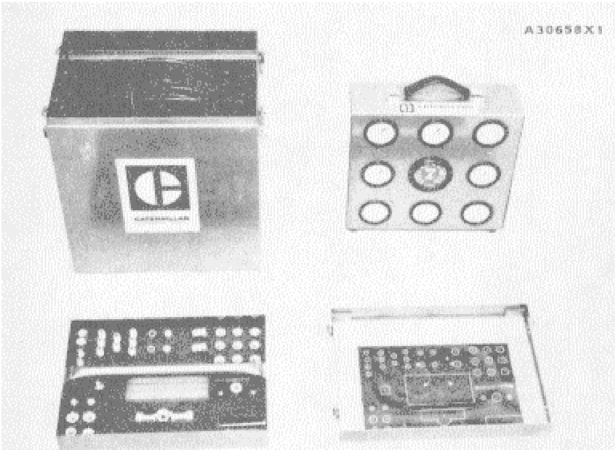
Too much oil consumption can also be the result of using oil with the wrong viscosity. Oil with a thin (low viscosity can be caused from dirt or fuel getting in the crankcase, or by the engine getting too hot.

OIL PRESSURE IS LOW

An oil pressure gauge that has a defect may give an indication of low oil pressure.

When the engine is running at rated speed with SAE 30 oil at operating temperature, the oil pressure measured at the clean side of the oil filter at the oil filter base will be 55 to 85 psi (380 to 590 kPa).

A minimum low pressure reading of 15 psi (105 Kpa) is normal at low idle rpm. If there is no oil pressure, stop the engine immediately. An 8M2744 Gauge, which is part of 5P6225 Hydraulic Test Box, can be used for checking pressure in the system.



5P6225 HYDRAULIC TEST BOX

Crankcase Oil Level

Check the level of the oil in the crankcase. Add oil if needed. It is possible for the oil level to be too far below the oil pump supply tube. This will result in the oil pump not having the ability to supply enough lubrication to the engine components.

Oil Pump Does Not Work Correctly

The inlet screen of the supply tube for the oil pump can have a restriction. This will result in cavitation and a loss of oil pressure. Air leakage in the supply the oil pump will also cause cavitation and loss of oil pressure. If the pressure regulating valve for the system is held in the open (unseated) position, the lubrication system can not get to maximum pressure. Oil pump gears that have too much wear will cause a reduction in oil pressure.

Oil Filter and Oil Cooler

A dirty oil filter will cause a reduction in oil pressure. When the oil filter is filled with dirt, a restriction of oil flow thru the filter and a reduction of filtered oil pressure is the result.

The bypass valve will cause the flow of oil to go around the filter elements when there is a reduction to the flow through the elements. When the bypass vavle is open, oil that is not filtered is permitted to flow thru the engine. To correct this problem, install a new Caterpillar filter.

Look for a restriction in the oil passages of the oil cooler. If the oil cooler has a restriction, the oil cooler bypass valve in the oil filter base will open. This will cause the flow of oil to go around the oil cooler. The temperature will be higher than normal when the engine is running. The oil pressure of the engine will be low if the oil cooler has a restriction.

Too Much Clearance at Engine Bearings or Open, Broken or Disconnected Oil Line Passage in Lubrication System

Components that are worn and have too much bearing clearance can cause oil pressure to be low. Low oil pressure can also be caused by an oil line or oil passage that is open, broken or disconnected.

OIL PRESSURE IS HIGH

Oil pressure will be high if the bypass valve for the oil pump can not move from the closed position

TOO MUCH COMPONENT WEAR

When some components of the engine show bearing wear in a short time, the cause can be a restriction oil passage. A broken oil passage can also be the cause.

If the gauge for oil pressure shows the correct oil pressure, but a component is worn because it is not getting enough lubrication, look at the passage for oil supply to that component. A restriction in a supply passage will not let enough lubrication get to a component and this will cause early wear.

COOLING SYSTEM

The cooling system is a pressure type. The engine has the temperature regulator at the outlet. The cooling system is equipped with a shunt line.

A pressure type cooling system gives two advantages. The first advantage is that the cooling system can have safe operation at a temperature that is higher than the normal boiling (steam) point of water. The second advantage is that this type system prevents cavitation (the sudden making of low pressure bubbles in liquids by mechanical forces) in the water pump. With this type system, it is more difficult for air or steam pockets to be made in the cooling system.

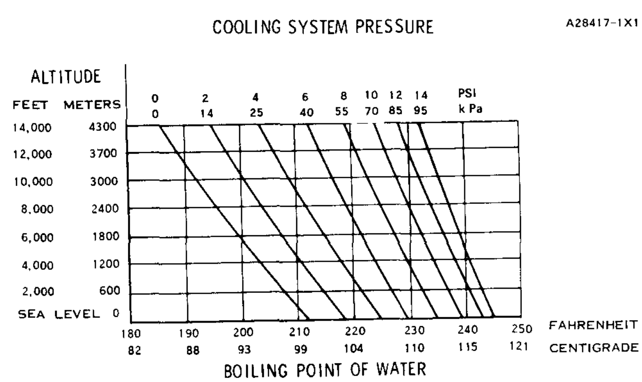
The cause for an engine getting too hot is generally because regular inspections of the cooling system were not made. Make a visual inspection of the cooling system before testing with testing equipment.

VISUAL INSPECTION OF THE COOLING SYSTEM

1. Check coolant level in the cooling system.
2. Look for leaks in the system.
3. Look for bent radiator fins. Be sure that air flow through the radiator does not have a restriction.
4. Inspect the drive belt for the fan.
5. Check for damage to the fan blades.
6. Look for air or combustion gas in the cooling system.
7. Inspect the pressure cap and the sealing surface for the cap. The sealing surface must be clean.

TESTING THE COOLING SYSTEM

Remember that temperature and pressure work



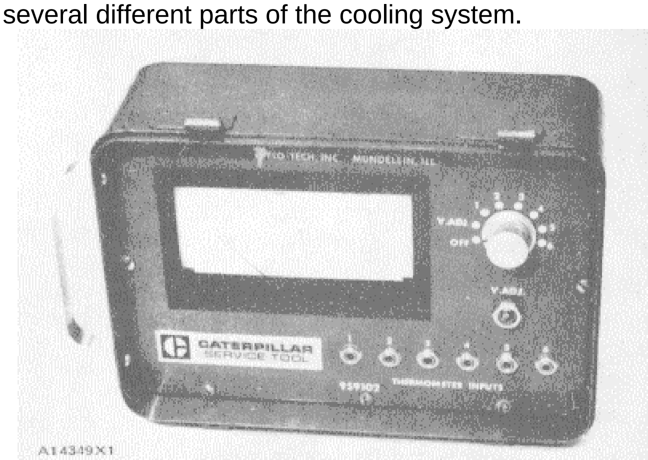
together. When making a diagnosis of a cooling system problem, temperature and pressure must both be checked. Cooling system pressure will have an effect on cooling system temperatures. For an example, look at the chart to see the effect of' pressure and height above sea level the boiling (steam) point of' water.

Test Tools for Cooling System

Tools Needed:

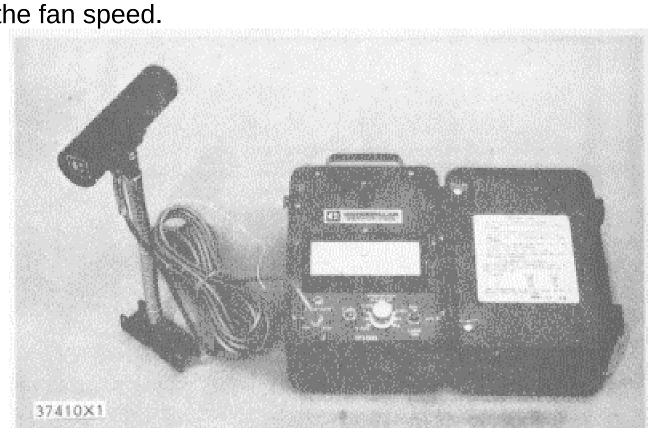
- 9S9102 Thermistor Thermometer Group.
- 9S7373 Air Meter Group.
- 1P5500 Portable Phototach Group.
- 9S8140 Cooling System Pressurizing Pump Group.

The 9S9 102 -Thermistor Thermometer Group is used in the diagnosis of overheating (engine running too hot) or over cooling(engine runs too cool) problems. This group can be used to check temperatures in several different parts of the cooling system.



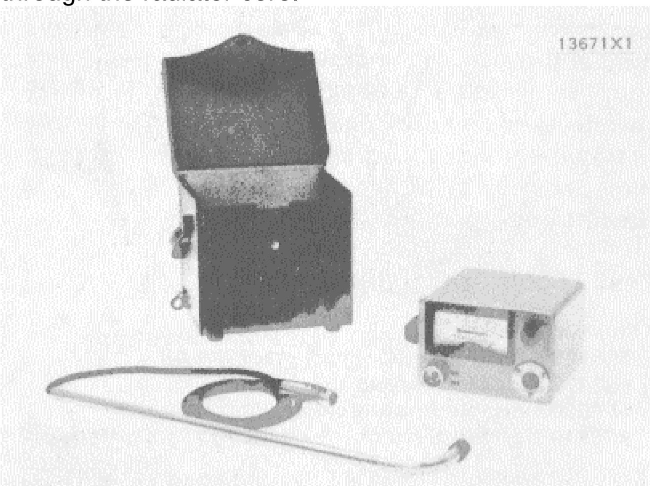
9S9102 THERMISTOR THERMOMETER GROUP

The IP5500 Portable Phototach Group is used to check the fan speed.



1P5500 PORTABLE PHOTOTACH GROUP

The 9S7373 Air Meter Group is used to the air flow through the radiator core.



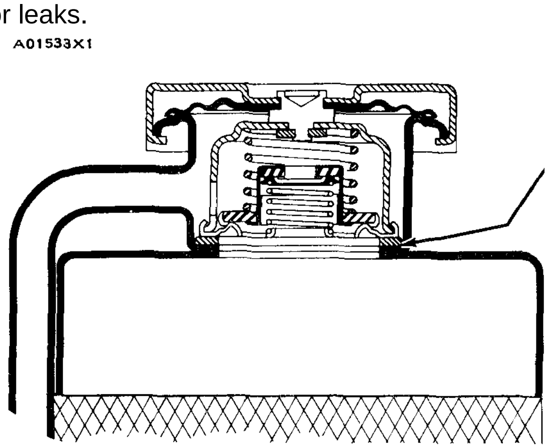
9S7373 AIR METER GROUP

Pressure Cap Test

Tools Needed:
9S8140 Cooling System Pressuring Pump Group

One cause for a pressure loss in the cooling system can be a bad seal on the pressure cap system. Inspect the pressure cap carefully. for damage to the seal or to the surface that seals. Any foreign material or deposits on the cap, seal, or surface that seals must be removed.

The 9S8140 Cooling System Pressurizing Group is used to test pressure caps and to pi check the cooling system for leaks.



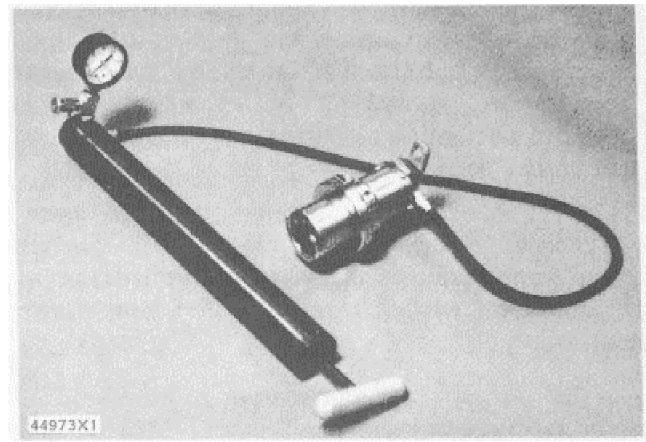
TYPICAL SCHEMATIC OF PRESSURE CAF
A. Sealing Surface of cap and radiator.

To check the pressure cap for the pressure makes the pressure cap open, use the procedure that follows:

1. Remove the pressure cap from the radiator.

WARNING

If the engine has been operated and the coolant is hot, loosen the pressure cap to the first and let the pressure out of the cooling system then remove the pressure cap.



9S8140 COOLING SYSTEM PRESSURIZING PUMP GROUP

2. Put the pressure cap on the 9S8140 Cooling System Pressurizing Pump Group.
3. Look at the gauge for the exact pressure makes the pressure cap open.
4. Make a comparison of the reading on the guage with the correct pressure at which the pressure cap must open.

NOTE: The correct pressure that makes the sure cap open is on the pressure cap and is a the SPECIFICATIONS.

5. If the pressure cap *is* bad, install a new pressure cap.

Radiator and Cooling System Leak Tests

To test the radiator and cooling system for leaks, use the procedure that follows:

1. Remove the pressure cap from the radiator

WARNING

If the engine has been operated and the coolant is hot, loosen the pressure cap to the first top and let the pressure out of the cooling system then remove the pressure cap.

2. Make sure the coolant is over the top of the radiator core.
3. Put the 9S8140 Cooling System Pressurizing Pump Group on the radiator.
4. Get the pressure reading on the gauge to (20 kPa) more than the pressure on the pressure cap.
5. Check the radiator for outside leakage.
6. Check all connections and hoses for the cooling system for outside leakage.
7. If you do not see any outside leakage and pressure reading on the gauge is still the same after 5 minutes, the radiator and cooling system does not have leakage. If the reading on gauge goes down and you do not see any side leakage, there is leakage on the inside the cooling system. Make repairs as necessary

The 9S8140 Cooling System Pressurizing Pump Group is used to test pressure caps and pressure relief valves, and to pressure check the cooling system for leaks.

Gauge for Water Temperature

Tools Needed:
9S9102 Thermistor Thermometer Group.

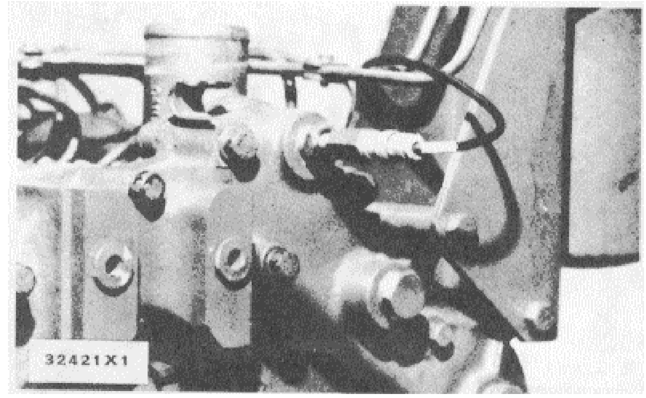
If the engine gets too hot and a' loss of coolant is a problem, a pressure loss in the cooling system can be the cause. If the gauge for water temperature shows that the engine is getting too hot, look for coolant leakage.

If a place can not be found where there is coolant leakage, check the accuracy of the gauge for water temperature. Use the 9S9102 Thermistor Thermometer Group.

⚠ WARNING

To help prevent an accident caused by parts in rotation, work carefully on an engine that has been started.

Start the engine. Put a cover over part of the radiator. The reading on the gauge for water temperature must be the same as the reading on thermistor thermometer.



**9S9102 THERMISTOR THERMOMETER GROUP INSTALLED
(Typical Example)**

Temperature Regulator

Test procedure for water temperature regulators:

I. Remove the regulator from the engine.
2. Put heat to a pan of water. Get the temperature of the water to 1970 F (920 C).
3. Hang the regulator in the pan of hot water. Put the regulator completely under the water. Do not let the regulator make contact the pan.
4. Keep the temperature of the water at 197°F (92° C) for ten minutes. Make the water move around. This keeps all of the water at the temperature.
5. After ten minutes, remove the regulator and immediately measure the distance the regulator is opened. See the SPECIFICATIONS for the correct opening distance.

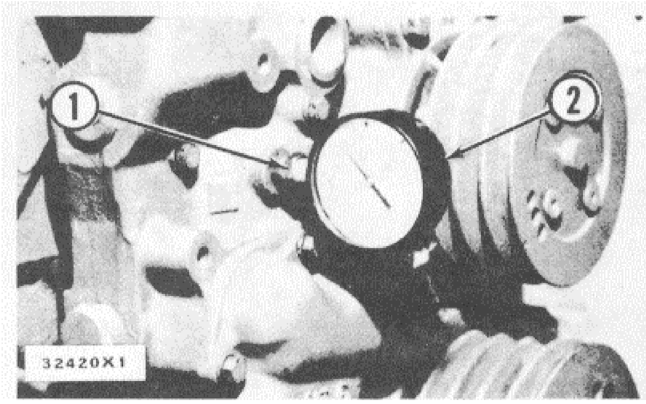
WATER PUMP PRESSURE CHECK

Tools Needed:
9S8138 Pressure Gauge.
3B7722 Bushing.

The pressure at the outlet for the water pump tells if the shunt system and water pump are operating correctly. To check the pump pressure install pressure gauge (2) in the front cover. The pressure must be a minimum of 15 psi (105 kPa) at 2800 rpm.

If the pump pressure is less than the minimum pressure: First, check the vent tube between radiator top tank and the surge tank; it must an inside diameter of approximately .19 in 4.8mm).

Second check to see that the shunt line has a minimum inside diameter of .75 in. (19.1 mm).

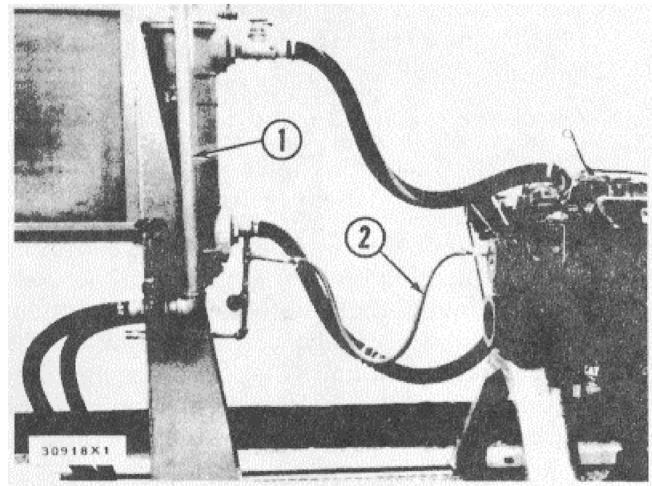


GAUGE INSTALLED
Typical Example
1. 3B7722 Bushing 2. 9S8138 Pressure Gauge

The front housing has several plugs that give access to water passages inside the housing

DYNAMOMETER TEST CAUTION

To prevent possible damage to an engine while testing on a dynamometer, the water temperature regulators must be installed and shunt line (2) connected as shown.



SHUNT LINE CONNECTED TO ENGINE
(Typical Example)
1. FT790 Cooling Tower Group. 2. Shunt Line.

V-BELT TENSION CHART

BELT SIZE	WIDTH BELT TOP		WIDTH TOP OF PULLEY GROOVE		BELT TENSION "INITIAL"* GAUGE READING		BELT TENSION "USED"** GAUGE READING		BORROUGHS GAUGE NUMBERS	
	in.	mm	in.	mm	lb.	N	lb.	N	OLD GAUGE NO.	NEW GAUGE NO.
3/8	.422	10.72	.380	9.65	100 ± 5	445 ± 22	90 ± 5	400 ± 22	BT-33-73F	BT-33-95
1/2	.547	13.89	.500	12.70	120 ± 5	534 ± 22	90 ± 10	400 ± 44	BT-33-96-4-16	BT-33-95
5V	.625	15.88	.600	15.24	120 ± 5	534 ± 22	90 ± 10	400 ± 44	BT-33-72-4-15	BT-33-72C
11/16	.688	17.48	.625	15.88	120 ± 5	534 ± 22	90 ± 10	400 ± 44	BT-33-72-4-15	BT-33-72C
3/4	.750	19.05	.690	17.53	120 ± 5	534 ± 22	90 ± 10	400 ± 44	BT-33-72-4-15	BT-33-72C
15/16	.938	23.83	.878	22.30	120 ± 5	534 ± 22	90 ± 10	400 ± 44	BT-33-72-4-15	BT-33-72C

MEASURE TENSION OF BELT FARTHEST FROM THE ENGINE

*"INITIAL" BELT TENSION is for a new belt.
**"USED" BELT TENSION is for a belt which has more than 30 minutes of operation at rated speed of engine. A10232X5

BASIC BLOCK

CONNECTING RODS AND PISTONS

Use the 5F9059 Piston Ring Expander to remove or install piston rings.

Use the 5P3524 Piston Ring Compressor to install pistons into cylinder block.

Tighten the connecting rod nuts in the following step sequence:

1. Put engine oil on bolt threads and seating surfaces of cap and nut.
2. Tighten both nuts to 30 ± 3 lb. ft. (40 ± 4N•m
3. Put a mark on each nut and cap.
4. Tighten each nut 600 from the mark.

The connecting rod bearings should fit tightly in the bore in the rod. If bearing joints or backs are worn (fretted), check for bore size as this is an indication of wear because of looseness.

A 5P3519 Piston Ring Grove Gauge is available for checking ring grooves with straight sides

NOTE: The 5P3519 Piston Ring Groove Gauge is used to check the top ring groove only.

PISTON RING GROOVE GAUGE

CONNECTING ROD AND MAIN BEAR

Bearings are available with a smaller inside diameter than the original size bearings. These bearings are for crankshafts that have been "ground" (made smaller than the original size). Main bearings are available with a larger outside diameter than the original size bearings. These bearings are for cylinder blocks that have had the bore main bearings "bored" (made larger than the original size).

FLYWHEEL AND FLYWHEEL HOUSIN(

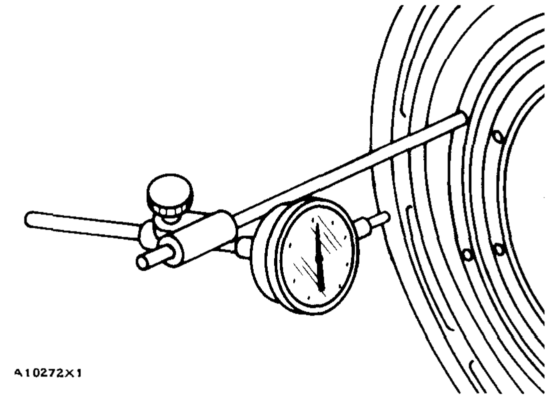
Tools Needed:
8S2328 Dial Indicator Group.

Heat the ring gear to install it. Do not heat to more than 400 F (204 C). Install the ring gear so the chamfer on the gear teeth is next to the pinion when the flywheel is installed.

Face Runout (axial eccentricity) of the Flywheel Housing

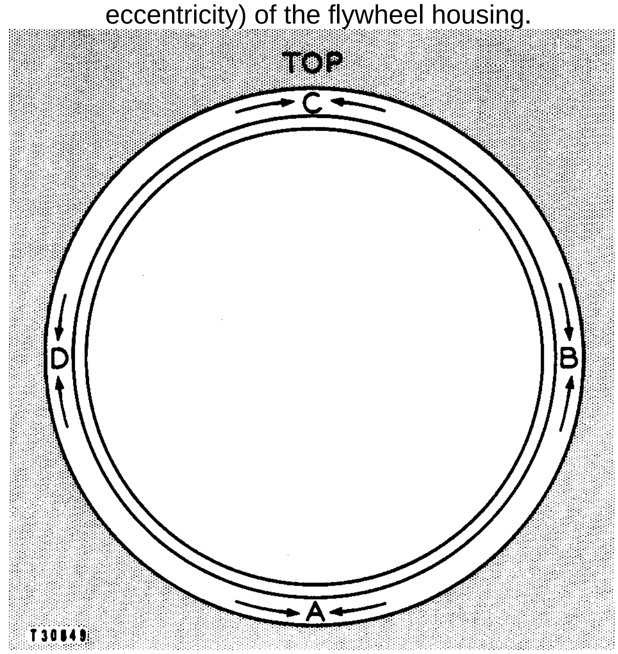
If any method other than given here is used, always remember bearing clearances must moved to get correct measurements.

1. Fasten a dial indicator to the crankshaft flange so the anvil of the indicator will touch face of the flywheel housing.
2. Force the crankshaft to the rear before reading the indicator at each point.



8S2328 DIAL INDICATOR GROUP

3. With the dial indicator set at .000 in. at location (A), turn the crankshaft and read the indicator at locations (B), (C) and (D).
4. The difference between lower and measurements taken at all four points must not be more than .010 in. (0.25 mm), which is the maximum permissible face runout (axial eccentricity) of the flywheel housing.



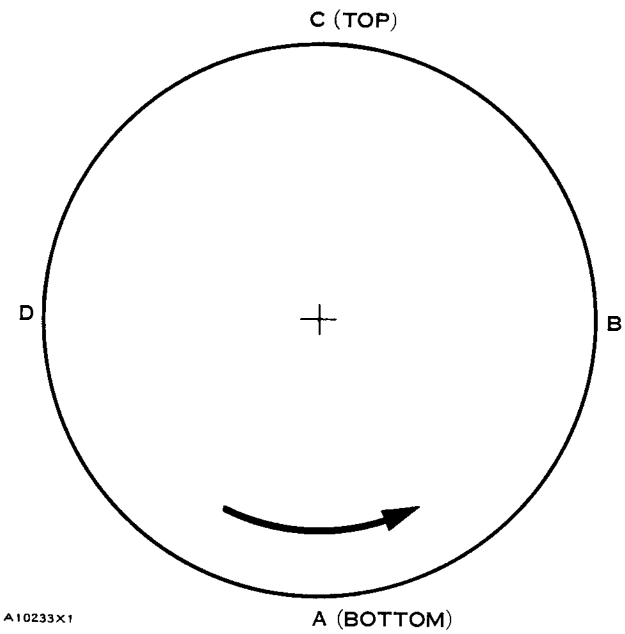
CHECKING FACE RUNOUT OF THE FLYWHEEL HOUSING

A. Bottom. B. Right side. C. Top. D. Left side.

Bore Runout (radial eccentricity) of the Flywheel Housing

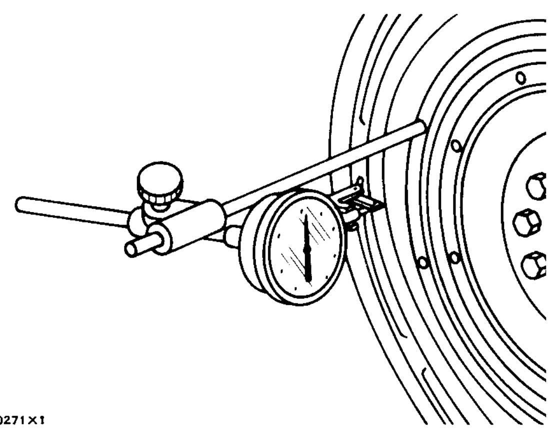
1. With the dial indicator in position at (C), adjust the dial indicator to .000 in. Push crankshaft up against the top bearing. Write the measurement for bearing clearance on line 1 in column (C).

2. Divide the measurement from Step I by 2. Write this number on line I in columns (B) & (D)



3. Turn the crankshaft to put the dial indicator at (A). Adjust the dial indicator to .000 in

4. Turn the crankshaft counterclockwise to put the dial indicator at (B). Write down the measurement in the chart.



8S2328 DIAL INDICATOR GROUP INSTALLED

NOTE: Write the dial indicator measurements with their positive(+) and negative(-) notation (signs). This is necessary for making the calculations in the chart correctly

5. Turn the crankshaft counterclockwise to put the dial indicator at (C). Write the measurement in the chart.

6. Turn the crankshaft counterclockwise to put the dial indicator at (D). Write the measurement in the chart.

7. Add lines I & 11 by columns.

8. Subtract the smaller number from the larger number in line III in columns (B) & (D). The result is the horizontal "eccentricity" (out of round). Line II, column (C) is the vertical eccentricity.

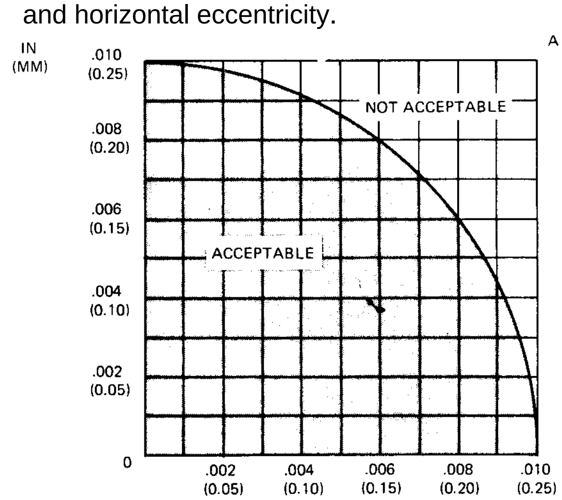
CHART FOR DIAL INDICATOR MEASUREMENTS

	Position of dial indicator				
	Line No.	A	B	C	D
Correction for bearing clearance	I	0			
Dial Indicator Reading	II	0			
Total of Line 1 & 2	III	0	**	*	**

*Total Vertical eccentricity (out of round).
**Subtract the smaller No. from the larger No. The difference is the total horizontal eccentricity.

A10234X1

9. On the graph for total eccentricity find the point of intersection of the lines for vertical eccentricity and horizontal eccentricity.



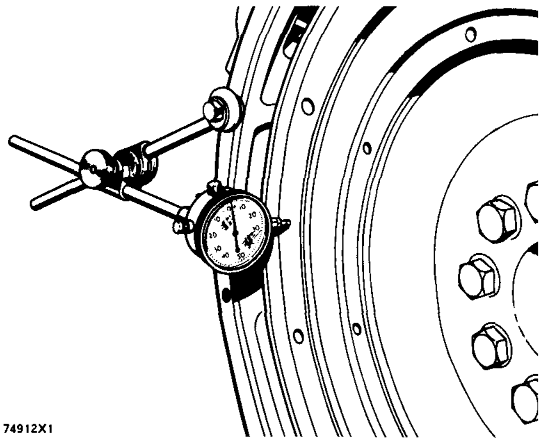
GRAPH FOR TOTAL ECCENTRICITY

10. If the point of intersection is in the range marked "Acceptable" the bore is in alignment If the point of intersection is in the range marked "Not Acceptable" the flywheel housing must be changed.

Face runout (axial eccentricity) of the Flywheel

I. Install the dial indicator as shown. Force the crankshaft the same way before the indicator is read so the crankshaft end clearance (movement) is always removed.

2. Set the dial indicator to read .000 in.



CHECKING FACE RUNOUT OF THE FLYWHEEL

3. Turn the flywheel and read the indicator every 90°.

4. The difference between the lower and higher measurements taken at all four points not be more than .006 in. (0.15 mm), is the maximum permissible face runout (axial eccentricity) of the flywheel.

Bore Runout (radial eccentricity) of the Flywheel

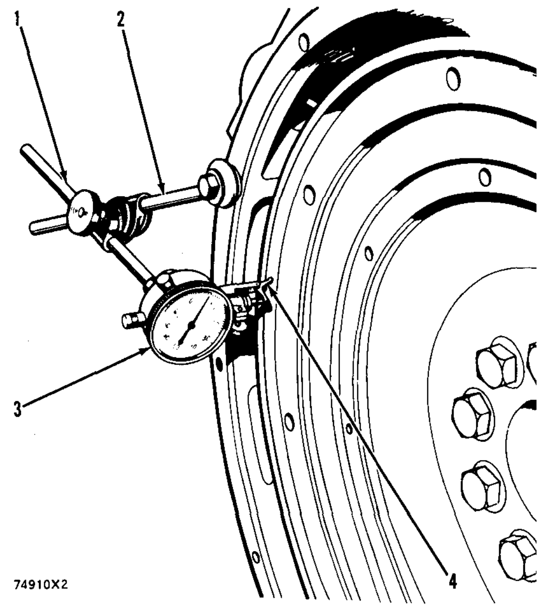
I. Install the dial indicator (3) and make adjustment of the universal attachment (4) so it makes contact as shown.

2. Set the dial indicator to read .000 in.

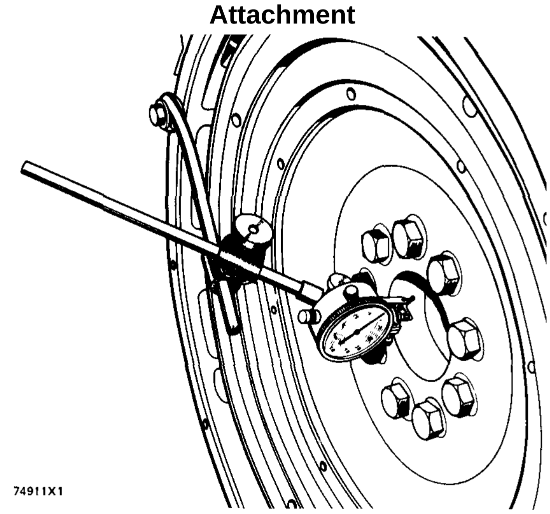
3. Turn the flywheel and read the indicator 90°.

4. The difference between the lower and higher measurements taken at all four points must not be more than .006 in. (0.15 mm), which is the maximum permissible bore runout (radial eccentricity) of the flywheel.

5. Runout (eccentricity) of the bore for the pilot bearing for the flywheel clutch, must not exceed .005 in. (0.13 mm).



CHECKING BORE RUNOUT OF THE FLYWHEEL
1. 7H1945 Holding Rod. 2. 7H1645 Holding Rod 3. 7H1942 Indicator. 4. 7H1940 Universal Attachment



CHECKING FLYWHEEL CLUTCH PILOT BEARING BORE

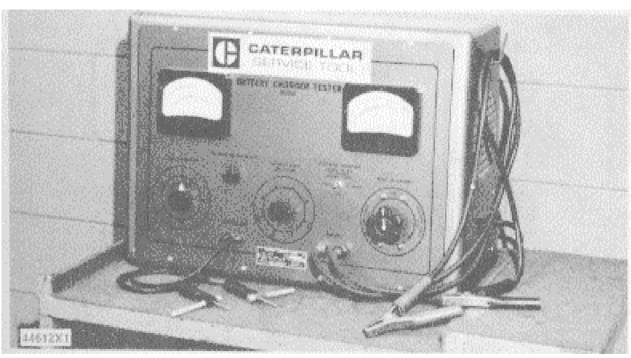
ELECTRICAL SYSTEM

Most of the testing of the electrical system can be done on the engine. The wiring insulation must be in good condition, the wire and cable connections clean and tight and the battery fully charged. If on the engine test shows a defect in a component remove the component for more testing.

BATTERY

Tools Needed:
5P300 Electrical Tester.
9S1990 or 1P7400 Battery Charger Tester.
5P957 or 5P3414 Coolant and Battery Tester.

The battery circuit is an electrical load on the charging unit. The load is variable because of the condition of the charge in the battery. Damage to the charging unit will result, if the connections (either positive or negative) between the battery and charging unit are broken while the charging unit is charging. This is because the battery load is lost and there is an increase in charging voltage. High voltage will damage, not only the charging unit but also the regulator and other electrical components.



9S1990 BATTERY CHARGER TESTER

CAUTION
Never disconnect any charging unit circuit battery circuit cable from battery when charging unit is charging.

Load test a battery that does not hold a charge when in use. To do this, put a resistance, across battery main connections (terminals). For a 6 volt battery, put a resistance of two times the ampere/hour rating of the battery. For a 12 volt battery, put a resistance of three times the ampere/ hour rating. Let the resistance remove the charge (discharge battery) for 15 seconds. Immediately test the battery voltage. A 6 volt battery in good condition test 4.5 volts; a 12 volt battery in good condition will test 9 volts.

CHARGING SYSTEM

Tools Needed:
5P300 Electrical Tester.

The condition of charge in the battery at each regular inspection will show if the charging system is operating correctly. An adjustment is necessary when the battery is always in a low condition of charge or a large amount of water is needed (one ounce per cell per week or every 50 service hours)

Test the charging units and voltage regulators on the engine, when possible, using wiring and components that are a permanent part of the system. Off the engine (bench) testing will give an operational test of the charging unit and voltage regulator. This testing will give an indication of needed repair. Final testing will give proof that the units are repaired to their original operating condition.

Before starting on the engine testing, the charging system and battery must be checked. See the following Steps.

1. Battery must be at least 75% (1.240 Sp. Gr.) full charged and held tightly in place. The battery holder must not put too much stress on the battery.

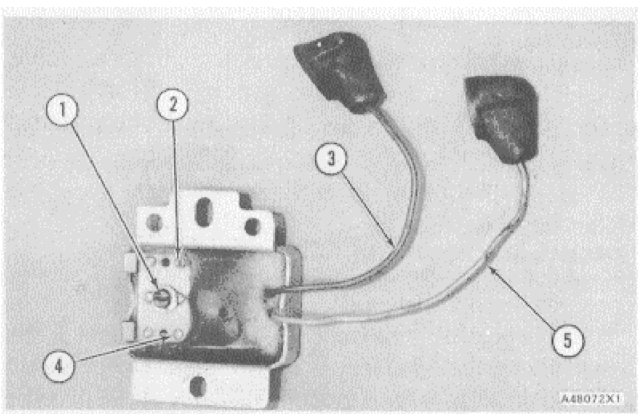
2. Cables between the battery, starter and engine ground must be the correct size. Wires and cables must be free of corrosion and have cable support clamps to prevent stress on battery connections (terminals).

3. Leads, junctions, switches and panel instruments that have direct relation to the charging circuit must give proper circuit control.

4. Inspect the drive components for the charging unit to be sure they are free of grease and oil and are able to drive the load of the charging unit.

Alternator Regulator (Prestolite)

The regulator components are sealed in an insulation of epoxy. The regulator is an electronic component with no moving parts (solid state) and an adjustment screw (1) on the back. This voltage adjustment screw is used to meet different operating needs at different times of the year. An increase or decrease by .5 volts from the normal setting is made by removing the regulator changing the position of the adjustment screw washer. An increase to the voltage will be mad moving the screw and washer to the "H" position (2).



ALTERNATOR REGULATOR

1. Adjustment screw with washer. 2. High output position. 3. Orange wire to battery. 4. Low output position. 5. Green wire to field terminal of the alternator (F).

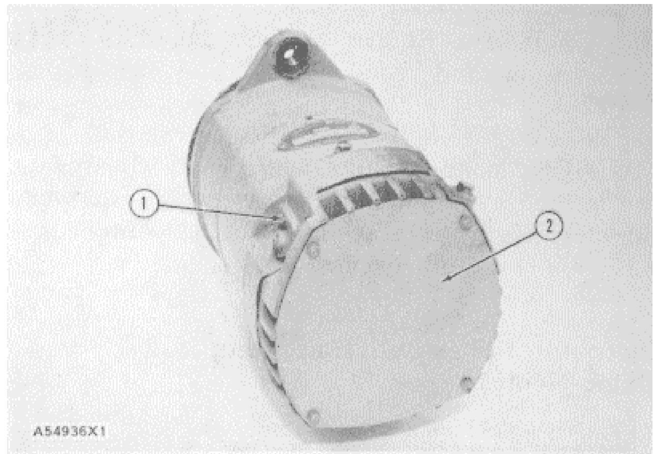
Alternator Regulator (Delco-Remy)

The voltage adjustment screw for the later alternator is located under the end plate.

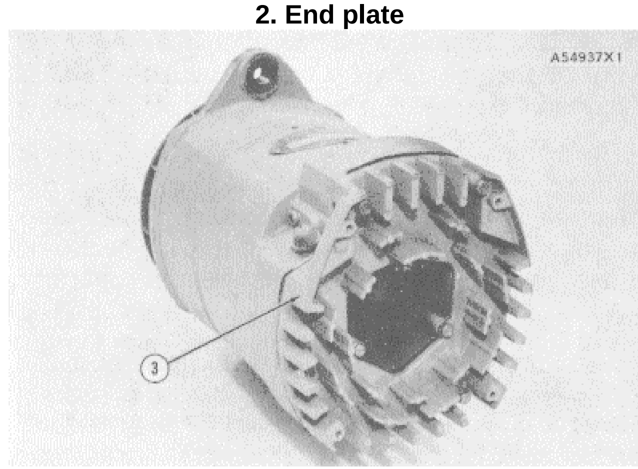
To adjust the voltage setting, use the follow procedure:

1. Remove end plate (2) and cover (3) from alternator.

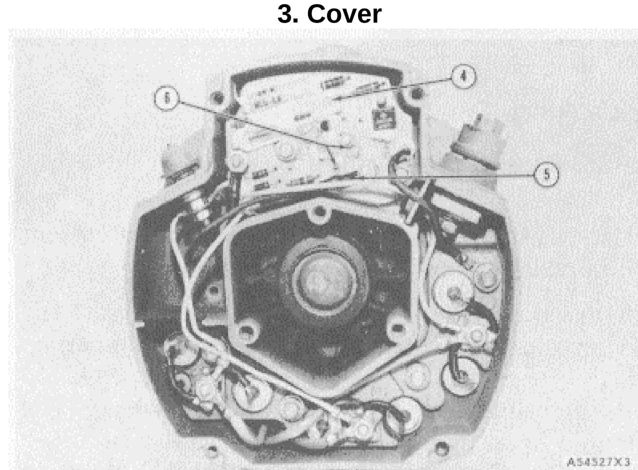
2. Remove the rubber sealant from the adjustment screw (4).



ALTERNATOR
1. Adjustment screw under plug (earlier regulator).
2. End plate



LOCATION OF COVER
3. Cover



ALTERNATOR REGULATOR
4. Voltage adjustment screw. 5. Field wire. 6. Transistor pins

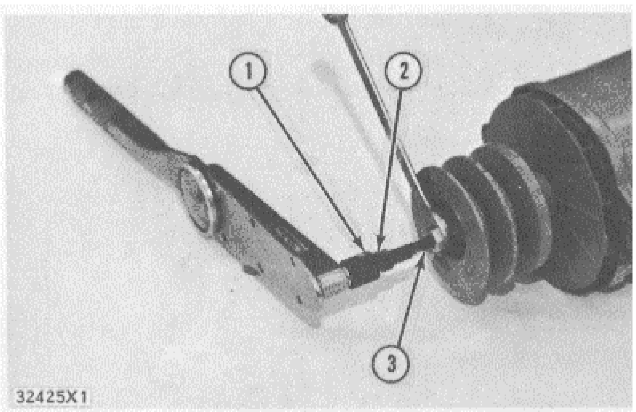
3. Use a voltmeter to measure alternator volt output.

4. Turn adjustment screw (4) counterclockwise to lower the voltage setting. Turn adjustment screw (4) clockwise to raise the voltage setting.

5. Put 3S6252 Rubber Sealant on adjustment screw (4) and install cover (3) and end plate (2).

CAUTION: Make certain that the field wire (5) is not located over the transistor pins (6). The pins can make a hole in the insulation of the wire.

Alternator: Pulley Nut Tightening (Delco-Remy



ALTERNATOR PULLEY INSTALLATION 1. 8S1588 Adapter(1/2” **female to** 3/8” **male). 2. 8S1590 Socket (5/16**”**-3/8**” **drive). 3. 1P2977 Tool Group. 8H8555 Socket (15/6**” **- ½**” **drive) not shown.**

Tighten nut holding the pulley to a torque of 60 to 75 lb. ft. (80 to 100 N•m) with the tools shown

STARTING SYSTEM

Tools Needed: 5P300 Electrical Tester.

Use a D. C. Voltmeter to find starting system components which do not function.

Move the starting control switch to activate starter solenoid. Starter solenoid operation can be heard as the pinion of the starter motor is engaged with the ring gear on the engine flywheel. The solenoid operation also closes the electric circuit the motor. Connect one lead of the voltmeter the solenoid connection (terminal) that is fastened to the motor. Put the other lead to a good ground Activate the starter solenoid and look at the meter. A reading of battery voltage show problem is in the motor. The motor must moved for further testing. No reading on the meter shows that the solenoid contacts d close. This is an indication of the need for to the solenoid or an adjustment to be made starter.

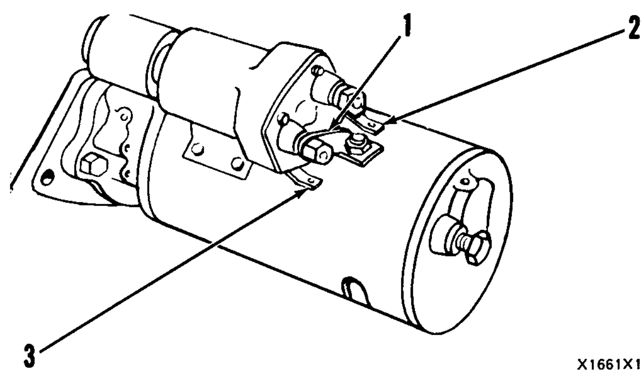
If the solenoid for the starting motor will not operate, it is possible that the current from the battery is not getting to the solenoid. Fasten one lead of the voltmeter to the connection (terminal) for the battery cable on the solenoid. Put the lead to a good ground. No voltmeter reading shows there is a broken circuit from the battery. Further testing is necessary when there is a reading on the voltmeter.

Further test by fastening one voltmeter lead to the connection (terminal) for the small wire solenoid and the other lead to the ground. Look at the voltmeter and activate the starter solenoid voltmeter reading shows that the problem is solenoid. No voltmeter reading shows that problem is in the starter switch or wiring. Fasten one lead of the voltmeter to the battery wire connection of the starter switch and put the lead to a good ground. A voltmeter reading indicates a failure in the switch.

A starting motor that operates too slow can have an overload because of too much friction in the engine being started. Slow operation of the starting motor can also be caused by shorts, loose connections, and/or dirt in the motor.

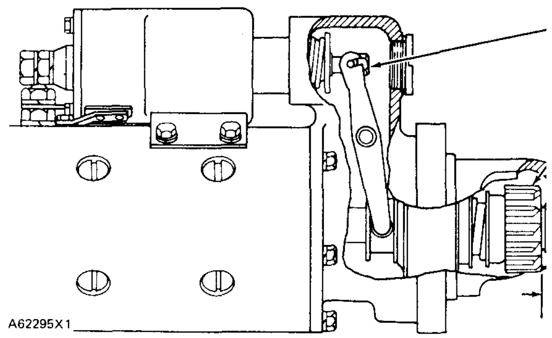
Pinion Clearance Adjustment (Delco-Remy)

Whenever the solenoid is installed, make an adjustment of the pinion clearance. The adjustment can be made with the starting motor removed.



CONNECTION FOR CHECKING PINION CLEARANCE 1. Connector from MOTOR terminal on solenoid to motor. 2. SW terminal. 3. Ground terminal.

1. Install the solenoid without connector (1) from the MOTOR connection (terminal) on solenoid to the motor.
2. Connect a battery, of the same voltage solenoid, to the terminal (2), "SW".
3. Connect the other side of battery to ground terminal (3).



PINION CLEARANCE ADJUSTMENT
4. Shaft nut. 5. Pinion. 6. Pinion clearance.

4. Connect for a moment, a wire from the solenoid connection (terminal) "MOTOR" to the ground connection (terminal). The pinion shift to crank position and will stay until the battery is disconnected.

5. Push the pinion toward commutator end to remove free movement.

6. See SPECIFICATIONS for the correct Delco-Remy pinion clearance.

7. Pinion clearance adjustment is made moving plug and turning nut (4).

Pinion Clearance Adjustment (Prestolite)

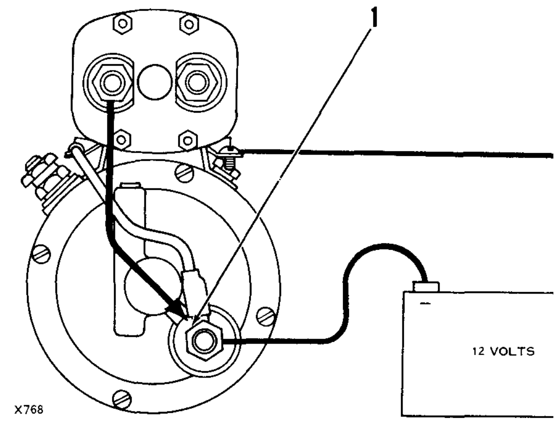
There are two adjustments for this type starting motors. They are end play for the armature pinion clearance.

End Play for the Armature

The correct end play for the armature is .005 to .030 in. (0.13 to 0.76 mm). To make an adjustment to the end play for the armature, add or remove thrust washers on the commutator end of the armature shaft.

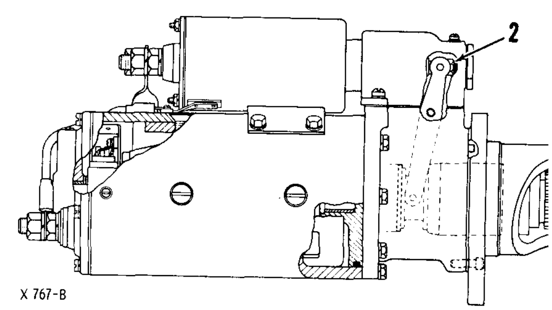
Pinion Clearance

1. To make an adjustment to the pinion clearance, connect the solenoid to a 12 volt battery as shown.
2. Connect for a short moment, a wire from the solenoid connection (terminal) "MOTOR" to the terminal (I) at the commutator end. The solenoid and drive will shift to the position and will stay there until the battery is disconnected.
3. Push the drive toward the commutator remove any free movement.
4. Measure the pinion clearance (3). The pinion clearance (3) must be .020 to .050 in. (0.51 to 1.27 mm).



CONNECTIONS FOR ADJUSTMENT OF THE PINION CLEARANCE
1. Terminal

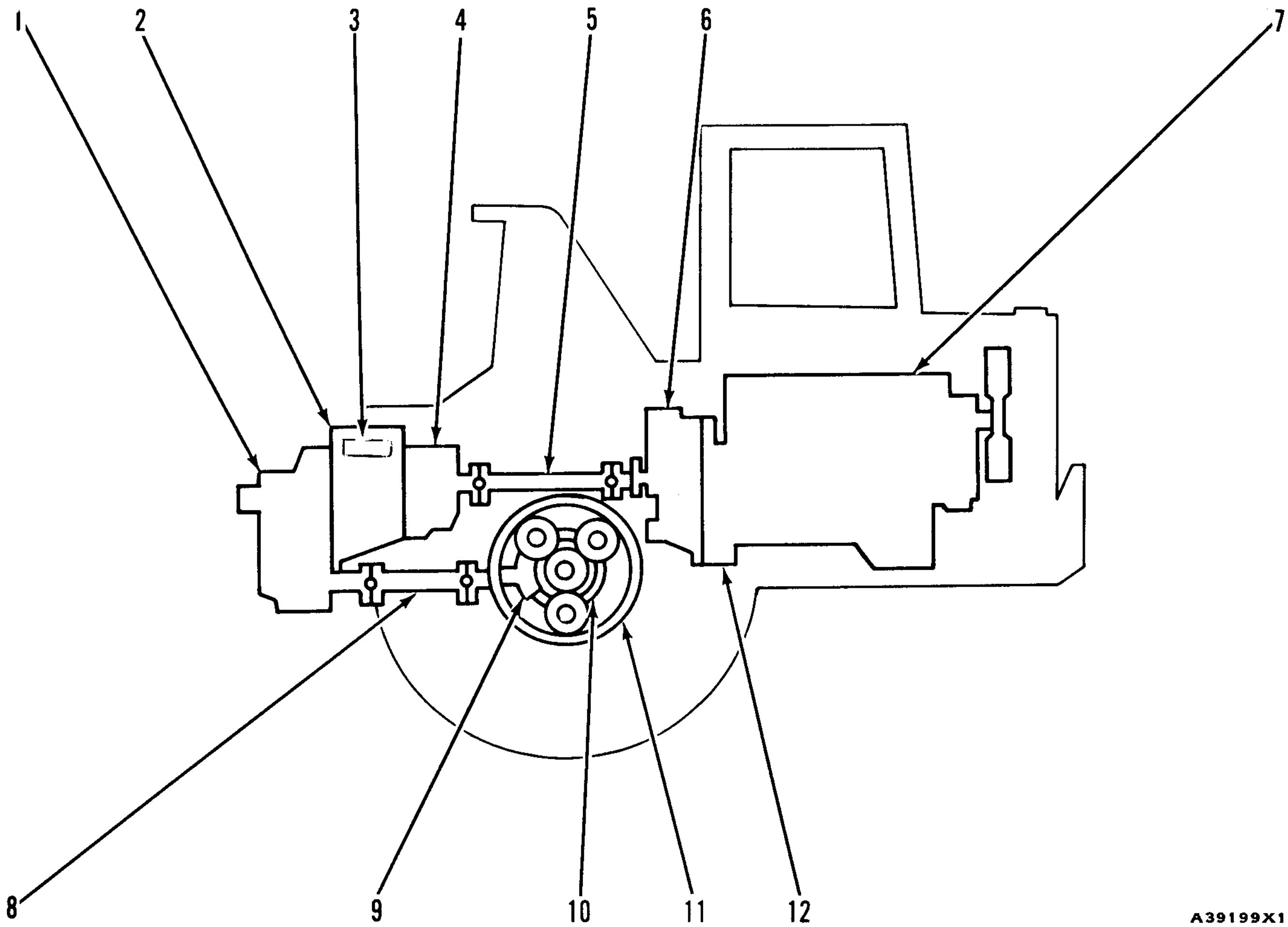
5. To make an adjustment to the pinion clearance, remove the plug and turn the adjustment nut (2) as necessary.



PINION CLEARANCE ADJUSTMENT
2. Adjustment nut. 3. Pinion clearance.

SECTION 2
SYSTEMS OPERATION, TESTING, AND ADJUSTING
POWER TRAIN

GENERAL INFORMATION



POWER FLOW

1. Output transfer gears.
2. Planetary transmission.
3. Transmission hydraulic controls.
4. Input transfer gears.
5. Upper drive shaft.
6. Torque converter.
7. Diesel engine.
8. Lower drive shaft.
9. Pinion shaft and bevel gear.
10. Differential.
11. Final drives and wheels.
12. Engine flywheel.

Power from the diesel engine (7) is sent from the engine flywheel (12) through the torque converter (6). The output shaft of the torque converter sends the power through upper drive shaft (5) to the input shaft of the planetary transmission (2). The planetary transmission (2) has six clutches which are hydraulically engaged. Two clutches turn and the other four clutches are stationary. Four planet systems are used in combination with the six clutches to give four speeds forward and two speeds reverse. The direction and speeds are changed manually.

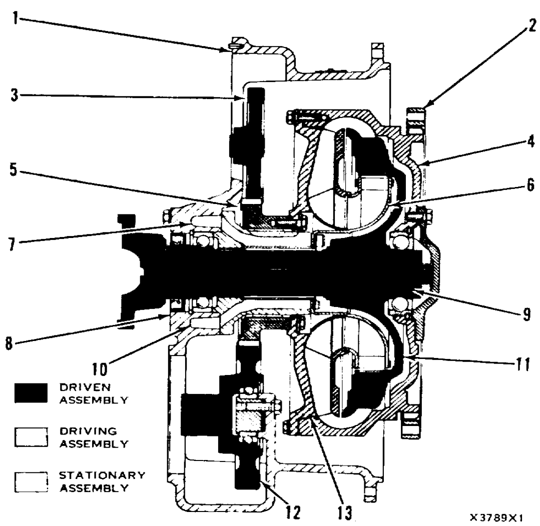
The output shaft of the planetary transmission sends the power to the output transfer gears (1). From the output transfer gears (1), power goes through the lower drive shaft (8) to the pinion shaft and bevel gear (9). The pinion shaft and bevel gear send the power through the differential (10). The differential sends the power to the final drives and wheels (11).

Splines are used as connections between the axles and the sun gears of the final drives. When the sun gears turn, the planet gears in the carrier move around the inside of the stationary ring gear. This action turns the carrier and the wheels.

TORQUE CONVERTER

The torque converter connects the engine to the planetary transmission. This connection between the engine and the transmission is a hydraulic connection. There is no direct mechanical connection between the engine and the transmission.

The torque converter uses oil to send torque from the engine to the transmission. When the machine is working against a load, the torque converter can multiply the torque from the engine and send a higher torque to the transmission.



POWER FLOW THROUGH TORQUE CONVERTER

1. Torque converter housing. 2. Flywheel adapter gear. 3. Gear for the transmission oil pump. 4. Rotating housing. 5. Drive gear for the oil pumps. 6. Stator. 7. Outlet passage. 8. Carrier. 9. Output shaft. 10. Inlet passage. 11. Turbine. 12. Gears (two) for the hydraulic pump. 13. Impeller.

The oil for the operation of the torque converter comes from the oil pump for the transmission. The oil pump is driven by gear (3) and gear (5). An inlet ratio valve (part of the pressure control valve in the transmission) controls the maximum oil pressure to the torque converter. An orifice in the outlet passage controls the minimum oil pressure in the torque converter.

The rotating housing (4) is connected to the engine flywheel with splines of gear (2). The impeller (13) and the drive gear (5) for the oil pump are connected to the rotating housing. These components turn with the engine flywheel at engine speed.

The stator (6) is connected to the carrier (8) which is connected to the torque converter cover. The stator does not turn.

The turbine (11) is connected to the output shaft (9). Drive gear (5) is fastened to the impeller and turns the gears (3) and (12) for the oil pumps.

Oil from the hydraulic controls of the transmission goes into the torque converter through an inlet passage (10) in the carrier (8).

The impeller (13) [which turns with the rotating housing (4) at engine speed] makes the oil go toward the outside of the impeller, around the inside of the rotating housing (4), and against the blades of the turbine (11). The oil that hits the turbine blades causes the turbine (11) and the output shaft (9) to turn. This sends torque through a drive shaft to transfer gears and to the input shaft of the transmission.

TORQUE CONVERTER
4. Rotating housing. 6. Stator. 11. Turbine. 13. Impeller.

After the oil hits the turbine blades, the oil goes toward the inside of the turbine (11). As the oil goes from the turbine, it moves in a direction opposite the direction of impeller rotation. The stator (6) causes the oil to change direction and go back into the impeller (13) in the direction of rotation. This gives an increase to the impeller oil output which gives an increase to the torque output from the turbine (11).

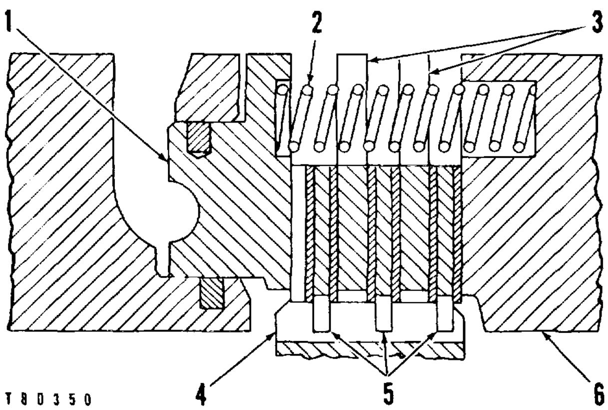
The larger the difference between the speeds of rotation of the impeller (13) and the turbine (11) the larger the output torque becomes.

Oil from the outlet passage (7) goes to the oil cooler.

PLANETARY TRANSMISSION

The transmission has four speeds FORWARD and two speeds Reverse. It has planetary gear systems and six hydraulic clutches. The No. 6 clutch is a rotating clutch and acts as the output member. It fastens to the output gear.

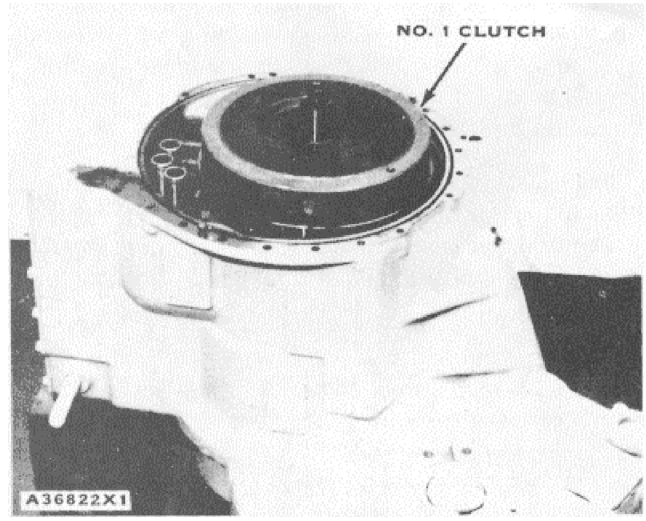
The transmission output gear is connected to the transfer gear with splines. The transfer gear is connected with splines to the output shaft. The output shaft is connctled h) a yoke a;nd universal joint to the drive shaft .



CLUTCH OPERATION
1. Piston. 2. Springs. 3. Plates. 4. Ring gear. 5. Discs. 6. Clutch housing.

The six transmission clutches are the disc type and in separate housings. Each clutch has discs (5) and plates (3). The inside teeth of discs (5) are engaged with the outside teeth (,f ring gear (4). Notches on the outside diameter of plates (3) are engaged with pins in the clutch housing. The pins keep the plates from turning.

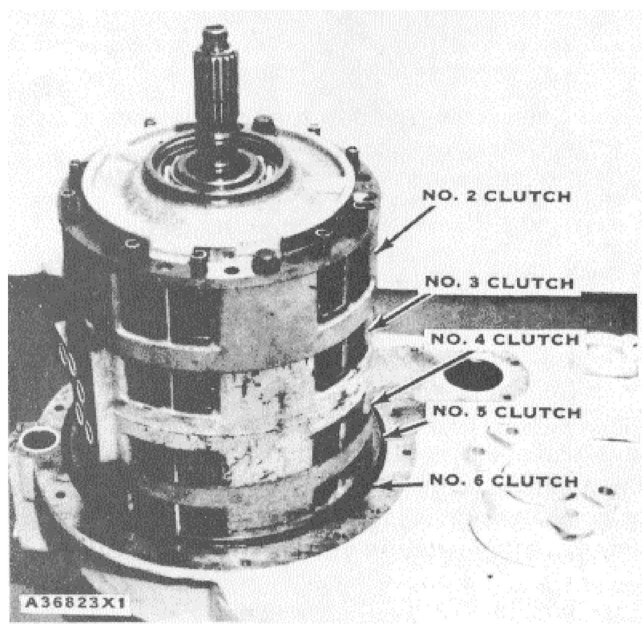
The springs (2) arc between clutch housing (6) and piston (I). The springs keep the clutches disengaged (not engaged). The clutches are engaged oil is sent into the area behind piston (I). When the pressure of the oil in the area behind the piston increases, the piston moves to the right. The piston moves against the force of springs (2) and pushes the discs and plates together. The clutch is no' engaged. The discs keep ring gear (4) from turning. When the clutch is released, the pressure in the area behind piston (1) decreases and the springs now' push the piston to the left. The discs and plates are now apart. The clutch is not engaged.



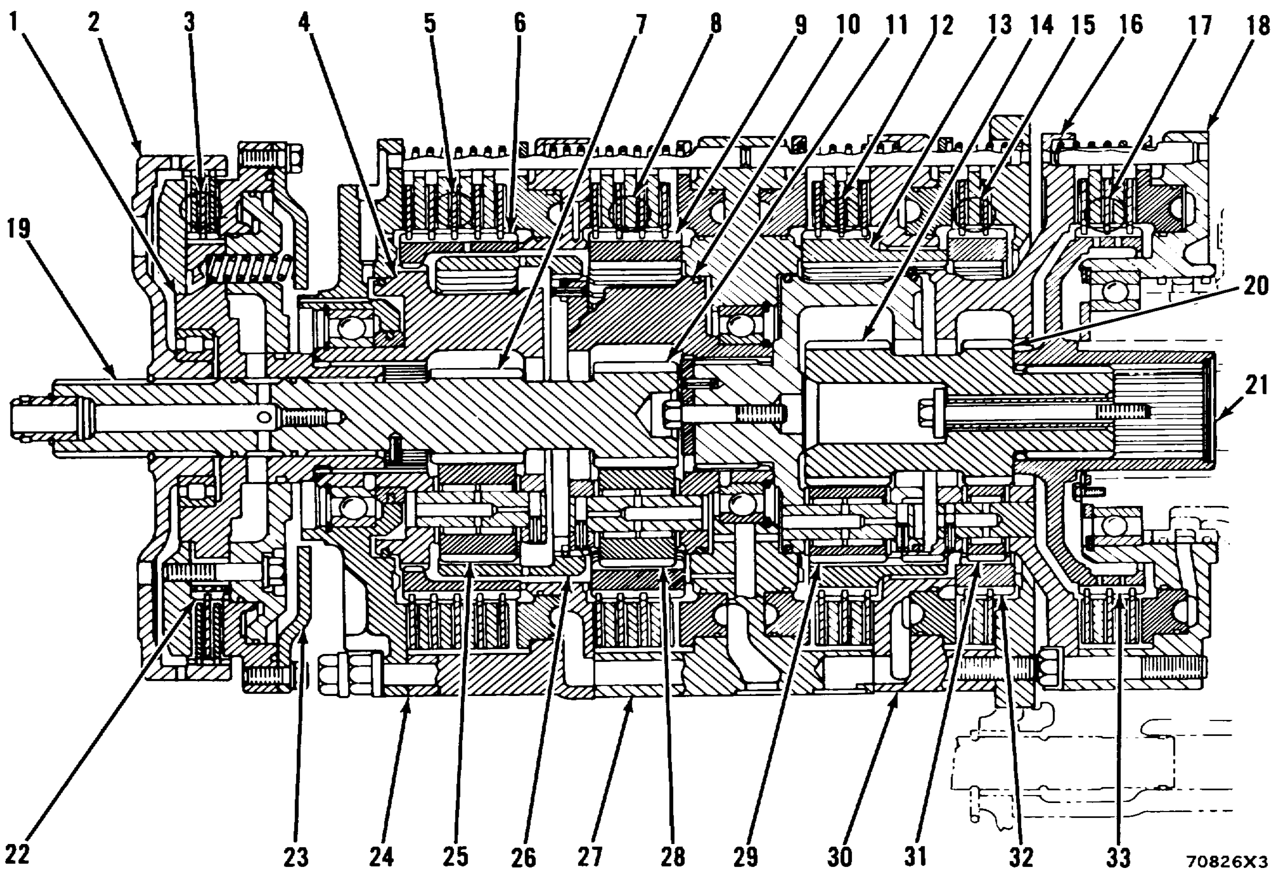
CLUTCH IDENTIFICATION

The three front clutches (No. I, No. 2 and No. 3) are direction clutches. The No. 2 clutch is the REVERSE direction clutch. The No. 1 and No. 3 clutches are the FORWARD direction clutches. The three rear clutches (No. 4, No. 5 and No. 6) are speed clutches. No. clutch is a direction clutch for FOURTH FORWARD speed.

A speed and a direction clutch must be engaged in the transmission before power goes through the transmission.



CLUTCH IDENTIFICATION
NOTE: No. 6 clutch is inside output transfer gear case.



PLANETARY TRANSMISSION

1.No. 1 clutch hub.
2.No. 1 clutch coupling.
3.No.1 clutch.
4.No. 2 carrier.
5.No. 2 clutch.
6.No. 2 clutch ring.
7.No. 2 sun gear.
8.No. 3 clutch.
9.No. 3 clutch ring gear.
10.No. 3 carrier.
11. No. 3 sun gear.
12. No. 4 clutch.
13. No. 4 clutch ring gear.
14. No. 4 sun gear.
15. No. 5 clutch.
16. No.5 carrier.
17. No. 6 clutch.
18. No. 6 clutch housing.
19. Input shaft.
20. No. 5 sun gear.
21. Output shaft
22. No. 1 clutch gear.
23. No. 1 clutch balance piston.
24. No.2 clutch housing.
25. No. 2 planet gear.
26. No. 1 and No. 2 carrier ring gear.
27. No. 3 and No. 4 clutch housing.
28. No. 3 planet gear.
29. No. 4 planet gear.
30. No. 5 clutch housing.
31. No.5 planet gear.
32. No. 5 clutch ring gear.
33. No. 6 clutch gear.

The planetary transmission has four stationary clutches; No. 2, No. 3, No. 4, and No. 5, and two clutches that turn; No. 1 and No. 6. Clutches No. 1, No. 2, and No. 3 control the direction of the machine (FORWARD or REVERSE). No. 1 clutch (3) is the forward direction clutch for FOURTH speed only. No. 2 clutch (5) is the clutch for reverse direction. No. 3 clutch (8) is the clutch for forward direction for FIRST, SECOND and THIRD speeds.

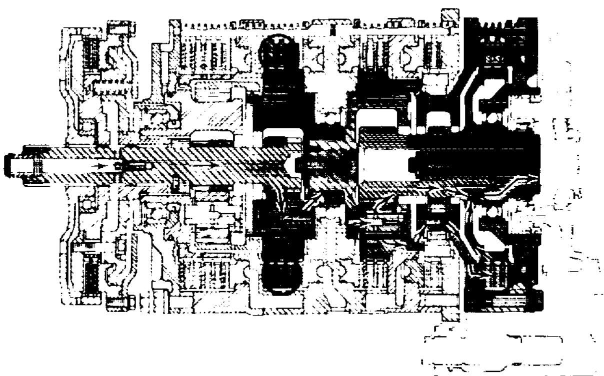
The No. 2 clutch ring gear and the No. 2 carrier are connected with splines and turn as a unit. The No. 2 and No. 3 carrier ring gear, the No. 3 and No. 4 carrier, and the No. 5 carrier are connected with splines and turn as a unit. The No. 2 and No. 3 sun gears are both part of one shaft assembly, and turn as a unit.

Clutches No. 4, No. 5 and No. 6 control the speed of the machine (FIRST, SECOND, THIRD, and FOURTH speed). No. 4 clutch (12) is the clutch for THIRD speed. No. 5 clutch (15) is the clutch for SECOND speed. No. 6 clutch (17) is the clutch for FIRST speed. No. 6 clutch is fastened to the No. 5 carrier. The No. 4 and No. 5 sun gears are one assembly, connected with splines to the No. 6 clutch gear which acts as the output of power for the output shaft.

CLUTCH NO.	OPERATION
No 1	Forward Direction (fourth speed)
No 2	Reverse Direction
No. 3	Forward Direction
No. 4	Third Speed
No. 5	Second and Fourth Speeds
No 6	First Speed

Most all the components inside the planetary transmission turn when the controls are in each FORWARD or REVERSE speed. Only these components that have been made dark in the illustrations that follow are used in the flow of power through the transmission.

FIRST SPEED FORWARD



T99750

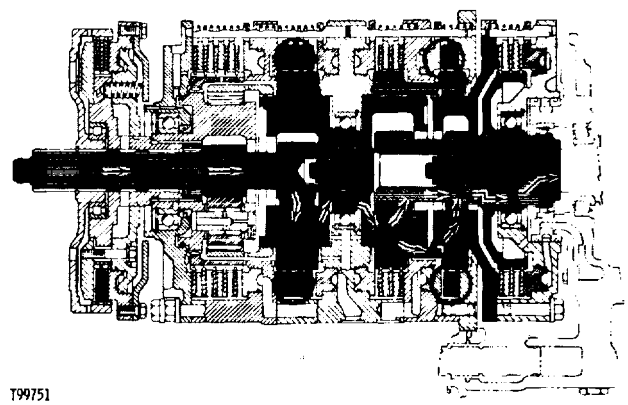
T99750

POWER FLOW THROUGH TRANSMISSION IN FIRST SPEED FORWARD (No. 3 and No. 6 Clutches Engaged.)

The No. 3 clutch ring gear is held stationary. This causes the No. 3, No. 4 and No. 5 carriers and No. 6 clutch to turn. Since the No. 6 clutch is engaged, torque is sent to the No. 6 clutch gear and output shaft.

SECOND SPEED FORWARD

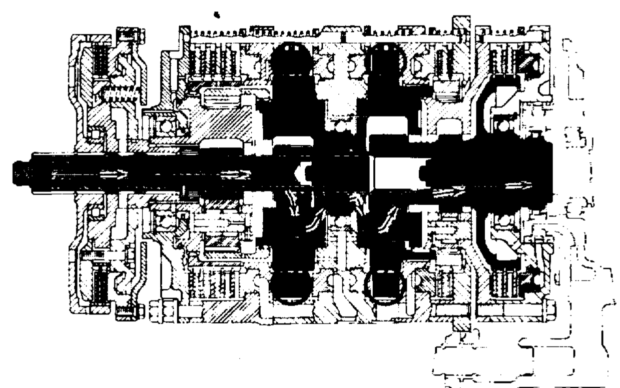
The No. 3 clutch ring gear is held stationary. This causes the No. 3, No. 4 and No. 5 carriers to rotate. The No. 5 clutch ring gear is held stationary by the engaged No. 5 clutch. The No. 5 planet gears turn around the inside of the No. 5 clutch ring gear driving the No. 5 sun gear which in turn drives the No. 6 clutch gear and output shaft.



T99751

POWER FLOW THROUGH TRANSMISSION IN SECOND SPEED FORWARD (No. 3 and No. 5 Clutches Engaged.)

THIRD SPEED FORWARD



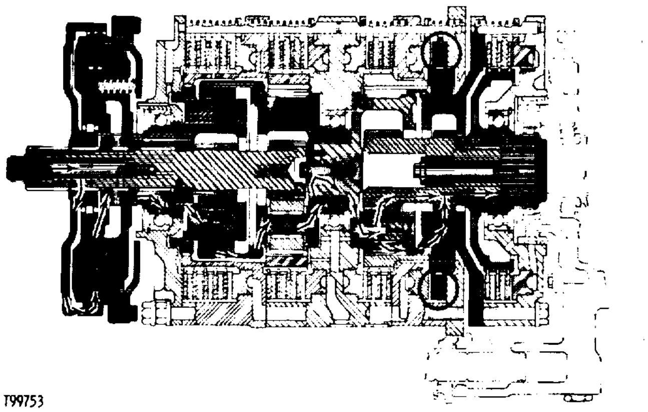
T99752

POWER FLOW THROUGH TRANSMISSION IN THIRD SPEED FORWARD (No. 3 and No. 4 Clutches Engaged.)

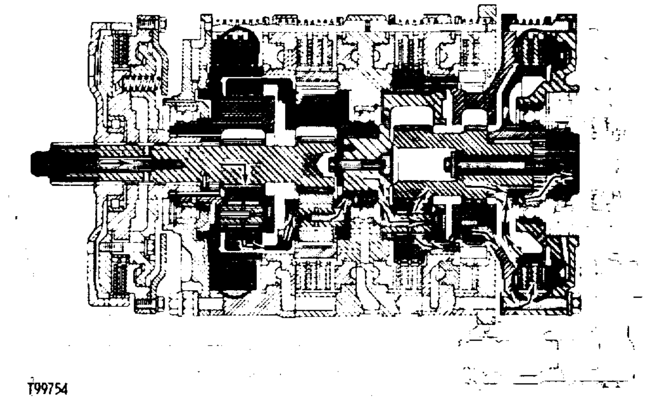
The No. 3 clutch ring gear is held stationary by the No. 3 clutch. The No. 4 clutch ring gear is held stationary by the No. 4 clutch. The No. 3 sun gear drives the No. 3 planet gears which turn around the inside of the No. 3 clutch ring gear to rotate the No. 3 carrier. The No. 4 planet gears are driven around the inside of the stationary No. 4 clutch ring gear and drive the No. 4 sun gear, No. 6 clutch gear and output shaft.

FOURTH SPEED FORWARD

The No. 1 clutch holds the No. 2 carrier to the input shaft which causes the No. 2 and No. 3 ring gears, carriers, and carrier ring gears to turn at transmission input speed. The rotation of the No. 3 and No. 4 carriers send torque to the No. 4 ring gear and sun gear. When the No. 5 ring gear is held stationary by the No. 5 clutch, torque is sent by the No. 4 and No. 5 sun gears to the output shaft.



POWER FLOW THROUGH TRANSMISSION IN FOURTH SPEED FORWARD (No. 1 and No. 5 Clutches Engaged.)



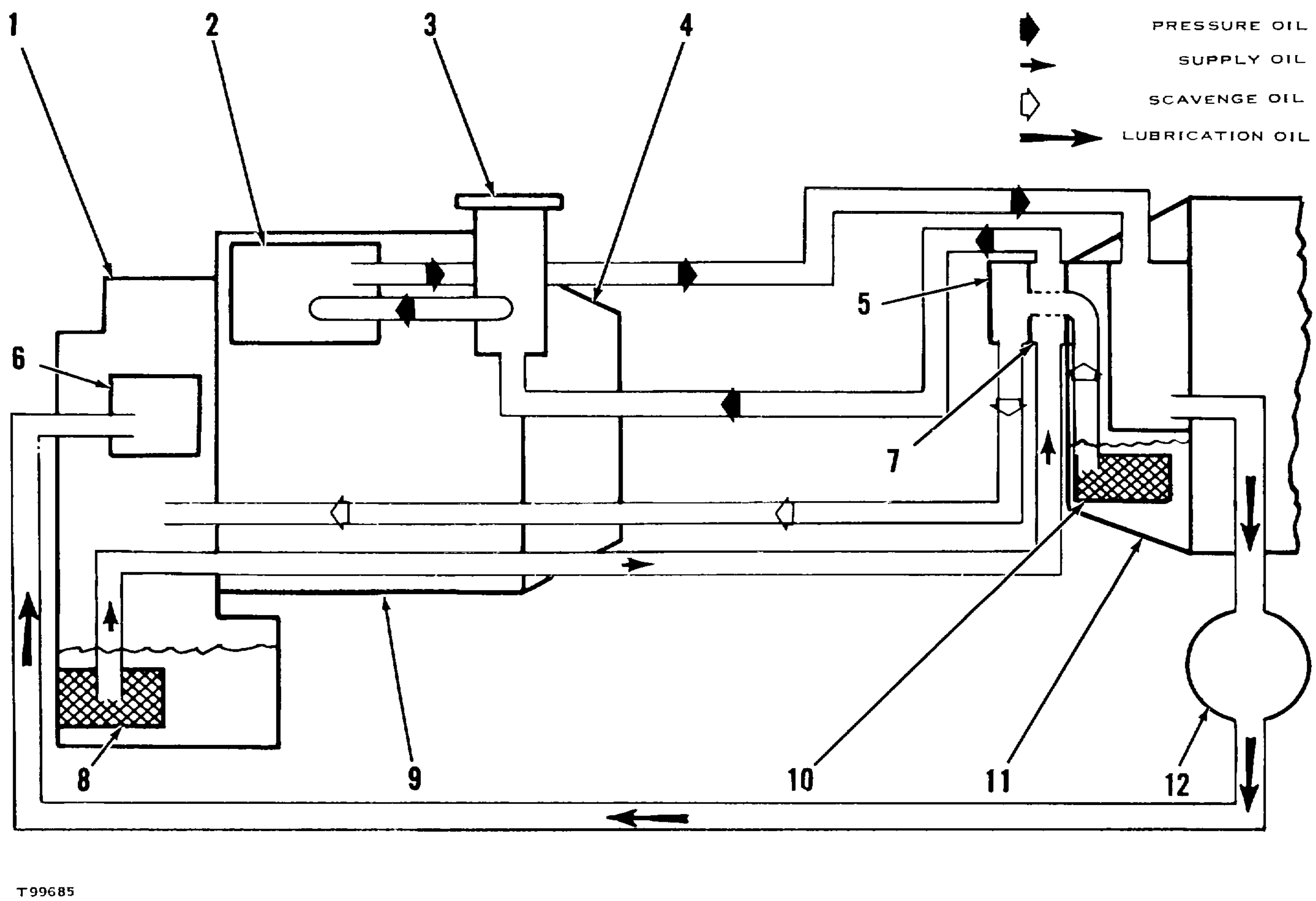
POWER FLOW THROUGH TRANSMISSION IN FIRST SPEED REVERSE (No. 2 and No. 6 Clutches Engaged.)

FIRST SPEED REVERSE

The No. 2 clutch ring gear and No. 2 carrier are held stationary by the No. 2 clutch. The No. 2 sun gear moves the No. 2 and No. 3 carrier ring gear through the No. 2 planet gears. This causes the No. 3, No. 4 and No. 5 carriers and No. 6 clutch to turn in the opposite direction. Since the No. 6 clutch is engaged, torque is sent to the No. 6 clutch gear and output shaft.

In SECOND SPEED REVERSE, the No. 2 and No. 5 clutches are engaged. The power flow through the direction clutch section of the transmission is the same as FIRST SPEED REVERSE. The power flow through the speed clutch section of the transmission is the same as for SECOND SPEED FORWARD.

TRANSMISSION LUBRICATION SYSTEM



TRANSMISSION LUBRICATION SYTEM

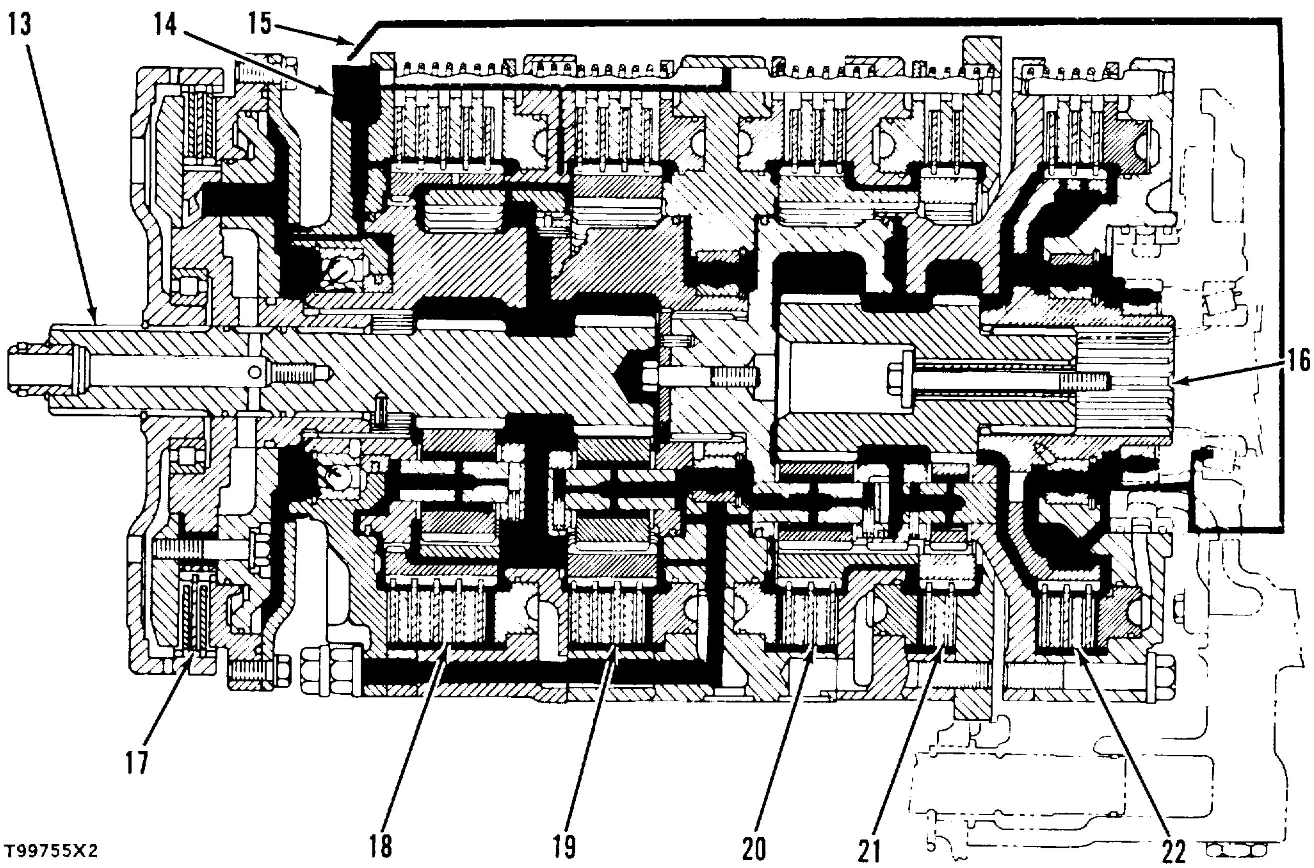
1.Case for output transfer gears.
2.Transmission hydraulic controls.
3.Oil filter for transmission.
4. Case for input transfer gears.
5. Scavenge section of oil pump.
6. Lubrication relief valve.
7. Pressure section of oil
8. Magnetic strainer.
9. Transmission case.
10. Screen.
11. Torque converter housing.
12. Oil cooler.

The oil for the operation and lubrication of the transmission is made available by the pressure section (7) of the oil pump. The scavenge section (5) of the oil pump sends oil from the reservoir of torque converter housing to the reservoir for the transmission. The two section pump is turned by a drive gear which is engaged with a gear that is fastened to the impeller of the torque converter.

The reservoir of the torque converter is in the bottom of torque converter housing (11). The reservoir for the transmission is in the bottom of case for output gears (l).

The oil is pulled by' pressure section (7) of the oil pump to the magnetic strainer (8) Which separates foreign material from the pump inlet oil. The oil goes to the pump through an external line. The oil goes from the pump through oil filter (3) to the transmission hydraulic controls (2). If there is a restriction in the oil filter, or if the viscosity of the oil is very high, the bypass valve in the housing of oil filter (3) A ill open. This action lets the oil go past the filter element to the transmission hydraulic controls.

Valves in the transmission hydraulic controls send the oil to the clutches in the transmission and to the torque converter. Oil that is not needed to fill the clutches is sent into the torque converter. From the torque converter, the oil goes through an oil cooler (12) to the lubrication relief valve (6) on the output transfer gear case. The lubrication relief valve prevents too high pressure oil from going to the planetary transmission.



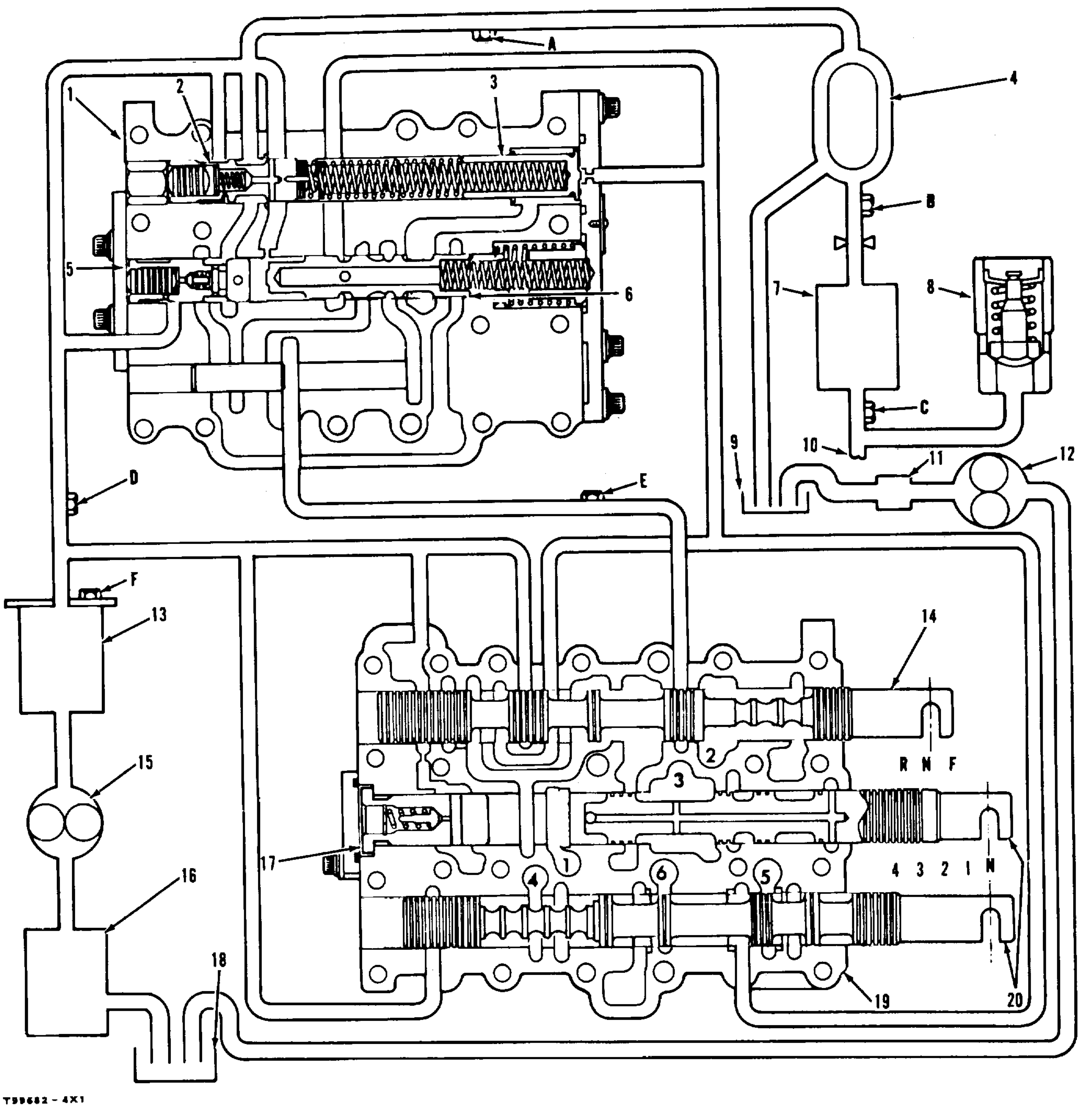
PLANETARY LUBRICATION

13.Input shaft.
14.Inlet passage for oil from oil cooler.
15. Tube.
16. Output shaft.
17. No. 1 clutch.
18. No. 2 clutch.
19. No.3 clutch.
20. No. 4 clutch.
21. No. 5 clutch.
22. No.6 clutch.

Oil comes from oil cooler (12) through an oil line to lubrication relief valve (6). Oil from the lubrication relief valve goes into passage (14) and gives lubrication to the planet gears, discs, plates and bearings of No. 1 clutch (17), No. 2 clutch (18) and No. 3 clutch (19) through a common passage. Oil for lubrication of the components of No. 4 clutch (20) and No. 5 clutch (21) comes from leakage. No. 6 clutch (22) gets oil for lubrication from tube (15). Tube (15) also sends oil for lubrication of the transfer gears.

The normal leakage of oil from the torque converter goes into the reservoir in bottom of torque converter housing (I1). The scavenge pump pulls the oil through a screen (10), through the pump and sends the oil to the reservoir for the transmission.

TRANSMISSION HYDRAULIC CONTROLS



TRANSMISSION CONTROLS IN NEUTRAL AND ENGINE NOT RUNNING

1. Pressure control valve.
2. Modulation relief valve.
3. Load piston.
4. Torque converter.
5. Inlet ratio valve for the converter.
6. Differential and safety valve.
7. Oil cooler.
8. Lubrication relief valve.
9. Reservoir n the torque converter.
10. Oil line for lubrication of transmission.
11. Screen.
12. Scavenge pump.
13. Oil filter.
14. Valve spool for direction selection.
15. Oil pump.
16. Magnetic strainer.
17. Relief valve.
18. Reservoir for the transmission.
19. Selector valve.
20. Spools for speed selection.

A. Pressure tap for the inlet of the torque converter (P3).
B. Pressure tap for the outlet of the torque converter.
C. Pressure tap for lubrication pressure.
D. Pressure tap for sped clutch pressure (P1).
E. Pressure tap for direction clutch pressure (P2).
F. Pressure tap for the pump.

NEUTRAL WITH ENGINE NOT RUNNING

The basic components of the oil system for the hydraulic controls are: oil reservoir (18), magnetic strainer (16), oil filter (13), oil pump (15), pressure control valve (1), selector valve (19), torque converter (4), lubrication relief valve (8) and oil cooler (7). All the oil passages are inside the cases except the supply lines for the oil pumps and the lines to and from the oil cooler.

The hydraulic controls have a pressure control valve (I) and a selector valve (19). The controls are fastened to the clutch housings and are completely inside the transmission case.

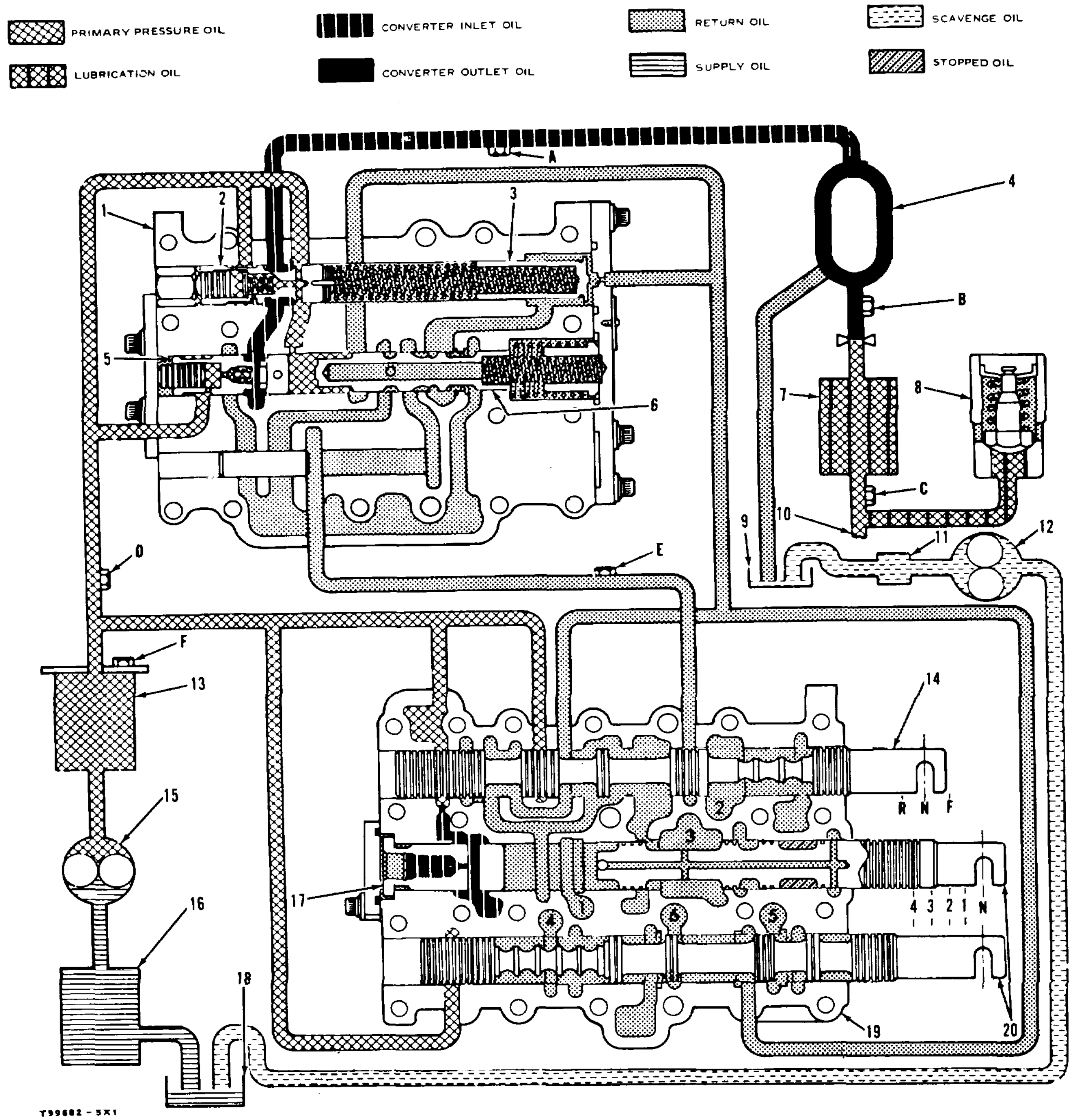
Valve spools (20) in the selector valve are connected together and work as a unit. These spools send oil to the speed clutches (No. I, No. 4, No. 5 or No. 6 clutch). Valve spool (14) in the selector valve sends oil to the direction clutches (No. 2 or No. 3 clutch). One speed clutch (No. 1, No. 4, No. 5 or No. 6 clutch) and one direction clutch (No. 2 or No. 3 clutch) must be engaged to make the machine move.

The differential and safety valve (6) is in the pressure control valve. This valve causes a difference in pressure in the speed and direction clutches, keeps the machine from moving if the engine is started in any speed except NEUTRAL, controls the flow of oil to the direction clutches, and is a check valve for the chamber behind load piston (3).

With the engine not running, the pump is not being turned and there is no pressure oil in the system. The springs for valves (2) and (6) and load piston (3) are extended and the valves and load piston are against their stops.

This chart gives a description of the function of the valves in the hydraulic controls.

VALVE	FUNCTION
Modulation Relief Valve (2) and Load Piston (3).	Controls the increase of pressure in the direction and speed clutches to gradually engage the clutches.
	Does not let the system pressure be more than 310 psi (21.80 kg/cm2) (2137 kPa).
Ratio Valve (5).	Does not let the oil going to the torque converter have a pressure of more than 115 psi (8.08 kg/cm2) (793 kPa)
Differential and Safety Valve (6).	Controls the pressure difference between the speed and direction clutches.
	Keeps oil from going to the direction clutches if the machine is started in any speed except NEUTRAL
	Controls the flow of oil to the direction clutches.
	Opens a return passage to release the pressure from the right end of the load piston during a shift.
Direction Selector Spool (14).	Opens the direction clutches to pressure oil or to the reservoir.
Speed Selector Spools (20)	Opens the speed clutches to pressure oil or to the reservoir.



TRANSMISSION CONTROLS IN NEUTRAL AND ENGINE RUNNING

1. Pressure control valve.
2. Modulation relief valve.
3. Load piston.
4. Torque converter.
5. Inlet ratio valve for the converter.
6. Differential and safety valve.
7. Oil cooler.
8. Lubrication relief valve.
9. Reservoir In the torque converter.
10. Oil line for lubrication of transmission.
11. Screen.
12. Scavenge pump.
13. Oil filter.
14. Valve spool for direction selection.
15. Oil pump.
16. Magnetic strainer.
17. Relief valve.
18. Reservoir for the transmission.
19. Selector valve.
20. Spools for speed selection.

A. Pressure tap for the inlet of the torque converter (P3).
B. Pressure tap for the outlet of the torque converter.
C. Pressure tap for lubrication pressure.
D. Pressure tap for speed clutch pressure (P1).
E. Pressure tap for direction clutch pressure (P2).
F. Pressure tap for the pump.

NEUTRAL WITH ENGINE RUNNING

When the engine is started with the console selection lever in the NEUTRAL position, the oil pump (15) pulls oil from the reservoir (18) through the magnetic strainer (16) and sends the oil to the filter (13). Oil from the filter is sent to the selector valve (19) and to the pressure control valve (1).

With the spool (14) for direction selection in the NEUTRAL position, the passage to the direction clutches is not open to the flow of oil.

Some of the oil from the oil pump is sent to the pressure control valve (1). The oil with pressure goes into the inlet ratio valve (5) through an orifice and works between the slug and the ratio valve to move the ratio valve to the right and close the passage to the reservoir.

Pressure oil also goes through a passage and a drilled hole in the modulation relief valve (2) and to the left end of differential and safety valve (6). The pressure oil in the drilled hole in the modulation relief valve (2) also opens a poppet valve and works between the slug and the modulation relief valve (2).

When the pressure of the oil gets to approximately 75psi (5.3 kg/cm2) (517 kPa), the pressure oil between the slug and the modulation relief valve moves the valve to the right and connects passages to send oil to the torque converter (4).

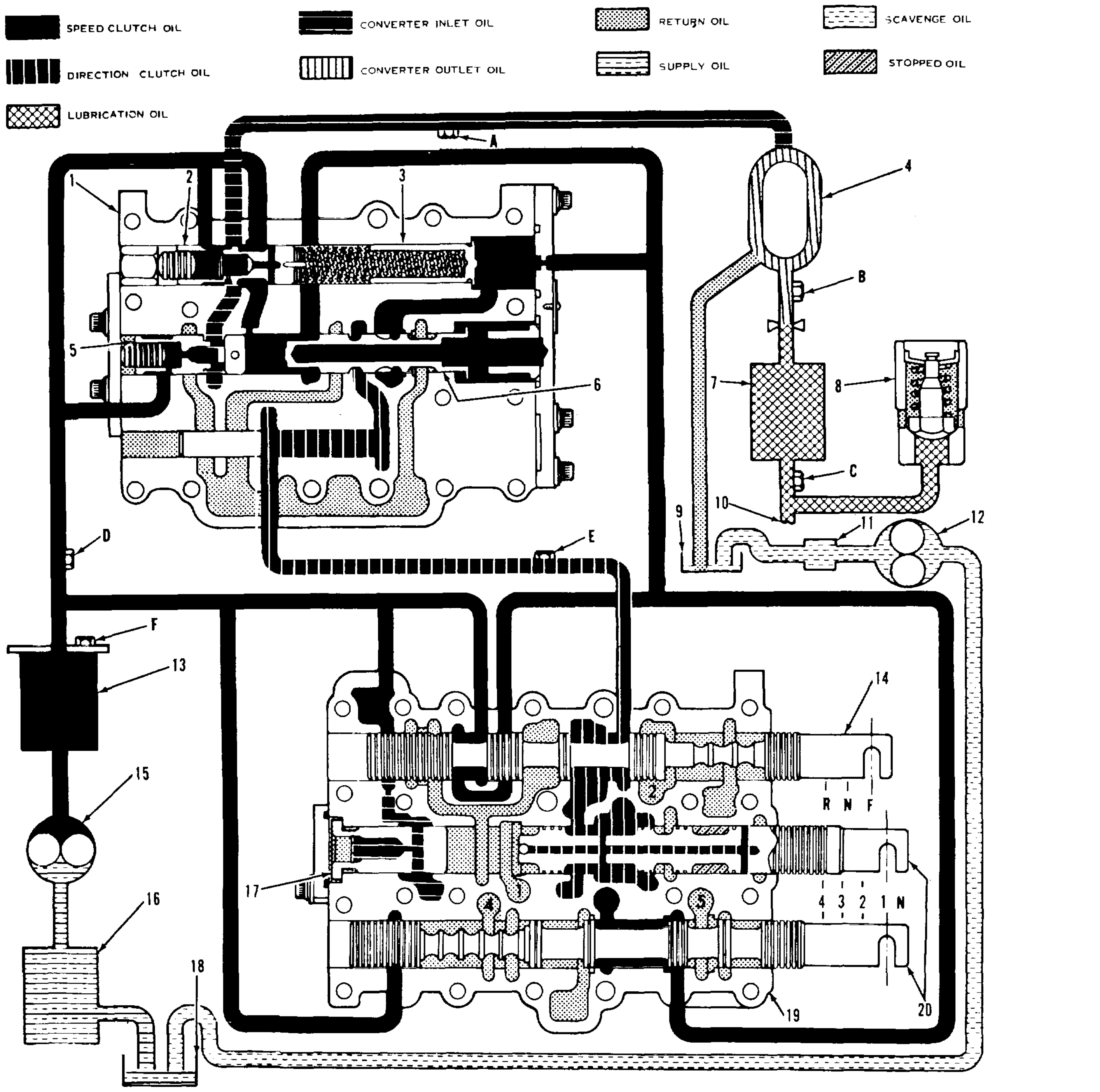
This pressure oil also moves differential and safety valve (6) to the right just far enough to open the oil chamber at the left end of the differential and safety valve to the reservoir through the body of selector valve (19). In this position, the oil chamber for load piston (3) is connected to a passage to the reservoir.

Because no pressure oil is in the chamber for load piston (3), the oil pressure can not go over approximately 75 psi (5.3 kg/cm2) (517 kPa). This oil pressure is primary pressure.

With the console selection lever in the NEUTRAL position, all the clutches are open to the reservoir and they can not engage. Because no speed or no direction clutches are engaged, the machine will not move.

If the engine is started with the console selection lever in any position except NEUTRAL, pressure oil is sent from selector valve (19) through the orifices in differential and safety valve (6) to the right side of the valve. The force of the pressure oil plus the force of the springs hold differential and safety valve (6) to the left. In this position, the direction clutches (No. 1, No. 2 and No. 3 clutch) can not get pressure oil and will not engage. Because no direction clutch is engaged, the machine will not move.

While the console selection lever is in the NEUTRAL position, the pressure oil in the spring side of differential and safety valve (6) is free to go to the transmission reservoir through the body of selector valve (19). The pressure oil on the left side of the combination valve then works against the spring force, and differential and safety valve moves to a neutral, or balanced position. In this position, the direction clutches have no pressure and will not engage.



TRANSMISSION CONTROLS IN FIRST SPEED FORWARD

1.Pressure control valve.
2.Modulation relief valve.
3.Load piston.
4.Torque converter.
5.Inlet ratio valve for the converter.
6.Differential and safety valve. 14. Valve spool for direction
7.Oil cooler.
8.Lubrication relief valve.

9. Reservoir In the torque converter.
10. Oil line for lubrication of transmission.
11. Screen.
12. Scavenge pump.
13. Oil filter.
A. Pressure tap for the Inlet selection.
15. Oil pump.

16. Magnetic strainer.
17. Relief valve.
18. Reservoir for the transmission.
19. Selector valve.
20. Spools for speed selection.
clutch pressure (P2).
of the torque converter (P3).

B. Pressure tap for the outlet of the torque converter.
C. Pressure tap for lubrication pressure.
D. Pressure tap for speed clutch pressure (P1).
E. Pressure tap for direction
F. Pressure tap for the pump.

FIRST SPEED FORWARD

When the console selector lever is moved from the NEUTRAL position to the FIRST SPEED FORWARD position, spool (14) for direction selection is moved to the FORWARD position. With spool (14) for direction selection in the FORWARD position, the passages for No. 1 and No. 2 clutches are open to the reservoir. The pressure oil for these clutches goes to the reservoir and neither is engaged.

Also, with spool (14) for direction selection in the FORWARD position, the passages for the No. 6 clutch is open to the flow of oil. As the No. 6 clutch fills, the pressure of the oil in the system has a decrease.

When the oil pressure has a decrease, the spring force on modulation relief valve (2) moves the modulation relief valve to the left against its slug. When the modulation relief valve moves to the left, it stops the flow of oil from the passages for oil going to torque converter (4).

An orifice in the passage to the left end of differential and safety valve (6) controls the flow of oil from the left end of the combination valve. This orifice keeps the combination valve from being moved completely to the left by the spring force during a normal shift sequence. This keeps the differential and safety valve from working as a safety valve between shifts.

When the No. 6 clutch is filled, the oil pump causes an increase in the pressure of the oil. Pressure oil goes through a passage and a drilled hole in modulation relief valve (2) to the left end of differential and safety valve (6). The pressure oil in the drilled hole in modulation relief valve (2) also opens its poppet valve and works between the slug and the modulation relief valve.

As PI pressure oil has an increase, differential and safety valve (6) is moved to the right. The passage to the reservoir that stopped the movement of the differential and safety valve in NEUTRAL now has PI pressure oil. This valve moves to the right until the orifices in the valve are open to the P I1 pressure oil from selector valve (19). The orifices control the flow of oil to the No. 3 clutch. When the No. 3 clutch is filled, the P2 pressure oil plus the spring force move differential and safety valve (6) to the left to stop the flow of oil through the orifices. Now PI pressure has an increase.

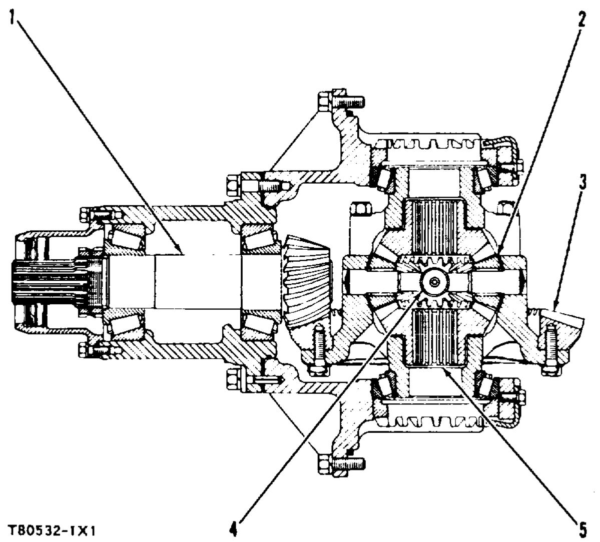
As the P1 pressure oil has an increase, the PI pressure between the slug and modulation relief valve (2) moves the modulation relief valve to the right. When the modulation relief valve moves to the right, it connects the passages to let pressure oil go to torque converter (4). PI pressure also goes through the orifice to the right of load piston (3). The P1 pressure on the load piston, plus the spring force, makes modulation relief valve (2) move to the left. When the modulation relief valve moves to the left, it stops the flow of oil to the passages to torque converter (4) and PI pressure has an increase.

As PI pressure becomes higher, the modulation relief valve moves to the right again and opens the passages to the torque converter. This higher P1 pressure also goes through the orifice to the right of load piston (3). The higher PI pressure on the load piston, plus the spring force, makes the modulation relief valve move to the right again and again until the PI pressure is at a maximum. The modulation relief valve controls the maximum pressure by letting the extra pressure go to the passage for the torque converter. This gradual increase in pressure is modulation. The modulation relief valve (2) gives modulation for all the clutches (speed and direction).

The differential and safety valve (6) causes a constant pressure difference of 50 psi (3.5 kg/cm2) (344 kPa) less than the PI pressure to the speed clutches. This pressure difference lets the speed clutches become engaged first, and then the direction clutches are engaged last. When the PI pressure is at a maximum of approximately 3 10 psi (21.80 kg/cm2) (2137 kPa), the P2 pressure is at approximately 160 psi (11.25 kg/cm2) (1103 kPa). The shift is now complete.

The inlet ratio valve (5) controls the maximum oil pressure to the torque converter. P1 pressure between the ratio valve and its slug keeps the valve closed. The pressure of the oil that goes through the passage to the torque converter is felt by the end of the ratio valve opposite the slug. When the pressure of the oil to the torque converter is less than 1 15 psi (8.08 kg/cm2) (793 kPa), the ratio valve closes and the pressure oil goes to the torque converter.

DIFFERENTIAL AND BEVEL GEAR



DIFFERENTIAL
1. Pinion shaft. 2. Pinions (four). 3. Bevel gear. 4. Spider. 5. Side gears (two).

The gear on the transmission output shaft is engaged with the transfer output shaft gear which sends power through universal joints to the drive shafts. The drive shafts are connected with splines to the pinion shaft (1). The pinion shaft turns the bevel gear (3) which is fastened to the differential case. The differential case contains four pinions (2), installed on a spider (4), and two side gears (5). The four pinions are engaged at right angles with the two side gears. The side gears are connected with splines to the inner ends of the drive axles.

The differential makes the torque equal that goes to both drive wheels. When one wheel is turning slower than the other, as in a turn, the differential permits the inside wheel to stop or slow in relation to the outside wheel.

When the machine is moving straight ahead with equal traction under each drive wheel, equal torque on each axle stops the pinions (2) so they will not turn on the spider (4). This gives the same action as if both drive wheels were locked on the same driving axle. When loads that are not equal are put on the drive wheels, as in a turn, forces that are not equal are put on opposite sides of the differential causing the pinions (2) to turn. When the pinions are turning, the inside wheel slows or stops and increases the turning of the outside wheel. This action causes the machine to be driven with full power in a turn.

The hubs of the differential cases are installed on the differential carrier with tapered roller bearings. The pinions (2) turn on hardened steel bearings. Both the pinions (2) and side gears (5) turn against thrust washers which take the end thrust against the differential case.

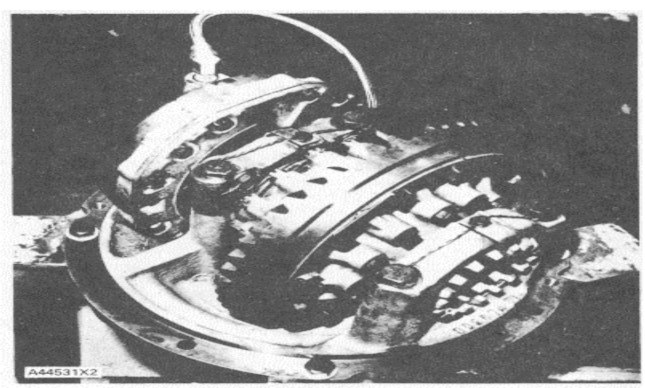
The differential gets lubrication from oil thrown about by the moving parts. Flat surfaces on the spider permit passage of oil for lubrication to the pinion bearings and the thrust washers.

DIFFERENTIAL LOCK

When one drive wheel has bad traction, the other wheel turns freely. This action causes a loss of power which is stopped by the differential lock. This is done by sending power to both wheels through a jaw clutch. The jaw clutch lets the differential engage or release while machine is using full power at any speed. The jaw clutch can be engaged at any speed before the wheels start to turn freely.

The operator must choose the time he needs to engage the jaw clutch. An example of one such need is, when one wheel starts to turn freely, or a noise is caused by the jaw clutches hitting each other, lower the engine speed to let the jaw clutches engage.

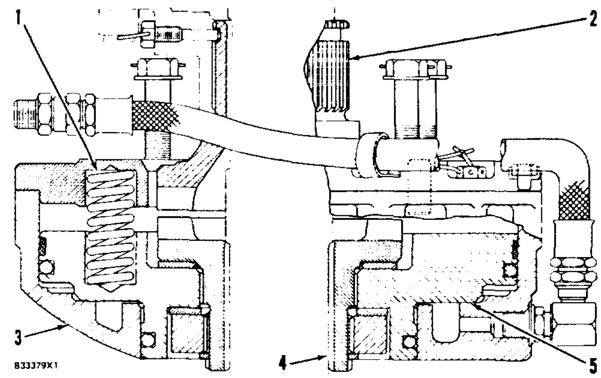
The operator must keep the pedal for the differential lock pushed down to keep the jaw clutches engaged. When the differential lock is engaged, the speed of the wheels is the same. The condition of the surface has no effect on the speed at which the wheels turn. Power is divided and the same amount is sent to each wheel. This stops a loss of power by not letting one wheel turn freely. Releasing the pedal releases the differential lock.



DIFFERENTIAL LOCK

WARNING: Do not turn the machine while the pedal for the differential lock is pushed down.

When the pedal for the differential lock is pushed down, pressure air from the control valve of differential lock goes to air cylinder (3) of the differential lock.

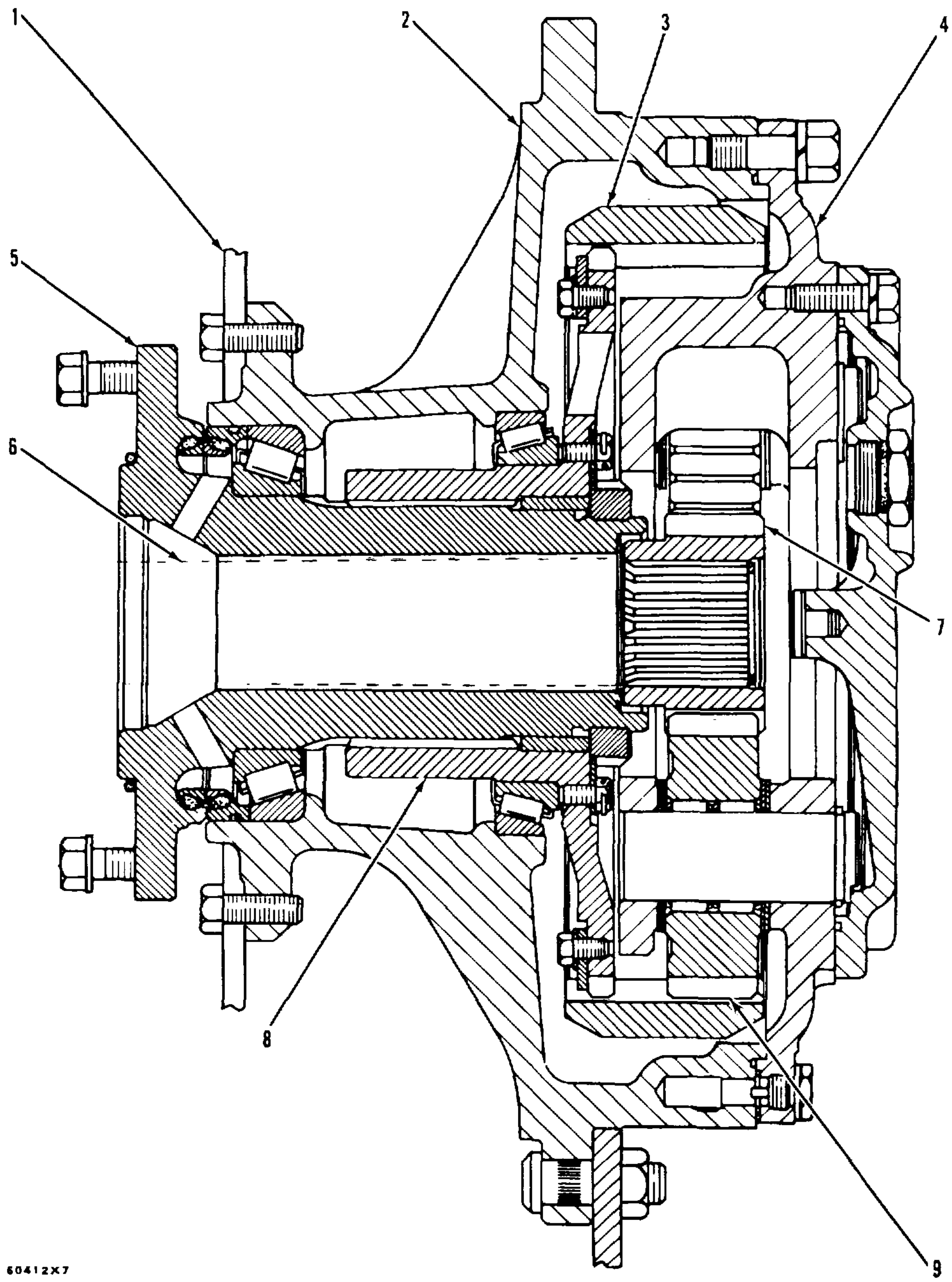


DIFFERENTIAL LOCK
1. Springs. 2. Jaw. 3. Cylinder. 4. Jaw. 5. Piston.

The pressure air pushes piston (5) to the inside causing the jaws to engage. Jaw (2) of the clutch is fastened to the differential housing by splines. Jaw (4) is fastened to the right axle shaft. When the jaws are engaged, there is a connection between the right axle shaft and the differential housing. The differential gears and the differential housing do not move so this connection causes the effect of one axle drive.

When the pedal is released, the reduction in air pressure to cylinder (3) causes piston (5) to move to the outside. The jaws are then not engaged. Springs (I) between housing and piston keep the jaws from being engaged, until air pressure is sent to the cylinder. When the differential is not engaged, the operation of the differential is normal.

FINAL DRIVE AND WHEELS



FINAL DRIVE

1. Brake disc.	**4. Carrier.**	**7. Sun gear.**
2. Wheel assembly.	**5. Spindle.**	**8. Final drive hub.**
3. Ring gear.	**6. Axle.**	**9. Planet gears.**

The final drive is a planetary gear system. Axle (6) is connected to the differential at one end and to the sun gear (7) at the other end with splines. The ring gear (3) of the planetary system is connected to the hub (8) with splines. The hub is connected to the spindle (5) with splines. The spindle is fastened to the axle housing.

When axle (6) is turned by the differential, the sun gear (7) turns the planet gears (9). Because the ring gear (3) is held by the axle housing, the planet gears (9) (turned by the sun gear) make the carrier (4) turn at a slower speed than the sun gear (7). The carrier (4) is connected to the wheel assembly (2) and the rim assembly and the power is sent to the ground.

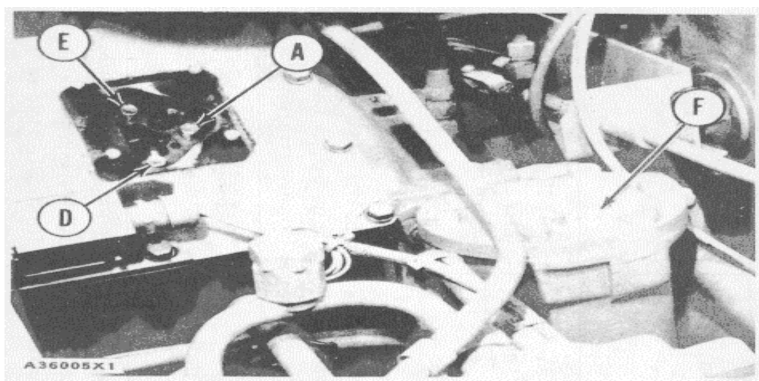
TRANSMISSION HYDRAULIC CONTROLS

PERFORMANCE TESTS AND ADJUSTMENTS

WARNING: When you make a complete test of the hydraulic controls and/or an adjustment of the shift points, remove both drive axles and disconnect the steering linkage. Let only approved personnel on the machine. Keep other personnel off the machine and in view of the operator.

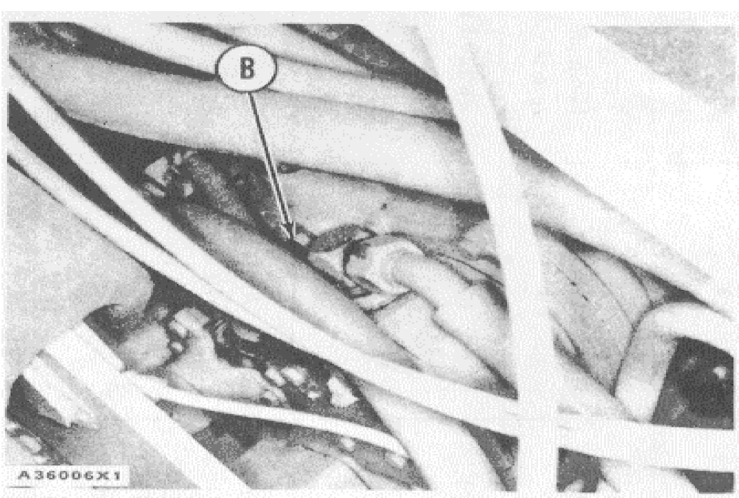
NOTE: All tests and adjustments must be made with the oil in the hydraulic control system at the temperature of normal operation. Be sure the linkage adjustments are correct before the tests and adjustments are made.

LOCATION OF PRESSURE TAPS



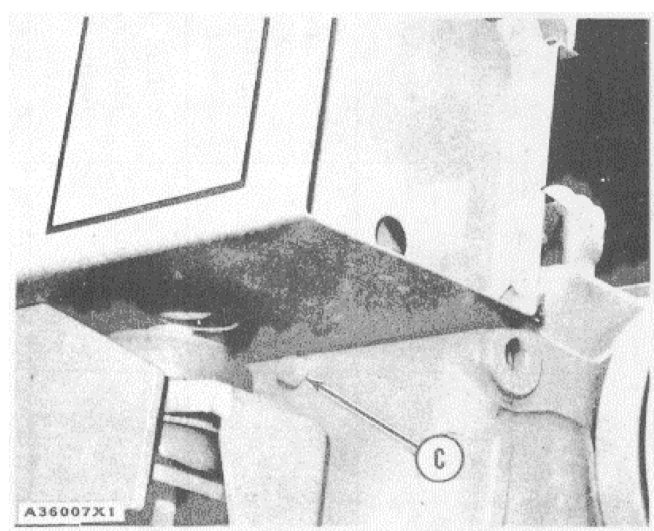
LOCATION OF PRESSURE TAPS

A. Pressure tap for converter inlet pressure, (P3). D. Pressure tap for speed clutch oil, (P1). E. Pressure tap for direction clutch oil, (P2). F. Pressure tap for transmission oil pump.



LOCATION OF PRESSURE TAP

B. Pressure tap for outlet oil from torque converter.

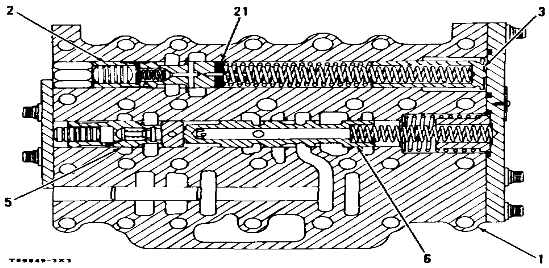


LOCATION OF PRESSURE TAP

C. C. Pressure tap for lubrication oil (on transfer gear case, under left battery box.

GOVERNOR CONTROL LEVER AT:

PRESSURE	PRESSURE TAP LOCATION	MINIMUM SETTING	MAXIMUM SETTING	ADJUSTMENT
Pump	(F) Filter Cover	260 psi (18.3 kg/cm^2) (1793 kPa) Minimum. Check in all forward and reverse speeds.	310± 15 psi (21.8 ± 1.1 kg/cm^2) (213 7 ± 103 kPa). Check in all forward and reverse speeds.	NONE. Adjustment is controlled by the modulation relief valve.
Speed Clutch (Primary Setting)	(D) P1 Pressure Control Valve	73 ± 3 psi (5.1 ± 0.21 kg/cm^2) (503 ± 21 kPa) with selector lever in NEUTRAL.		Add or remove spacers (21) behind modulation relief valve (2). See spacer chart.
Speed Clutch	(D) P1 Pressure Control Valve.	260 psi (18.3 kg/cm^2) (1 793 kPa) Minimum. Check in all forward and reverse speeds.	310 ± 15 psi (21.8 ± 1.1 kg/cm^2) (2137 ± 103 kPa). Check in all forward and reverse speeds.	NONE. Adjustment is controlled by the modulation relief valve.
Direction Clutch	(E) P2 Pressure Control Valve	50 ± 8 psi (3.5 ± 0.621 kg/cm^2) (345 ± 55 kPa) less than the pressure of ± the speed clutch. Check in all forward and reverse speeds.	50 8 psi (3.5 ± 0.6 kg/cm^2) (345 55 kPa) less than the pressure of the speed clutch. Check in all forward and reverse speeds.	NONE.
Transmission Lubrication Oil	(C) On transfer gear case	1 psi (0.1 kg/cm^2) (7 kPa) Minimum. Check in all forward and reverse speeds.	10 ± 3 psi (0.7 ± 0.2 kg/cm^2) (69 21 kPa). Check in all forward and reverse speeds.	NONE.
Outlet from the Torque Converter	(B) On converter housing near outlet line to oil cooler	2 psi (0.1 kg/cm^2) (14 kPa) Minimum with selector lever in THIRD SPEED forward, brakes activated and converter stalled.	40 ± 5 psi (2.8 ± 0.4 kg/cm^2) (276 ± 35 kPa) with selector lever in THIRD SPEED forward, brakes activated and converter stalled.	NONE. Controlled by orifice.
Inlet to the Torque Converter: BENCH TEST for correct operation	(A) P3 Pressure Control Valve		1 125 psi (8.1 kg/cm^2) (793 kPa) Maximum.	NONE.



PRESSURE CONTROL VALVE

1. Pressure control valve. 2. Modulation relief valve. 3. Load piston. 5. Inlet ratio valve for torque converter. 6. Differential and safety valve. 21. Spacers.

1T984 TRANSMISSION OIL PRESSURE AND TORQUE CONVERTER SCAVENGE PUMP BENCH TEST SPECIFICATIONS

Type....................Gear
Number of sections....................Two
Rotation....................Counterclockwise
Pressure section:
Capacity [With SAE 10W oil at
120°F (49-C)]....................24.3 U.S. gpm (91.97 litre/min)
At a speed of....................2855 rpm
At a pressure of.......... 310 psi (21.8 kg/cm^2) (2137 kPa)
Scavenge section:
Capacity [With SAE 10W oil at
120°F (49°C)....................9.7 U.S. gpm (36.73 litre/min)
At a speed of....................2855 rpm
At a pressure.................... 60 psi (4.2 kg/cm^2) (413 kPa)

PRESSURE CHANGE TO MODULATION RELIEF VALVE (2) BY REMOVAL OR ADDITION OF ONE SPACER (21)

SPACER	THICKNESS		CHANGE IN PRESSURE		
PART NO.	in.	mm	psi	kg/cm^2	kPa
5M3492	.010	0.25	1.7	0.12	12
7M1397	.036	0.91	6.2	0.44	43
7M1396	062	1.57	10.7	0.75	74

LINKAGE ADJUSTMENTS FOR THE TRANSMISSION HYDRAULIC CONTROLS

WARNING: Do not make any adjustments to the linkage with the engine running.

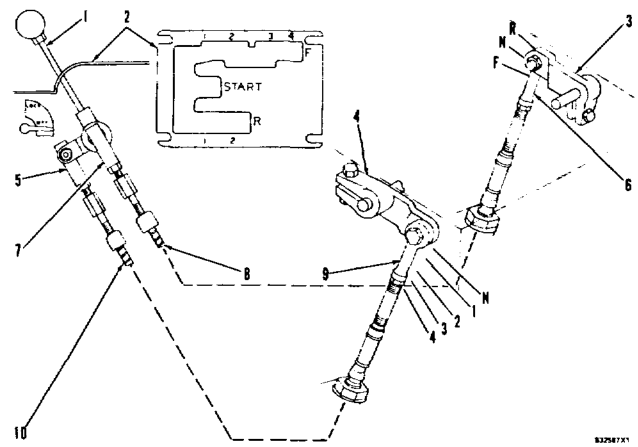
1 . Put speed selection lever (I) in the center position of the NEUTRAL "N" slot in shift guide (2). Turn the safety lock lever to the LOCK position.

2. Turn speed control lever (4) on the transmission counterclockwise to the last detent or NEUTRAL position.

3. Turn ends (5) and (9) as necessary to make an adjustment to the length of control cable (10) to connect to levers (4) and (1). Tighten the locknuts after the adjustment is made.

4. Turn direction control lever (3) on the transmission to the center detent or NEUTRAL position.

5. Turn ends (6) and (7) as necessary to make an adjustment to the length of control cable (8) to connect to levers (3) and (I). Tighten the locknuts after the adjustment is made.



LINKAGE FOR THE HYDRAULIC CONTROLS

1. Speed selection lever. 2. Shift guide. 3. Direction control lever. 4. Speed control lever. 5. End. 6. End. 7. End. 8. Control cable. 9. End. 10. Control cable.

6. Move lever (I) to each FORWARD position to be sure the lever is in the center of each detent. Make an adjustment if necessary.

7. Turn cable (10) to make it short enough, if necessary, to have a positive FOURTH SPEED detent.

C

TROUBLESHOOTING

Use this as a reference for the location and correction of problems in the power train. When more checking is necessary, use the 5P6225, 7S8875 or 8M2736 Hydraulic Test Box.

Always make visual checks first. Then check the operation of the machine and go on to check with the instruments.

VISUAL CHECKS

I. Check the oil level in the transmission.
2. Check all oil lines, hoses and connections for leaks and damage. Look for oil on the ground under the machine.
3. Move the selector handle to all REVERSE and all FORWARD positions. The detents must be felt in all positions.
4. Let the oil out of the filter housing. Remove and check the filter element for loose particles. Also, check the magentic strainer.
   a. Bronze-colored particles give an indication of clutch failure.
   b. Shiny steel particles give the indication of a clutch failure.
   c. Rubber particles give an indication of a seal failure or hose failure.
   d. Aluminum particles give an indication of a torque converter failure. If you find metal or rubber particles, all components of the transmission hydraulic system must be washed clean. Do not use parts , with damage. Use new parts.

CHECKS DURING OPERATION.

With the engine running, move the selector lever to all speed positions. The detents must be felt in all positions.

Operate the machine in each direction and in all speeds. Make note of all noises that are not normal and find their sources. If the operation is not correct, make reference to the CHECK LIST DURING OPERATION for "problems, " "probable causes, " and "recommended action."

CHECK LIST DURING OPERATION

Transmission

PROBLEM
PROBABLE CAUSE
RECOMMENDED CORRECTIVE ACTION

Transmission does not operate in any speed or does not engage (slips) in all speeds.

1. Low oil pressure.

   a. Low oil level.
   b. Control linkages loose or adjustment not correct.
   c. Failure of the oil pump or the pump drive.
   d. Air leaks on inlet side of pump.
   e. Leakage inside the transmission.
   f. Adjustment of the modulation relief valve not correct, or valve does not close.
   g. Load piston or differential and safety valve will not close.

      1. Check oil level, adjust as needed.
      2. Check control linkage for proper adjustment.
      3. Repair or replace oil pump/pump drive.
      4. Repair or replace pump.
      5. Repair as necessary to stop leakage.
      6. Check modulation relief valve for proper adjustment. If valve does not close, repair or replace as necessary.
      7. Repair or replace load piston/differential and safety valve.

2.Mechanical failure in transmission.
   a. Repair or replace parts as necessary.

3. Failure of the torque converter.
   a. Repair or replace as necessary.

4. Failure of the differential or the final drive planetaries.
   a. Repair or replace the differential/final drive planetaries.

PROBLEM
PROBABLE CAUSE
RECOMMENDED CORRECTIVE ACTION

Transmission does not shift.

1. Low oil pressure.
   a. Check oil pressure, adjust as necessary.

2. Air leaks on inlet side of pump.
   a. Repair or replace pump.

3. Control linkage loose or adjustment not correct.
   a. Check control linkage for proper adjustment.

Transmission engages very suddenly (rough shifting).

1. Primary setting of the relief valve not correct.
   a. Correct primary setting of the relief valve.

2. Adjustment of control linkage not correct.
   a. Check control linkage for proper adjustment.

3. Operation of load piston or differential and safety valve not correct.
   a. Repair or replace load piston/differential/safety valve as necessary.

4. Valve springs are weak or have damage.
   a. Replace valve springs.

Shifts slowly.

1. Low oil pressure.
   a. Check oil pressure, adjust as needed.

2. Adjustment of control linkage not correct.
   a. Check control linkage for proper adjustment.

3. Air leaks on inlet side of pump.
   a. Repair or replace pump.

PROBLEM
PROBABLE CAUSE
RECOMMENDED CORRECTIVE ACTION

4. Operation of load piston or differential and safety valve not correct.
   a. Repair or replace load piston/differential and safety valve.

5. Orifice in modulation relief valve not open.
   a. Repair or replace modulation relief valve.

Transmission engages but the machine does not move and the engine stops.

1. The gears in the transmission cannot turn.
   a. Parking brake is on.
   b. Planetary in the final drive has broken gears and cannot turn.
   c. Differential has broken gears and will not turn.
   d. Too many transmission clutches are being engaged in the transmission.
      1. Release parking brake.
      2. Replace planetary in the final drive.
      3. Replace differential.
      4. Repair or replace transmission clutches as necessary.

Loss of power during or after a shift.

1. Two or more clutches wrongly engaged.
   a. Repair or replace clutches as necessary.

Pump noise is not normal.

1. Loud sounds at short intervals that give an indication that particles are going through the pump is caused by pump cavitation (the sudden making of low pressure bubbles in a liquid). Cavitation is caused by a restriction or an air leak in the inlet line to the pump.
   a. Repair or replace pump.

2. A constant loud noise is an indication of pump failure.
   a. Repair or replace pump.

PROBLEM
PROBABLE CAUSE
RECOMMENDED CORRECTIVE ACTION

Noise in the transmission which is not normal.

1. Parts have wear or have damage.

   a. Repair or replace parts as necessary.

Transmission does not operate in FORWARD, but does operate in all REVERSE speeds.

1. No. 3 clutch does not engage.

   a. Low oil pressure caused by leakage at the seals.
   b. Discs and plates have too much wear.
   c. Control linkage loose or adjustment not correct.

      1. Replace seals.
      2. Replace discs and seals.
      3. Check control linkage for proper adjustment.

Transmission does not operate in REVERSE, but does operate in all FORWARD speeds.

1. No. 2 clutch does not engage (slips).

   a. Low oil pressure caused by leakage at the seals.
   b. Discs and plates have too much wear.
   c. Control linkage loose or adjustment not correct.

      1. Replace seals.
      2. Replace discs and seals.
      3. Check control linkage for proper adjustment.

Transmission does not operate in FIRST speed, FORWARD, or REVERSE.

1. No. 6 clutch does not engage (slips).

   a. Low oil pressure caused by leakage at the seals.
   b. Discs and plates have too much wear.
   c. Control linkage loose or adjustment not correct.

      1. Replace seals.
      2. Replace discs and plates.
      3. Check control linkage for proper adjustment.

PROBLEM
PROBABLE CAUSE
RECOMMENDED CORRECTIVE ACTION

Transmission does not operate in SECOND speed, FORWARD, or REVERSE.

1. No. 5 clutch does not engage (slips).

   a. Low oil pressure caused by leakage at the seals.
   b. Discs and plates have too much wear.
   c. Control linkage loose or adjustment not correct.

      1. Replace seals.
      2. Replace discs and plates.
      3. Check control linkage for proper adjustment.

Transmission does not operate in THIRD speed, FORWARD, or REVERSE.

1. No. 4 clutch does not engage (slips).

   a. Low oil pressure caused by leakage at the seals.
   b. Discs and plates have too much wear.
   c. Control linkage loose or adjustment not correct.
      1. Replace seals.
      2. Replace discs and plates.
      3. Check control linkage for proper adjustment.

Transmission does not operate in FOURTH speed only.

1. No. 1 clutch does not engage (slips).

   a. Low oil pressure caused by leakage at the seals.
   b. Discs and plates have too much wear.
   c. Control linkage loose or adjustment not correct.

      1. Replace seals.
      2. Replace discs and plates.
      3. Check control linkage for proper adjustment.

Transmission does not shift out of speed and/or direction when the shift lever is moved to NEUTRAL.

1. Control linkage has damage or wrong adjustment.
   a. Repair or adjust control linkage as necessary.

PROBLEM
PROBABLE CAUSE
RECOMMENDED CORRECTIVE ACTION

2. Direction clutch does not release.

 a. Repair or replace direction clutch as necessary.

Torque converter gets hot.

1. Bad temperature gauge.

 a. Replace temperature gauge.

2. Operation of the machine is not correct. It has a constant overload.

 a. Adjust the operation of the machine as necessary to reduce the overload.

3. Core of oil cooler is not completely open.

 a. Repair or replace oil cooler.

4. Not enough oil goes to the oil cooler.

 a. Converter oil has leakage through the bearing for the oil pump gear and into the transmission.
 b. Converter oil has leakage through seal rings (near the bearing on the output shaft of the torque converter) and into the transmission.
 c. The supply of oil to the torque converter is low.

  1. Replace bearing for the oil pump gear.
  2. Replace seal rings.
  3. Check oil level, adjust as needed.

5. Ratio valve does not operate correctly.

 a. Repair or replace ratio valve.

6. Mechanical failure in the torque converter.

 a. Repair or replace parts in torque converter as necessary.

PROBLEM
PROBABLE CAUSE
RECOMMENDED CORRECTIVE ACTION

7. Transmission oil is too hot.

 a. Low oil level.
 b. Clutch drag (friction when clutch is not engaged).
 c. Bad pump causes low oil flow.
 d. Leakage in the transmission.

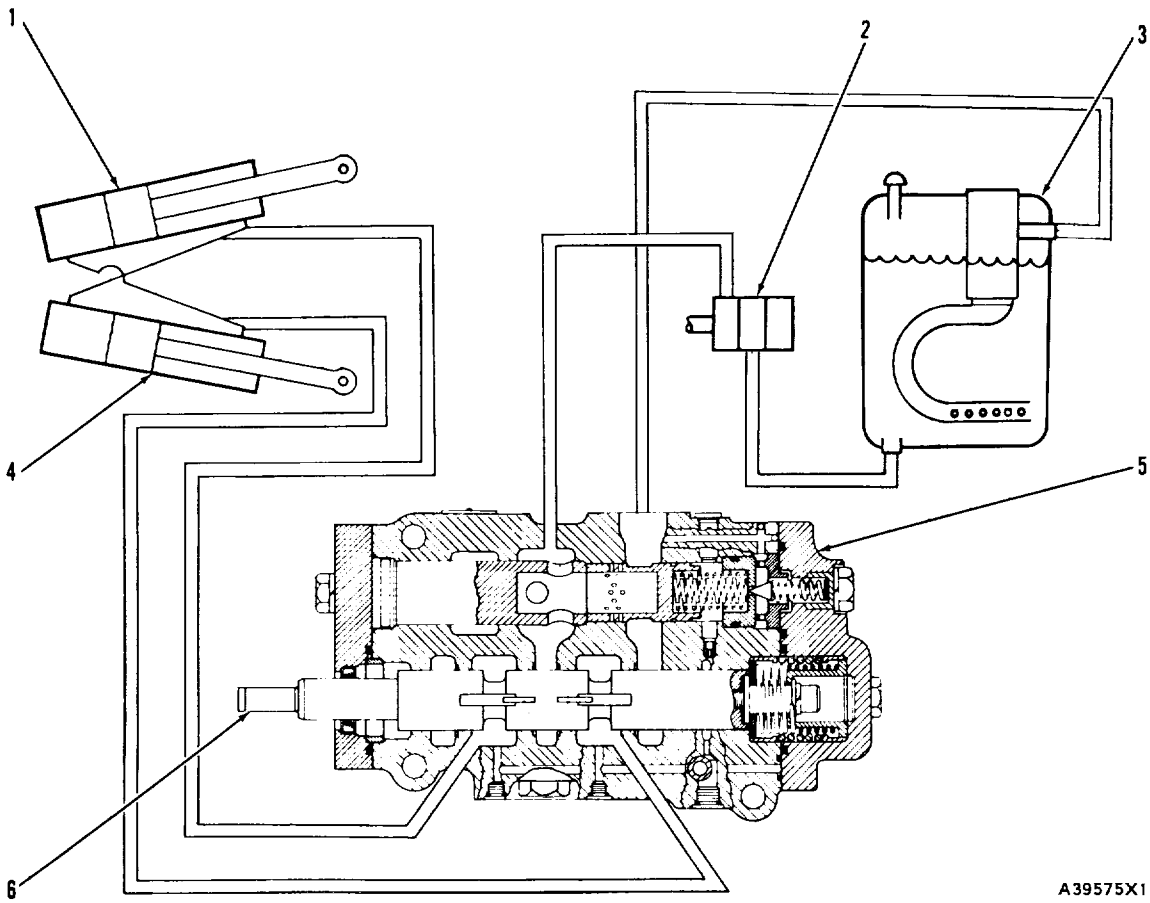
  1. Check oil level, adjust as needed.
  2. Repair or replace clutch.
  3. Repair or replace pump.
  4. Check for area of leakage, repair or replace parts as necessary.

TRANSMISSION	CLUTCHES ENGAGED
Neutral	2
First Speed Forward	3-6
Second Speed Forward	3-5
Third Speed Forward	3-4
Fourth Speed Forward	1-5
First Speed Reverse	2-6
Second Speed Reverse	2-5

CLUTCH NO.	OPERATION
No. 1	Forward Direction
	(fourth speed)
No. 2	Reverse Direction
No. 3	Forward Direction
No 4	Third Speed
No. 5	Second and Fourth Speeds
No. 6	First Speed

SECTION 3
SYSTEMS OPERATION, TESTING, AND ADJUSTING
STEERING SYSTEM

STEERING HYDRAULIC SYSTEM



STEERING SYSTEM SCHEMATIC

1. Left steering cylinder.
2. Hydraulic pump (large
3. Hydraulic tank and filter.
4. Right steering cylinder.
5. Steering control valve.
6. Control valve spool.

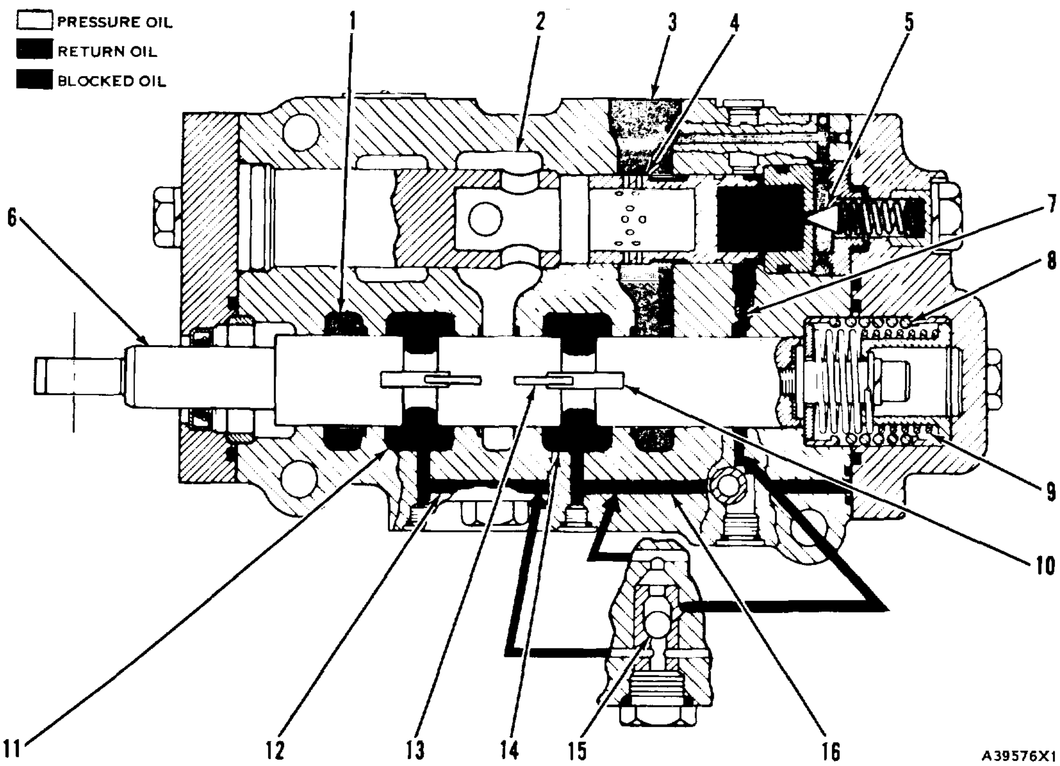
The steering system for the 613B is a variable flow modulated system. The modulated steering gives the operator good control for a slow turn. This is necessary when the machine operates either in a tight area or at faster speeds. With this system, the operator can also make fast turns ashen necessary.

The main components of the steering system are the hydraulic pump (2), steering control valve (5), and steering cylinders (I) and (4).

The hydraulic pump is a two-section pump; a small section for the implement system and a large section for the steering system. The pressure oil from the pump flows to the steering control valve.

Spool (6) for the steering control valve is connected to the steering w, heel by linkage. When the steering wheel is turned, the valve spool moves. This lets oil from the pump go to the steering cylinders.

STEERING CONTROL VALVE
NEUTRAL POSITION



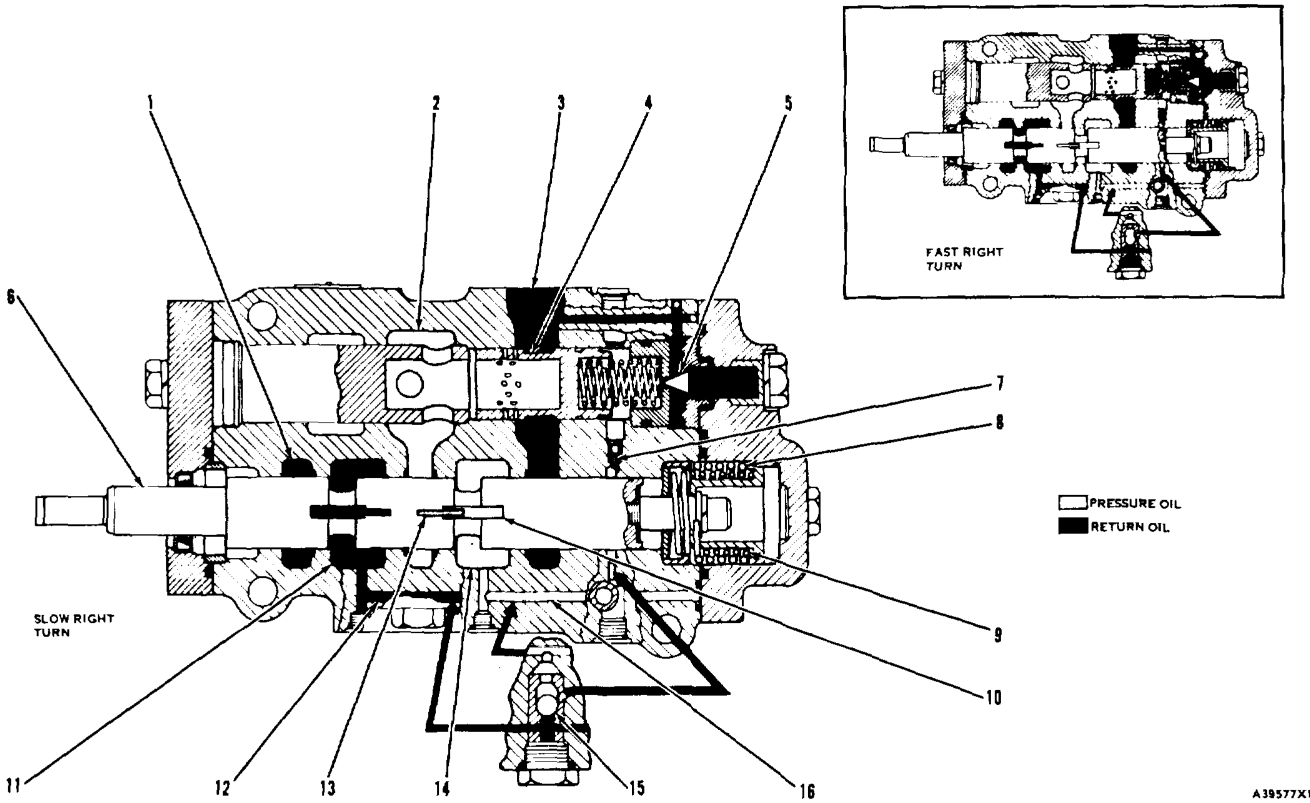
STEERING CONTROL VALVE IN NEUTRAL POSITION

1. Tank return passage. 2. Inlet. 3. Outlet to tank. 4. Flow control valve. 5. Pilot valve. 6. Spool. 7. Orifice. 8. Outer spring. 9. Inner spring. 10. Wide slots. 11. Outlet to cylinders (for left turn). 12. Passage. 13. Narrow slots. 14. Outlet to cylinders (for right turn). 15. Ball resolver valve. 16. Passage.

When there is no force on the steering wheel, springs (8) and (9) keep spool (6) in the NEUTRAL position. Oil from the hydraulic pump flows into the control valve through inlet (2). The flow of oil to the cylinders is stopped by spool (6). This causes an increase in the pressure of the oil in the inlet passage, and flow control valve (4) opens. The valve opens until the oil from the pump can flow through the holes in the flow control valve. The oil then flows through outlet (3) and back to the hydraulic tank.

In the NEUTRAL position, the valve spool also blocks (stops) the oil in the lines to the cylinders. This holds the machine in the turned position where the steering wheel was stopped. A very small amount of oil can flow to and from the steering cylinders through slots (13). This reduces the shocks caused when the wheels come in contact with an object.

The pressure of the oil in the blocked outlets (I) and (14) is felt through passages (12) and (16) and against pilot valve (5). If an outside force tries to turn the machine when the valve spool is in the NEUTRAL position, the increase in pressure is felt against pilot valve (5). The pressure will not go higher than 2000 ± 25 psi (140.6 ± 1.8 kg/cm^2) (13 790 ± 172 kPa).



STEERING CONTROL VALVE IN RIGHT TURN POSITION

1. Tank return passage.
2. Inlet.
3. Outlet to tank.
4. Flow control valve.
5. Pilot valve.
6. Spool.
7. Orifice.
8. Outer spring.
9. Inner spring.
10. Wide slots.
11. Outlet to cylinders (for left turn).
12. Passage.
13. Narrow slots.
14. Outlet to cylinders (for right turn).
15. Ball resolver valve.
16. Passage.

When the steering wheel is turned to the right a few degrees (SLOW RIGHT TURN), spool (6) is moved out of the valve body a small amount. This causes compression of inner spring (9). Pump oil flows from inlet (2) through narrow slots (13) on the valve spool. The oil flows into outlet (14) and then to the steering cylinders. The force of the oil in the cylinders causes the machine to turn slowly to the right.

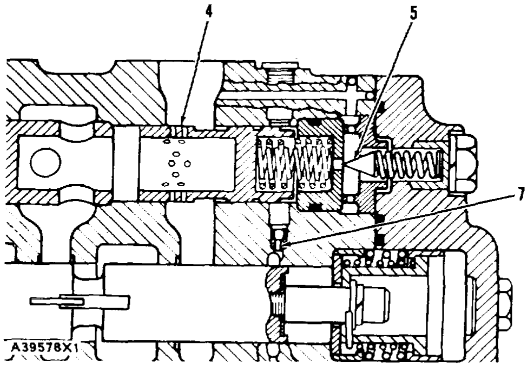
If the steering wheel is turned against the stop (FAST RIGHT TURN), spool (6) will move out of the valve body some more. There is compression of both the inner and outer springs (9) and (8). When compression of the outer spring starts, there is an increase in the force needed to turn the steering wheel. This lets the operator feel the spool move to the FAST TURN position.

When the spool is in the FAST TURN position, the pump oil flows from inlet (2) through wide slots (10) in the spool. These large slots let more oil flow to the cylinders than the small slots. The result is a FAST RIGHT TURN.

Return oil that is pushed from the steering cylinders is sent into the control valve through outlet (11). The oil is sent through slots in the valve spool into return passage (1). The oil then flows through outlet (3). From the outlet, the oil flows back to the filter and hydraulic tank.

The pressure of the oil to the cylinders is also felt through passage (16). When oil goes into passage (16), the pressure moves ball resolver valve (15). The pressure of the oil to the cylinders is then felt against pilot valve (5) and flow control valve (4).

If an outside force keeps the machine from turning, the pressure in outlet (14) and passage (16) will increase. This pressure increase is also felt against the pilot valve and flow control valve. The pressure against the flow control valve causes it to move to the left. This lets more oil flow to the cylinders. If the pressure goes above the relief valve setting of 200025 psi (140.6 ± 1.8 kg/cm2) (13 790 ± 172 kPa), the pilot valve will open.



STEERING CONTROL VALVE WITH RELIEF VALVE OPEN
4. Flow control valve. 5. Pilot valve. 7. Orifice.

When the pilot valve opens, oil flows through orifice (7) and past the pilot valve. The flow of oil past the orifice causes a lower pressure in the chamber for the flow control springs. This lets the pressure of the oil in the inlet passage move flow control valve (4). Oil from inlet (2) can flow through the holes in the flow control valve. This releases the extra pressure from the circuit. When the outside force is gone and the pressure is reduced, the flow control valve and pilot valve return to their normal positions.

Left Turn Position

The control valve operation for a LEFT TURN is similar to that for a RIGHT TURN. When the steering wheel is turned to the left, the valve spool moves into the valve body. Pump oil, from the inlet, flows through the slots on the valve spool into outlet (1 I). This oil then flows to the cylinders and a LEFTTURN is the result.

The cylinder pressure is felt through passage (12), and against the pilot valve and flow control valve. The rest of the relief valve operation is the same as a RIGHT TURN.

TROUBLESHOOTING

The 5P5224 Pressure Gauge Kit can be used to make the pressure tests of the steering system. Before any tests are made, visually inspect the complete hydraulic stem for leakage of oil and for parts that have damage. For some of the tests a magnet and a measuring rule (either for inches or millimeters) are usable tools.

⚠ WARNING: When testing and adjusting the steering system, move the machine to a smooth horizontal location. Move away from personnel and machines that are at work. There must be only one operator. Keep all other personnel away from the machine.

VISUAL CHECKS

A visual inspection of the steering system and its components is the first step when a diagnosis of a problem is made. To remove the tank filler cap, slowly turn the filler cap until it is loose. If oil comes out the bleed hole, let the tank pressure lower before the filler cap is removed. Make the following inspections:

1. Measure the oil level.
2. Check for air in the hydraulic oil. Do this immediately after the machine has been operated (% with the engine still running). Use a clear bottle or 'container to get a sample of the oil in the hydraulic tank. Check the sample to see if there are air bubbles in the oil.
3. Remove the filter elements and look for particles. removed from the oil by the filter element. A magnet will separate ferrous particles from non-ferrous particles (Piston rings, O-ring seals, etc.).

4. Check all oil lines and connections for damage or leaks.

PERFORMANCE TESTS

Performance tests of the steering system can be used for a diagnosis of poor performance and to find the source of oil leakage inside the hydraulic system. The oil must be at the normal temperature for operation when the tests are done.

PROBLEM
PROBABLE CAUSE
RECOMMENDED CORRECTIVE ACTION

Steering wheel hard to turn.

1. Mechanical linkage does not move freely.

2. Valve spool does not move freely in its bore.

a. Check mechanical linkage, repair or replace as necessary.
b. Check valve spool, repair or replace as necessary.

PROBLEM
PROBABLE CAUSE
RECOMMENDED CORRECTIVE ACTION

Machine steers slowly in both directions.

1. Valve spool does not move enough.

2. Relief valve setting is too low.

3. Failure or damage of pilot valve or flow control valve.

4. Pump output is low.

5. Failure of a piston seal in the steering cylinders.

a. Check valve spool, repair or replace as necessary.
b. Check relief valve setting, adjust as necessary.
c. Replace pilot valve/flow control valve.
d. Check pump, repair or replace as necessary.
e. Check piston seals in the steering cylinders, repair or replace as necessary.

Machine turns slowly in one direction.

Valve spool does not move enough in one direction (spool not centered).

Check spool and adjust or replace as necessary.

Steering is not smooth (jerky).

1. Air in the hydraulic oil.
2. Relief valve setting is low.
a. Bleed the hydraulic oil lines.
b. Check relief valve, adjust or replace as necessary.

Machine turns correctly when roading (moving), but is slow in both directions when the machine turns against a load (high resistance).

1. Leakage past relief valve seat or seals.
2. The fit of the flow control valve in the bore is not correct.
a. Check relief valve setting, valve seats and seals, replace as necessary.
b. Inspect flow control valve spool and bore, replace as necessary.

PROBLEM
PROBABLE CAUSE
RECOMMENDED CORRECTIVE ACTION

Machine turns slowly, even when the steering wheel is in NEUTRAL.

1. Mechanical linkage for steering does not move freely.

2. Valve spool does not move freely (is stuck).

3. Valve spool in control valve is not adjusted correctly (not centered).

a. Check linkage, repair or replace as necessary.
b. Check spool, adjust or replace as necessary.
c. Check spool adjustment, repair or replace as necessary.

The oil pressure is low.

1. The relief valve setting is low.

2. The pump has too much wear.

3. The failure of a seal in the system.

a. Check relief valve setting, adjust as necessary.
b. Check pump, repair or replace as necessary.
c. Check seals in system, replace as necessary.

The oil temperature is too high.

1. The viscosity of the oil is wrong.

2. The relief valve setting is too low.

3. Loose connection of the oil line on the inlet side of pump.

4. The pump has too much wear.

a. Replace with oil of the proper viscosity.
b. Adjust relief valve as necessary.
c. Secure connection.
d. Check pump, repair or replace as necessary.

5. Jumper hose to load transfer valve (on right side of tractor near fender) not in place.

Pump makes noise and the steering cylinder rod does not move smoothly.

1. Air in the steering hydraulic circuit.
2. The pump has too much wear.
3. Loose connection of the oil line on the inlet side of the pump.
4. The viscosity of the oil is wrong.
5. The relief valve opens at low oil pressure.
6. The oil level in the tank is low.
   a. Bleed hydraulic oil lines.
   b. Check pump, repair or replace as necessary.
   c. Tighten line connection.
   d. Replace oil with oil of proper viscosity.
   e. Adjust relief valve as necessary.
   f. Fill tank to proper level.

STEERING HYDROAULIC SYSTEM

PUMP EFFICIENCY CHECK

For any pump test at a given rpm, the pump flow (gpm) at 100 psi (7.0 kg/cm^2) (690 kPa) will be larger than the pump flow (gpm) at 1000 psi (70.0 kg/cm^2) (6900 kPa).

The difference between the pump flow of two operating pressures is the flow loss.

Method of finding flow loss...
Pump flow at 100 psi 57.5 gpm (litre/min)*
Pump flow at 1000 psi -52.0 gpm (litre/min)*
Flow loss 5.5 gpm (litre/min)*

Flow loss when given as a percent of pump flow is used as a measure of pump performance.

Example of finding percent of flow loss...

$$\frac{(\text{ gpm flow loss })}{(\text{Pump flow @ 100 psi})} \times 100 = \text{Percent of flow loss}$$

or $\frac{(*5.5)}{(*57.5)} \times 100 = 9.5\%$

If the percent of flow loss is more than 10%, pump performance is not good enough.

*Numbers in examples are for illustration and are not values for any specific pump or pump condition. See SPECIFICATIONS for pump flow of a new pump at 100 psi and 1000 psi.

Test On The Machine

Install a 9S2000 Flow' Meter. Measure pump flow at 100 psi (7.0 kg/cm^2) (690 kPa) and at 1000 psi (70.0 kg/cm^2) (6900 kPa) with engine at 2000 rpm.

NOTE: See Tee Test Tooling Chart Form No. REG009 10.

Formula I:

$$\frac{(\text{gpm100 psi - gpm @ 1000 psi})}{(\text{gpm @ 100})} \times 100 = \text{Percent of flow loss}$$

Test On The Bench

If the test bench can not be run at 1000 psi at a high rpm, do the first part of the test with the pump shaft rotation at 1000 rpm. Measure pump flow at 100 psi (7.0 kg/cm^2) (690 kPa) and at 1000 psi (70.0 k, g/cm^2) (6900 kPa). Then to measure the pump flow, s for the last part of the test, see SPECIFICATIONS for: Pump rpm at 100 psi with the engine at 2000 rpm.

Formula II:

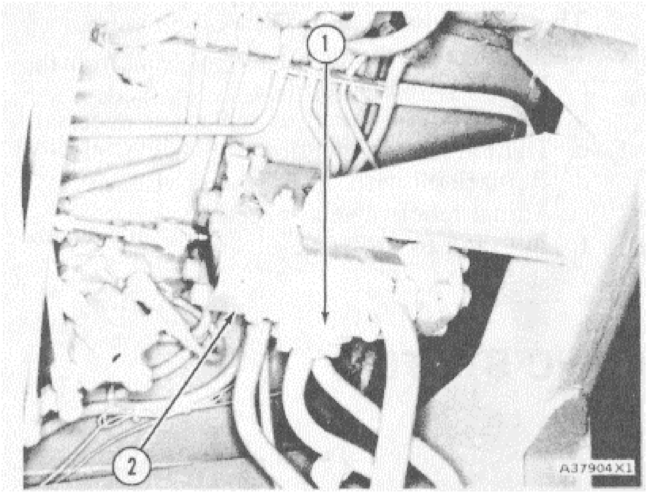
$$\frac{(\text{gpm @ 100 psi - gpm @ 1000 psi})}{(\text{gpm @ 100 psi @ 2000 rpm })} \times 100 = \text{Percent of flow loss}$$

STEERING CONTROL VALVE

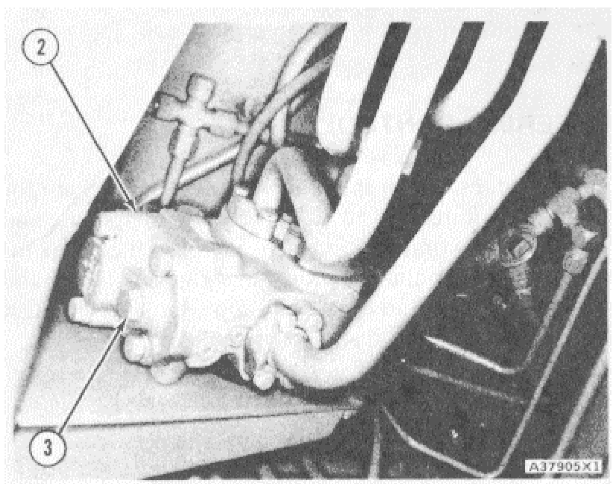
The values shown in the SPECIFICATIONS are for hydraulic oil that is I 50°F (65°C). Run the engine and operate the hydraulic system to increase the temperature of the hydraulic oil. Stop the engine and loosen the filler cap to let the airout of the supply tank before a test hose and gauge are installed or removed.

Relief Valve for the Steering Circuit

The steering control valve is located under the operator's station.



STEERING CONTROL VALVE
1. Plug for relief valve pressure tap. 2. Steering control valve.



1. Remove plug (I) from steering control valve (2) and install the hose for the pressure gauge. Connect the other end (of the hose to the 0 to 4000 psi gauge (from the 5P5224 Pressure Gauge Kit).

2.Start the engine and turn the machine against the stop.

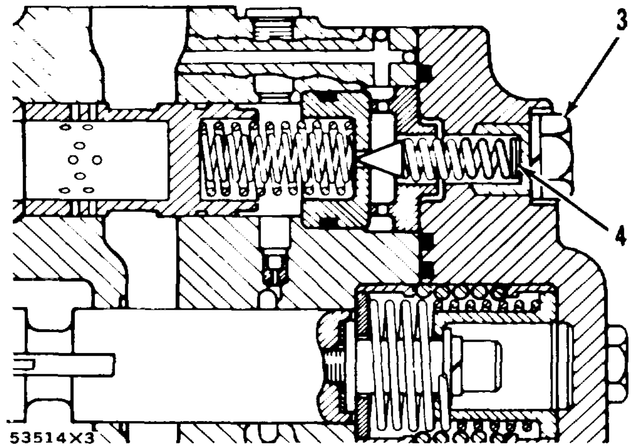
3.With the engine at high idle, keep the steering wheel in the turned position. Watch the pressure gauge.

4. The indication on the gauge is the pressure of the oil that opens the relief valve for) the steering circuit. The correct pressure setting of the relief valve is 2000 ± 25 psi (140.6 ± 1.8 kglcm^2) (13 790 ± 172 kPa).

STEERING CONTROL VALVE
2. Steering control valve. 3. Plug.

5. If it is necessary to change the relief valve setting, remove plug (3) from the steering control valve. Add shims (4) for an increase in the pressure setting, and remove the shims for a pressure decrease .

PRESSURE CHANGE FOR ONE SHIM		
Part No.	Thickness	Change in Pressure
3H2549	010 in. (O 25 mm)	40 psi (2 8 kg/cm^2)
		(276 kPa)



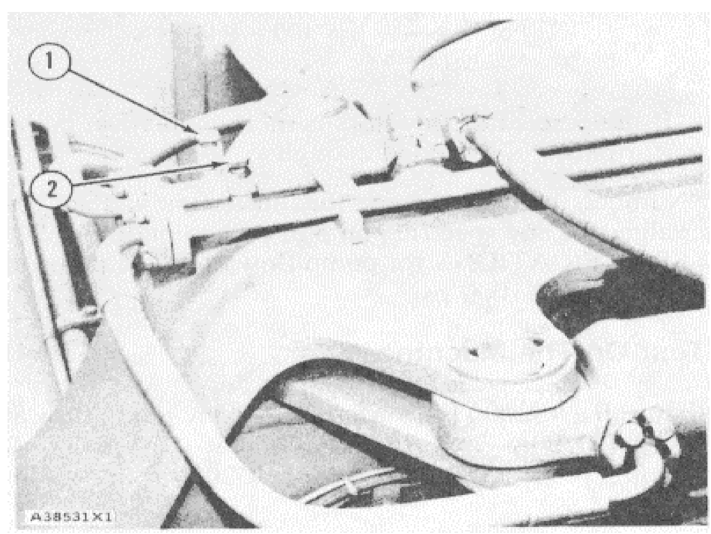
STEERING CONTROL VALVE
3. Plug. 4. Pressure relief shims.

Check of Valve Spool Center Position

The valve spool is kept in the NEUTRAL position by springs (3) and (4). The spool must be in its center position .when the springs move the spool to NEUTRAL.

To check the center position of the spool:

1. Install two 600 psi gauges to check the pressure at valves (1) and (2).

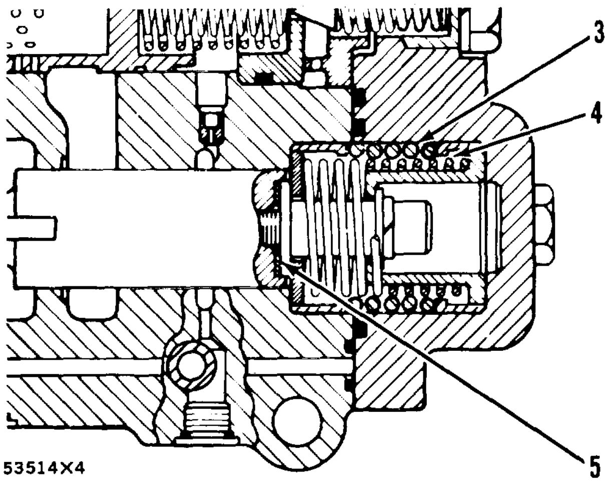


STEERING LINES (TOP OF GOOSENECK)
1. Bleed valve for right turn circuit. 2. Bleed valve for left turn circuit.

CAUTION: Do not turn the steering wheel when the engine is running and a low pressure gauge is installed in the steering circuit. If the steering wheel is turned, the gauge will be damaged.

2. Start the engine and run it at high idle.
3. The indication on each gauge must be 40 ± 10 psi (2.8 ± 0.7 kg/cm2) (276 ± 69 kPa). The difference between the two indications must not be more than 10 psi (0.7 kg/cm2) (69 kPa).

If the pressures are not correct, the valve spool is not in its center position. Shims (5) are used to make the adjustment to the spool position.



STEERING CONTROL VALVE

3. Spring (outer). 4. Spring (inner). 5. Flow balance shims.

4. Add shims to increase the pressure at valve (I) and decrease the pressure at valve (2).

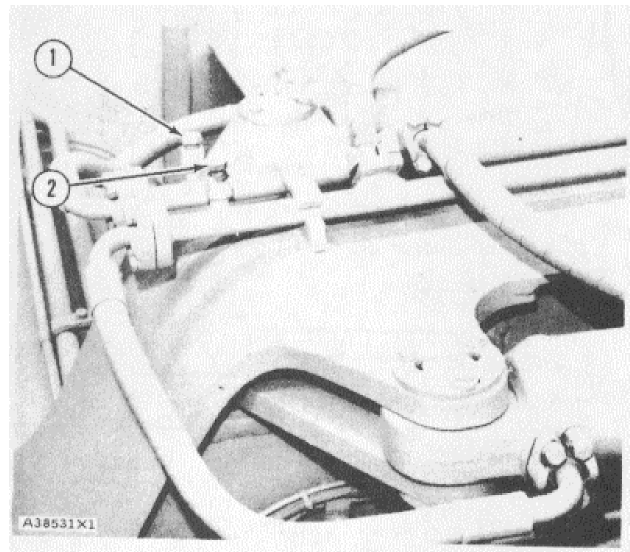
5. If a pressure increase is necessary at valve (2), remove shims (5). This will also decrease the pressure at valve (1).

AIR IN THE STEERING CIRCUIT

Use the procedure that follows to remove air from the steering system before and after tests are made:

1. Start the engine and turn the machine against either the right or the left stop.

2. With the engine running and the machine against the stop, open valves (I) and (2).



STEERING LINES (TOP OF GOOSENECK)

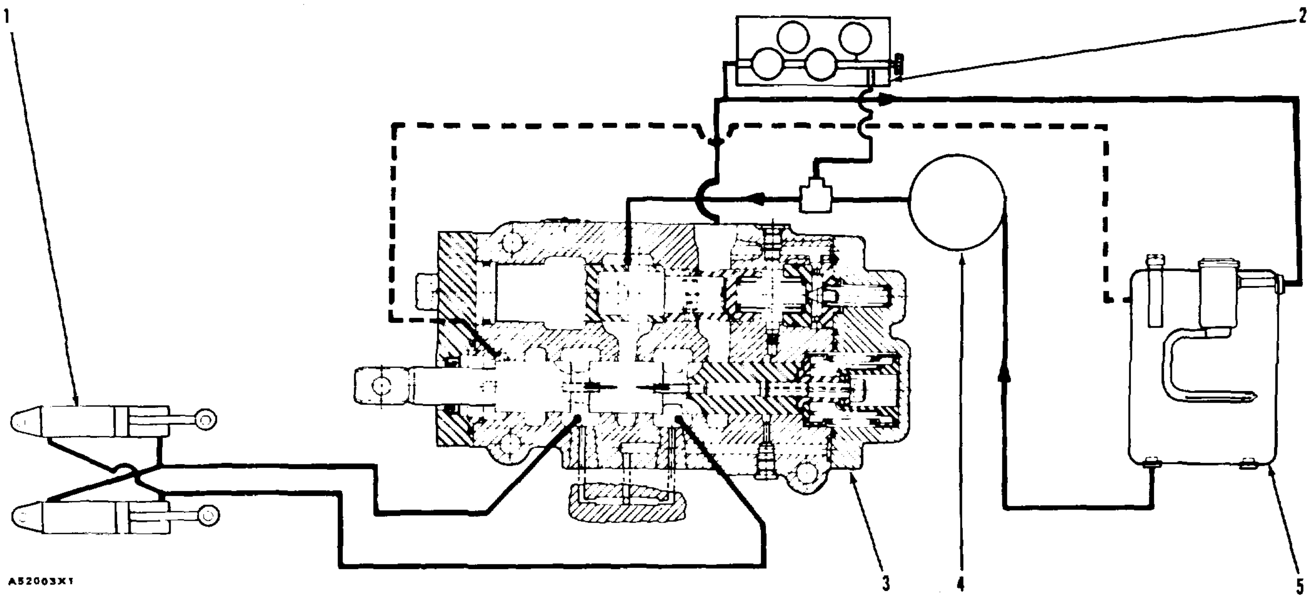
1. Bleed valve for right turn circuit. 2. Bleed valve for left turn circuit.

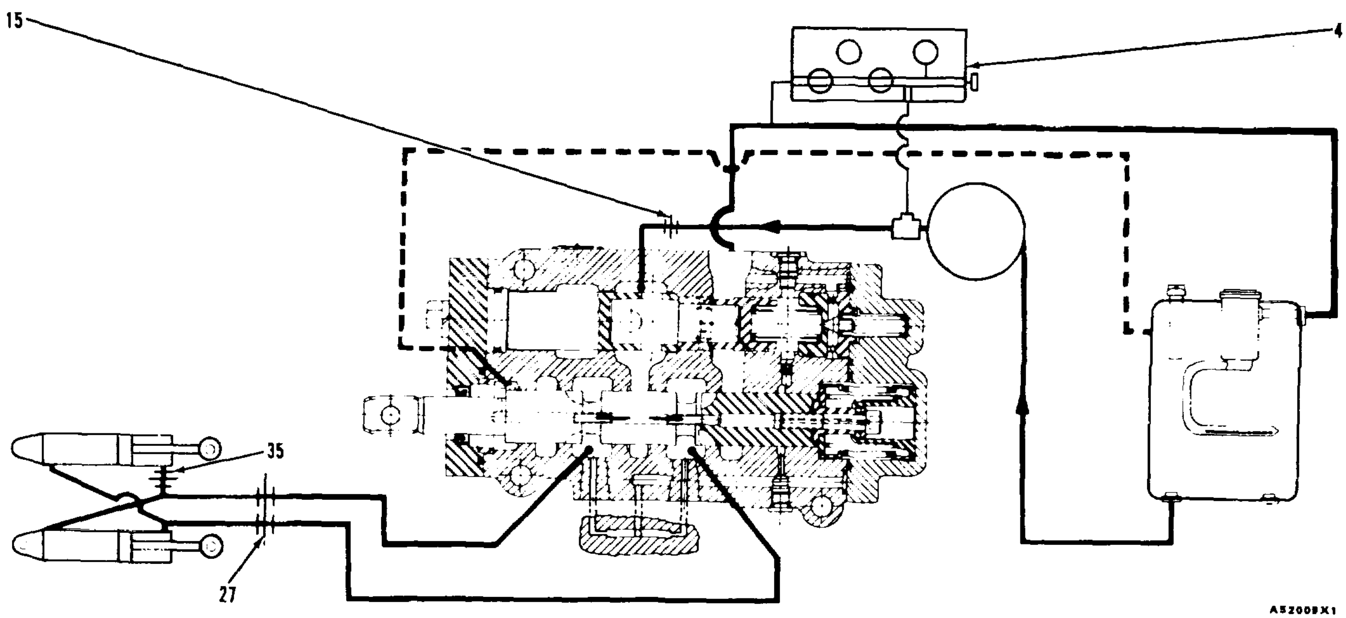
3. When only oil (w with no air) runs out of the open valves, close the valves.

4. Turn the machine against the stop in the other direction and open the valves again.

5. Close both valves when no air can be seen in the oil that runs out of the open valves.

STEERING TEE TEST PROCEDURE- I

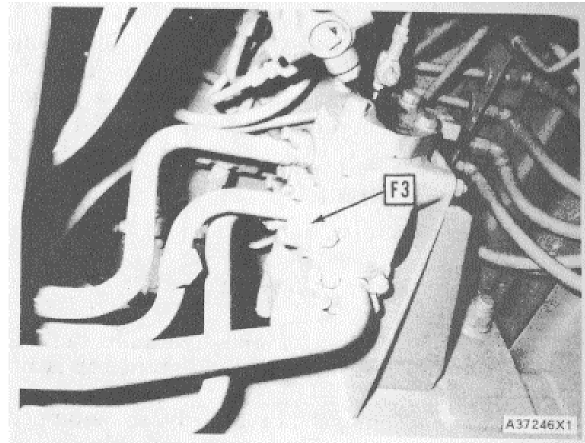




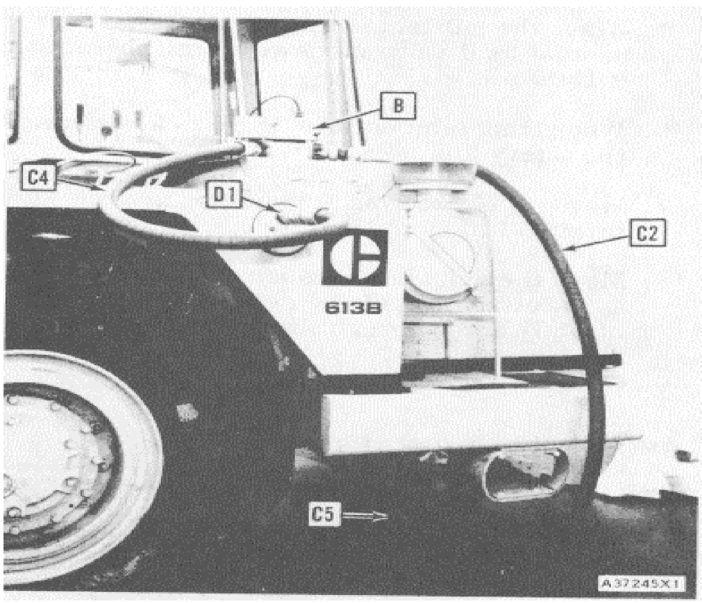
TESTING STEERING CIRCUIT

TEST	COMPONENTS IN EACH TEST	DESIRED FLOW
4	System Test, Steering Circuit	21 U.S. gpm
15	Pump (Implement, Large Section)	21.6 U S. gpm
27	Pump (Implement, Large Section) and Control Valve	21.3 U.S. gpm
35	Pump (Implement, Large Section), Control Valve and Left	
	Steering Cylinder	21 2 U S. gpm

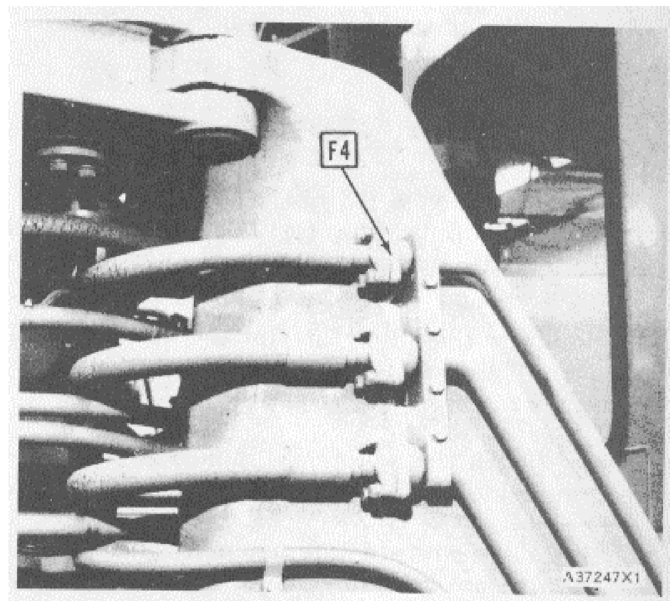
	TOOLS NEEDED	
Assembly No.	Description	Quantity
A2	Pump Supply Line Adapter	1
B	Flow Meter Assembly	1
D1	Return Line Assembly	1
F4	Blocking Plate Assembly	1
F3	Blocking Plate Assembly	1
C4	Connecting Hose Assembly	1
C5	Connecting Hose Assembly	1
C2	Connecting Hose Assembly	1



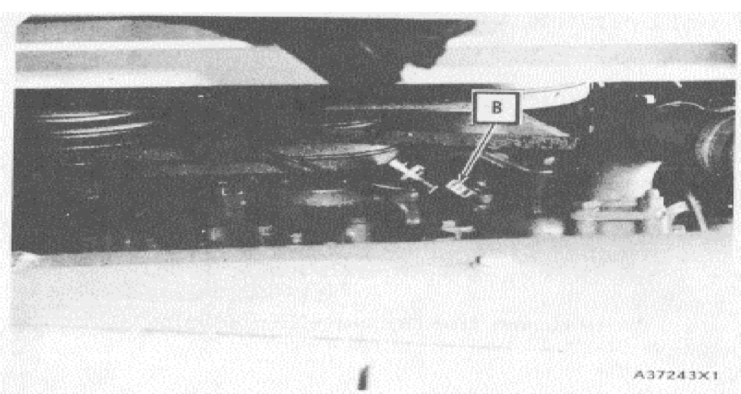
BLOCKING LOCATION FOR PUMP TEST
(See Tee Test Tooling Chart for parts reference)



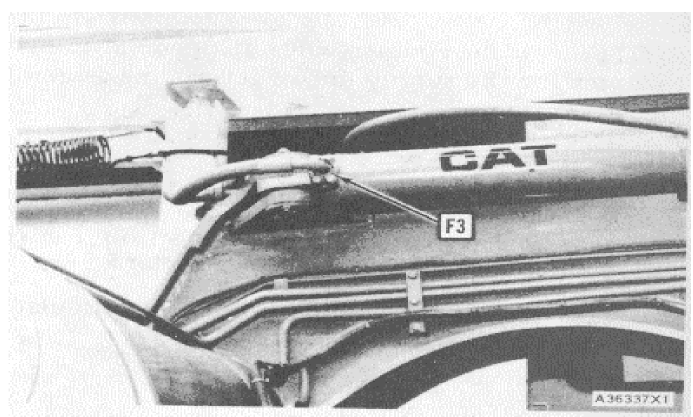
FLOW METER INSTALLED
(See Tee Test Tooling Chart for parts reference)



BLOCKING LOCATION FOR STEERING CIRCUIT
(See Tee Test Tooling Chart for parts reference)



TACHOMETER DRIVE INSTALLED
{See Tee Test Tooling Chart for parts reference)



BLOCKING LOCATION FOR STEERING CYLINDER
(See Tee Test Tooling Chart for parts reference)

INTRODUCTION

When making an analysis of the hydraulic system, a standard procedure of checking must be used, This method of checking the system will follow these steps in order:

1. Visual checks.
2. Performance tests.
3. Instrument tests.

EQUIPMENT INSTALLATION

1. Remove the cap for the hydraulic tank to release any pressure and tighten the cap again.
2. If the machine is not already so equipped, install the correct filter cover assembly.
3. Start the engine.
4. Move the ejector fully forward.
5. Stop the engine.

WARNING: Do not install the adapter in the supply line for the pump with the engine running. Injury to personnel can result.

6. Remove the plug for the tee test from the supply line for the pump. Install the correct adapter.

NOTE: Install the adapter as rapidly as possible to keep the oil loss at a minimum.

7. Install the return line assembly. Connect the return line assembly and the adapter for the pump supply line to the flow meter with the correct connecting hose assemblies.

NOTE: A plain coupler will not open valve in the adapter for the supply line or return line assembly.

8. Return the ejector to the rear position.

9. Install the tachometer generator with the correct drive. Install the cable between the generator and the input connection for the tachometer (rpm) on the flow meter.

10. Connect the safety link to hold the articulated frames rigid.

PREPARATION OF SYSTEM FOR TEST

1. Open the manual load valve fully (turn counterclockwise).

2. The steering wheel must be turned constantly.

3. With the engine at test rpm, slowly turn the manual load valve clockwise until the pressure goes up to 1000 psi.

WARNING: The tractor will articulate (turn) to the right until it is against the stop.

4. Look at the oil temperature.

5. When the oil temperature is 100° F, turn the manual load valve clockwise until the pressure is 1500 psi.

6. When the temperature is 160° F, disconnect the safety link.

7. Move the steering cylinders several times through full cylinder travel.

8. Move the cylinders through their cycles as long as necessary to get the desired oil temperature of 150° F all through the system.

9. Connect the safety link.

SYSTEM TEST (CHART A)
Write Down The Basic Test Data

NOTE: Conditions in the hydraulic system must be constant before writing down the test data. The steering wheel must be turned constantly. Best results are found when the oil temperature is 150 + 50 F. Make sure the brake accumulator is not operating while taking test data.

1. Open the manual load valve fully.

2. Hold the steering wheel in the RIGHT TURN position.

3. With the engine at test rpm, slowly close the manual load valve until the oil flow through the flow meter stops (0 gpm).

4. Write down the pressure.

The setting of the relief valve for maximum pressure must be according to the Service Manual.

CAUTION: When the pressures are higher than 1000 psi, slowly open the manual load valve before turning the steering wheel back to center. This will prevent possible damage to the pressure gauge.

Test 2: System Oil Temperature

1. Open the manual load valve fully.

2. Turn the steering wheel to the RIGHT TURN position.

3. Write down the oil temperature.

Test 3: System Base Flow Rate

1. Open the manual load valve fully.

2. Turn the steering wheel to the RIGHT TURN position.
3. Run the engine at test rpm.

4. Check pressure to make sure it is at a minimum valve of approximately 100 psi.

5. Write down the flow rate (gpm). The base flow rate of the system will be the same as the low pressure flow of the hydraulic pump. Because there will be minimum leakage in the control valves, lines and cylinder packings at 100 psi, the base flow rate can be used to find the flow differential in Tests 4 and 5.

NOTE: If the base flow rate (Test 3) is less than the flow rate in Test 4, do Test 4 first and then Test 3. For vane pumps only, this takes place when the vanes in the pump do not have full extension at low pressure.

Tests 4 and 5: Leakage Rates

These two tests are similar. Each test is done as follows:

1. Move the steering wheel to the respective TURN positions.

2. Run the engine at test rpm.

3. Make an adjustment to the manual load valve to get 1000 psi pressure.

4. Make the system constant with these conditions.

5. Write down the flow rate (gpm) for each test. The flow differential for each test (4 and 5) is found by taking the flow rate for each test away from the base flow rate (Test 3). The percent of flow loss for each test (4 and 5) is found by dividing the flow differential for each test by the base flow rate (Test 3).

Test 10: System Oil Temperature

1. Open the manual load valve fully.

2. Turn the steering wheel to the RIGHT TURN position.

3. Write down the oil temperature.

Make a comparison of the oil temperature from Tests 2 and 10. Test 2 must be 150 ± 5° F and Test 10 must be inside of (within) 10° F of Test 2. For each 10° F higher difference (Test 10 higher than Test 2), take away .5 gallon per pump cartridge from the leakage rate. For each 10° F lower difference, add .5 gallon per pump cartridge to the leakage rate.

Is It Necessary To Make More Tests?
If so, Which Circuit(s)?

Make a comparison of the test data with the data on Chart A for the specific machine under test. The percent of flow loss on Chart A is maximum for best performance.

Components that are worn, or not working correctly, are found by their flow differential and percent of flow loss or lower system efficiency. System values for new and rebuilt machines must not be more than the percent of flow loss in the system tests shown on Chart A for the specific machine. The permissible flow differential is a function of machine application. For applications with low travel speeds, the permissible flow differential can be more than for applications with high travel speeds.

If the percent of flow loss is acceptable, the Tee Test is completed.

If the percent of flow loss is not acceptable, the tests for the pump and/or the blocked cylinders must be done.

Troubleshooting

The following examples are a list of problems and probable reasons. They will aid in finding the location of the components that are worn, or not working correctly. Not all probable reasons have an application to all machines.

PROBLEM: Setting of the relief valve is higher or lower than given in Test 1. Percent of flow loss for Tests 4 and 5 is 15% to 50%.

PROBABLE REASON:
Setting for relief valve is not correct and leakage is too high.

RECOMMENDATION FOR ACTION:
Make adjustments to the relief valve to get the correct pressure. See the Service Manual for the machine under test. Make a test for leakage in the following problems.

PROBLEM: Percent of flow loss for Tests 4 and 5 is 15% or MORE.

PROBABLE REASON:

A. Bad pump.
B. Leakage in the relief valve.
C. Leakage in one or both of the piston seals for the steering cylinders.
D. Wear or damage in the valve body or valve spool.
E. Hand metering pump, unloading valve, selector valve or diverter valve is worn or not working correctly.

RECOMMENDATION FOR ACTION:

A. Do the Pump Test.
B. If the extra percent of flow loss is not caused by a bad pump, the problem is in the control valve or cylinders. Do the Blocked Cylinder Tests 26, 27 and 28. If the leakage is still too high, the problem is in the control valve. Inspect its components.

PROBLEM: Percent of flow loss for Test 4 is 15% or MORE; for Test 5 it is 0 to 15%.
PROBABLE REASON:

A. Wear or damage in the valve body or valve spool.
B. Adjustment of follow-up linkage is not correct.
C. Unloading valve or relief valve does not move freelv.

RECOMMENDATION FOR ACTION:

The problem is in the control valve or linkage.
Inspect these components.

PROBLEM: Percent of flow loss for Test 5 is 15% or MORE; for Test 4 it is 0 to 15%.

PROBABLE REASON:

A. Wear or damage in the valve body or valve spool.
B. Adjustment of follow-up linkage is not correct.
C. Unloading valve or relief valve does not move freely.

RECOMMENDATION FOR ACTION:

The problem is in the control valve or linkage. Inspect these components.

PUMP TEST (CHART B)

This test is used to find the efficiency of the hydraulic pump. Install a Blocking Plate Assembly in the return line on the control valve. This prevents oil from going through the system. All pump flow now goes through the flow meter.

NOTE: Make sure the brake accumulator is not operating while taking test data.

WARNING: Open the manual load valve on L . the flow meter fully before starting the diesel engine. The relief valve is not part of the circuit for the Pump Test. If the pressure gets too high, it is possible to cause injury to personnel or damage to equipment.

Test 14: Pump Flow at Low Pressure (test rpm)

1. Open the manual load valve fully.
2. Start the diesel engine.
3. Run the engine at test rpm.
4. Slowly close the manual load valve to get 100 psi pressure.
5. Write down the oil temperature and flow rate (gpm).

Test 15: Pump Flow at High Pressure (test rpm)

1. Run the engine at test rpm.
2. Slowly close the load valve to get 1000 psi pressure.
3. Write down the oil temperature and flow rate (gpm).

Test 16: Pump Flow at Low Pressure (1/2 test rpm)

1. Run the engine at 1/2 test rpm.
2. Open the load valve to get 100 psi pressure.
3. Write down the oil temperature and flow rate (gpm).

Test 17: Pump Flow at High Pressure (1/2 test rpm)

1. Run the engine at %/2 test rpm.
2. Slowly close the load valve to get 1000 psi pressure.
3. Write down the oil temperature and flow rate (gpm).

Make a comparison of the test data with the data on Chart B for the specific machine under test. The information on Chart B is the maximum for best performance.

Troubleshooting

PROBLEM: Percent of flow loss for Test 15 is 10% or MORE; for Tests 4 and 5 it is 15% or MORE.

PROBABLE REASON:
Pump is worn and there is leakage in control valve and/or cylinder.

RECOMMENDATION FOR ACTION:
Do the Blocked Cylinder Tests to find leakage rate in control valve and/or cylinder. Install a new or rebuilt pump.

PROBLEM: Percent of flow loss for Test 15 is 0 to 10%; for Tests 4 and 5 it is 15% or MORE.
PROBABLE REASON:
Pump is in good condition, but there is leakage in control valve and/or cylinder.

RECOMMENDATION FOR ACTION:
Do the Blocked Cylinder Tests to find leakage rate in control valve and/or cylinder.

PROBLEM: For vane pumps only, the percent of for Test 15 is 10% or MORE. Flow differential for Test 15 is higher than the flow differential for Test 17 by 0 to 2 gpm

PROBABLE REASON:
Pump is worn.

RECOMMENDATION FOR ACTION:
If flow loss is found to be too high for machine application, install a new or rebuilt pump.

PROBLEM: For vane pumps only, the percent of flow loss for Test 15 is 10% or MORE. Flow differential for Test 15 is higher than the flow differential for Test 17 by 0 to 2 gpm.

PROBABLE REASON:

A. Oil aeration (low oil level, hydraulic oil that is not the correct type, air leak in the suction line for the pump, oil leaks in the tank such as failure of seals or loose connections).

B. Pump cavitation (restriction in the suction line for the pump, oil viscosity that is not correct).

RECOMMENDATION FOR ACTION:
Do Tests 18 through 25 to find if the reason is aeration or cavitation.

Pump Test for Aeration and Cavitation

Tests 18 through 25: Aeration and Cavitation
Tests These eight tests are similar. Do the tests as follows:

1. Open the manual load valve fully before starting the diesel engine.
2. Run the engine at rpm indication shown on Chart B.
3. Slowly close the manual load valve to get 1000 psi pressure.
4. Write down the flow rate (gpm) and the oil temperature.
5. Then run the engine at the next rpm indication shown on Chart B (Test 20: rpm indication on Chart, Test 21: rpm indication on Chart, etc.) while keeping the adjustment of the manual load valve at 1000 psi pressure.
6. Write down the flow rate (gpm) and oil temperature for each test.

CAUTION: Immediately after stopping the diesel engine, remove the Blocking Plate Assembly from the return line on the control valve. This will prevent any possible damage later.

Troubleshooting

PROBLEM: The percent of flow loss for Test 15 is 10% or MORE. Flow differential for Test 15 is 2 gpm or MORE than flow differential for Test 17. Tests 18 through 25 have the same flow differential.

PROBABLE REASON:

Oil aeration (low oil level, hydraulic oil that is not the correct type, air leak in the suction line for the pump, oil leaks in the tank such as failure of seals, loose connections or pump cartridge is not installed correctly in pump body).

RECOMMENDATION FOR ACTION:

A. Check oil level and type of hydraulic oil being used.

B. Check suction line for air leaks [Put foam (like shaving cream) on all connections. The foam will be pulled into the line at any point of leakage.]

C. Remove cover from hydraulic tank and inspect for oil leak (check above the oil level first).

D. Disassemble pump and check for correct assembly.

PROBLEM: Flow differential between each of the Tests 18 through 25 suddenly becomes lower at one test and the flow rate is the same for the remainder of the tests at higher engine speed (rpm). Example: 8 gpm differential between Tests 18 and 19. 19 and 20, 20 and 21, but 1 gpm differential between 21 and 22 and flow rates for Tests 23, 24 and 25 are the same as 22.

PROBABLE REASON:

Pump cavitation (restriction in the suction line for the pump).

RECOMMENDATION FOR ACTION:

Inspect suction line and tank.

BLOCKED CYLINDER TESTS (CHART C) If the System Tests and Pump Test give an indication of leakage in the control valves and/or cylinders that is not acceptable, do the Blocked Cylinder Tests.

Blocking Plate Assemblies or Caps and Plugs can be put in each of the cylinder lines. For best accuracy, do these tests with the oil temperature approximately 150° F (near the oil temperature for the System Tests and Pump Test).

WARNING: Install the safety link. Lower all implements to the ground. Move the steering wheel from RIGHT TURN to LEFT TURN several times to release any pressure oil in the cylinder lines. All pressure in the lines must be released or injury to personnel and damage to equipment can result while loosening the lines to install or remove the plate assemblies.

All Cylinders Blocked

1. Put control levers in HOLD position.
2. Open the manual load valve fully.
3. Start the diesel engine.

Test 26: System Oil Temperature

1. Turn the steering wheel to the RIGHT TURN position.

2. Run the engine at any rpm with the system pressure at 0 to 100 psi,

3. Write down the oil temperature.

Test 27 and 28: Leakage Rates

These two tests are similar. Do the tests as follows:

1. With the manual load valve fully open, turn the steering wheel to the RIGHT TURN position.

2. Run the engine at test rpm.

3. Slowly close the manual load valve to get 1000 psi pressure.

4. Write down the flow rate (gpm).

5. Do this procedure again in the LEFT TURN position.

Test 33: System Oil Temperature

1. Turn the steering wheel to the RIGHT TURN position.

2. Run the engine at any rpm with the system pressure at 0 to 100 psi.

3. Write down the oil temperature.

Find the leakage rate of the cylinders and the leakage rate of the control valves. Use the test information from the System Tests, Pump Test and Blocked Cylinder Tests.

Example: Find the leakage rates in the RIGHT TURN position.

Test 15: flow rate of the pump only.

Test 27: flow rate of pump and control valve.

Test 4: flow rate of pump, control valve and cylinders.

The system components tested in Tests 15 and 27 are the same except for the control valve. Then the difference in flow rates must be the leakage in the control valve (take the test information for Test 27 away from the test information for Test 15).

The system components tested in Tests 27 and 4 are the same except for the cylinders. Then the difference in flow rates must be the leakage in the cylinders (take the test information for Test 4 away from the test information for Test 27).

Make a comparison of the test data with the data on Chart C for the specific machine under test. The information on Chart C is the maximum for best performance.

Troubleshooting

PROBLEM: Tests 27 and 28 give an indication of leakage in one or more of the cylinders.
PROBABLE REASON:

A. Leakage in only one of the cylinders.

B. Leakage in both cylinders.

RECOMMENDATION FOR ACTION:
Do the Blocked Cylinder Test for cylinders on the right side.

PROBLEM: Test 27 and 28 give an indication of leakage in
the valves.
PROBABLE REASON:

A. Leakage in the relief valve.
B. Wear or damage in the valve body or valve spool.
C. Hand metering pump, unloading valve, selector valve or diverter valve is worn or not working correctly.

RECOMMENDATION FOR ACTION:

A. To find the leakage on machines with supplemental steering, use a Blocking Plate Assembly between the diverter valve and the control valve for steering.

B. Inspect the components of these valves to find the problem.

Right Side Cylinders Blocked

If the Blocked Cylinder Tests gives an indication of leakage that is too high in one or more of the cylinders, do the Blocked Cylinder Tests for the Right Side. For best accuracy, turn the steering wheel through several cycles to get the temperature of the oil in the cylinders the same as the temperature of the oil in the hydraulic tank. Make the temperature of the complete system 150° F.

1. Install the safety link.

2. Lower all implements to the ground.

3. Stop the engine.

4. Move the steering wheel from RIGHT TURN to LEFT TURN several times to release any pressure oil in the cylinder lines.

5. Move the steering wheel back to center.

6. Remove the cap for the hydraulic tank to release any pressure and tighten the cap again.

7. Put a Blocking Plate Assembly in the rod end of the right steering cylinder.

Test 34: System Oil Temperature

1. Open the manual load valve fully.

2. Start the diesel engine.

3. Run the engine at any rpm with the system pressure at 0 to 100 psi.

4. Move the steering wheel to the RIGHT TURN position.

5. Write down the oil temperature.

Test 35: STEER RIGHT Flow Rate
1. With the manual load valve fully open, move the steering wheel to the RIGHT TURN position.

2. Run the engine at test rpm.
3, Slowly close the manual load valve to get 1000 psi pressure.
4. Write down the flow rate (gpm).

Test 38: System Oil Temperature

1, Open the manual load valve fully.

2. Run the engine at any rpm with the system pressures at 0 to 100 psi.

3. Move the steering wheel to the RIGHT TURN position.

4. Write down the oil temperature.

WARNING: All pressure in the lines must be released or injury to personnel and damage to equipment can result while loosening the lines to install or remove the plate assemblies.

Find the leakage rates for the right and left cylinders. Use the test information from System Test, Pump Test and Blocked Cylinder Tests. Example: Find the leakage rate for the steering cylinders.

Test 27: flow rate of pump and control valve.

Test 35: flow rate of pump, control valve and left side cylinder.

Test 4: flow rate of pump, control valve and both cylinders.

The system components tested in Tests 27 and 35 are the same except for the left side cylinder. Then the difference in flow rates must be the leakage in the left side cylinder (take the test information for Test 35 away from the test information for Test 27).

The system components tested in Tests 35 and 4 are the same except for the right side cylinder. Then the difference in flow rates must be the leakage in the right side cylinder (take the test' information for Test 4 away from the test information for Test 35). Make a comparison of the test values with the values on Chart C.

Troubleshooting

PROBLEM: Leakage is in right steering cylinder.

PROBABLE REASON:

A. Piston seals are worn.

B. Loose piston nut.

C. Damage in cylinder assembly.

RECOMMENDATION FOR ACTION:
Disassemble and make repairs to the right steering cylinder.

PROBLEM: Leakage is in left steering cylinder.
PROBABLE REASON:

A. Piston seals are worn.

B. Loose piston nut.

C. Damage in cylinder assembly.

RECOMMENDATION FOR ACTION:
Disassemble and make repairs to the left steering cylinder.

TEE TEST

DATE____________________ 613B PROCEDURE DATA SHEET MACHINE SERIAL NUMBER 38W1-UP

STEERING SYSTEM SERVICE METER READING _______

PUMP TEST

CHART A

Test Name	Maximum Pressure Relief Valve Setting	System Oil Temperature (Start)	System Base Flow Rate	Steer Right Flow Rate	Steer Left Flow Rate	Tilt TILTBACK Flow Rate	Tilt DUMP Flow Rate	Auxiliary RETRACT Flow Rate	Auxiliary EXTEND Flow Rate	System Oil Temperature (End)	Lift Circuit Drift Comparison	Tilt Circuit Drift Comparison	Auxiliary Circuit Drift Comparison
Test Number	1	2	3	4	5	6	7	8	9	10	11	12	13
Steering Wheel Position	Steer Right	Steer Right	Steer Right	Steer Right	Steer Left	Tilt TILTBACK	Tilt DUMP	Auxiliary RETRACT	Auxiliary EXTEND	Steer Right	Lift 1. HOLD 2. RAISE	Tilt 1. HOLD 2. TILTBACK	Auxiliary 1. HOLD 2. RAISE
Bowl Position	Fully Lowered	Fully Lowered	Fully Lowered	Fully Lowered	Fully Lowered	Lift Arms Horizontal Full Tiltback	Lift Arms Horizontal Full Dump	Ripper Lowered or Log Fork Clamp Open	Ripper Raised or Log Fork Clamp Closed	Fully Lowered	Lift Arms Horizontal Bucket Level	Lift Arms Horizontal Bucket Level	Ripper Raised or Log Fork Clamp Open
Engine Speed	2200 RPM	Any Speed	2200 RPM	2200 RPM	2200 RPM	2000 RPM	2000 RPM	2000 RPM	2000 RPM	Any Speed	Low Idle or Stopped	Low Idle or Stopped	Low Idle or Stopped
System Test Pressure	Maximum	0-100 PSI	100 PSI	1000 PSI	1000 PSI	1000 PSI	1000 PSI	1000 PSI	1000 PSI	0-100 PSI	0 PSI	0 PSI	0 PSI
Test Data	2000 ± 50 PSI	150 ± 5 °F	24.0 GPM	21.0 GPM	21.0 GPM	______ GPM	______ GPM	______ GPM	______ GPM	150 ± 5 °F	RAISE Drift M | S Than HOLD Drift Rate	TILTBACK M | S Than HOLD Drift Rate	RAISE Drift M | S Than HOLD Drift Rate
Flow Differential				(3-4) 3.0 GPM	(3-5) 3.0 GPM	(3-6) ______ GPM	(3-7) ______ GPM	(3-8) ______ GPM	(3-9) ______ GPM				
Percent Flow Loss				$\frac{(3-4)}{3} \times 100$ 15 %	$\frac{(3-5)}{3} \times 100$ 15 %	$\frac{(3-6)}{3} \times 100$ ____ %	$\frac{(3-7)}{3} \times 100$ ____ %	$\frac{(3-8)}{3} \times 100$ ____ %	$\frac{(3-9)}{3} \times 100$ ____ %				

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TEE TEST

DATE____________________ 613B PROCEDURE DATA SHEET MACHINE SERIAL NUMBER 38W1-UP

STEERING SYSTEM SERVICE METER READING _______

SYSTEM TEST

CHART B

Test Name	Full Speed Pump Flow		Half Speed Pump Flow		Pump Test For Aeration And/Or Cavitation							
	Low Pressure	High Pressure	Low Pressure	High Pressure	Varied Speeds — Constant Pressure							
Test Number	14	15	16	17	18	19	20	21	22	23	24	25
Engine Speed	2200 RPM	2200 RPM	1100 RPM	1100 RPM	1000 RPM	1300 RPM	1600 RPM	1900 RPM	2200 RPM	1600 RPM	1800 RPM	2000 RPM
Pump Test Pressure	100 PSI	1000 PSI	100 PSI	1000 PSI	1000 PSI	1000 PSI	1000 PSI	1000 PSI	1000 PSI	1000 PSI	1000 PSI	1000 PSI
Oil Temperature	150 ± 5 °F	150 ± 5 °F	150 ± 5 °F	150 ± 5 °F	150 ± 5 °F	150 ± 5 °F	150 ± 5 °F	150 ± 5 °F	150 ± 5 °F	____ °F	____ °F	____ °F
Test Data	24.0 GPM	21.6 GPM	12.0 GPM	9.6 GPM	9.0 GPM	12.0 GPM	15.0 GPM	18.0 GPM	21.6 GPM	GPM	GPM	GPM
Flow Differential		(14-15) 2.4 GPM		(16-17) 2.4 GPM	(19-18) 3.0 GPM	(20-19) 3.0 GPM	(21-20) 3.0 GPM	(22-21) 3.6 GPM	(23-22) ____ GPM	(24-23) ____ GPM	(25-24) ____ GPM	
Percent Flow Loss		(14-15) x 100 / 14 = 10 %										

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TEE TEST

DATE____________________ 613B PROCEDURE DATA SHEET MACHINE SERIAL NUMBER 38W1-UP

STEERING SYSTEM SERVICE METER READING _______

BLOCKED CYLINDERS TEST

CHART C

	All Cylinders Blocked								Right Cylinder Blocked				
Test Name	System Oil Temperature (Start)	Steer Right Flow Rate	Steer Left Flow Rate	Tilt TILTBACK Flow Rate	Tilt DUMP Flow Rate	Auxiliary RETRACT Flow Rate	Auxiliary EXTEND Flow Rate	System Oil Temperature (End)	System Oil Temperature (Start)	Steer Right Flow Rate	Tilt TILTBACK Flow Rate	Auxiliary RETRACT Flow Rate	System Oil Temperature (End)
Test Number	26	27	28	29	30	31	32	33	34	35	36	37	38
Steering Wheel Position	Steer Right	Steer Right	Steer Left	Tilt TILTBACK	Tilt DUMP	Auxiliary RETRACT	Auxiliary EXTEND	Steer Right	Steer Right	Steer Right	Tilt TILTBACK	Auxiliary RETRACT	Lift LOWER
Engine Speed	Any Speed	2200 RPM	2200 RPM	2000 RPM	2000 RPM	2000 RPM	2000 RPM	Any Speed	Any Speed	2200 RPM	2000 RPM	2000 RPM	Any Speed
System Test Pressure	0-100 PSI	1000 PSI	1000 PSI	1000 PSI	1000 PSI	1000 PSI	1000 PSI	0-100 PSI	0-100 PSI	1000 PSI	1000 PSI	1000 PSI	0-100 PSI
Test Data	150 ±5 °F	21.3 GPM	21.3 GPM	____ GPM	____ GPM	____ GPM	____ GPM	150 ±5 °F	150 ±5 °F	21.15 GPM	____ GPM	____ GPM	150 ±5 °F
Cylinder Leakage Rate		(27-4) 0.3 GPM	(28-5) 0.3 GPM	(29-6) ____ GPM	(30-7) ____ GPM	(31-8) ____ GPM	(32-9) ____ GPM		Right Cylinder Leakage	(35-4) 0.15 GPM	(36-6) ____ GPM	(37-8) ____ GPM	
Control Valve Group Leakage		(15-27) 0.3 GPM	(15-28) 0.3 GPM	(15-29) ____ GPM	(15-30) ____ GPM	(15-31) ____ GPM	(15-32) ____ GPM		Left Cylinder Leakage	(27-35) 0.15 GPM	(29-36) ____ GPM	(31-37) ____ GPM	

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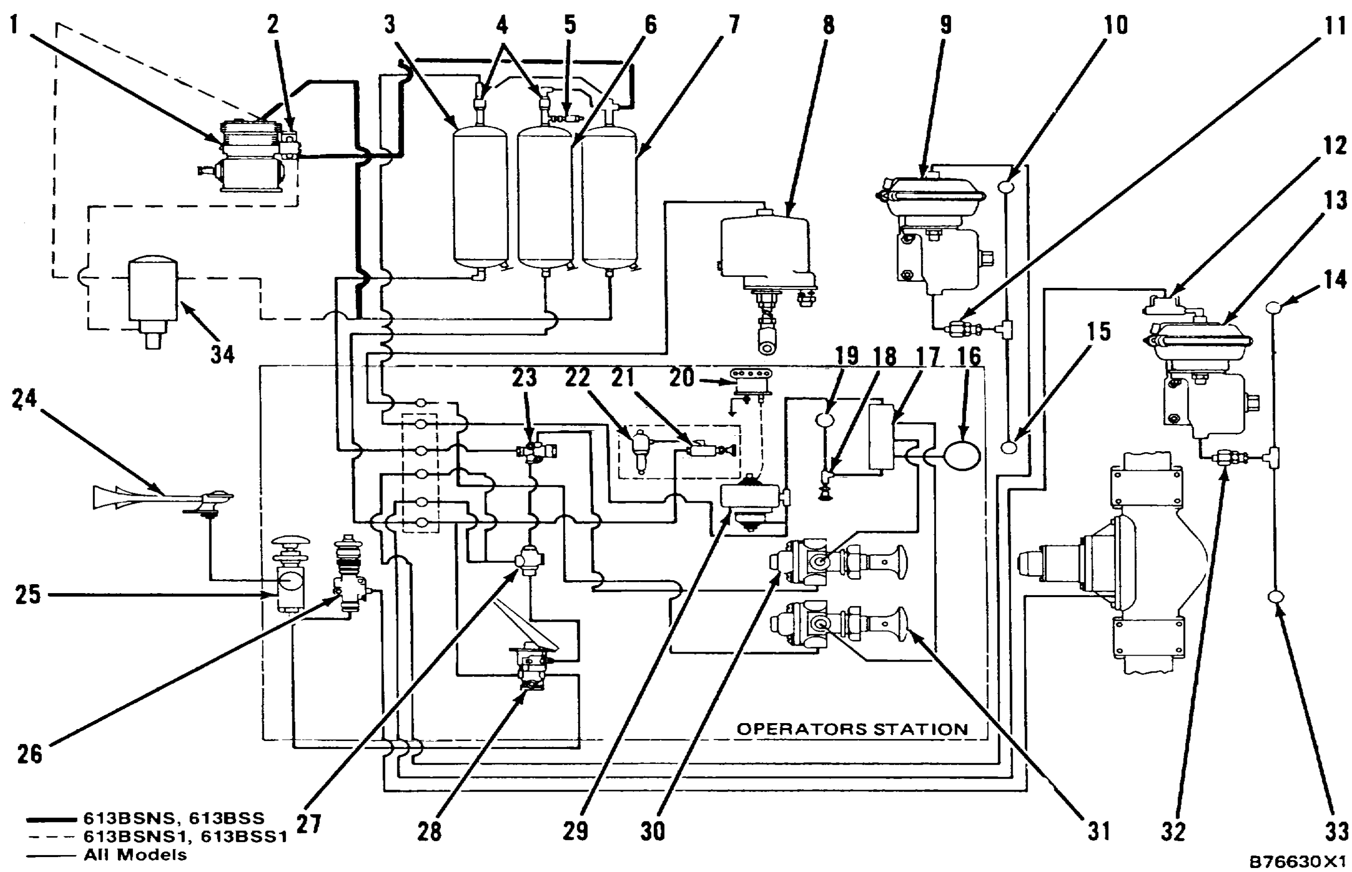
SECTION 4
SYSTEMS OPERATION, TESTING, AND ADJUSTING
AIR SYSTEM AND BRAKES



TRACTOR-SCRAPPER SCHEMATIC

1. Air compressor.
2. Air compressor governor.
3. Reserve tank.
4. Check valve.
5. Relief valve.
6. Dry tank.
7. Wet tank.
8. Rotochamber for parking brake.
9. Tractor air chamber master cylinder.
10. Right tractor brake.
11. Residual pressure valve. (check valve).
12. Quick release valve.
13. Scraper air chamber and master cylinder.
14. Right scraper brake.
15. Left tractor brake.
16. Air pressure gauge.
17. Junction block.
18. Control valve for window washer.
19. Reservoir for window and washer.
20. Warning buzzer.
21. Control valve for seat(check valve). suspension.
22. Shock absorber for seat.
23. Emergency pilot valve.
24. Horn.
25. Control valve for horn.
26. Differential lock valve.
27. Double check valve.
28. Brake control valve.
29. Low air pressure indicator.
30. Control valve for emergency brakes.
31. Control valve for parking brake.
32. Residual pressure valve
33. Left scraper brake.
34. Air Dryer (613BSNS1, 613BSS1)

The tractor-scraper system is divided into two sections, air flow and oil flow.

The oil flow comes from an air actuated hydraulic brake system. The tractor and scraper have their own air 'chamber and master brake cylinder (9) and (13), brake lines and caliper assemblies. Each master cylinder has its own fluid reservoir and the maintenance for the level of the fluid is done separately.

When the brake pedal is pushed air extends the air chamber rod and it pushes the master cylinder piston. Piston movement sends oil through the lines into the caliper assemblies. At each caliper the oil pushes on the back of the pistons and the pistons push the friction pads against the brake discs.

When the brake pedal is released, the air pressure against the brake master cylinder is relieved (let out). The master cylinder piston is retracted and hydraulic oil pressure is let off of the caliper pistons. The residual pressure valves (check valves) keep a 3 to 6 psi (20 to 40 kPa) back pressure on the pads to keep them against the discs. The pistons and pads are not returned by springs. They just release their grip on the disc. The pads do not move away from the discs so no adjustment is needed when the pads begin to wear because the pads keep a little contact with the discs, the pads keep the discs clean.

The air flow comes from three air tanks (3), (6) and (7) filled by air compressor (1) through the air dryer (34) (Models 613BSNS1 and 613BSS1). From the air tanks the air flow is divided into four separate circuits: service brake, emergency brake, parking brake and accessory air circuits.

SERVICE BRAKE CIRCUIT

When the brake pedal is pushed, pressure air is sent from brake control valve (28) to the tractor and scraper air chamber and brake cylinders. The tractor and scraper brakes are now engaged.

NOTE: Air from the control valve goes through double check valve (27) before it goes to the air chamber and brake cylinders.

EMERGENCY BRAKE CIRCUIT

When there is air pressure in all the air tanks, the service (wheel) brakes can be used for emergency brakes. Emergency brake control valve (30) is acti-vated either manually or automatically. The valve is controlled manually by a knob and automatically when air pressure in the system is too low.

Air flows from wet tank (7) to emergency brake control valve (30). The air holds the emergency brake control valve in, which keeps the exhaust port closed. Air then flows from the emergency brake control valve to emergency pilot valve (23).

When there is pressure in the line from emergency brake control valve (30) to emergency pilot valve (23) air from reserve air tank (3) can not go through the emergency pilot valve. When air pressure to the emergency pilot valve is released through the emergency brake control valve, the emergency pilot valve opens. Air pressure from reserve air tank (3) now goes through emergency pilot valve (23), double check valve (27) and to the tractor and scraper brakes. The tractor and scraper brakes are now engaged.

PARKING BRAKE CIRCUIT

Parking brake control valve (3 1) is activated either manually or automatically. The valve is controlled manually by a knob and automatically when air pressure in the system is too low.

When there is no pressure in the air system, the knob in parking brake control valve (31) is pulled out (parking brake ON position). There is no air pressure in parking brake chamber (8). The spring force in the parking brake chamber keeps the brake activated.

After the engine is started and air pressure is at the correct pressure for operation, the knob on the control valve must be pushed in and held for a moment (parking brake OFF position). Air pressure now goes from parking brake control valve (31) to parking brake chamber (8). The air pressure puts the springs of the parking brake chamber in compression. The parking brake is released.

ACCESSORY CIRCUITS

Part of the air pressure from wet air tank (7) goes to window washer valve (18) and air pressure gauge (16). The remainder of the accessory air circuits get air pressure from dry air tank (6) and brake control valve (28).

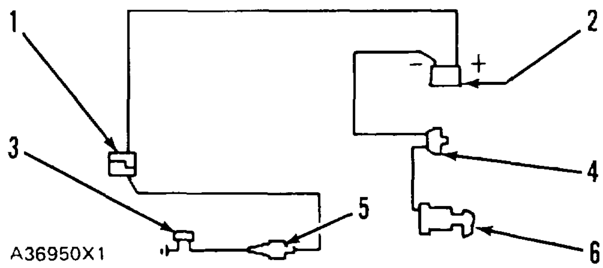
From the dry air tank, the flow of air is to seat suspension valve (21).

From the brake control valve the flow of air is to horn valve (25) and differential lock valve (26).

SYSTEMS COMPONENTS

Electric Warning System

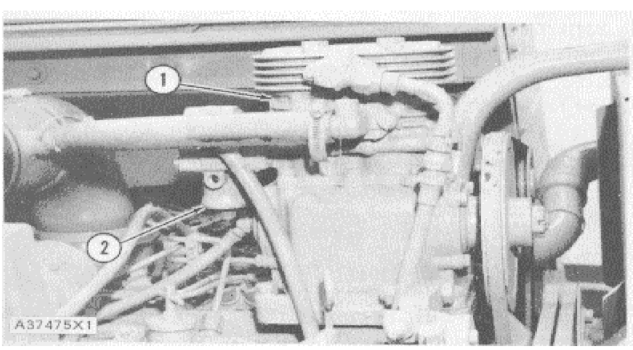
The buzzer (3) is a warning of low air pressure. The low. air pressure indicator (6) makes a measurement of air pressure in the brake air system. The low air pressure indicator is closed (current flows and the buzzer sounds) when the air pressure is below approximately 60 psi (415 k Pa). The buzzer is located under the dash.



Electric Warning System
1. Pin connector. 2. Ammeter. 3. Low air pressure warning buzzer. 4. Circuit breaker. 5. Low air pressure indicator. 6. Starter switch.

Air Compressor and Tanks

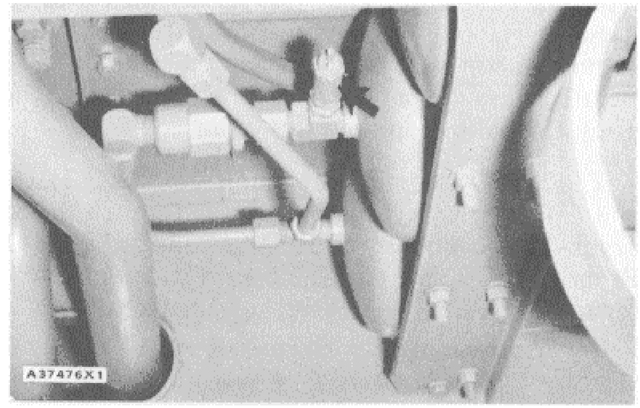
The air compressor is belt driven by the engine. It is used to supply air pressure for the brakes. The air compressor governor controls the pressure of operation.



AIR COMPRESSOR
1. Air compressor. 2. Air compressor governor.

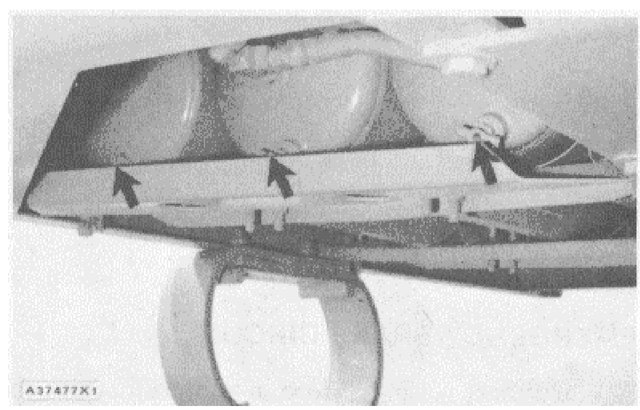
If the air pressure in the tanks is low, nothing will change in the governor and the air compressor will send air to the tanks. When the tank air pressure goes up to cutout pressure [125 + 5 psi (860 + 35 kPa)], it moves the governor piston against its spring and lets air go from the governor to the compressor unloading valves. Compressed air pushed against the unloading valves holds them open and stops the delivery of air from the compressor.

When the air pressure in the tanks drop to cut-in pressure [100 to 105 psi (690 to 725 kPa)], the force of the governor spring will return the governor piston and stop the flow of air from the air tanks to the compressor unloading valves. The compressor unloading valves close and the compressor will send air to the air tanks.



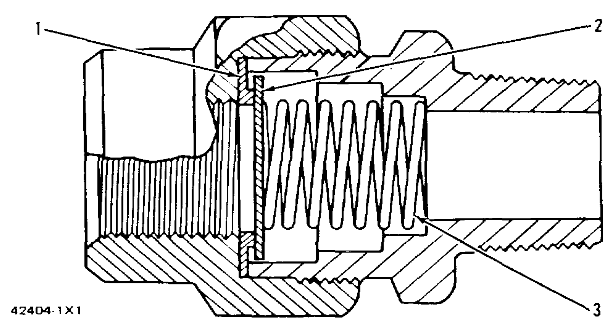
RELIEF VALVE

A relief value is used to prevent damage to the air system if the compressor governor should have a failure. The relief valve will open when the air pressure in the air tanks is approximately 150 psi (1030 kPa). Each air tank has a drain valve in the front end of it.



DRAIN VALVES.

Check Valve



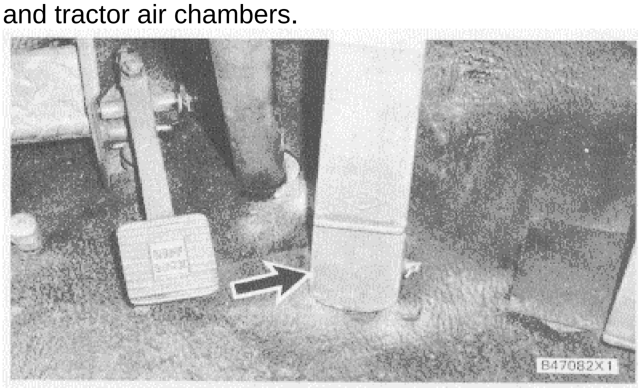
COMPONENTS OF THE CHECK VALVE
1. Seat. 2. Valve. 3. Spring.

The one-way check valves are used to let air flow in one direction only. Air, coming into the check valve on the internal thread end of the valve, will put spring (3) in compression and valve (2) will open. Air under pressure is now' free to flow through the check valve.

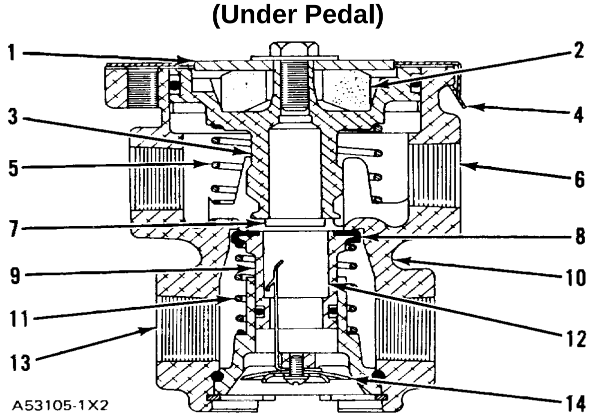
Air, coming into the check valve on the external thread end, will push valve (2) against seat (I). The flow of air is stopped.

Brake Control Valve

When the brake pedal is pushed, a force is put on seat (I). This force pushes rubber spring (2) and piston assembly (3) down. Valve seat (7) closes exhaust passage (12) in valve (9). Piston assembly (3) moves valve (9) off of valve seat (8). Pressure air from inlet passage (13) goes around salve (9) to outlet passage (6). The air then goes to the relay valve for the scraper and tractor air chambers.



TYPICAL LOCATION OF BRAKE CONTROL VALVE (Under Pedal)



BRAKE CONTROL VALVE

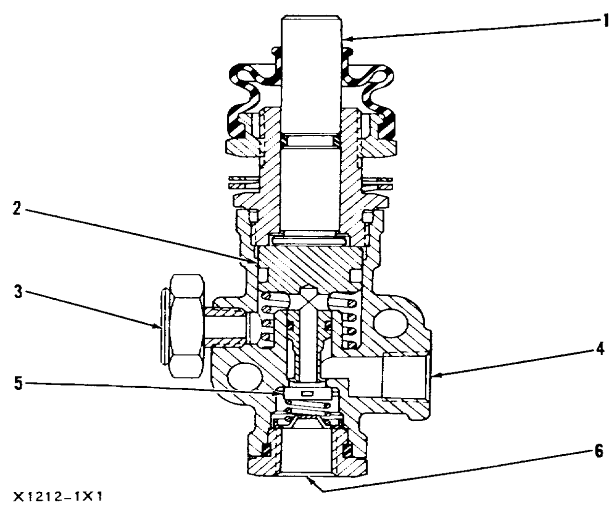
1. Seat. 2. Rubber spring (2). 3. Piston assembly. 4. Retainer. 5. Spring. 6. Outlet to double check valve. 7. Valve seat. 8. Valve seal. 9. Valve. 10. Valve body. 11. Valve spring. 12. Exhaust passage. 13. Inlet passage to dry tank. 14. Exhaust diaphragm.

When the air pressure below piston assembly (3) becomes more than the force above the piston, the piston lifts enough to let valve (9) move up to valve seat (8). This stops the supply of pressure air. Piston assembly (3) is still in contact with valve (9), so exhaust passage (12) is also closed. The control valve is now in balance. A pressure is held in the lines and the air chambers for the wheel brakes.

If the pedal is lifted a small amount, the mechanical force above piston assembly (3) is less. The pressure air below the piston and the force of spring (5) will lift the piston off of valve (9). Pressure air in the lines and the air chambers goes around piston assembly (3), through exhaust passage (12) and out exhaust diaphragm (14) until the forces above and below the piston are in balance. When the pedal is complete released, piston assembly (3) moves off valve (9) and releases the air pressure. valve (9) is held against valve seat (8) by spring (11).

Differential Lock Valve

The differential lock valve controls the supply of air to the differential lock cylinder and to the control port of the pilot salve. Depressing the pedal moves plunger (I) and spool (2) down unseating valve (5) and allows air to flow from supply port (6) out through delivery port (4) to the locking piston and the pilot valve. Releasing the pedal allows the valve return, sealing supply port (6) and allowing air to flow from the piston and pilot valve out through exhaust port (3).

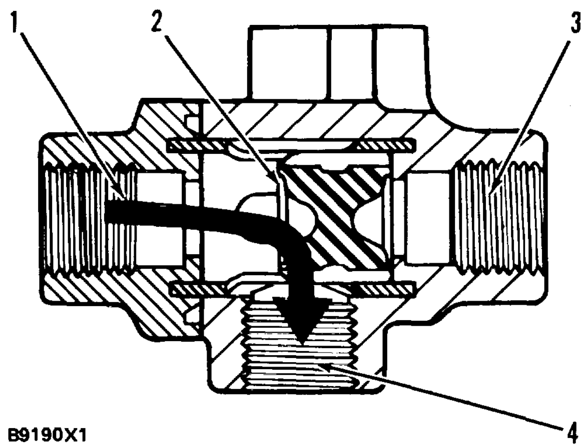


DIFFERENTIAL LOCK VALVE

1. Plunger. 2. Spool. 3. Exhaust port. 4. Delivery port. 5. Valve. 6. Supply port.

Double Check Valve

When the brake pedal is pushed and the emergency brake control valve is pushed in (OFF position), there is no pressure air at inlet passage (1). Air pressure from the brake control valve causes shuttle (2) to move to the right and air pressure goes to the air chamber of the tractor wheel brake. This causes the wheel (service) brakes to activate. When the brake pedal is released and the emergency brake control valve is pulled out (ON position), there is no air pressure at inlet passage (3). Air pressure from the emergency pilot valve causes shuttle (2) to move to the left and air pressure again goes to the air chambers of the tractor and scraper wheel brakes. This causes the wheel (emergency) brakes to activate.



DOUBLE CHECK VALVE
1. Inlet passage from emergency pilot valve. 2. Shuttle. 3. Inlet passage from brake control valve. 4. Outlet to air chambers.

Air Dryer (Models 613BSNS1 and 613BSS1)

The air dryer is used to remove moisture and foreign material from the compressed air before it gets to the air reservoir. Clean dry air is very important for safe operation and performance of brake systems that use com-pressed air. Clean dry air will also prevent corrosion of parts.

Desiccant beads are used to make the drying bed. The desiccant beads are of a material that cleans and makes the air dry. Each bead has a large number of submicroscopic cavities. Each desiccant bead absorbs or collects moisture and other foreign material from the air.

The air dryer is installed in the vertical position in the air line between the air compressor and the first air reservoir. The dryer will help reduce corrosion and prevent possible problems in the air system, especially the air brake system caused by moisture in temperatures below 32°F (0°C).

With the use of an air dryer, it is not necessary to drain the air system reservoirs daily. The desiccant cartridge and the paper oil filter are removable and must be replaced at regular service intervals. The cartridge housing is used to hold the desiccant beads. The cartridge housing has a plate with holes in it on each end. There is a filter cloth under each plate. The top plate is held in place by a spring and the bottom plate is held by a shoulder near the bottom of the cartridge housing. A long bolt is used through the center of the assembled cartridge to hold it in place in the air dryer. The end cover assembly is held to the bottom of the air dryer by a lock ring, bolts and retainers. The purge valve and heater assembly are in the cover assembly. The heater and thermostat assembly keeps moisture from freezing in the purge valve drain when the air dryer is used in temperatures of 320F (0°C) or lower. The 60 watt, 24 volt DC heater and thermostat assembly has an operating range between 500F (10°C) and 850F (300C).

OPERATION

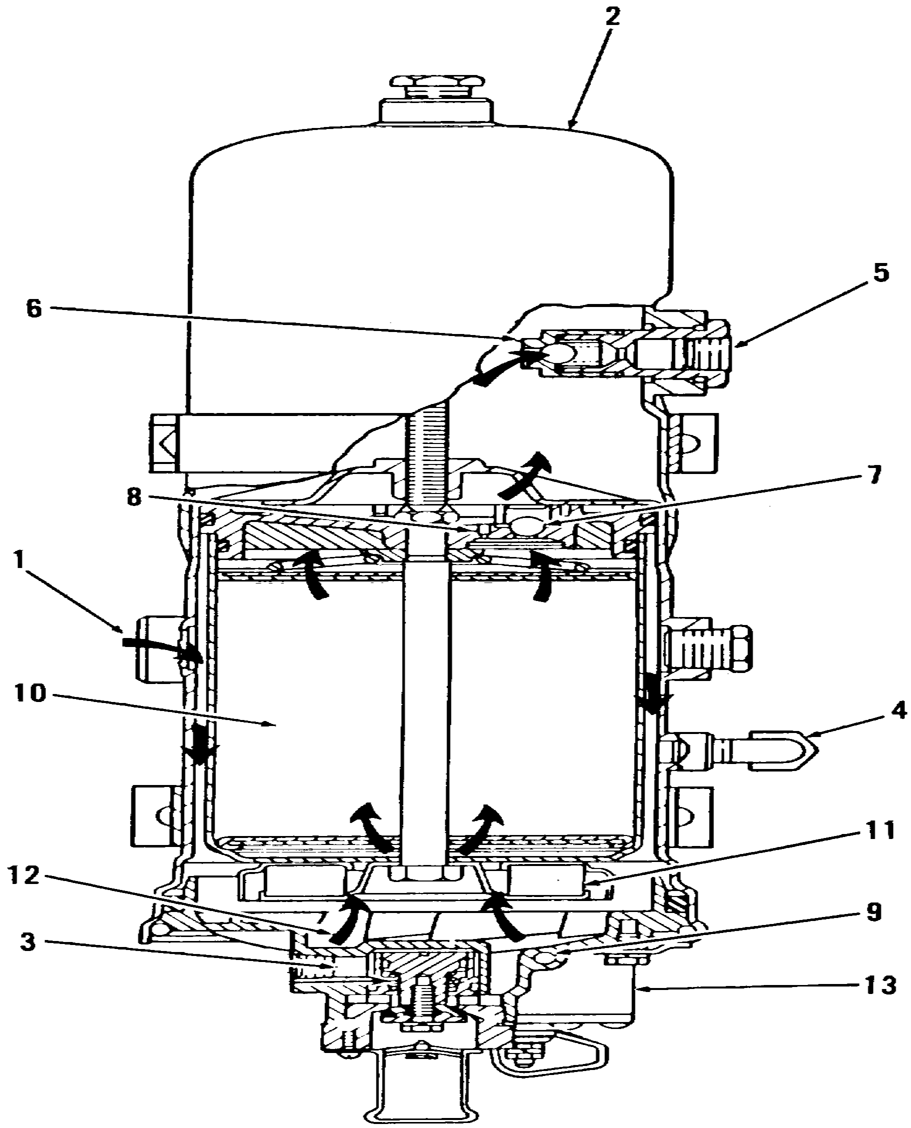
The operation of the air dryer is given in two parts, the charge cycle and the purge cycle.

CHARGE CYCLE

With the air compressor in its "loaded" or compressing cycle, air under pressure is sent to the air dryer from the air compressor through air supply line (1). When the air enters the Air Dryer, the velocity (speed) of the air goes down and cools. Much of the oil and water in the air drops into the sump (12). The direction of the air flow is to the bottom of the Air Dryer where its direction is reversed and more water and oil go into the sump. The air now goes through the oil filter (II) and some oil and foreign material is removed, but the water vapor is not removed. At this point, the air is still saturated (full) of water.

The filtered air and vapors go up into the bottom of the desiccant drying bed of the desiccant cartridge (10) and the adsorption procedure begins. Water vapor is removed from the air by the desiccant.

The unsaturated "dry air" goes through the check valve (7) and purge orifice (8) into the purge volume (2). From the purge volume (2) the air goes through check valve (6), through line (5) to the air reservoir.



CHARGE CYCLE

1. Line from air compressor to dryer
2. Purge volume
3. Unloader line from air compressor to purge valve

4. Air relief valve
5. Line to air reservoir
6.
7. Check valve
8. Purge orifice

9. Heater
10. Dessicant cartridge
Check valve 11. Oil filter
12. Sump
13. Thermostat

PURGE CYCLE

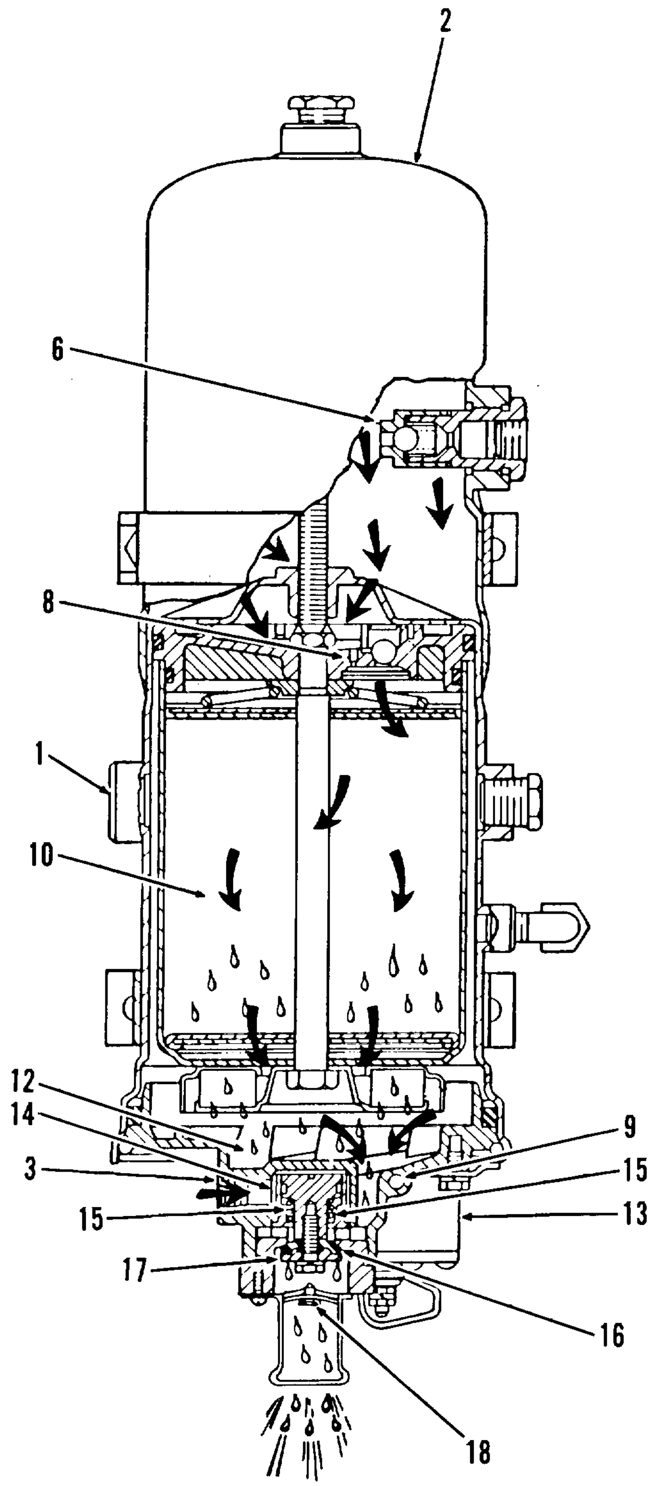
For the purge or regeneration cycle, the air flow through the desiccant bed of the air dryer goes in reverse.

When the air pressure from the air compressor goes up to high pressure setting of the governor, it goes through the governor and into the area below the unloader pistons in the air compressor cylinder block. The unloader pistons go up and the unloader plungers move up and hold the inlet valves off of their seats.

With the inlet valves held off their seats, air goes through the unloader line (3) into the purge valve opening (14). The purge valve plunger (1 7) is moved off of its seat (16). The sudden opening of the purge valve piston (15) and purge valve plunger (17) permits the air pressure that is in the dryer to exhaust the condensation and foreign material that has gathered in the sump (12) past the purge valve exhaust deflector (18) to the atmosphere. The sudden decompression (decrease in air pressure) of the drying bed of the desiccant cartridge (10) removes moisture from the pores (cavities) of the micro-crystalline particles that make up the drying bed. After the rapid decompression caused when the purge valve is opened, air goes from the purge volume (2) through the purge orifice (8) into the desiccant cartridge (10). As the air passes through the purge orifice (8) it expands and goes through the drying bed in the reverse direction, and through the purge valve to exhaust to atmosphere.

The air in the purge volume (2) was dried as it moved through the desiccant bed during the charge cycle. As it moves back into the desiccant bed, it becomes "super dry" (extra dry) after expansion to atmosphere pressure, through purge orifice (8). This super dry air is very efficient (very good) in removal of water in its reverse flow through the desiccant bed. If the purge cycle goes longer than the time needed to completely drain the purge volume to atmosphere, no more action takes place. The air dryer check valve (6) will keep the air in the air reservoirs from going into the purge volume (2). The electric heater (9) and thermostat (13) keeps moisture in the sump (12) from freezing. The thermostat will turn heater on at 500F (100C) and off at 850F (300°C).

When the air pressure in the air system goes below the governor pressure setting, the governor will cut in and the unloader pistons and plunger will no longer hold the inlet valves of the air compressor off their seats. The air compressor will again begin sending compressed air to the air dryer through air supply line (1) and the charge cycle begins.



PURGE CYCLE

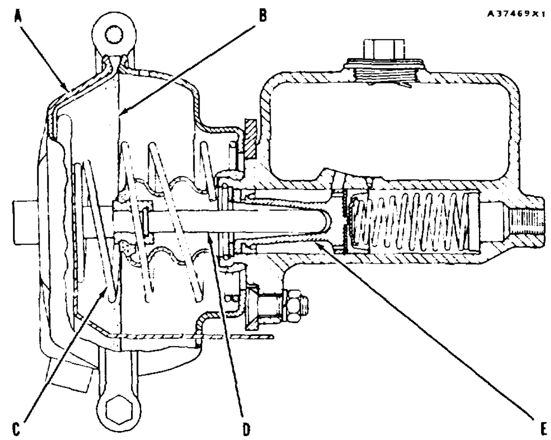
1. Line from air compressor to dryer
2. Purge volume
3. Unloader line from air compressor to purge valve
6. Check valve
8. Purge orifice
9. Heater
10. Desiccant cartridge
12. Sump
13. Thermostat
14. Purge valve opening
15. Purge valve piston
16. Seat
17. Purge valve plunger
18. Purge valve exhaust deflector

Air Chambers and Master Cylinders

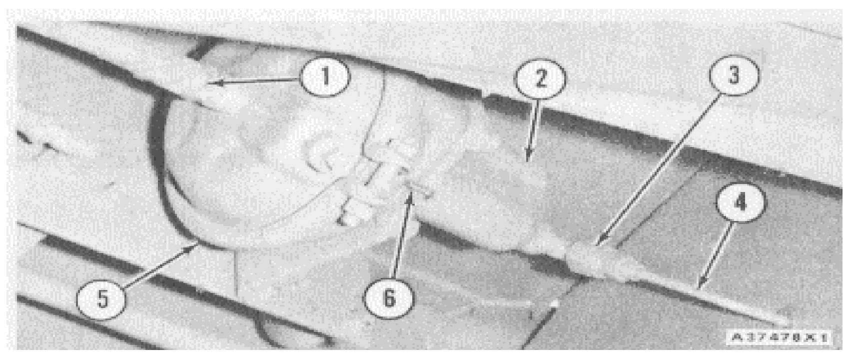
The brake system for the tractor has one air chamber and one hydraulic brake master cylinder. The brake system for the scraper has one air chamber and one hydraulic brake master cylinder.

The air chambers activate the pistons of the hydraulic brake master cylinders. Compressed air in air chamber (A) is pushed against diaphragm (B) to move the air chamber rod (D) out. When the rod is moved out, it will push on the back of piston (E). The diaphragm and rod are pushed back by spring (C) when the air pressure is released.

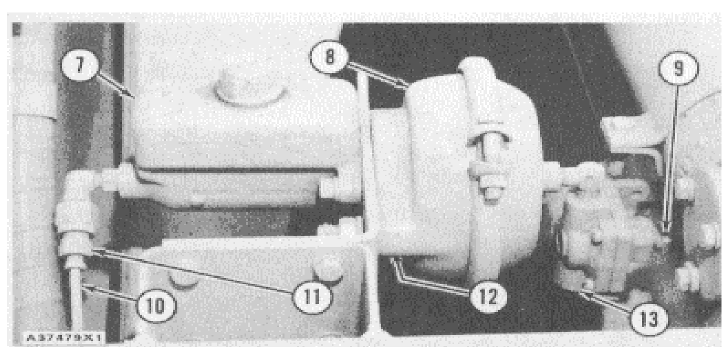
NOTE: The valves (3) and (11) let about 3 to 6 psi (20 to 40 kPa) oil pressure to be in the lines. This pressure will be enough to let the brake pads release from the brake discs but will keep a small amount of pressure so that the brake pads will clean themselves.



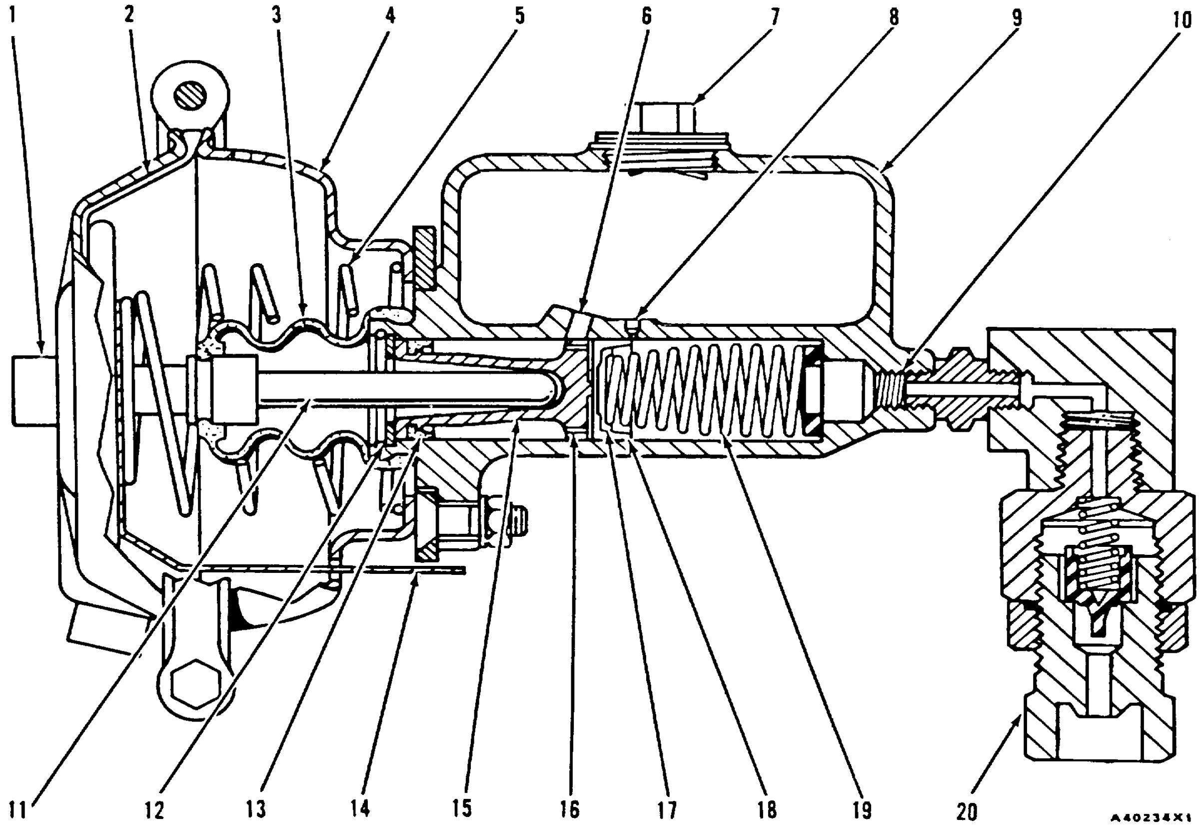
AIR CHAMBER AND MASTER CYLINDER
A. Air chamber. B. Diaphragm. C. Spring. D. Rod. E. Piston.



TRACTOR AIR CHAMBER AND MASTER CYLINDER
1. Air line. 2. Master cylinder. 3. Valve. 4. Oil line to tractor brakes. 5. Air chamber. 6. Stroke indicator.



SCRAPER AIR CHAMBER AND MASTER CYLINDER
7. Master cylinder. 8. Air chamber. 9. Air line. 10. Oil line to scraper brakes. 11. Valve. 12. Stroke indicator. 13. Quick release valve.



AIR CHAMBER AND MASTER CYLINDER OPERATION

1. **Air chamber inlet passage from brake valve.**
2. **Diaphragm.**
3. **Boot.**
4. **Air chamber assembly.**
5. **Spring.**
6. **Supply passage.**
7. **Cap.**
8. **Bypass passage.**
9. **Master cylinder assembly.**
10. **Master cylinder outlet passage.**
11. **Rod assembly.**
12. **Plate.**
13. **Cup.**
14. **Indicator.**
15. **Piston.**
16. **Passages.**
17. **Valve.**
18. **Cup.**
19. **Spring.**
20. **Residual pressure valve (check valve).**

When the brake is pushed, it sends air from the brake control valve through passage (1) to the air compartment of air chamber (4). Pressure air will push on the back of diaphragm (2) and rod assembly (11) and move the diaphragm (2), rod assembly) (11). indicator (14) and piston (15) to the right. As piston (15) moves cup (18) past bypass passage (8), brake fluid in the master) cylinder bore will go through passage (10) and residual pressure valve (check valve) (20) to the wheel cylinders.

When the brake pedal is released, pressure air is let out of air chamber (4) and spring (5) moves diaphragm (2) and rod assembly) (11) to the released position. Diaphragm (2) and rod assembly (11) moves faster than piston (15) because of the brake fluid which must be removed. This will cause a reduction in the pressure area between cup (18) and residual pressure valve (check valve) (20). Brake fluid ahead of cup (13) is pulled through passage (6), passages (16) in piston (15) and past valve (17).

When the brake fluid moves back through residual pressure valve (check valve) (20), spring (19) moves cup (18) and piston (15) toward plate (12).

When piston 15) contacts plate (12), bypass passage (8) is open to the master cylinder bore. Residual pressure valve (check valve) (20) keeps a small amount of residual pressure (back pressure) in the brake hydraulic system Cap (7) has passages to let air pressure out of the master cylinder reservoir. The brake fluid pushed out by the master cylinder piston causes the caliper pistons to extend and apply the brakes. When the apply force is released, a spring returns the master cylinder piston and the brake fluid returns to the reservoir-

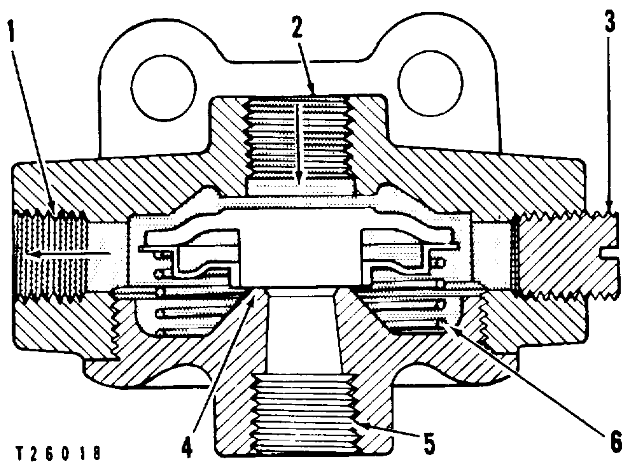
CAUTION

Always bleed air from the hydraulic brake system when a line has been disconnected.

Quick Release Valve

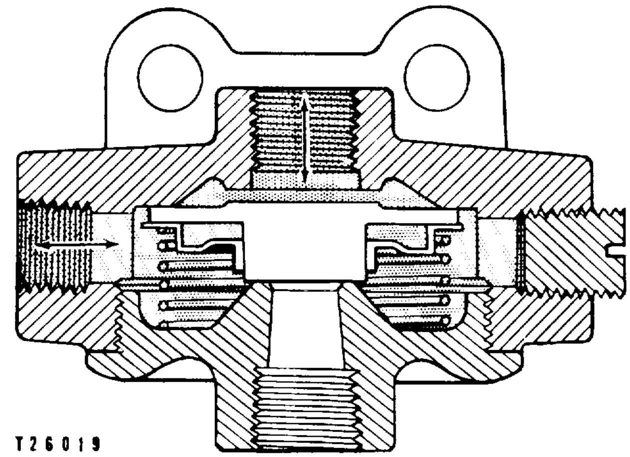
The quick release valve releases the air from the scraper rotochamber. The quick release have has three positions. In the OPERATE position, pressure air goes through, the valve into the rotochamber. In the HOLD position, pressure air is held in the rotochamber. In the RELEASE position, air in the rotochamber is released through exhaust passage (5).

When the brake pedal is pushed down. pressure air goes into the inlet passage t2) of the quick release valve. The diaphragm (4) moves down, closing the exhaust passage (5) The outer edges of the diaphragm are pushed down against the resistance of spring (6). Pressure air goes through the outlet passage (1) to the rotochamber.



QUICK RELEASE VALVE
(OPERATE POSITION)
1. Passage to rotochamber. 2. Inlet passage. 3. Plug. . 4. Diaphragm. 5. Exhaust passage. 6. Spring.

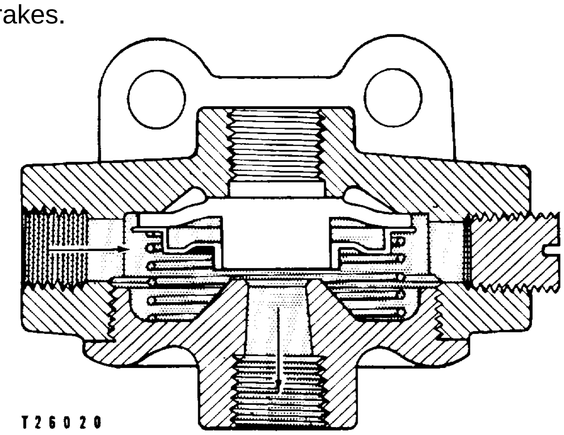
When the pressure below the diaphragm is the same as the pressure above the diaphragm. spring (6) moves the edge of the diaphragm up against the valve body. The center of the diaphragm still covers the exhaust passage (5). This is the HOLD position.



QUICK RELEASE VALVE

HOLD POSITION)

When the control valve for the service brakes is released, air pressure on top of the diaphragm is released. The air pressure in the rotochambers lifts the diaphragm and opens exhaust passage (5). Air goes out of the rotochambers through passage (1) to release the brakes.



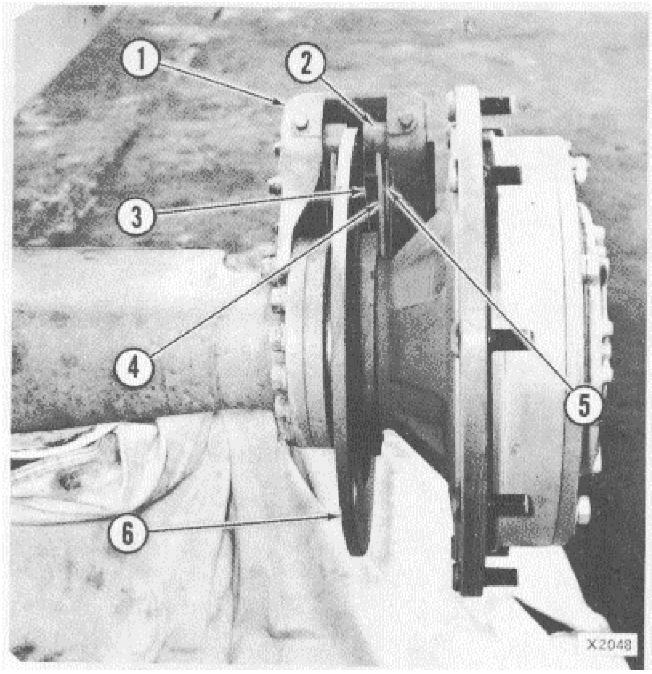
QUICK RELEASE VALVE
(EXHAUST POSITION)

Wheel Brakes

The friction pad (3) is pushed(against disc (6) to provide brakes for the machine. The discs turn with the hubs, and the calipers are connected solidly on the axle flange. The brake assembly has to pistons and a friction pad on each side of the disc. The pads and hacking are held in place by anchor pins. When there is a brake application, oil pushes the piston and pads against the disc.

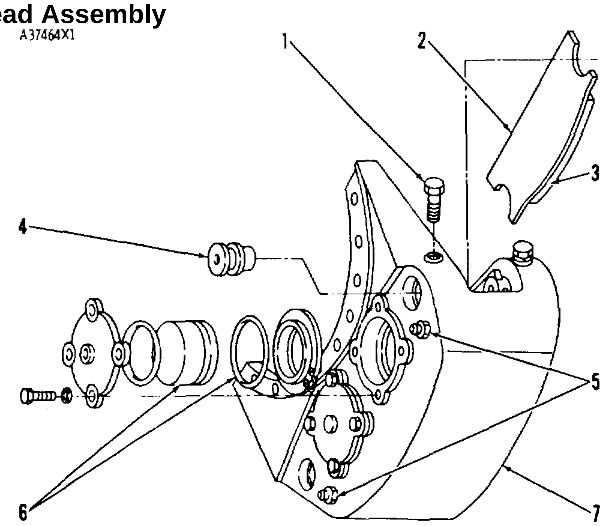
CAUTION

To prevent damage to pistons and seals, do not push on brake pedal when brake pads are removed.



DISC BRAKE ASSEMBLY
1. Head assembly. 2. Anchor pin. 3. Friction pad. 4. Metal backing. 5. Piston. 6. Disc.

Head Assembly



HEAD ASSEMBLY (CALIPER)
1. Anchor retaining bolt. 2. Metal backing. 3. Friction pad. 4. Anchor pin. 5. Bleed valves. 6. Piston and seal. 7. Head assembly.

Oil flow to the brakes is through lines and drilled passages to all pistons within each head assembly.

When an application of the brakes is made, the hydraulic pressure is made the same (balances) the pistons and the force on each side of the disc is the same. The pistons do not have return springs.

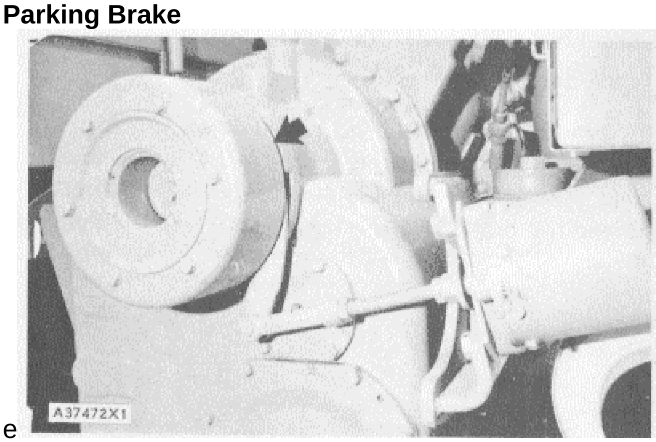
To make a pad replacement the caliper need not be removed. For replacement of pads, remove the anchor pin and slide the pad out.

CAUTION

Do not make a brake application with pads removed. The pistons must not be permitted to extend out of their bores as the pads are removed. Open the bleed valves on the caliper to release any pressure on the piston. If the pistons extend and let the seals come out, caliper removal will be needed to install the pistons.

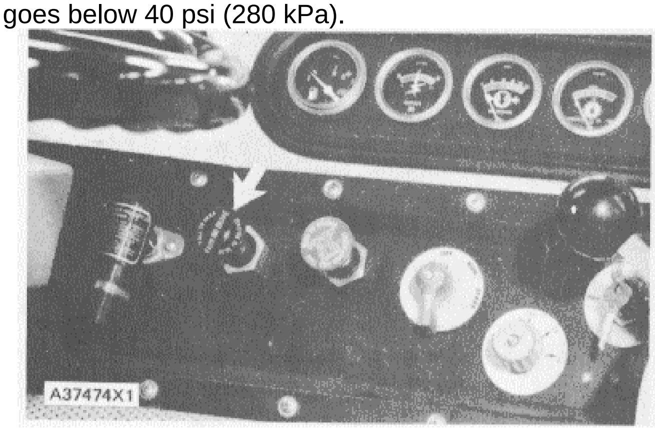
Two bleed valves on each caliper are used to let air out of the hydraulic brake system. Let air out of the brakes (bleed) whenever a line is disconnected in the hydraulic brake circuit.

Parking Brake

e 

PARKING BRAKE

Pull on the knob for the parking brake control valve to open the valve and activate the parking brake. Push on the knob to release the parking brake. Air pressure in the line to parking brake control valve must be 50 psi (345 kPa) minimum for the valve to stay closed. The parking brake activates automatically when the air pressure in the line to the parking brake control valve goes below 40 psi (280 kPa).



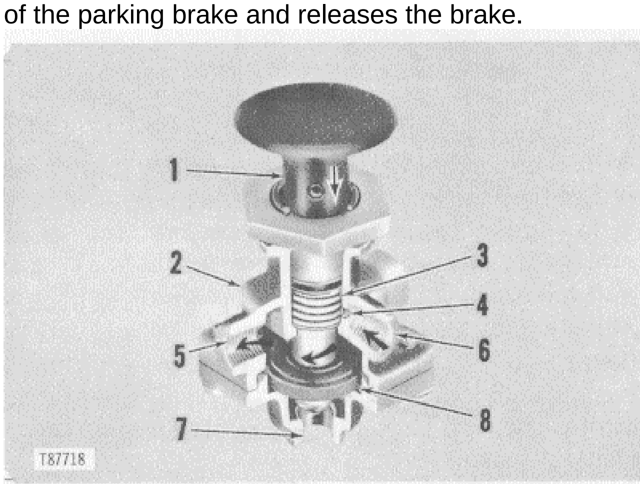
PARKING BRAKE CONTROL VALVE

The parking brake will not let the output shaft of the transmission turn when the air pressure to the brake chamber is below 40 + 5 psi (280 + 35 kPa). The brake drum with shoes inside is on the output shaft of the transmission.

The brake chamber activates the shoes. The parking brake is activated by a spring and released by air pressure. Force of the spring moves the rod of the brake chamber and the brake lever is pulled UP by the rod to activate the brake. Air pressure works on the diaphragm to cause compression of the spring and extension of the rod. The rod pushes the brake lever DOWN to RELEASE the brake.

Control Valve for Parking Brake

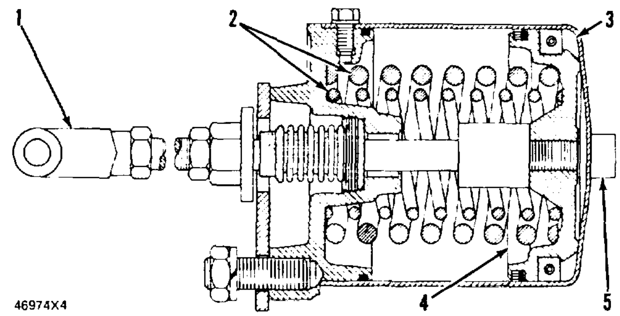
The control valve, which is on the dash, has control over the supply of air that goes to the chamber of the parking brake. With valve knob (I) pulled OUT, the line to the brake chamber is open to the atmosphere and causes the application of the brake. With valve knob (1) pushed IN, air goes from the reservoir into the chamber of the parking brake and releases the brake.



FLOW OF AIR; APPLICATION OF PARKING BRAKE
1. Knob and pin assembly. 2. Valve body. 3. Spring. 4.Orifice. 5. Outlet (to chamber of the parking brake). 6. Inlet (from air reservoir). 7. Exhaust (to atmosphere). 8. Valve assembly.

Parking Brake Chamber

Parking brake chamber (7) releases (disengages) and activates (engages) the emergency and parking brake. Rod assembly (I) is connected to lever (6) which moves the shoes in the brake. When there is no pressure from the parking brake control valve at air inlet(s), there is no air pressure in air chamber (3). Springs (2) hold piston (4) all the way to the right and keep the parking brake engaged.

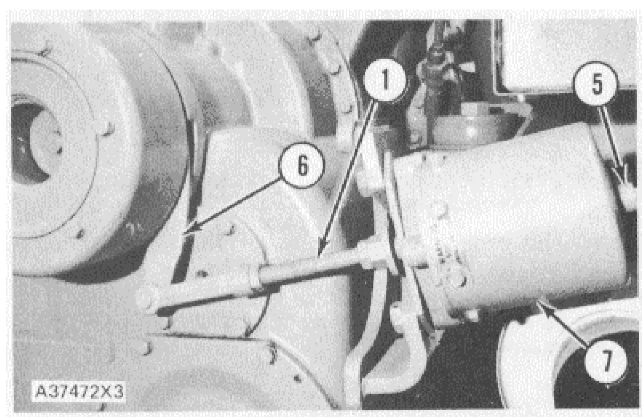


PARKING BRAKE CHAMBER IN ACTIVATED (BRAKE ON) POSITION
1. Rod assembly. 2. Springs. 3. Air chamber. 4. Piston. 5. Air Inlet.

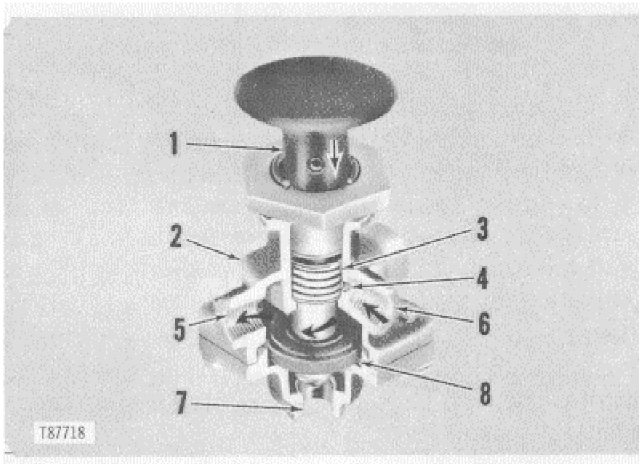
The brake stays activated until the air system is at the correct pressure for operation and the parking brake control valve is moved to the OFF position (knob is pushed in). At this time, air pressure goes to air chamber (3) and pushes piston (4) to the left. Rod assembly (1) moves lever (6) which releases the parking brake.

When air pressure decreases to approximately 40 psi (280 kPa), the parking brake control valve closes automatically (moves to the ON position) and stops the flow of air to chamber (3). Springs (2) are no longer in compression and pull rod assembly (I) into the brake chamber. The parking brake is activated.

This same operation takes place when the parking brake control valve is manually moved to the ON position (pulled out). This activates the brake for parking.



LOCATION OF PARKING BRAKE CHAMBER
1. Rod assembly. 5. Air inlet. 6. Lever. 7. Parking brake -chamber.



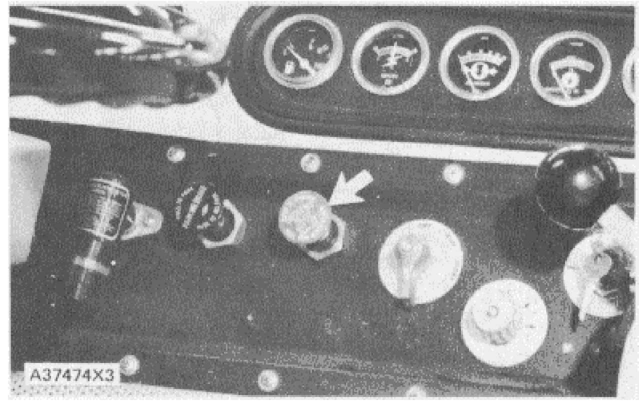
FLOW OF AIR; RELEASING OF PARKING BRAKE
1. Knob and pin assembly. 2. Valve body. 3. Spring. 4. Orifice. 5. Outlet (to chamber of the parking brake). 6. Inlet (from air reservoir). 7. Exhaust (to atmosphere). 8.

The control valve will be ON when there is little air in the air reservoir [knob (1) pulled out]. Valve (8) is against the upper face of valve body) (2) to stop pressure air to outlet (5) and exhaust (7). Air in the reservoir goes up to the necessary range.

When the pressure gauge gives the indication that the necessary air is in the reservoir, push in and hold knob (1) to release the parking brake. Pressure air from the reservoir goes in inlet 96), through orifice (4) and through outlet (5), into the brake chamber, to release the parking brake. Air pressure holds valve assembly (8) over exhaust (7).

If the air pressure in the system goes below 40 ± 5 psi (280 ± 35 kPa), spring (3) moves valve assembly (8), opening exhaust (7). Pressure air goes to the atmosphere and the parking brake activates.

EMERGENCY BRAKE CONTROL VALVE

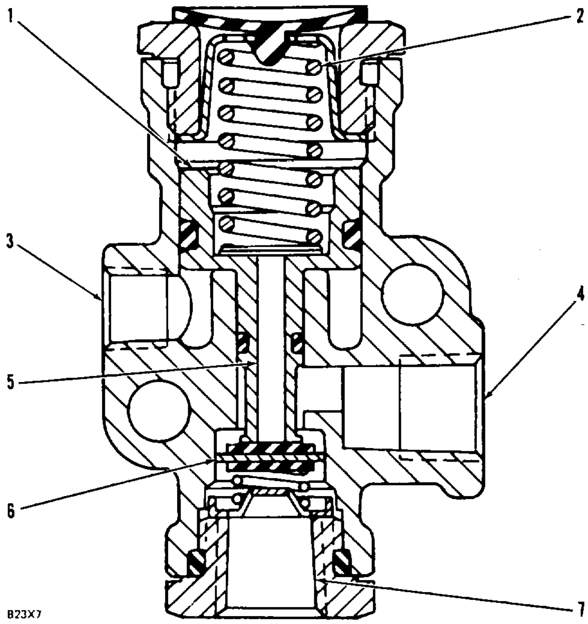


EMERGENCY BRAKE CONTROL VALVE

The emergency brake control valve has control over the supply of air to the emergency pilot valve. When the engine is first started and the control valve is in the ON (pulled out) position, the line to the emergency pilot valve has no pressure in it. The pilot valve is open and air flow from the reserve tank activates the tractor and scraper brakes.

When the emergency control valve is in the OFF (pushed in) position, air pressure then fills the line to the pilot valve and closes it. Air flow from the reserve tank is stopped and the tractor and scraper brakes are released.

Emergency Pilot Valve



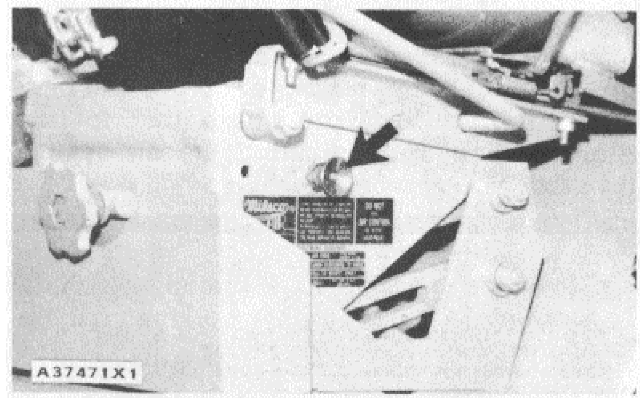
EMERGENCY PILOT VALVE
1. Piston. 2. Spring. 3. Control port from emergency brake control valve. 4. Delivery port to double check valve. 5. Exhaust passage. 6. Valve. 7. Supply port from tractor reserve air reservoir.

The emergency pilot valve controls the flow of air pressure to the tractor air chambers when the emergency brakes are activated. During normal machine operation, air pressure is in control port (3). This air pressure pushes up on piston (I) and puts spring (2) in compression. Valve (6) comes in contact with the valve body so that no air goes from supply port (7) through deliver: port (4). There is no air pressure to activate the emergency brakes.

When the emergency) brake control valve is activated (pulled out), the air pressure in control port (3) is released through the emergency brake control valve. Spring (2) now pushes piston (I) down which pushes valve (6) away from the valve body. Pressure air now goes from supply port (7) and out delivery port (4) to the double check valve and then to the tractor and scraper brake chambers. The emergency brakes are now activated.

Seat Air Suspension

Push on the control valve to increase shock ab-sorber charge. Pull on the control valve to decrease shock absorber charge.



CONTROL VALVE FOR SEAT SUSPENSION

AIR SYSTEM AND BRAKES

WARNING

Sudden movement of the machine or release of air under pressure can cause injury to persons on or near the machine. To prevent possible injury, do the procedure that follows before testing and adjusting the air system and brakes:

1. Move the machine to a smooth horizontal location. Move away from working machines and personnel. Stop the engine.
2. Permit only one operator on the machine. Keep all other personnel either away from the machine or in view of the operator.
3. Activate the parking and emergency brakes. Lower the bowl to the ground. Put blocks in front of and
4. Push on the brake pedal many times until there is no more brake air pressure.
5. Make sure all air pressure is released before any fitting, hose or component is loosened, tightened, removed or adjusted.

NOTE: Before any operation checks are made, open the drain valves to release any water in the air reservoirs. Water lowers the capacity in the reservoirs and can cause the air compressor to run constantly. Close the drain valve. Start the engine and operate the machine until it is at the normal temperature for operation.

VISUAL CHECKS

Before any operation checks are made to the air system and brakes, visually inspect the complete system as follows:

1. Check for cracks or wear in hoses and lines.
2. Check for restriction to flow; like sharp bends, clamps that are not installed correctly, and damage to hoses and lines.
3. Check for loose connections.
4. Check for damage to components.

OPERATION CHECKS

WARNING

Make reference to WARNING at the beginning of AIR SYSTEM AND BRAKES TESTING AND ADJUSTING section.

Operation checks of the air system and brakes can be used to find the source of leakage in the system or to make a diagnosis of bad performance.

Leakage Checks

Tools Needed: 8M2885 Pressure Gauge, 0 to 200 psi (O to 1380 kPa). 5S5123 or 6V4161 Hydraulic Testing Group.

NOTE: It is possible to hear the sound of air leakage. Air leakage can be seen when water with soap (soapy water) is put on the connections, valves and hoses.

1. Start the engine and let the air pressure go up to the cutout pressure. Stop the engine.

NOTE: The governor cutout pressure is to be 125 $\pm$ 5 psi (860 + 35 kPa). If cutout pressure is not correct, see the subject, AIR COMPRESSOR GOVERNOR.

2. Check for leakage in the hoses, lines and connections from the air compressor and governor to the tractor reservoirs.
3. Check for leakage in the hoses, lines and connections from the tractor reservoirs to the brake control valve, emergency pilot valve and accessory circuit.
4. Check for leakage in the brake control valve.

NOTE: If the air pressure gets below 100 psi (690 kPa) (cut-in pressure), start and run the engine until the air pressure goes up to the cutout pressure.

5. Check for leakage in the hoses, lines and connections from the brake control valve to the seat suspension, differential lock salve and emergency and parking brake control valves.
6. Check for leakage in the valves and switches.
7. Check for leakage in the hoses, lines and connections from the brake control valve to the parking and emergency brake control valves.
8. Move the knob on the parking and emergency brake control valves to the OFF position (pushed in).

9. Check for leakage in the hoses, lines and connections from the emergency brake control valve to the dry air tank. Also check for leakage from the emergency pilot valve to the double check valve.
10. Check for leakage in the hoses, lines and connections from the parking brake control valve to the parking brake chamber.
11. Check for leakage in the hoses, lines and connections from the brake control valve to the tractor and scraper air chamber and brake cylinder.
12. Operate each valve in the accessory circuit separately.

NOTE: The components in the accessory circuit are: differential lock valve, seat suspension, air horn solenoid valve, and window washer valve.

13. Check for leakage in the hoses, lines and connections and components from each valve.

NOTE: During the time the valves are checked for leakage, check the exhaust passages for restrictions, like mud or dirt. A restriction in an exhaust passage will prevent or slow the release of pressure air during normal operations.

Parking Brake Check

1. Start the engine and let the pressure go up to the cutout pressure.
2. Lift the bowl (empty).
3. Move the knob on the parking brake control valve to the ON position (pulled out).
4. The parking brake chamber must hold the rod extended.
5. If the parking brake chamber does not hold the rod, see TROUBLESHOOTING.
6. Move the knob on the control valve to the OFF position (pushed in).
7. The parking brake chamber must release the rod.
8. If the parking brake chamber does not release, see TROUBLESHOOTING.

TROUBLESHOOTING

Item	Problem
1.	Service Brakes Do Not Engage Correctly.
2.	Service Brakes Do Not Release Correctly.
3.	Emergency Brakes Do Not Engage Correctly.
4.	Emergence Brakes Do Not Release Correctly.
5.	Parking Brakes Do Not Engage Correctly.
6.	Parking Brakes Do Not Release Correctly.
7.	Differential Lock Does Not Engage Correctly.
8.	Differential Lock Does Not Release Correctly.

NOTE: If the TROUBLESHOOTING gives an indication that pressure air is not available at the supply passage(s) of the control valves, loosen the connection at the supply passage and use soapy, water to check for pressure air.

If the TROUBl.ESHOOTING gives an indication of leakage through a control valve(s), disconnect the delivery hose at the end opposite the delivery passage. Put the end of the hose in a pan of , water to check for leakage.

SERVICE BRAKES DO NOT ENGAGE CORRECTLY

Causes:

a. No pressure air at the inlet passage of the brake control valve. Wear or damage to brake control valve permits little or no pressure air at the outlet passages. Wear or damage to the components between the brake control valve and the tractor and scraper air chamber and brake cylinders.
d. Wear or damage to the air chamber and brake cylinder.
e. Wear or damage to the double check valve.
f. Brakes have wear or damage.

2. SERVICE BRAKES DO NOT RELEASE CORRECTLY

Causes:

a. Mud or dirt under pedal does not let the brake control valve release fully.
b. Wear or damage to the brake control valve prevents or slows the release of pressure air from the lines to the tractor and scraper air chamber and brake cylinders.

c. Wear or damage to the scraper quick release valve prevents or slows the release of pressure air from the air chamber and brake cylinder.
d. Wear or damage to the components between the brake control valve and the tractor and scraper air chamber and brake cylinder.
e. Wear or damage to the tractor and scraper air chamber and brake cylinder.
f. Wear or damage to the emergency brake control valve releases the pressure air to the tractor and scraper air chamber and brake cylinder.
g. Wear or damage to the double check valve.

3. EMERGENCY BRAKES DO NOT ENGAGE CORRECTLY

Causes:

a. Wear or damage to the emergency brake control valve prevents or slows the release of pressure air.
b. Wear or damage to the emergency pilot valve, and double check valve.
c. Brakes have wear or damage.
d. Wear or damage to the tractor and scraper air chamber and brake cylinder.

4. EMERGENCY BRAKES DO NOT RELEASE CORRECTLY

Causes:

a. Wear or damage to the emergency brake control valve releases the pressure air to the tractor and scraper air chamber and brake cylinder.
b. Wear or damage to the tractor and scraper air chamber and brake cylinder.

5. PARKING BRAKES DO NOT ENGAGE CORRECTLY

Causes:

a. Wear or damage to the parking brake control valve prevents or slows the release of pressure air.
b. Adjustment of rod travel of parking brake chamber not correct.
c. Brake has wear or damage.
d. Wear or damage to the parking brake chamber.

6. PARKING BRAKES DO NOT RELEASE CORRECTLY

Causes:

a. Wear or damage to the parking brake control valve releases the pressure air to the parking brake chamber.
b. Wear or damage to the parking brake chamber.

7. DIFFERENTIAL LOCK DOES NOT ENGAGE CORRECTLY

Causes:

a. No pressure air at the supply passage of the differential lock valve.
b. Wear or damage to the differential lock valve permits little or no air pressure at the differential lock.
c. Pedal adjustment not correct.

8. DIFFERENTIAL LOCK DOES NOT RELEASE CORRECTLY

Causes:

a. Wear or damage to the differential lock valve prevents or slows the release of pressure air from the line to the differential lock.
b. Pedal adjustment not correct.

TEST PROCEDURES

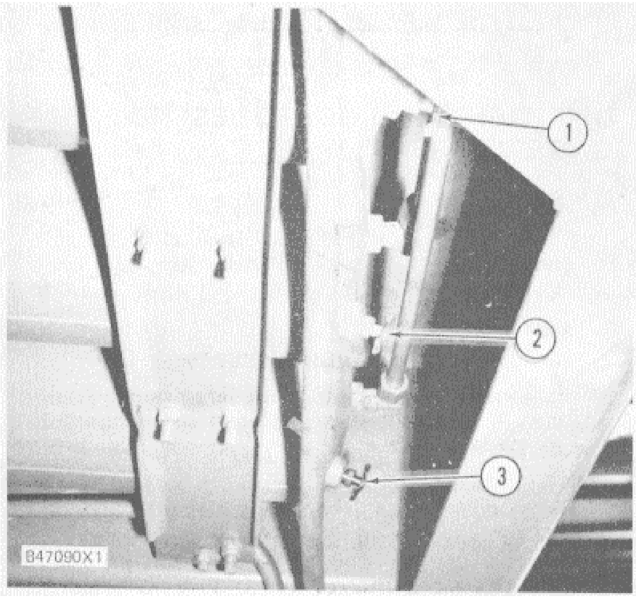
⚠ WARNING

Make reference to WARNING on first page of AIR SYSTEM AND BRAKES TESTING AND ADJUSTING section.

Air Pressure Gauge

Tools Needed: 8M2885 Pressure Gauge, 0 to 1400 kPa (O to 200 psi). 5S5123 or 6V4161 Hydraulic Testing Group.

1. Release the pressure air from the tractor reservoirs by opening front drain valve (1) and center drain valve (2).
2. Remove rear drain valve (3).
3. Install 4M5317 Reducing Bushing and the hose assembly in the opening for the drain valve.
4. Connect the hose assembly to the IS8937 Valve from the test group. Connect the 1400 kPa (200 psi) gauge to the valve.
5. Start the engine and let the pressure go up to the cutout pressure.
6. Make a comparison of the pressure gauge on the machine with the test gauge.



DRAIN VALVES
1. Front (reserve) tank drain valve. 2. Center (dry) tank drain valve. 3. Rear (wet) tank drain valve.

7. If the pressure on the gauge on the machine is more than 15 psi (105 kPa) different than the pressure on the test gauge, install a new gauge.

8. If it is necessary to install a new gauge, stop the engine and open the front and center drain valves until the pressure in the tractor reservoirs is released.

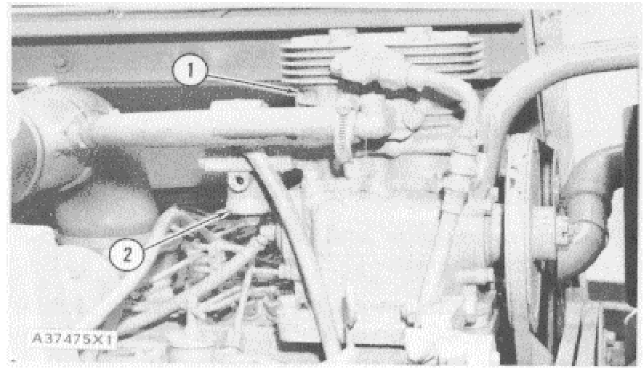
9. Do not disconnect the test gauge. It will be used in other tests.

⚠WARNING

Before the test equipment is disconnected, make sure all pressure is released from the tractor reservoirs. To prevent personal injury, make reference to WARNING on first page of AIR SYSTEM AND BRAKES TESTING AND ADJUSTING section.

Air Compressor Governor

1. Start the engine and let the pressure go up to the cutout pressure.
2. Read the cutout pressure on the test gauge.
3. Push the brake pedal rapidly several times.
4. Read the cut-in pressure on the test gauge.
5. The cut-in pressure is 100 to 105 psi (690 to 725 kPa). The cutout pressure is 125 ± 5 psi (860 ± 35 kPa).



AIR COMPRESSOR
1. Compressor. 2. Governor.

6. If necessary, make an adjustment to the air compressor governor as follows:

   a. Remove cover (I) on top of the governor.

   b. Loosen the locknut on the adjustment screw.

   c. Turn the adjustment screw counterclockwise to make the cutout pressure higher. One turn of the adjustment screw changes the pressure approximately 20 psi (140 kPa). The cut-in pressure will change the same amount.

7. If the adjustment screw does not change the cutout pressure, the unloading valves in the air compressor are not working correctly.

8. If the cut-in to cutout pressure difference is not correct, the governor is not working correctly.

Air Relief Valve

The air relief valve opens at 150 psi (1030 kPa) and has no adjustment.

Parking Brake Control Valve

I. Start the engine and let the pressure go up to cutout pressure [125 + 5 psi (860 + 35 kPa)].

2. With the control knob for the parking brake in the OFF position (pushed in), stop the engine.

3. Hold the control knob for the emergency brakes in the OFF position (pushed in). Push the brake pedal rapidly several times, until the control knob automatically moves to the ON position.

4. Read the pressure on the gauge.
5. The correct pressure to automatically engage the brakes is 40 + 5 psi (280 + 35 kPa). If the pressure on the gauge is not correct, the operation of the control valve is not correct.

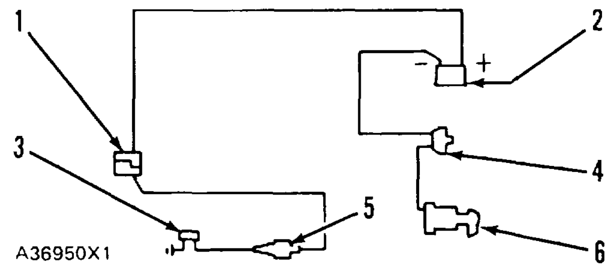
6. Disassemble the control valve and check for worn or damaged parts.
7. If this does not correct the problem, install a new valve.

Emergency Brake Control Valve

1. Start the engine and let the pressure go up to cutout pressure [125 ± 5 psi (860 ± 35 kPa)].
2. With the control knob for the emergency brake in the OFF position (pushed in), stop the engine.
3. Hold the control knob for the parking brake in the OFF position (pushed in). Push the brake pedal rapidly several times, until the control knob automatically moves to the ON position.
4. Read the pressure on the gauge.
5. The correct pressure to automatically engage the emergency brakes is 40 + 5 psi (280 + 35 kPa). If the pressure on the gauge is not correct. the operation of the control valve is not correct.
6. Disassemble the control valve and check for worn or damaged parts.
7. If this does not correct the problem, install a new valve.

Electric Warning System

1. Turn on the disconnect switch.
2. Start the engine.
3. Let the pressure go up to governor cutout pressure [125 + 5 psi (860 + 35 kPa)].
4. Slowly let the air out by pushing on the brake pedal. Note the air pressure shown on the gauge at which warning buzzer (3) begins. This must be at approximately 60 psi (415 kPa).
5. If warning buzzer (3) does not begin to sound at approximately 60 psi (415 kPa), check the electrical connections for pressure indicator (5) and warning buzzer (3).
6. If the connections are good, connect a continuity light across the terminals of one of the indicator and buzzer.

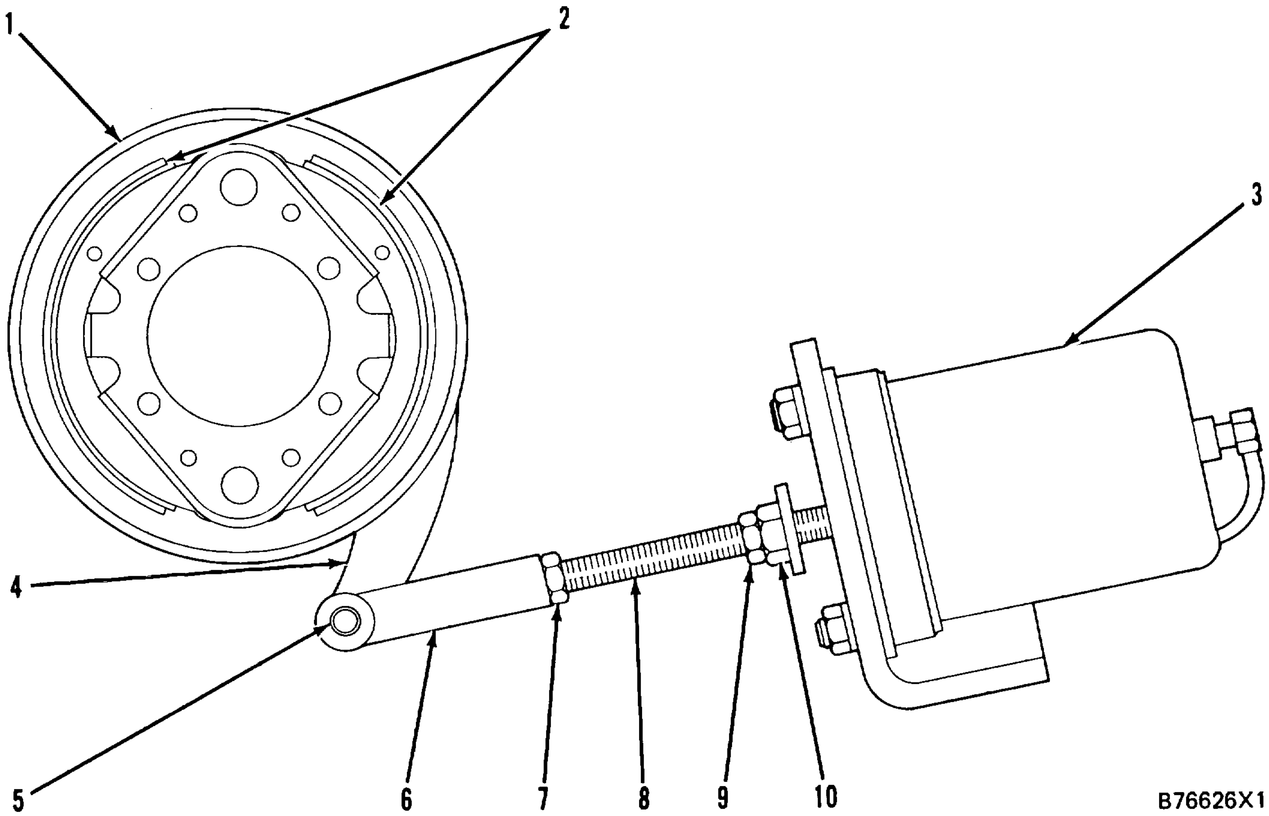


ELECTRIC WARNING SYSTEM

1. Pin connector. 2. Ammeter. 3. Low air pressure warning buzzer. 4. Circuit breaker. 5. Low air pressure indicator. 6. Starter switch.

7. If the continuity light does not operate, install a new pressure indicator warning buzzer.
8. If low pressure buzzer (3) comes ON above approximately 65 psi (450 kPa), stop the engine.
9. Install a new pressure indicator.
10. Start the engine.
11. Let the pressure go up to cutout pressure.
12. Slowly open the center tank drain valve.
13. Warning buzzer (3) must come ON at approxi-mately 60 psi (415 kPa).

PARKING BRAKE ADJUSTMENT



ADJUSTMENT OF PARKING BRAKE
1. Brake drum. 2. Brake shoes. 3. Parking brake chamber. 4. Lever. 5. Pin. 6. Rod end. 7. Locknut. 8. Rod. 9. Locknut. 10. Nut.

⚠WARNING

Make reference to WARNING on first page of AIR SYSTEM AND BRAKES TESTING AND ADJUSTING section.

1. Start the engine and let the air pressure go up to operating range.
2. Move the control knob for the parking brake to OFF (brake released) position. Stop the engine.

NOTE: If no air pressure is available to release the brake, loosen locknut (9). Turn nut (10) on rod (8) until nut (10) makes contact with parking brake chamber (3). Continue to turn nut (10) so that rod (8) moves out of parking brake chamber (3) and the parking brake is fully released.

3. Remove the cotter and pin (5).
4. Move the control knob for the parking brake to ON (brake activated) position.
5. Loosen locknut (9) and adjust nut (10) until it is .06 $\pm$ .03 in. (1.5 + 0.8 mm) from the face of parking brake chamber(3). Tighten locknut (9).
6. Move control knob for the parking brake to OFF (brake released) position.
7. Move lever (4) towards the parking brake chamber to remove the free movement (slack) from the lever.
8. Loosen locknut (7) and turn rod end (6) until the pin bores in lever (4) and rod end (6) are in alignment. It will be necessary to move lever (4) to turn rod end (6) but lever (4) must be in the same position as in Step 7 when pin (5) is installed.
9. Install pin (5) and cotter pin.
10. Tighten locknut (7).

Air Dryer Check (Models 613BSNS1 and 613BSS1)

Put a new or rebuilt desiccant cartridge in the air dryer when the desiccant in the cartridge does not have enough water absorption ability. First, make the checks that follow.

NOTE: The check for water may be made at 250 service hours but it is not expected that maintenance of the desiccant will be required for at least 1000 service hours.

1. Check for water in the air tanks. Open the drains on the tanks. In areas where there is more than 300 F (170 C) change in ambient temperature, there can be water in the air tanks because of condensation. A small amount of water from condensation is normal and is not an indication that the air dryer is not in operation. Steps A, B and C are probable causes of too much water in the air tanks.

   A. Air from another machine without an air dryer was put in the air reservoirs and did not go through an air dryer.
   B. Too much air has been used for a long time and the air compressor has not been let to load and unload in a normal way (abnormal usage of air compressor).
   C. The air dryer has been installed on a machine that did not have one before. This type of system will be saturated with moisture and several weeks of operation may be needed to dry it out.

2. Check all bolts that hold the air dryer to see that they are tight. Check all air and electrical connections.

3. Check the operation of the check valve in the discharge opening of the air dryer. Install an air pressure gauge in the line between the air dryer discharge and the air tanks. With the system air pressure at governor cut-out pressure and the engine not running, check the air pressure gauge. If there is a fast drop in air pressure, it could be an indication of a check valve with a defect. This can be checked by an inspection of the purge-valve exhaust. The purge valve will be open when the air pressure has gone up to governor cut-out pressure. Let two minutes go by for a complete purge cycle. If there is a constant flow of air from the purge valve exhaust with the engine shut off and if the air pressure on the test gauge went down, it is an indication there is an air leak in the check valve.

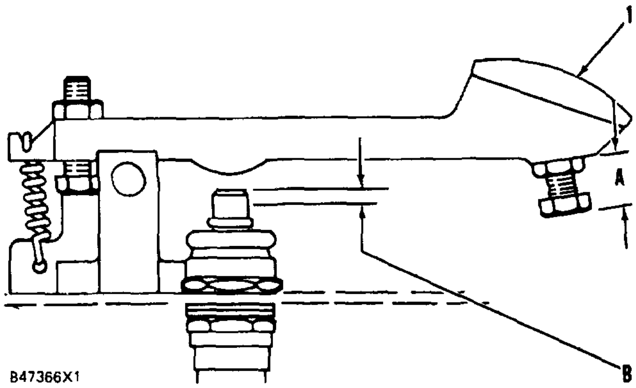
4. With the compressor loaded (compressing air), put a mixture of liquid soap and water on the exhaust of the purge valve to see if there is an air leak in the valve.

5. Pull on the stem of the relief valve while the air compressor is loaded (compressing air). There must be an exhaust of air from the valve and it must stop when the stem of the valve is released.

6. Check all lines and fittings that go to and from the air dryer for leakage.

7. Check the operation of the heater and the thermostat during cold weather operation.

DIFFERENTIAL LOCK PEDAL ADJUSTMENT



PEDAL ADJUSTMENT
1. Differential lock pedal. A. Distance .75 In. (19.00 mm). B. Valve stem movement .16 F .03 In. (4.1 i 0.8 mm).

1. Adjust the bolt on the bottom of pedal (I) so there is a distance (A) of approximately .75 in. (19.0 mm) between the bottom of the bolt head and the bottom of the shoulder on the pedals.
2. With the pedal pushed down, adjust the bolt to permit a valve stem movement (B) of. 16 + .03 in. (4.1 + 0.8 mm).

BRAKE CONTROL VALVE (LEAKAGE CHECK)

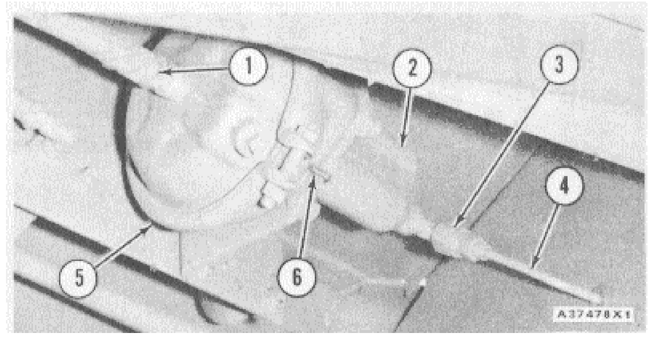
Start the engine and let the air pressure go up.

Push down on the brake pedal and hold it down. Put soap suds on the air line connections at the air chambers and check for air leakage. Release the brake pedal. Put soap suds on the exhaust passage of the brake control valve. Leakage must not be more than 1.00 in. (25.4 mm) soap bubble in one minute. Correct any air leaks.

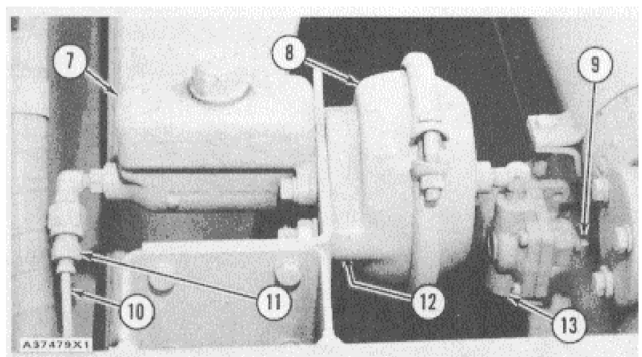
BRAKE ADJUSTMENT

Caliper disc hydraulic brakes need no adjustment. There is no return mechanism to force the pads away from the discs. The pads are in slight contact all the time with the discs to keep them clean.

AIR IN THE HYDRAULIC BRAKE SYSTEM



TRACTOR AIR CHAMBER AND MASTER CYLINDER
1. Air line. 2. Master cylinder. 3. Valve. 4. Oil line to tractor brakes. 5. Air chamber. 6. Stroke indicator.



SCRAPER AIR CHAMBER AND MASTER CYLINDER
7. Master cylinder. 8. Air chamber. 9. Air line. 10. Oil line to scraper brakes. A1. Valve. 12. Stroke Indicator. 13. Quick release valve.

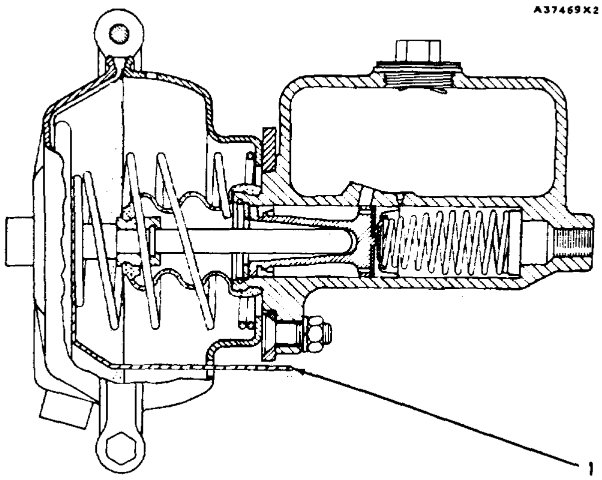
Air in the hydraulic brake system cannot be detected by brake pedal "feel." However, a stroke indicator on each master cylinder will provide a means of detecting a "soft" pedal condition which will cause increased master cylinder piston movement. If the movement of stroke indicators (6) and (12) is too much, check for hydraulic leaks or air in the system.

NOTE: If the leak results from a damaged cup or seal, the hydraulic brake system may be contaminated. Drain the brake fluid and flush the system with denatured alcohol. the system is free of leaks, check for air. Bleed each hydraulic brakes .system. See the topic, AIR REMOVAL FROM BRAKES (Bleeding the Brakes).

BRAKE SYSTEM TEST

Check of Operation

The stroke indicator (1) will give an indication when brake repair is needed. With the brake pedal pushed down, make note of the stroke of the rod (1) on each master cylinder. Brake repair is needed when, the stroke indicator moves more than 1.00 in. (25.4 mm) from the air chamber of the master cylinder.



MASTER CYLINDER
1. Stroke indicator.

1. Start the diesel engine and let the air pressure in the reservoir go up to cutout pressure.
2. Push the brake pedal down and keep it in that position.
3. Look at the stroke indicator.

   a. Slow movement of the stroke indicator after it has stopped once, is an indication that there is leakage in the hydraulic section of the brake system or that the cup is cut.

   b. Extra travel of the stroke indicator (with brake linings in contact with discs) is an indication that air is in the hydraulic section of the system.

4. Release the brake pedal.

   a. if either one or both of the stroke indicators do not retract, this is an indication that a bypass opening in one of the master cylinders is closed by dirt, corrosion or the primary cup has become too large.

NOTE: A primary cup which has become too large is an indication of wrong or dirty hydraulic fluid in the system. If hydraulic fluid is dirty, remove and repair all components in the hydraulic system of the brakes. Flush the brake lines with clean hydraulic fluid.

Check for Leakage

1. Push brake pedal down and keep it in that position.
2. Put soap suds on the connections of the air lines at the master cylinders and check for air leakage.
3. Release the pedal.
4. Put soap suds on the exhaust openings of the control valve for the brakes.
5. When the pedal is pushed down, leakage must not be more than a 1.00 in. (25.4 mm) soap bubble in one minute.
6. Repair any air leaks that are found.

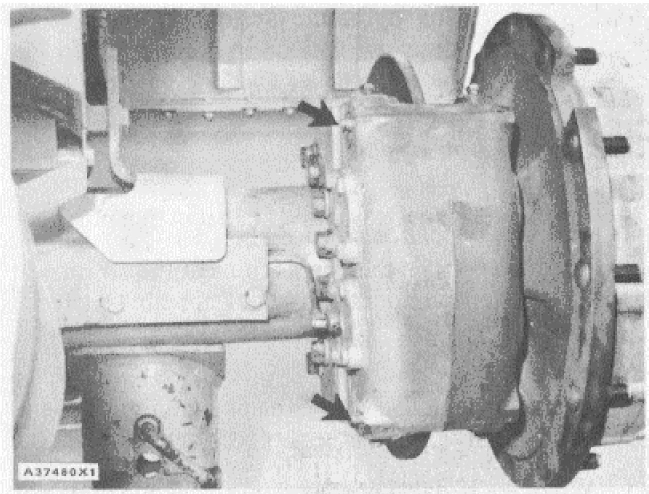
HYDRAULIC BRAKE SYSTEM SERVICING

Use heavy duty hydraulic brake fluids meeting SAE J1703C specifications only. Other fluids may cause damage to rubber parts.

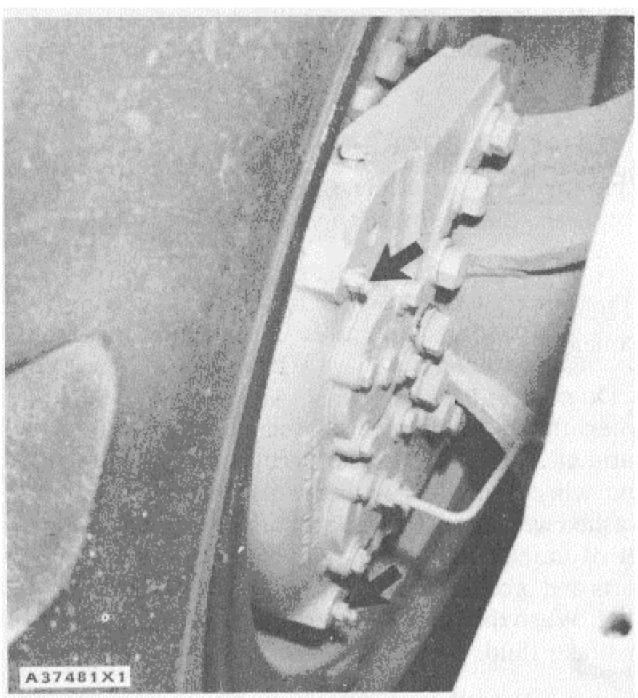
Do not let dirt or other material get in the brake fluid when the hydraulic brake system is serviced. Most parts cleaners may be used to clean master cylinders and wheel cylinders if the parts are then thoroughly washed with denatured alcohol or brake fluid to remove all of the solvent. After removal of the solvent, dry parts and protect from dust until cylinders are reassembled. Wash the rubber parts in clean denatured alcohol or brake fluid.

CAUTION
Do not use mineral base cleaning solvent such as gasoline, kerosene, distillant, carbon tetrachloride, acetone, paint thinner, etc. These solvents will damage rubber parts and cause them to become soft and of no use.

AIR REMOVAL FROM BRAKES
(Bleeding the Brakes)



VALVES THAT LET THE AIR OUT (TRACTOR BRAKES)
(Bleed Screws)



VALVES THAT LET THE AIR OUT (SCRAPER BRAKES)
(Bleed Screws)

Let the air out of system for the wheel brakes which is activated by the master cylinder.

1. Check the fluid level in the reservoir. The primary level must be .5 in. (12.7 mm) from the top of the reservoir.

NOTE: To keep air out of the master cylinder, fluid must always be seen in the reservoir while air is being let out of the system. When filling an empty system, loosen the caps on the master cylinders until fluid comes out, then tighten the caps.

2. Fasten .25 in. (6.4 mm) ID. (inside dimension) hoses to the bleed screws that lets the air out. Put the loose end of the hoses into ajar that has enough fluid in it so that the end of the hoses are under the surface of the fluid.

3. Push the brake pedal down and release it several times until the indicator rods make a shorter stroke.

4. Keep the brake pedal down and look at the indicator rod.

5. Open the bleed screws that lets the air out and look at the fluid that comes out of the hoses. Close the bleed screws when the indicator rod is extended 1.44 in. (36.6 mm).

6. Do Steps 3, 4, and 5 until the fluid that goes out of the hoses has no air bubbles.

7. Fill the reservoir to .50 in. (12.7 mm) from the top of the reservoir when necessary.

8. If necessary do the above procedure for the scraper.

TOO MUCH HEAT CAN CAUSE A TIRE TO HAVE AN EXPLOSION (SUDDEN BREAK)

WARNING

Explosions of pneumatic tires have resulted from heat-causing gas combustion inside the tires. The heat, caused by welding or heating rim components, fire, or too much use of brakes, can cause gas combustion.

A tire explosion is much more violent than a blowout. The explosion can throw the tire, rim and final drive components as far as 460 m (1500 ft.) or more from the machine. Both the force of the explosion and the debris can cause personal injury or death, and property damage.

Although an explosion is not probable, the hazard (danger) is very great, especially with large tires used on wheel tractor-scrapers.

All personnel must know of this danger and the actions to take to keep the risk at a minimum.

Heat from any source can be sent to the tire. This causes deterioration (decrease in quality) of the bead. Normally, the burned bead causes loss of air, and the tire goes flat without danger to anyone in the area.

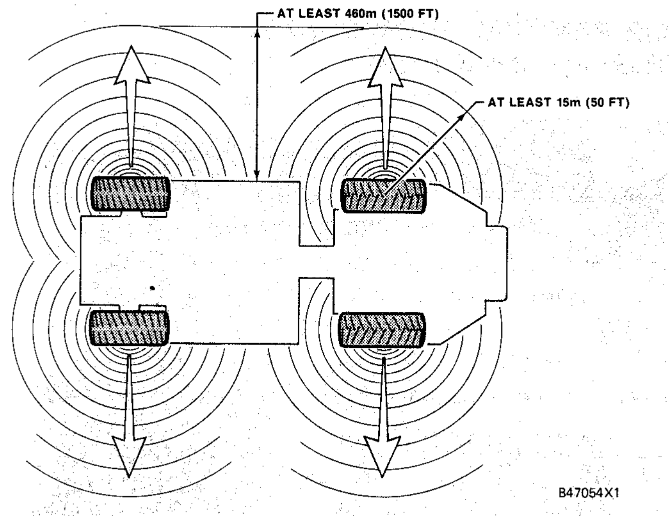
A bead that is burnt can result in the release of an explosive mixture of gas inside the tire. It is possible for the mixture of gas inside the tire to burn. The fire inside the tire causes a rapid increase in pressure. The result is a violent tire explosion. The explosion causes a blowout at the tire bead which throws the tire, rim assembly and final drive components far away from the machine.

When a wheel is in rotation, the movement of air around the tire helps in cooling the tire. There is more danger of a tire explosion after the machine stops, because of the loss of this cooling effect.

If smoke, too much heat, the smell of burning rubber or hot brakes, or other indications of bead burning are noticed, take action to prevent personal injury.

Move the machine to a remote area, but only if it can be done without danger to the operator or other personnel in the area.

Remove all personnel in the area of the machine.



WARNING

APPROACH AREAS. Do not get within 460 m (1500 ft.) from the side or within 15 m (50 ft.) from the front, rear or above a tire.

Do not go near any tire on the machine if there is a brake fire, burning rubber or other indications that the brakes have caused too much heat. This heat can have an effect on all other tires on the machine, even though the visual indication is only at one tire.

If there is an indication of a brake fire or the smell of burning rubber, do not go near the machine. FIGHT (put out) THESE FIRES FROM A REMOTE LOCATION. (Many times, the immediate action to a fire caused by tires or brakes, is for people to use a hand fire extinguisher and run up close to the machine to help put out the fire.) Keep away from the machine until the tires cool (temperature decreases). Permit at least eight hours for the tires to cool before a person goes near the machine.

Keep personnel out of the area, and at least 460 m (1500 ft.) away from the side of the tire and 15 m (50 ft.) away from the front or rear of the machine.

A small fire caused by debris on the machine is not a hazard. This type of fire can be put out with a hand fire extinguisher. A burning (smoking) tire or fire in the brake area is hazardous. These are sure indications of a hot tire. There is no completely safe way to get near a machine to put out this type of hazardous fire. Go near only at the front or rear of a machine and use a large bulldozer as a shield.

Current Recommendation

Use dry nitrogen (N2) gas for all pneumatic tires. Nitrogen will not burn inside the tire.

WARNING

Correct nitrogen inflation (charging) equipment and training in its use are needed to prevent too much pressure in a tire. A tire blowout or rim failure can result from equipment that is not correct or is not correctly used.

Also, the use of nitrogen instead of air in the tires, decreases the amount of tire deterioration. This is especially important for tires that have an expected long service life (4 or more years). It also decreases disassembly problems.

The pressure of a fully charged nitrogen cylinder is approximately 15 000 kPa (2200 psi). This high pressure can cause a tire blowout and or rim failure if the charging equipment is not used correctly. See Tire Inflation (Charging) With Nitrogen.

Tire Inflation (Charging) With Nitrogen

WARNING

Servicing and changing tires and rims can be dangerous. This work must be done only by trained personnel with correct tools and procedures. If correct procedures are not followed while servicing tires and rims, the assemblies can burst with explosive force and cause serious physical injury or death. Follow carefully the specific information provided by your tire servicing man or dealer.

When tires are changed be sure to clean all rim parts. If necessary, paint the components to prevent corrosion. Sand blasting is recommended for removal of rust. Check all components carefully and replace any cracked, badly worn, damaged, severely rusted or corroded parts with new parts of the same size and type. If there is any doubt, replace with new parts. Never rework, weld, heat or braze any rim components.

The tires on these machines are inflated (charged) with nitrogen instead of air. The recommendation is that nitrogen be used for pressure adjustments in a tire. See your tire dealer for the correct tire pressures for job conditions and for any questions on nitrogen inflation.

CORRECT POSITION FOR TIRE INFLATION (Behind the Tread)

WARNING

A tire blowout or rim failure can occur during tire inflation. To prevent possible injury get next to (behind) the tread, as shown, when inflating a tire.

Set the regulator of the nitrogen inflation equipment at no more than 140 kPa (20 psi) over the correct tire pressure.

CAUTION

Use only the 6V4040 Nitrogen Tire Inflation Group to inflate tires from a nitrogen gas cylinder. See Special Instruction, Form Number SMHS7867 for tire inflation instruction.

Use the same tire pressures for nitrogen inflation that are used for air inflation. See the Operator's manual for the shipping and operating pressures.

TOO MUCH HEAT CAN CAUSE A TIRE TO HAVE AN EXPLOSION (SUDDEN BREAK)

WARNING

Explosions of pneumatic tires have resulted from heat-causing gas combustion inside the tires. The heat, caused by welding or heating rim components, fire, or too much use of brakes, can cause gas combustion.

A tire explosion is much more violent than a blowout. The explosion can throw the tire, rim and final drive components as far as 460 m (1500 ft.) or more from the machine. Both the force of the explosion and the debris can cause personal injury or death, and property damage.

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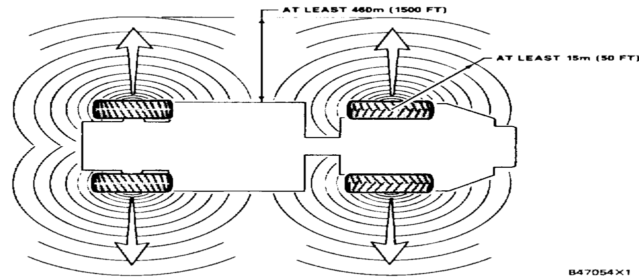

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Current Recommendation

Use nitrogen (N2) gas for all pneumatic tires. Nitrogen not burn inside the tire.

WARNING

Correct nitrogen inflation (charging) equipment and training in its use are needed to prevent too much pressure in a tire. A tire blowout or rim failure can result from equipment that is not correct or is not correctly used.

Also, the use of nitrogen instead of air in the tires, decreases the amount of tire deterioration. This is especially important for tires that ha-e an expected long service life (4 or more years). It also decreases the corrosion of rim components, which decreases disassembly problems.

The pressure of a full) charged nitrogen cylinder is approximatelI5 15000 kPa (2200 psi). This high pressure can cause a tire blovwout and or rim failure if the charging equipment is not used correctly. See Tire Inflation (Charging) With Nitrogen.

Tire Inflation (Charging) With Nitrogen

WARNING

Servicing and changing tires and rims can be dangerous. This work must be done only by trained personnel with correct tools and procedures. If correct procedures are not followed while servicing tires and rims, the assemblies can burst with explosive force and cause serious physical injury or death. Follow carefully the specific information provided by your tire servicing man or dealer.

When tires are changed be sure to clean all rim parts. If necessary, paint the components to present corrosion. Sand blasting is recommended for removal of rust. Check all components carefully and replace any cracked,bad) worn, damaged, severely rusted or corroded parts with new parts of the same size and type. If there is any doubt, replace with new parts. Never rework, weld, heat or braze any) rim components.

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CORRECT POSITION FOR TIRE INFLATION (Behind the Tread)

WARNING

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Set the regulator of the nitrogen inflation equipment at no more than 140 kPa (20 psi) over the correct tire pressure.

CAUTION

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Use the same tire pressures for nitrogen inflation that are used for air inflation. See the Operator's Manual for the shipping and operating pressures.

CHAPTER 3
DISASSEMBLY AND ASSEMBLY
(TRACTOR)

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SECTION 1
DISASSEMBLY AND ASSEMBLY
3208 VEHICULAR ENGINE

HOOD

REMOVE HOOD

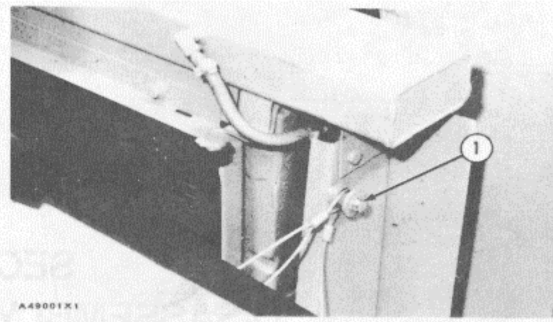
1. Remove bolts (1), the washers and lock washers from each side of the radiator. Disconnect the spring from the eyebolt on the right hand side of the radiator frame. Lower the hood all of the way forward.

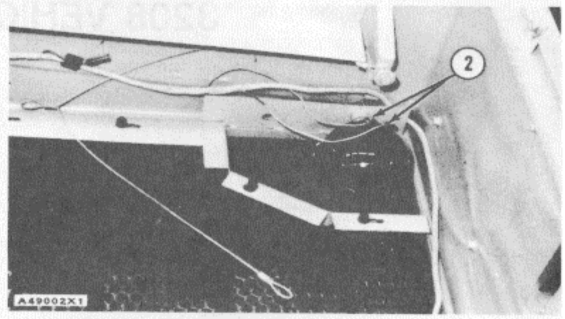
2. Put identification on wires (2) as to their location on the headlights and disconnect them from both headlights.

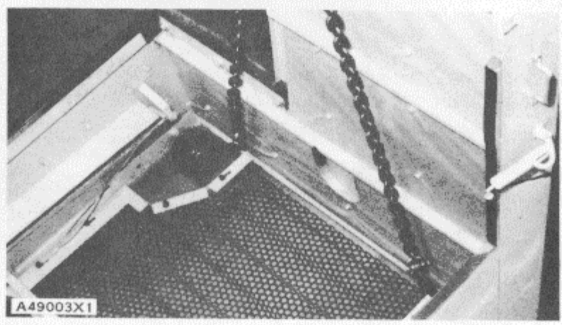
3. Fasten a hoist to the hood.

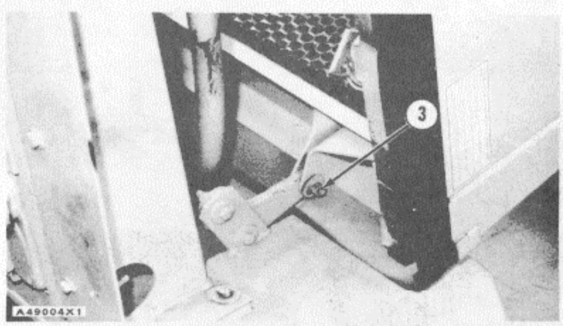
4. Remove nuts (3), the bolts, washers and lock washers from the two hinges. Remove the hood. The weight of the hood is 70 lb. (32 kg).

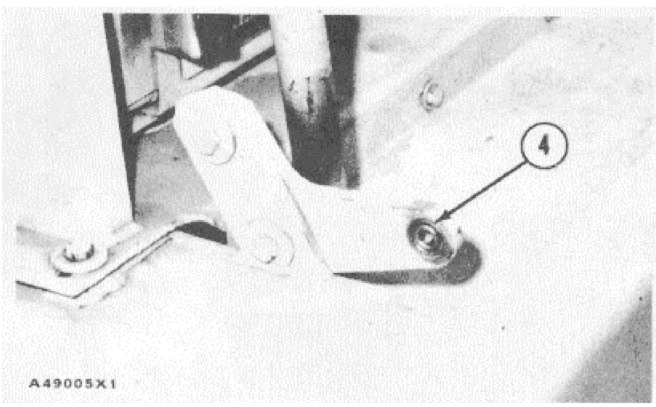
5. If necessary, remove four bushings (4) from the brackets on the tractor frame.











HOOD

INSTALL HOOD

1. Install bushings (2) into brackets (1).

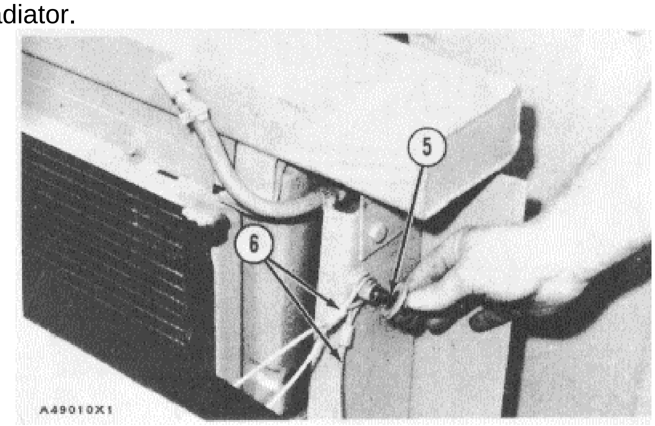
2. Fasten a hoist to the hood and put it in position on the machine.

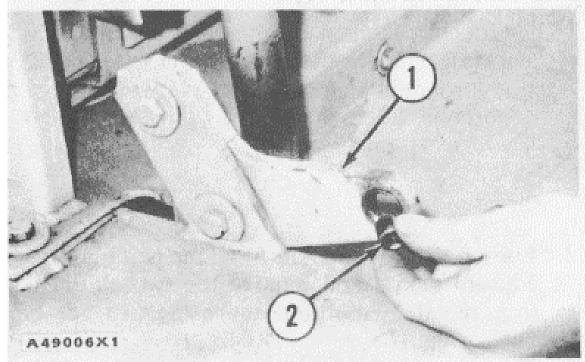
3. Install bolts (3), the washers, lock washers and nuts to hold the hood. Remove the hoist.

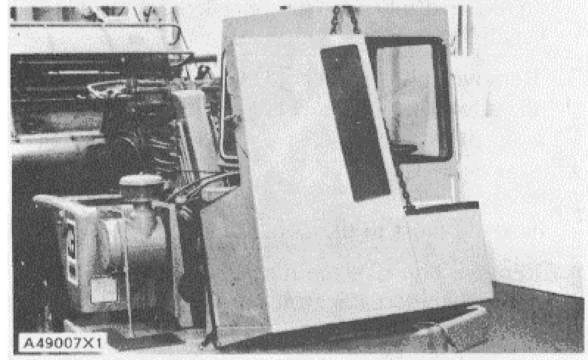
4. Connect wires (4) to their correct locations on both headlights.

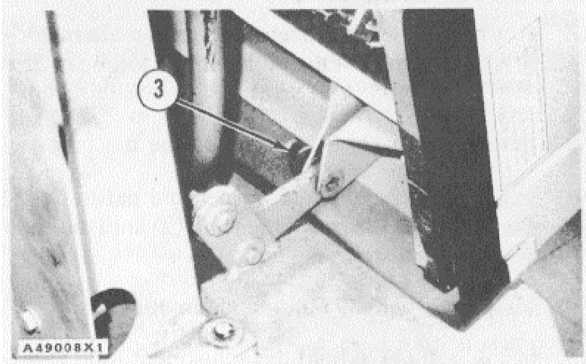
5. Lift the hood and put cables (6) in position on both sides of the radiator and install bolts (5), the washers and lock washers to hold them.

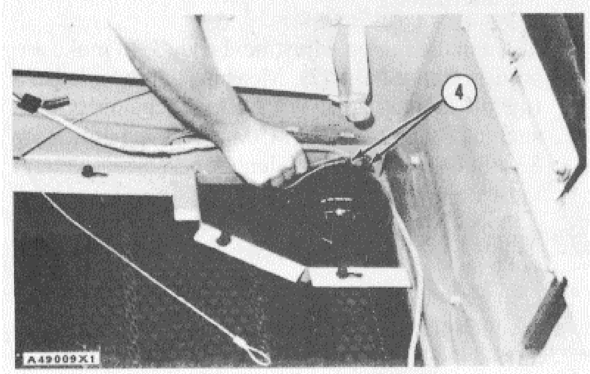
6. Fasten the spring to the eyebolt on the right hand side of the radiator.











ALTERNATOR

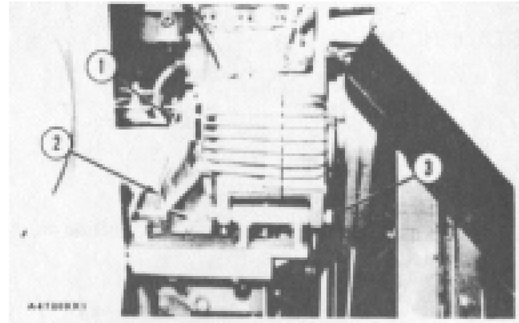
REMOVE ALTERNATOR

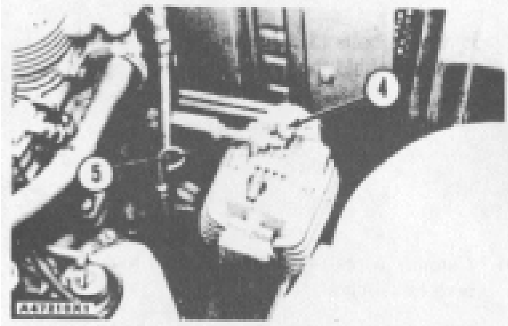
I. Put identification on electric wires (I) and (2)as to their location on the alternator. Disconnect the wires from the alternator.

2. Loosen bolt (3) and nut (5) on the belt tightener adjustment rod and remove the two vee belts from the alternator pulley.

3. Remove bolt (4) that holds the adjustment rod to the alternator.

4. Remove bolt (3), the nut and lock washer. Remove the alternator from the machine.





INSTALL ALTERNATOR

1. If a new pulley has been installed on alternator (i), tighten the nut that holds it to a torque of 75 + 5 lb. ft. (100 + 7 N. m). 2. Put alternator (1) in position on the machine.

3. Install bolt (2), the lock washer and nut to hold the alternator. Do not tighten bolt (2) until the vee belts are adjusted.

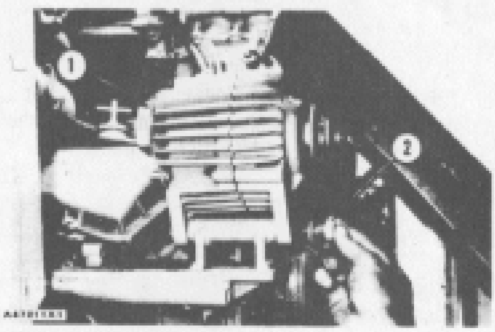
4. Install vee belts (7) on the alternator pulley.

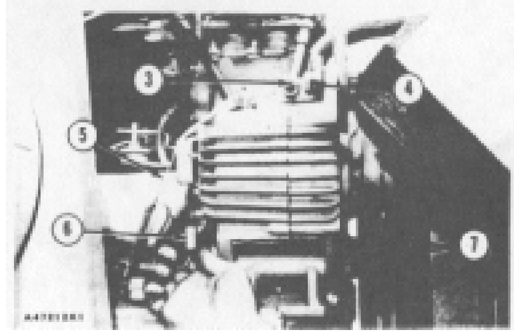
5 Install bolt (4) to hold the adjustment rod (3) to the alternator.

6. Tighten the nut on adjustment rod (3) to make an adjustment of belts (7). Measure the outside belt toward the radiator, with a belt tension gauge such as Burroughs Tool Company Part No. BT- 33-96-4-16 or an equivalent. The correct gauge indication is 120 + 5.

7. Tighten bolt (2).

8. Connect electrical wires (5) and (6) to their correct location on the alternator.





DISASSEMBLE DELCO REMY ALTERNATOR

1. Position alternator in a vise or similar clamping device.

CAUTION

Be careful not to over tighten alternator in vise. Damage is possible to alternator if vise is overtightened.

2. Retain alternator pulley (1) and remove lock-nut (2) and washer (3). Remove alternator pulley.

NOTE: Refer to page 3-10A for illustration. 3. Remove fan (4).

4. Remove four bolts (5) and pull end frame (6) and rotor (7) out of the alternator housing as an assembly.

5. Press rotor (7) out of end frame (6).

6 Remove three screws (8), retainer (9), and collar (10).

7. Remove shield (I 1) and collar (12).

8. Press bearing (13) out of end frame (6).

9. Remove plate (14) and washer (15).

10. Remove four screws (16) and regulator cover (17).

11. Disconnect three stator leads that are attached to regulator (18) by removing nuts (19) from rectifier bridge (20).

12. Remove nut securing regulator connector (1) to regulator.

13. Remove nut (22) and field coil lead from regulator (18).

14. Remove screw (23) and remaining field coil lead from regulator (18).

15. Remove two regulator mounting screws (24), lock washers (25), washers (26), and regulator (18).

16. Remove nut (27), lock washer ('8), and washer (29) from alternator output terminal.

17Remove nut (30) and insulator (31) from output terminal.

18. Remove screw (32), washer (33), bushing (34), connector (35), and output terminal (36) with terminal insulator (37).

19. Remove cap (38).

20. Remove nut which secures connector (39) to regulator (20).

21. Remove nut (40) and connector (39).

22. Remove nut (41), insulators (42, 43, 44). And relay terminal (45).

23. Remove screw (46), washer (47), and connector (2 1).

24. Remove rectifier bridge mounting screws (-18) and remove rectifier bridge (20) and bridge insulator (49).

25. Remove screw (50), suppression capacitor (51), and capacitor bracket (52).

26. If necessary, remove diodes (53) from rectifier bridge (20).

27. Remove screws (54) and field coil/support assembly (55).

28. Pull stator (56) leads and grommet (57) from stator housing (58). Remove stator.

29. If necessary, remove bearing (59) from stator housing.

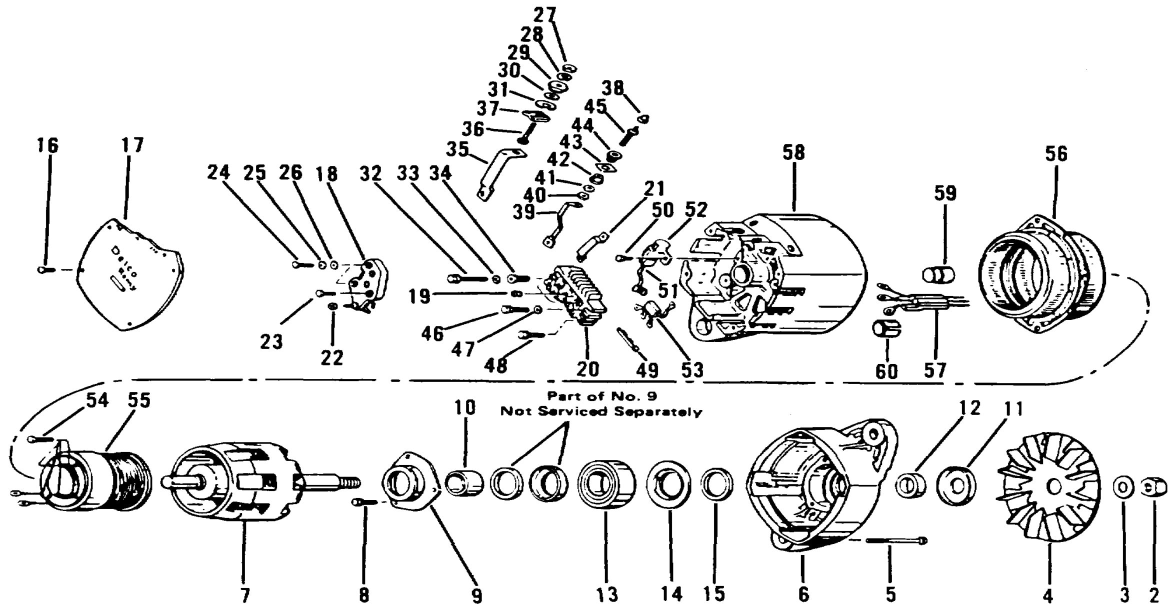
30. If necessary, remove hinge bushing (60)

ASSEMBLE DELCO REMY ALTERNATOR

1. If removed, press hinge bushing (60) into stator housing (58).

2. Use Delco-Remy lubricant (Part No. 1948791) to fill reservoir on bearing (57) half full. Posi-tion lubricant so that a portion of the lubricant touches the bearing surface.

3. Press bearing (59) into stator housing until end of bearing is even with the inside of the stator housing.



4. Apply a small amount of silicone grease to grommet (57) and pull stator wires into stator housing.

5. Secure field coil/support assembly (55) with screws (54).

6. If removed, install diodes (53) in rectifier bridge (20).

7. Secure suppression capacitor (51) with bracket (52) and screw (50).

8. Install screws (48) and rectifier bridge (20) with insulator (49). Tighten screws (48) to a torque of 17. 8 to 22. 2 lb. in. (2. 0 to 2. 5 N. m).

9. Secure connector (21) to rectifier bridge (20) with screw (46) and washer (47).

10. Install relay terminal (45), terminal insulators (44, 43, 42), and nut (41).

11. Attach connector (39) to relay terminal with nut (40).

12 Secure other end of connector (39) to regulator (20) with attaching nut.

13. Install cap (38) over relay terminal.

14. Install output terminal (36) with terminal insulator (37), connector (35), bushing (34), washer (33). and screw (32).

15. Install insulator (31) and nut (30) on output terminal.

16. Install washer (29), lockwasher (28), and nut (27) on output terminal.

17. Secure regulator (18) with washers (26), lockwashers (25), and mounting screws (24).

18. Connect field coil leads to regulator with screw (23) and nut (22).

19. Use nut to secure connector (21) to regulator.

20. Secure three stator leads to regulator (18) with nuts (19).
21. Attach regulator cover (17) to stator housing with four screws (16).
22. Install washer (15) and plate (14).
23. Install bearing (13) in end frame (6).
24. Install collar (10), retainer (9), and three screws (8).
25. Install rotor (7) shaft into end frame (6).
26. Secure end frame assembly to stator housing with four bolts (5).
27. Install fan (4), pulley (1), locknut (2), and washer (3).
28. Position alternator in a vise or similar clamping device.

CAUTION

Be careful not to overtighten alternator in vise. Damage is possible to alternator if vise is overtightened.

29. Tighten locknut (2) to a torque of 70 to 80 lb. ft. (95 to 109 N. m).

30. The rotor normally retains magnetism to provide voltage buildup as the rotor turns. However, after disassembly it may be necessary to remagnetize the rotor. Use the following procedures to magnetize the rotor:

(1) Install the alternator.

(2) Remove protective cap (38) from alter- nator relay terminal.

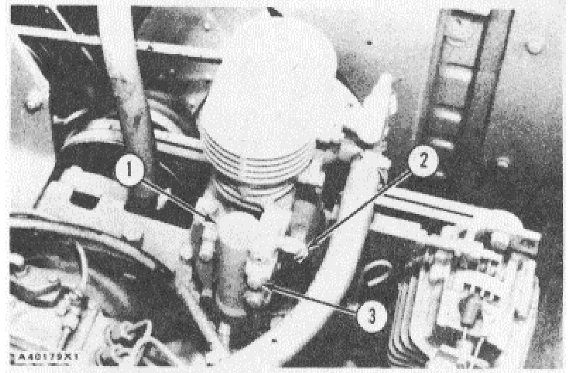
(3) Momentarily connect a jumper lead from the battery positive post to the relay terminal on the alternator.

(4) Install protective cap (38) on alternator relay terminal.

AIR COMPRESSOR GOVERNOR

REMOVE AIR COMPRESSOR GOVERNOR

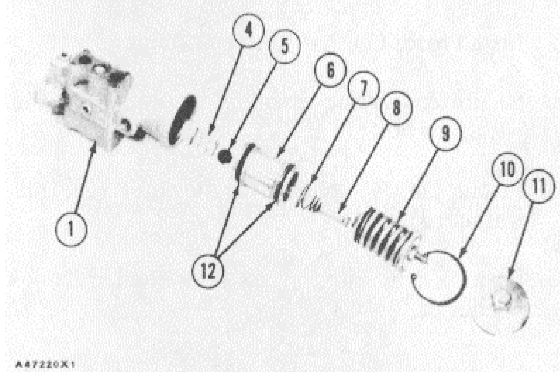
WARNING: Do not disconnect any air line unil the air pressure in the system is at zero.



NOTE: The governor can be disassembled to be cleaned and inspected. If the parts have wear or damage, install a new governor on the air compressor.

1. Disconnect air line (2) from governor housing (1).

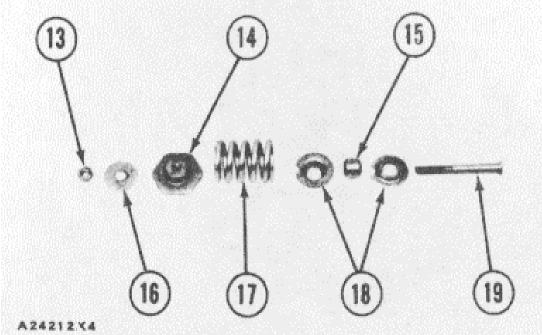
2. Remove two bolts (3) and remove governor housing (I), the spacer and two gaskets from the air compressor.



3. Remove cover (I I) from governor housing (1).

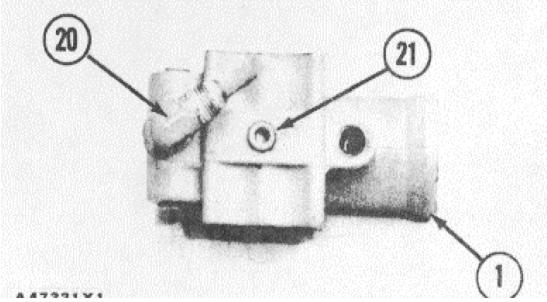
4. Remove ring (10), spring assembly (9), valve (8), spring (7), sleeve (6), valve (5) and spring (4) from the governor housing. Remove O-ring seals (12) from sleeve (6). Make a note of the position of valve (5) for installation purposes.

NOTE: Before spring assembly (9) is disassembled, mark the location of nut (13) on bolt (19) for correct spring tension at assembly.



5. To disassemble spring assembly (9), remove adjustment nut (13), washer (16), retainer (14), grommets (18), spacer (15) and bolt (19) from spring (17).

6. Remove elbow (20) and plug (2' 1) to remove the filters from governor housing (1).



AIR COMPRESSOR GOVERNOR

INSTALL AIR COMPRESSOR GOVERNOR

1. Put filters (3) in locations (I) and (2) in governor housing (4).

2. Install the plug in location (2) and the elbow in location (1) in governor housing (4).

3. Install O-ring seals (6) on sleeve (9). Make sure the small grommet is in position inside of sleeve (9).

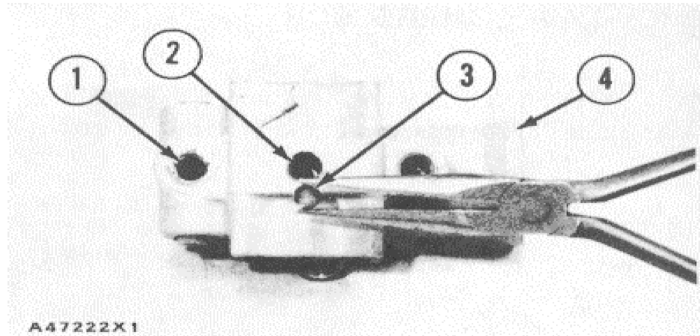
4. Install spring (5), valve (10), sleeve (9), spring (7) and valve (8) in governor housing (4).

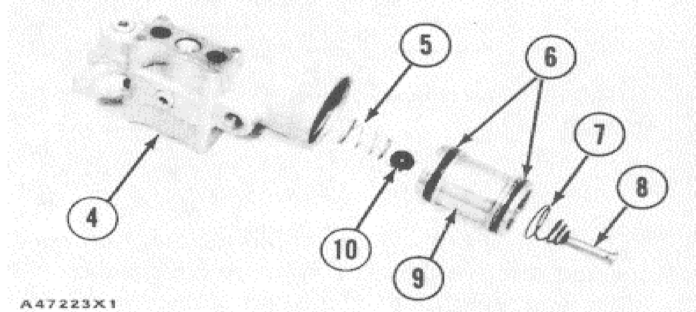
5. Install grommet (14). spacer(17), grommet (13) on bolt (18). Install this assembly in spring (16). Install retainer (12), washer (15) and tighten adjustment nut (II) over bolt (18) to the original position before it was disassembled for correct spring tension.

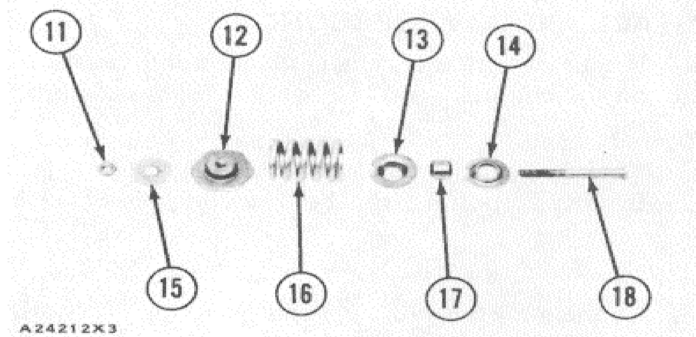
6. Install the spring assembly, ring (19) and cover (20) in governor housing (4).

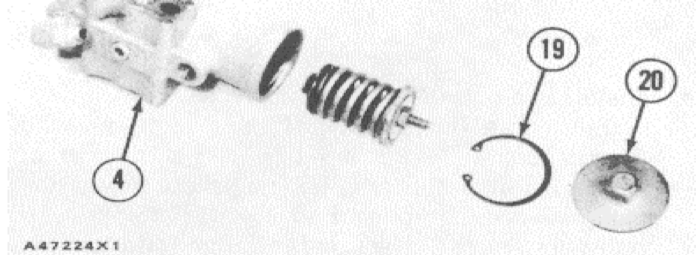
7 Put governor housing (4), the spacer and two gaskets in position on the air compressor and install bolts (22) to hold it.

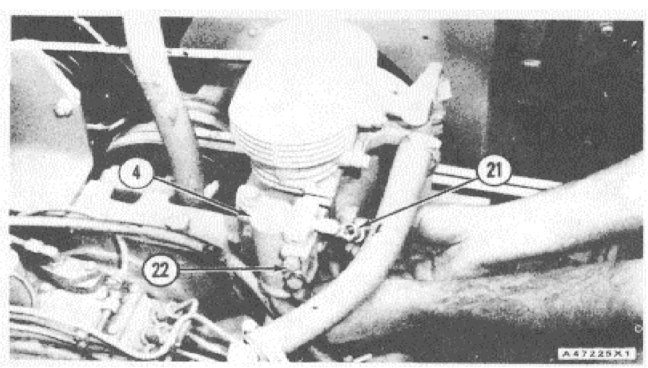
8. Connect air line (21) to governor housing (4). NOTE: For more information on the air compressor and governor see AIR COMPRESSORS in VEHICLE SYSTEMS.





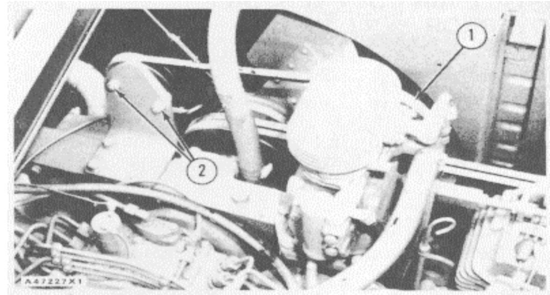






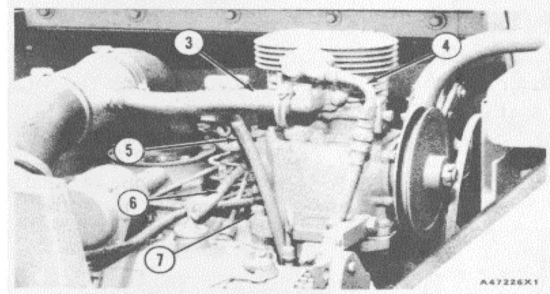
AIR COMPRESSOR

REMOVE AIR COMPRESSOR



WARNING: Do not disconnect the air lines until the air pressure in the system is at zero.

1 Loosen bolts (2) to release the tension and remove vee belt (1) from the air compressor pulley.

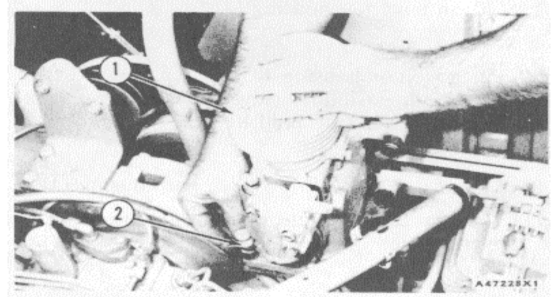


2. Disconnect air lines (3), (4) and (6) from the air compressor.

3. Disconnect air line (5) from the air compressor governor.

4. Remove four bolts (7) that hold the air compressor and remove the air compressor from the engine. The weight of the air compressor is 30 lb. (14 kg).

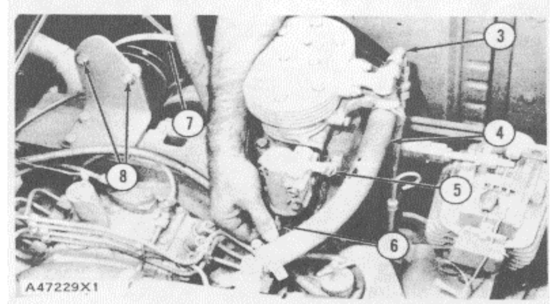
INSTALL AIR COMPRESSOR



1. Put air compressor (1) and the gasket in position on the engine.

2. Install four bolts (2) that hold air compressor(l).

3. Connect air lines (3), (4) and (6) to the air compressor.



4. Connect air line (5) to the air compressor governor.

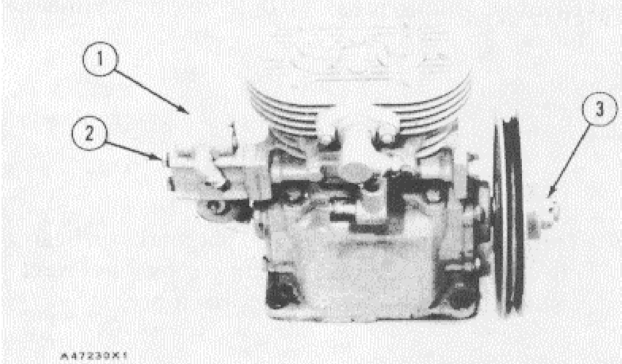
5. Install vee belt (7) on the air compressor pulley. Tighten bolts (8) for the belt tightener to hold the correct tension on vee belt (7). To get the correct belt tension use a tension gauge such as Burroughs Tool Company Part No. BT-33-96-4-16 or an equivalent. The correct gauge indication is 120 + 5.

AIR COMPRESSOR

DISASSEMBLE AIR COMPRESSOR

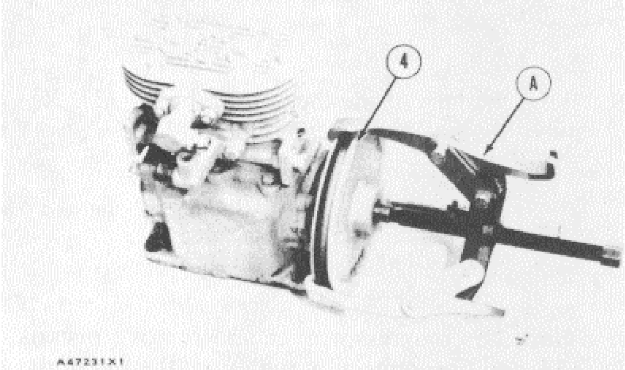
Tools Needed		A
B		
1 P2321	Puller Assembly	1
BH663 1	Bearing Puller Attachment	
1 P457	Plate	1

start by:
a) remove air compressor

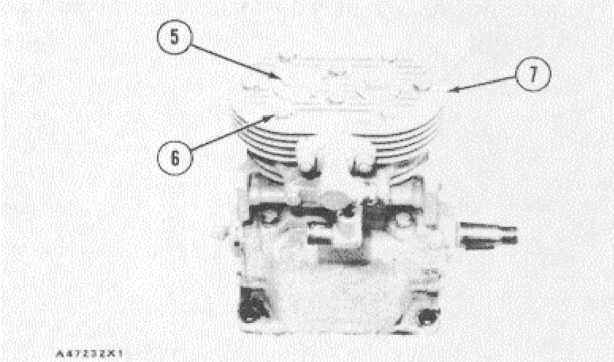


1. Remove two bolts (2) and remove air compressor governor (I), the spacer and two gaskets from the air compressor. NOTE: To disassemble governor (I) see REMOVE AIR COMPRESSOR GOVERNOR.

2. Remove the cotter pin and nut (3) from the air compressor.



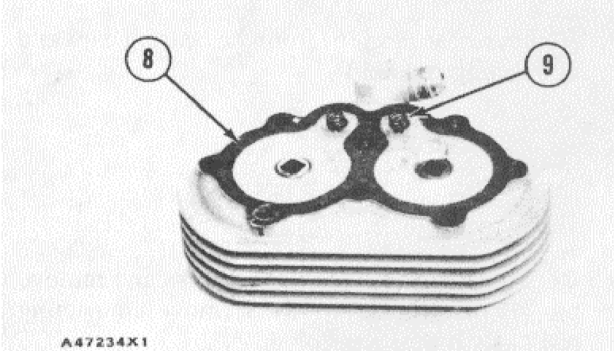
3. Remove pulley (4) from the air compressor with tool (A).
NOTE: Before the compressor is disassembled put identification marks on the crankcase, cylinder block, end covers, crankshaft, and cylinder head for correct installation and alignment at assembly.



4. Remove cap nuts (5), the springs and discharge valves.

5. Remove bolts (6) and cylinder head (7).

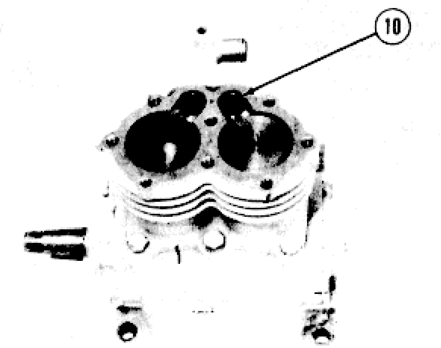
6. Remove gasket (8) and inlet valve springs (9) from the cylinder head.



AIR COMPRESSOR

7. Remove inlet valves (10) from the cylinder block.

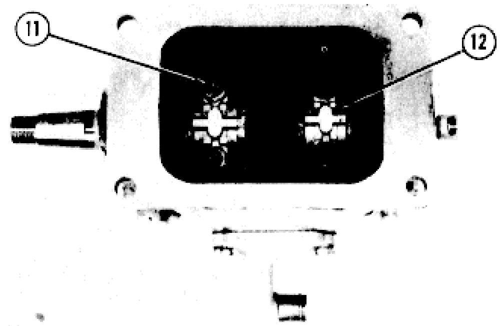
8. Turn the compressor over and put marks on bearing caps (12) and the connecting rods for correcinstallation and alignment at assembly.



A47235X1

9. Bend the tabs of the locks from bolts (I I). Remove the bolts and bearing caps (12).

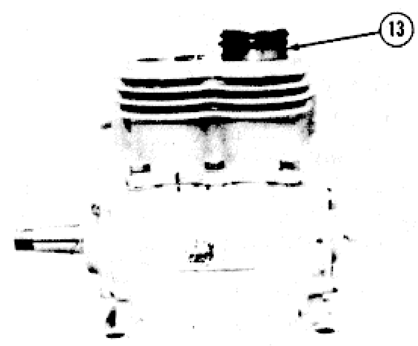
10. Turn the compressor over and remove pistons (1 3) and the connecting rods from the top of the cylinder block. Connect the bearing caps to their connecting rods so the) do not become mixed for assembl)y.



A47237X1

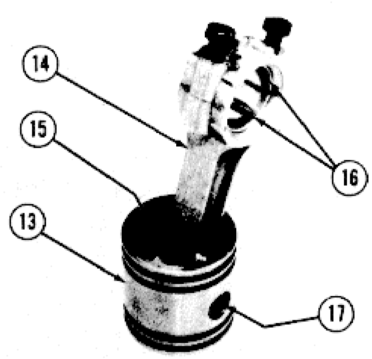
11. Remove the rings from pistons (13).

12. Remove bearings (16) from the bearing caps and connecting rods (14).



A47246X1

3. Remove lockwire (15). Use a press and remove pin (17) from piston (13). Remove connecting rod (14) from the piston.



A47239X1

AIR COMPRESSOR

14. Remove the six bolts that hold cylinder block (18) to the crankcase. Remove cylinder block (18) and the gasket.

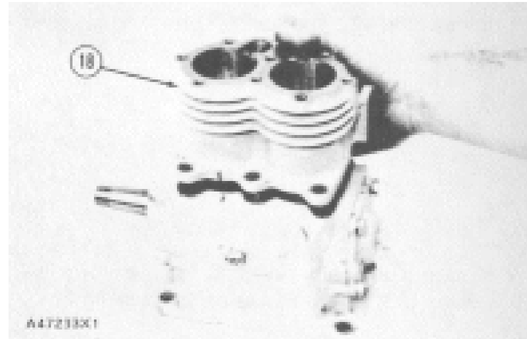
15. Remove the two bolts and remove inlet elbow (19) and plate (20) from cylinder block (18).

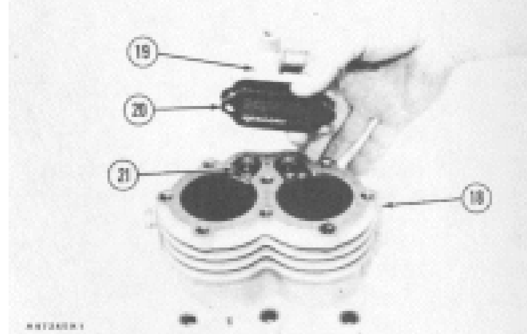
16. Remove inlet valve guides (21) from cylinder block (18).

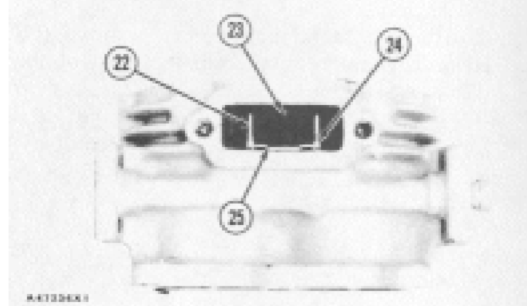
17. Remove the unloader mechanism from the cylinder block as follows:
    a) remove spring (23).
    b) remove saddle (25).
    c) remove plungers (22) and pistons (24).

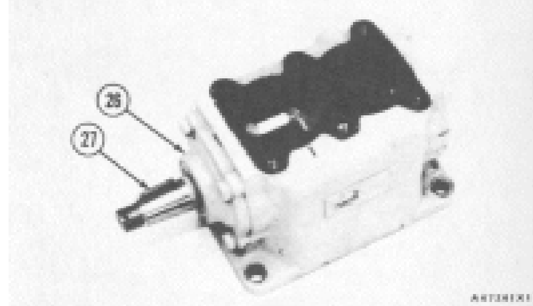
18. Remove key (27) from the crankshaft.

19. Remove the four bolts and remove front cover (26) from the crankcase.









AIR COMPRESSOR

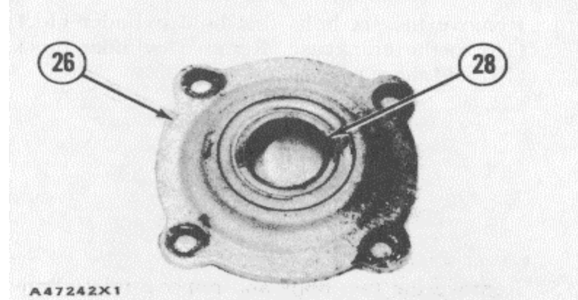
20. Remove the lip type seal (28) from front cover (26).

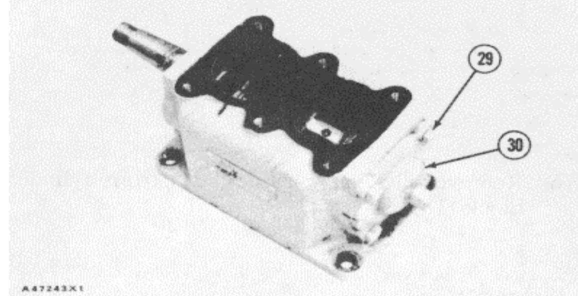
21. Remove four bolts (29) and remove cover assembly (30) from the rear of the crankcase.

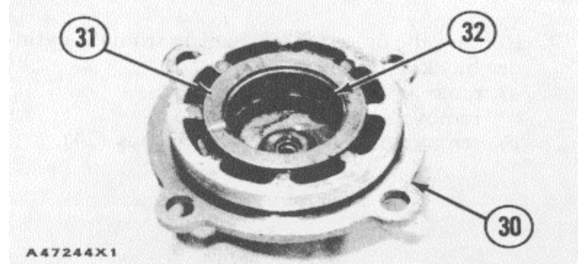
22. Remove washer (31) and bearing (32) from cover assembly (30).

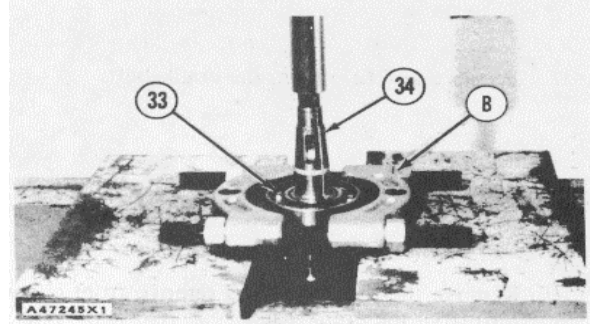
23. Use a soft faced hammer to remove the crankshaft and bearing from the front of the crankcase.

24. Use tooling (B) and a press to remove bearing (33) from crankshaft (34).









CLEANING AND INSPECTION OF PARTS

CLEANING

All parts should be cleaned thoroughly in a good cleaning solvent before inspection.

CYLINDER HEAD ASSEMBLY

Remove all carbon deposits from discharge cavities and all rust and scale from cooling cavities of cylinder head body. Scrape all foreign matter from body surfaces and use air pressure to blow dirt particles from all cavities. Discharge valves can be dressed by lapping them on a piece of fine crocus cloth on a flat surface, provided they are not excessively worn.

CYLINDER BLOCK

Clean carbon and dirt from inlet and unloader passages. Use air pressure to blow carbon and dirt deposits from unloader passages.

Inlet valves, as in the case of discharge valves, not worn excessively, can be cleaned by lapping them on a piece of fine crocus cloth on a flat surface.

OIL PASSAGE

Clean thoroughly all oil passages through crankshaft, connecting rods, crankcase and end covers. If necessary inspect passages with a wire and blow foreign matter out with air pressure.

INSPECTION OF PARTS

CYLINDER HEAD BODY

Inspect cylinder head body for cracks or damage.

DISCHARGE VALVES AND SEATS

If discharge valves are worn and grooved where they contact the seats, they should be replaced. If the discharge valve seats are worn excessively so that there is no longer enough metal left to reclaim them by lapping, the seats should be replaced.

DISCHARGE VALVE SPRING AND CAP NUTS

Replace all used discharge valve springs and cap nuts.

CRANKCASE AND END COVERS

Check for cracks or broken lugs in crankcase and end covers. Also check their oil passages to make sure they are open and clean

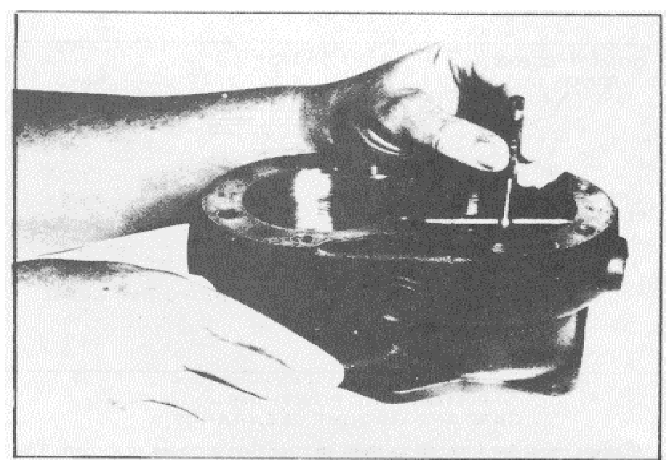
Check the crankshaft sleeve bearing in the rear end cover for excessive wear and flat spots and replace if necessary.

CYLINDER BLOCK

Check for cracks or broken lugs on cylinder block. Also check unloader bore bushings to be sure they are not worn, rusted or damaged. If these bushings are to be replaced they can be removed by running a 1/8 in. pipe thread tap inside the bushing, then inserting a 1/8 in. pipe threaded rod and pulling the bushing straight up and out. Do not use an easy-out for removing these bushings.

INLET VALVES AND SEATS

If inlet valves are grooved or worn where they contact the seat, they should be replaced. If the inlet valve seats are worn or damaged so they cannot be reclaimed by facing, they should be replaced.



MEASURING CYLINDER BORES

CYLINDER BORES

Cylinder bores which are scored or out of round by more than 0. 002 in. or tapered more than 0. 003 in. should be rebored or honed oversize. Oversize pistons are available in 0. 010, 0. 020, and 0. 030 oversizes.

Cylinder bores must be smooth, straight, and round. Clearance between cast iron pistons and cylinder bores should be between 0. 002 in. minimum and 0. 004 in. maximum (Fig. 20).

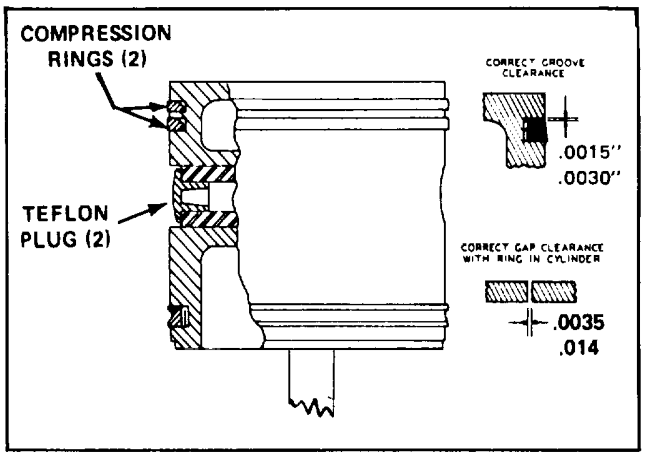
PISTONS

Check pistons for scores, cracks or enlarged ring grooves; replace pistons if any of these conditions are found. Measure each piston with a micrometer in relation to the cylinder bore diameter to be sure the clearance is between 0. 002 in. minimum and 0. 004 in. maximum.

Check fit of wrist pins on pistons and connecting rod bushings. Wrist pin should be a light press fit in pistons. If wrist pin is loose fit, the pin, piston, or both should be replaced. Check fit of wrist pin in connecting rod bushing by rocking the piston. This clearance should not exceed 0. 0015 in. Replace wrist pin bushings if excessive clearance is found. Wrist pin bushings should be reamed after being pressed into connecting rods. Replace Teflon plugs in each end of the wrist pins.

PISTON RINGS

Check fit of piston rings in piston ring grooves. Check ring gap with rings installed in cylinder bores.



PISTON RING POSITIONS - GAPS AND GROOVE CLEARANCE

All rings must be located in their proper ring grooves as shown. The rings can be identified by the width and should be installed with the bevel or the pipmark (if any) toward the top of the piston. This applies to Cast Iron Pistons (only as shown above).

CRANKSHAFT

Check crankshaft screw threads, keyways, tapered ends and all machined and ground surfaces for wear, scores, or damage. Crankshaft journals which are out of round more than 0. 001 in. must be reground. Bearing inserts are avail- able in 0. 010 in. , 0. 020 in. , and 0. 030 in. undersizes for reground crankshafts. Main bearing journals must be maintained so bearings are snug fit. Check to be sure the oil passages are open and clean through the crankshaft.

CONNECTING ROD BEARINGS

Check connecting rod bearings on crankshaft journals for proper fit. Used bearing inserts should be replaced. Connecting rod caps are not interchangeable. The locking slots of the connecting rod and cap should be positioned adjacent to each other. Clearance between the connecting rod journal and the connecting rod bearing must not be less than 0. 0003 in. Or more than 0. 0021 in. after rebuilding.

MAIN BEARINGS

Check for wear or flat spots; if found, bearings should be replaced. The sleeve bearing should be checked for scores and wear and replaced if necessary.

UNLOADER MECHANISM

Used unloader mechanism should be replaced by unloader kit 265014.

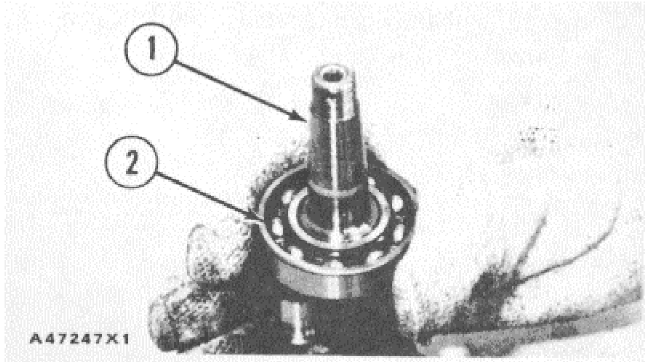
The new unloader pistons should be a loose sliding fit in the unloader piston bores of the cylinder block.

AIR COMPRESSOR

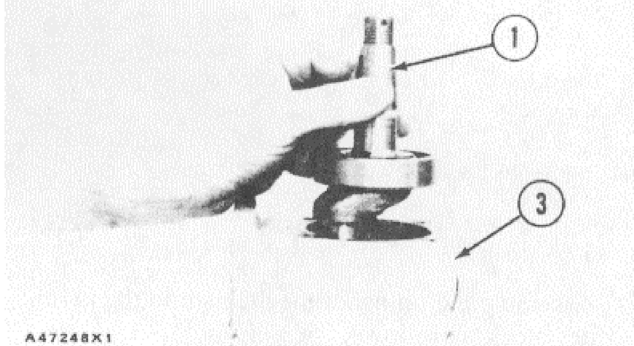
ASSEMBLE AIR COMPRESSOR

	Tools Needed	A	B	C
1P510	Driver Group	1		
9S289	Compressor		1	
	PLASTIGAGE			

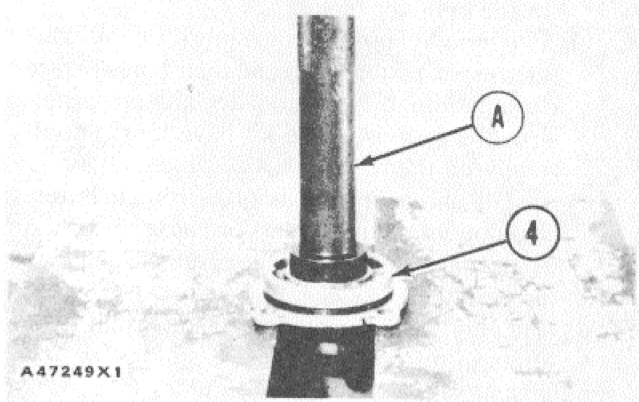
1. Heat bearing (2) in oil to a maximum temperature of 275°F (I 35°C) and install it on crankshaft (I)



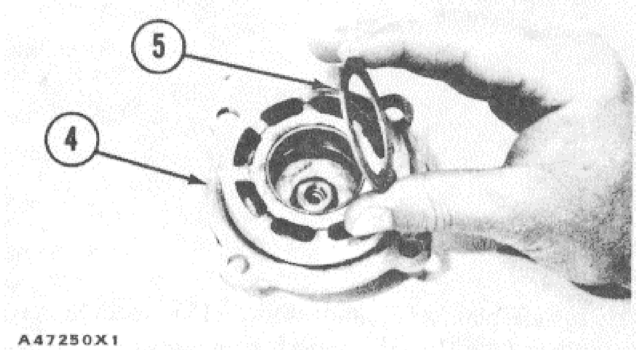
2. Install crankshaft (1) in crankcase (3).



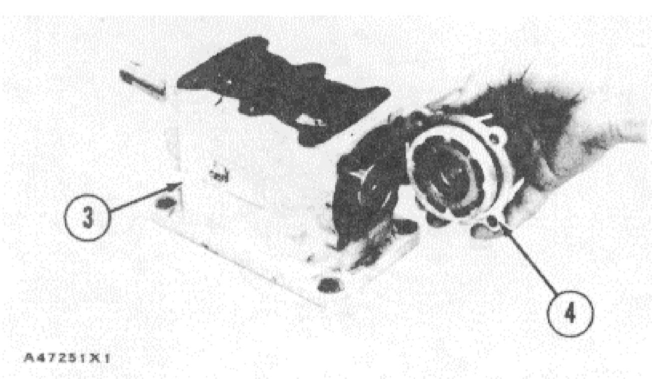
3. Install the bearing in rear crankshaft cover assembly (4) with tool group (A).



4. Install washer (5) in cover assembly (4).

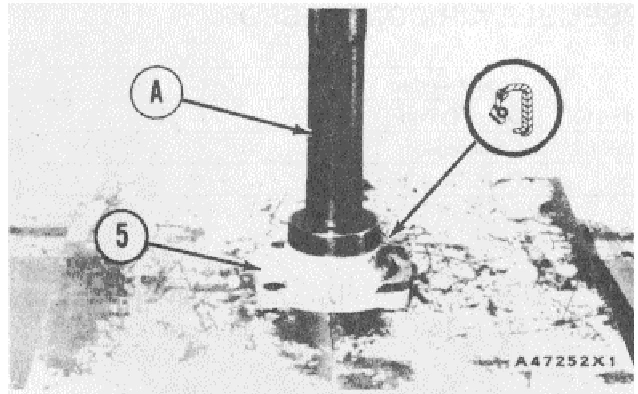


5. Install cover assembly (4) on crankcase (3).

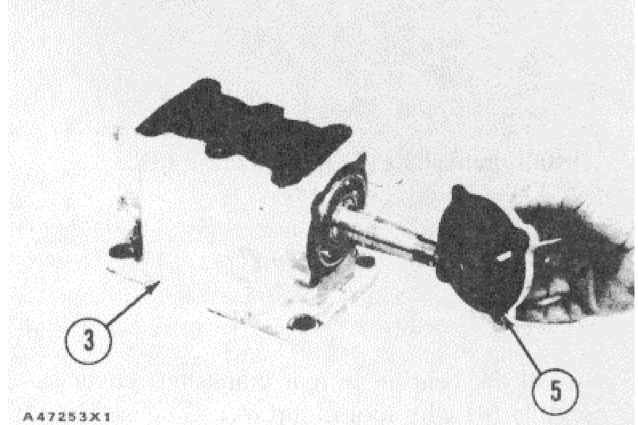


AIR COMPRESSOR

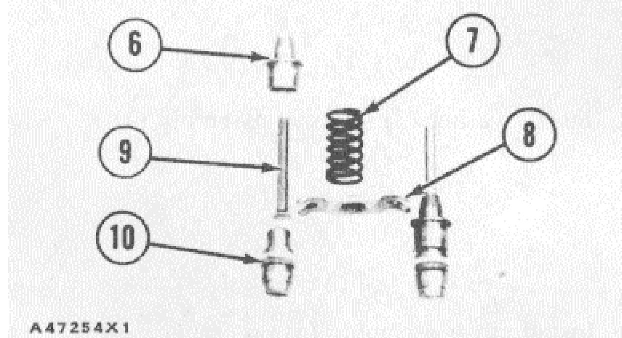
6. Use tool group (A) and install the seal in front cover (5) with the lip of the seal toward the inside as shown.



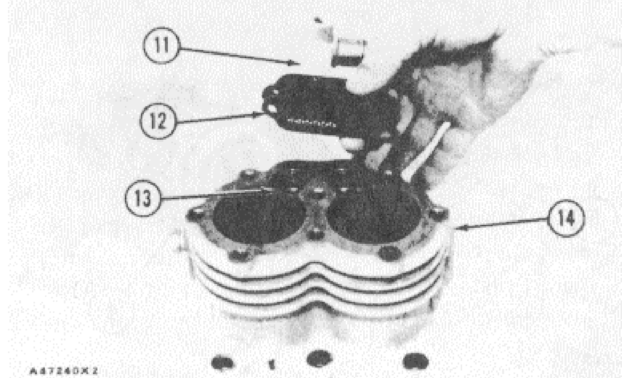
7. Install cover (5) on crankcase (3).



8. Assemble the unloader mechanism in the cylinder block as follows:
   a) Make sure the seat for spring (7) is in position in the cylinder block.
   b) Put diethy1 polysiloxane lubricant (silicone grease) on pistons (10) and their bores before installation. If new unloader kits are installed, the pistons in the kit have lubricant already on them.
   c) Install unloader pistons (10) in their bores. Do not cut the grommets or cause distortion to the back-up rings on the pistons when they are installed.
   d) Put plungers (9) in guides (6) and install these units in pistons (10).
   e) Install saddle (8) between guides (6).
   f) Install spring (7). Make sure the spring is fitted correctly on the seat and saddle (8).

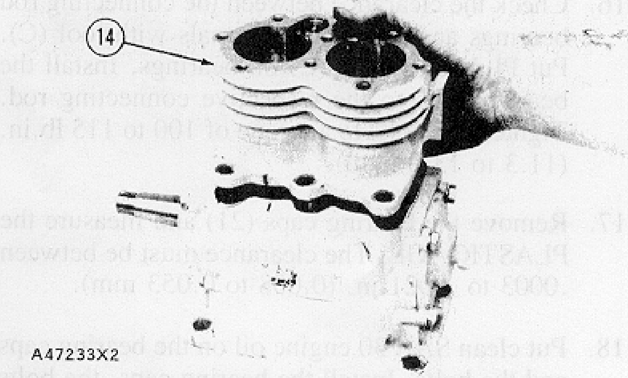


9. Install plate (12) and elbow (II) on cylinder block (14). Install inlet valve guides (13).

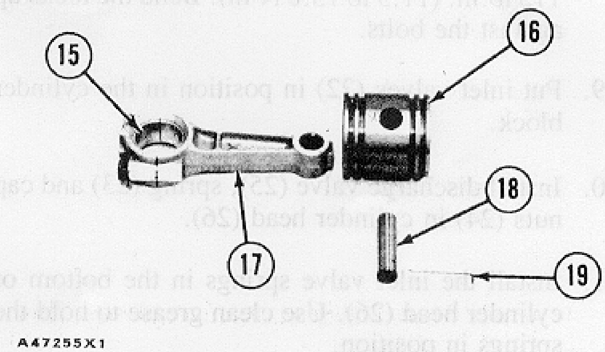


AIR COMPRESSOR

10. Put cylinder block (14) in position on the crankcase and install the six bolts that hold it.

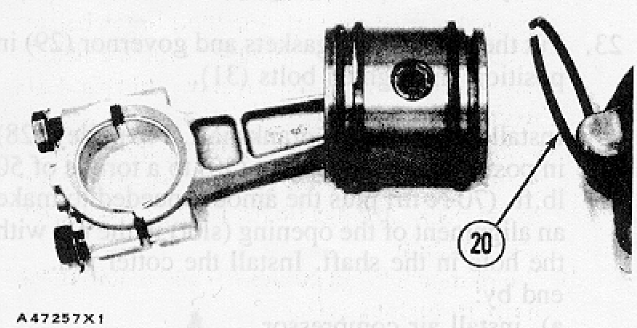


11. If necessary use a press and install a new bushing in connecting rod (17). The new bushing must be made larger with a reamer after it is installed.

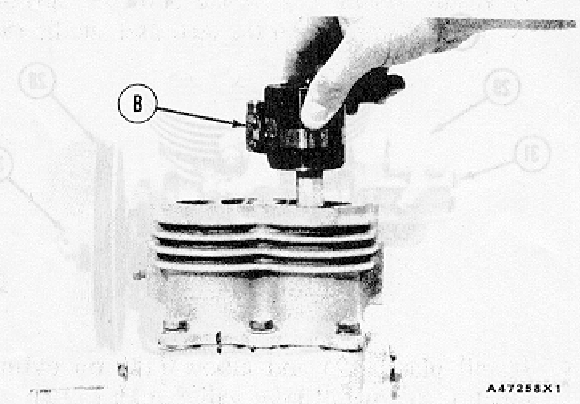


12. Put piston (16) in position on connecting rod (17) and use a press to install pin (18). Make sure the hole in the pin is in alignment with the hole in the piston so the lockwire can be installed. Install lockwire (19).

13. Install bearings (15) in connecting rod (17).



14. Install rings (20) on the pistons with the narrow side of the rings toward the top of the piston.



15. Put clean SAE 30 engine oil on the piston rings and connecting rod bearings. Turn the crankshaft so one of the connecting rod journals is in the "DOWN" position. Install tool (B) over the piston to put the piston rings under compression. Install piston assembly in cylinder bore. Make sure the connecting rod is over the crankshaft journal.

AIR COMPRESSOR

16. Check the clearance between the connecting rod bearings and crankshaft journals with tool (C). Put PLASTIGAGE (C) on bearings. Install the bearing caps to the respective connecting rod. Tighten the bolts to a torque of 100 to 115 lb. in. (I 1.3 to 13.0 N m).

17. Remove the bearing caps (21) and measure the PLASTIGAGE. The clearance must be between .0003 to .0021 in. (0.008 to 0.053 mm).

18. Put clean SAE 30 engine oil on the bearing caps and the bolts. Install the bearing caps, the bolts and lock,,. Tighten the bolts to a torque of 100 to 1 15 lb. in. (I 1.3 to 13.0 N m). Bend the locks up against the bolts.

19. Put inlet valves (22) in position in the cylinder block.

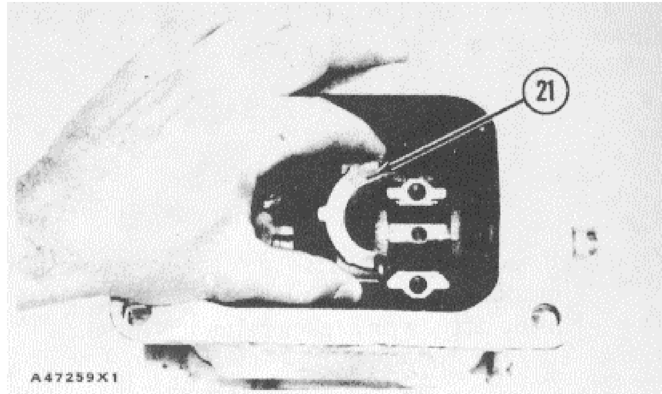
20. Install discharge valve (25), spring (23) and cap nuts (24) in cylinder head (26).

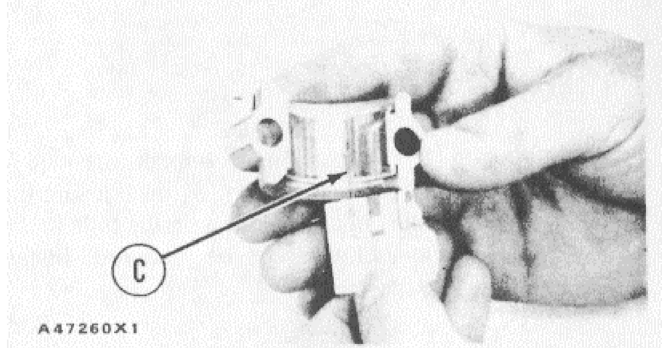
21. Install the inlet salve springs in the bottom of cylinder head (26). Use clean grease to hold the springs in position.

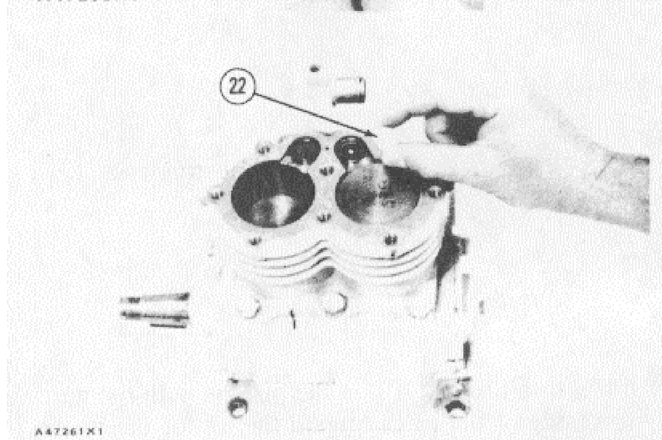
22. Put the cylinder head and gasket in position on the cylinder block and tighten bolts (27) evenly.

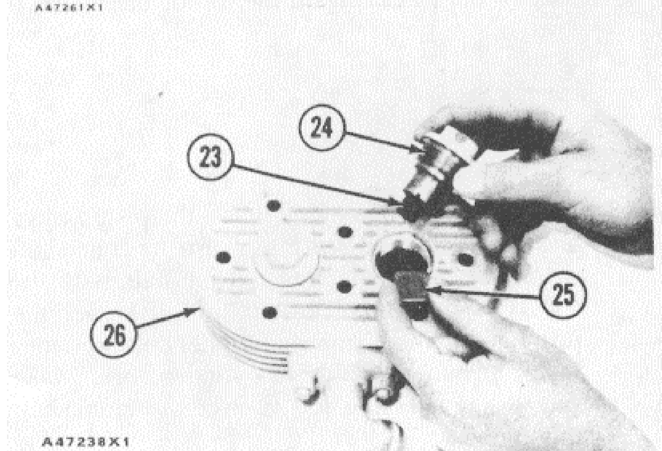
23. Put the spacer, two gaskets and governor (29) in position and tighten bolts (31).

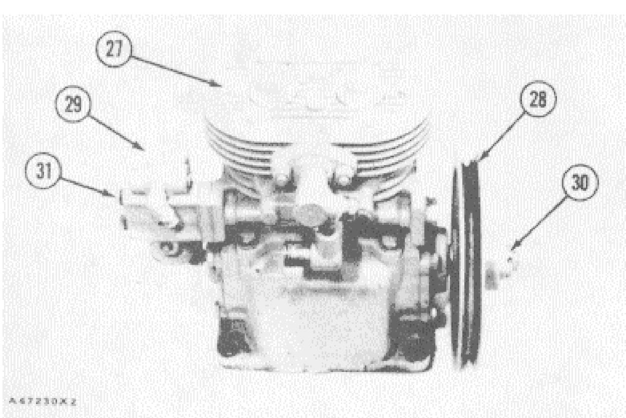
24. Install the key in the crankshaft. Put pulley (28) in position and tighten nut (30) to a torque of 50 lb. ft. (70 N-m) plus the amount needed to make an alignment of the opening (slot) in the nut with the hole in the shaft. Install the cotter pin. end by:
    a) install air compressor





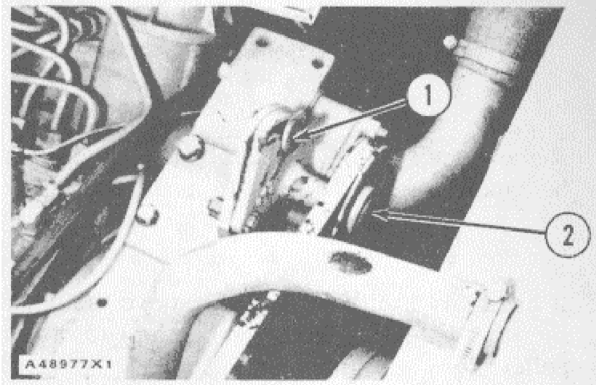






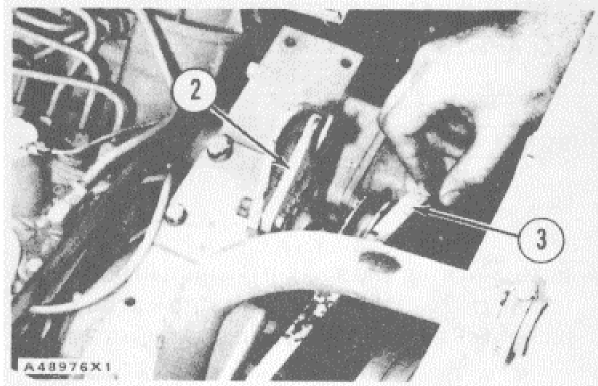
BELT TIGHTENER (AIR COMPRESSOR)

REMOVE AND INSTALL BELT TIGHTENER (AIR COMPRESSOR)



1. Loosen two bolts (1) and nuts to release the tension on the vee belt. Remove the belt from tightener pulley.

2. Remove bolts ( ), the nuts and belt tightener (2).



3. Put belt tightener (2) in position on the bracket and install bolts (1) and the nuts.

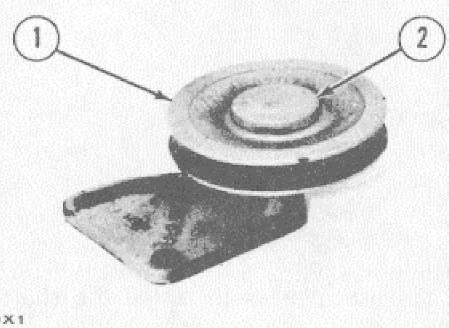
4. Put vee belt (3) in position.

5. Make an adjustment of the belt tension. To get the correct belt tension use a tension gauge such as Burroughs Tool Company Part No. BT-33-96-4-16 or an equivalent. The correct gauge indication is 120 + 5.

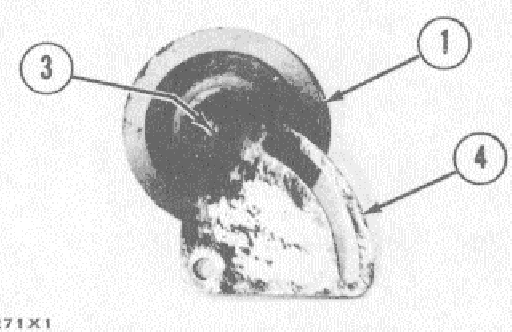
DISASSEMBLE BELT TIGHTENER (AIR COMPRESSOR)

	Tools Needed	A
1P1857	Pliers	1

start by:
a) remove belt tightener



1. Remove cap (2) from pulley (1).



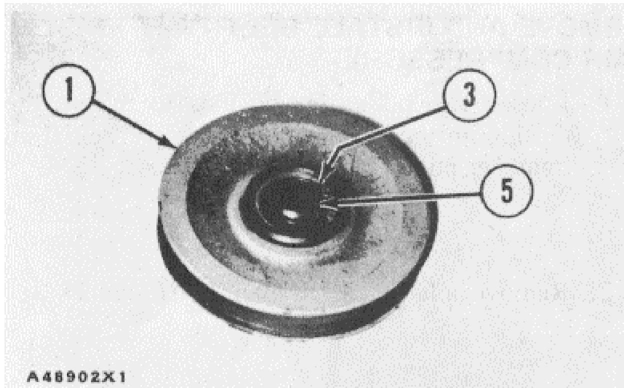
2. Use a hammer and punch to remove shaft (3) and pulley (1) from bracket (4).

BELT TIGHTENER (AIR COMPRESSOR)

3. Use tool (A) to remove ring (3) that holds the bearing and shaft (5) in pulley (1).

4. Remove shaft (5) and the bearing from pulley (1) by hand. Remove the shaft from the bearing.

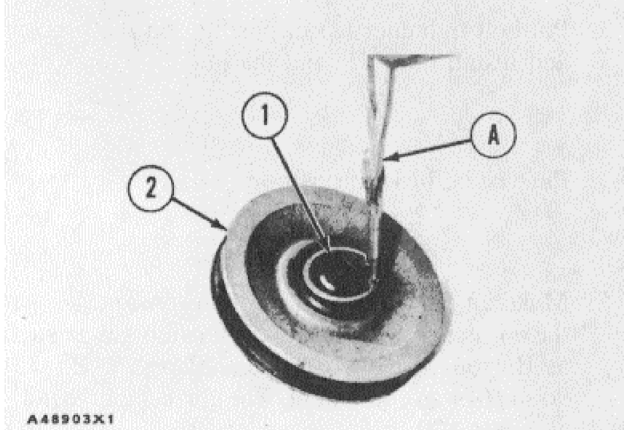
5. If necessary use tool (A) and remove the other ring that holds the bearing and shaft (5) from pulley (1).



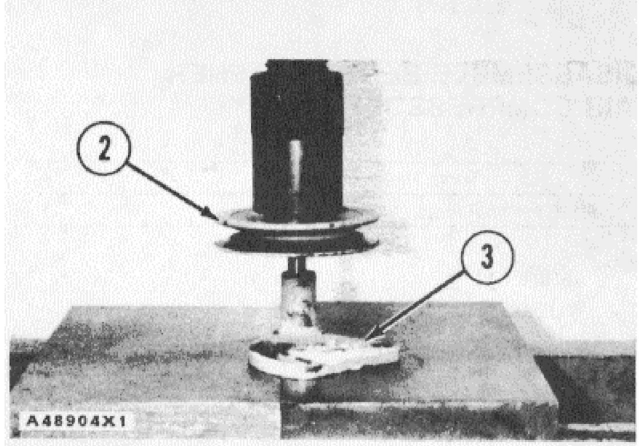
ASSEMBLE BELT TIGHTENER (AIR COMPRESSOR)

	Tools Needed	A
1P1857	Pliers	1

1. Put the bearing and shaft in position in pulley (2). Install rings (1) with tool (A) on each side of pulley (2) to hold the bearing in position.

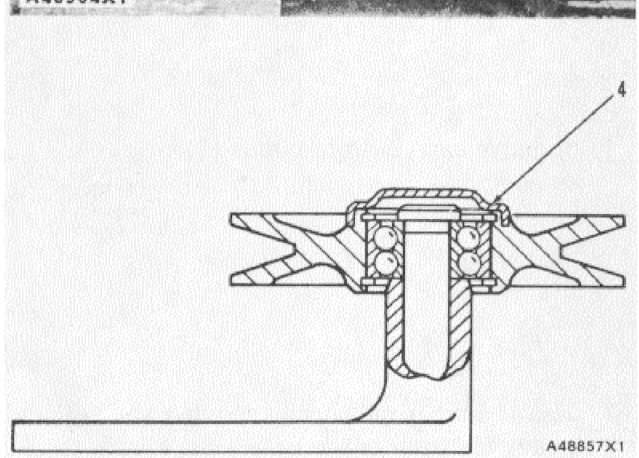


2. Put pulley (2) and the shaft in position on bracket (3) and use a press to install the shaft in the bracket.



3. Install cover (4) on the pulley.

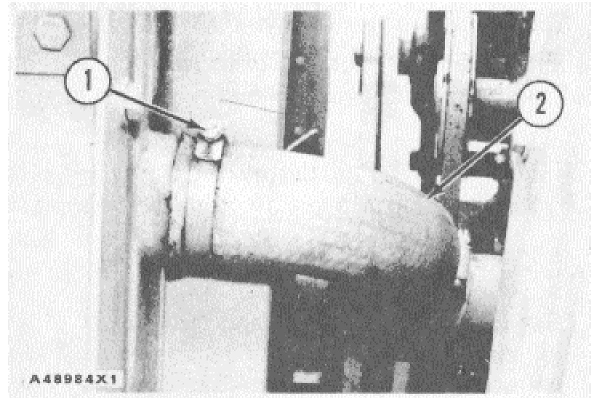
   end by:
   a) install belt tightener



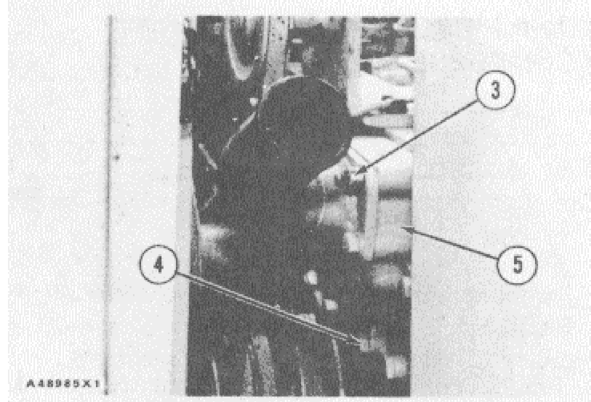
WATER TEMPERATURE REGULATORS

REMOVE WATER TEMPERATURE REGULATORS

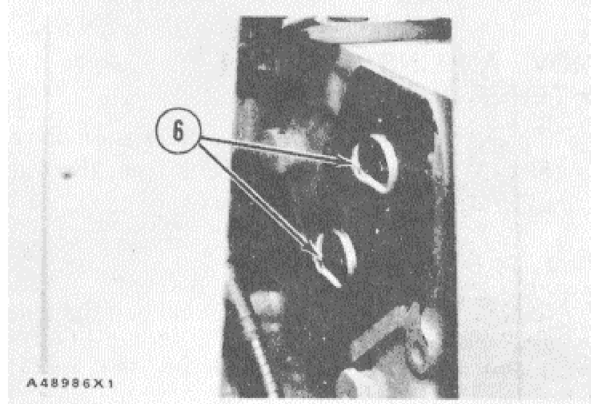
1. Drain the coolant from the cooling system.



2. Loosen clamps (1) and remove hose (2) from the radiator and water temperature regulator housing.



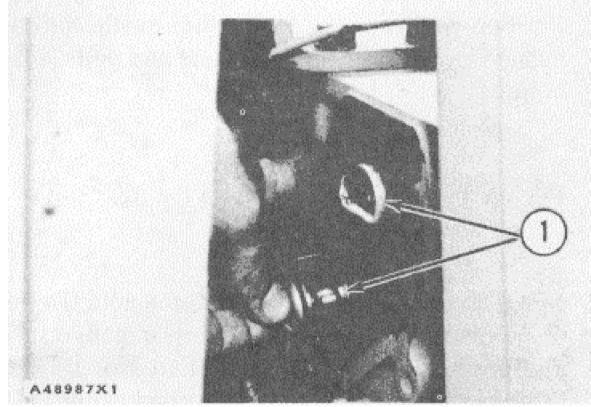
3. Remove bolts (4), the washers and nuts (3) and remove water temperature regulator housing (5) and gasket from the timing gear cover.



4. Remove water temperature regulators (6).

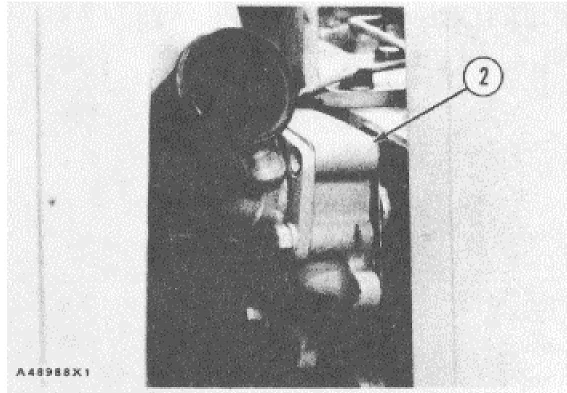
INSTALL WATER TEMPERATURE REGULATORS

1. Install water temperature regulators (1) in the timing gear cover with the spring toward the inside as shown.

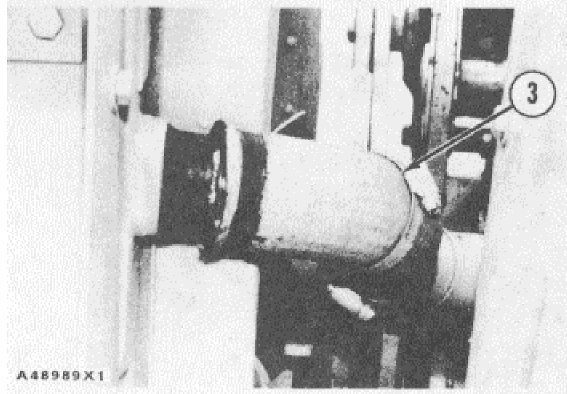


**WATER TEMPERATURE REGULATORS,
BELT TIGHTENER (WATER PUMP)**

2. Put housing (2) and the gasket in position and install the bolts, washers and nuts to hold it.



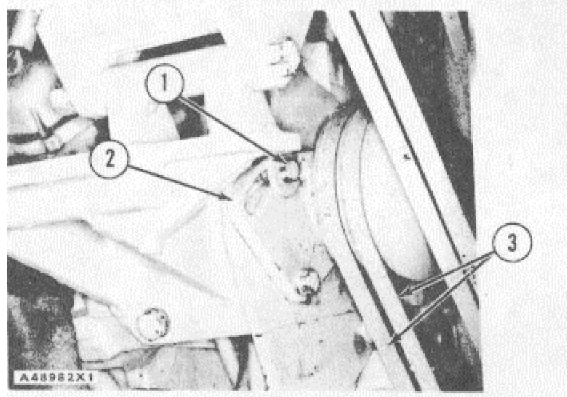
3. Install hose (3) and tighten the clamps.



4. Fill the cooling system with coolant to the correct level.

REMOVE AND INSTALL BELT TIGHTENER (WATER PUMP)

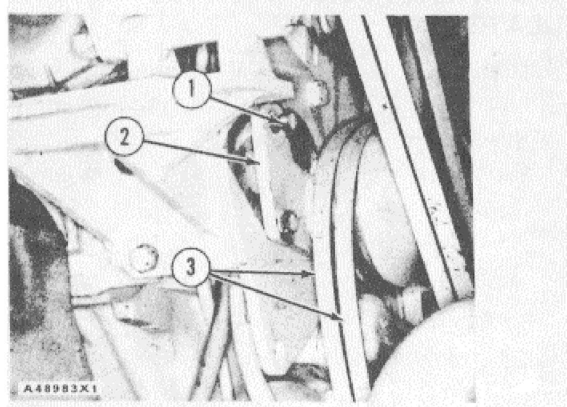
1. Loosen two bolts (1) to release the tension on vee belts (3). Remove the vee belts from the idler pulley.



2. Remove bolts (1), the washers and belt tightener (2).

3. Put belt tightener (2) in position on the timing gear cover and install the washers and bolts (1) to hold it.

4. Put vee belts (3) in position on the idler pulley.

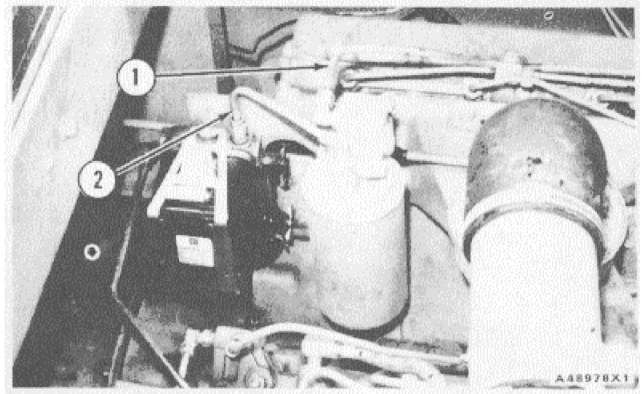


5. Make an adjustment of the belt tension. To get the correct belt tension use a tension gauge such as Burroughs Tool Company. Part No. BT-33- 96-4-16 or an equivalent. The correct gauge indication is 120 + 5.

FUEL FILTER BASE

REMOVE FUEL FILTER BASE

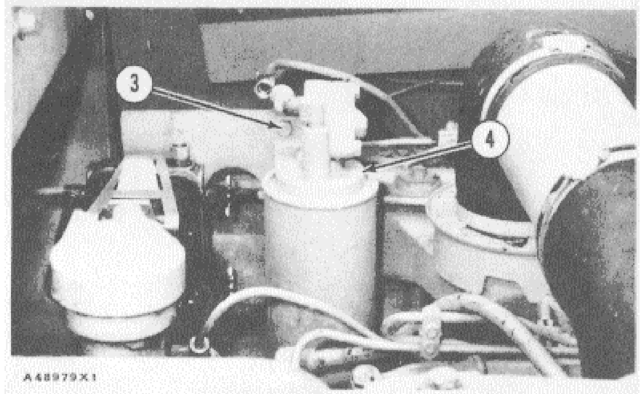
	Tools Needed	A
1P8250	Strap Wrench	1



1. If the fuel filter is to be removed from the base use tool (A) to loosen it.

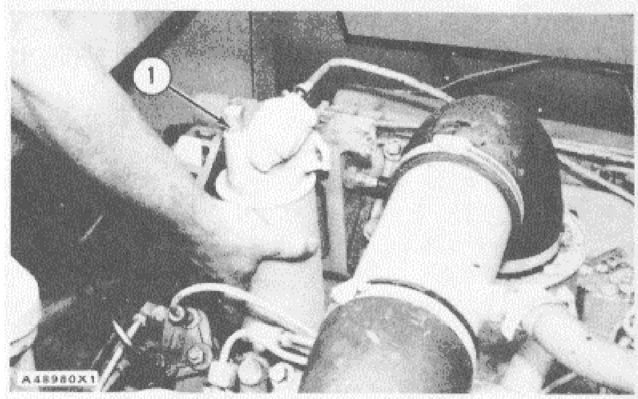
2. Disconnect tube assembly (1) from the fuel filter base.

3. Remove tube assembly (2) from the engine.

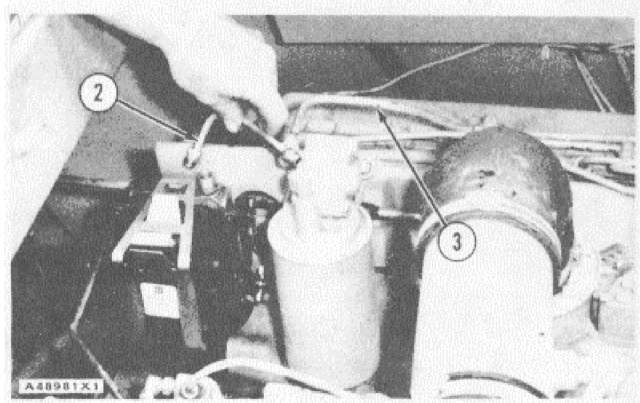


4. Remove bolts (3), the nuts and washers and remove fuel filter and filter base (4) from the engine.

INSTALL FUEL FILTER BASE



1. Put the fuel filter and filter base (1) in position on the bracket assembly and install the bolts, washers and nuts that hold it.

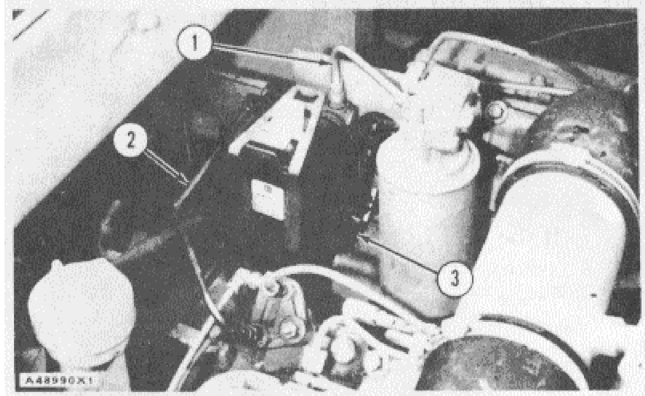


2. Connect tube assembly (3) to the fuel filter base.

3. Install tube assembly (2) to the water separator and fuel filter base.

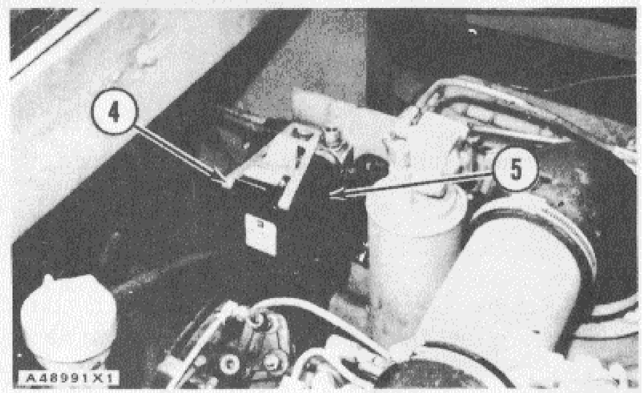
WATER SEPARATOR

REMOVE WATER SEPARATOR

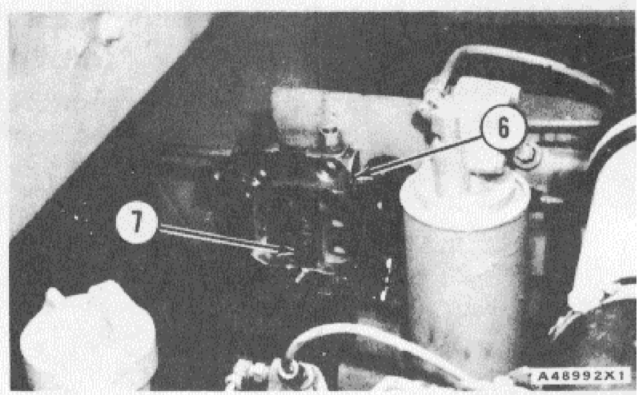


1. Drain the water from the separator.

2. Remove tube assemblies (1) and (2). Put plugs and caps over all fuel line openings.



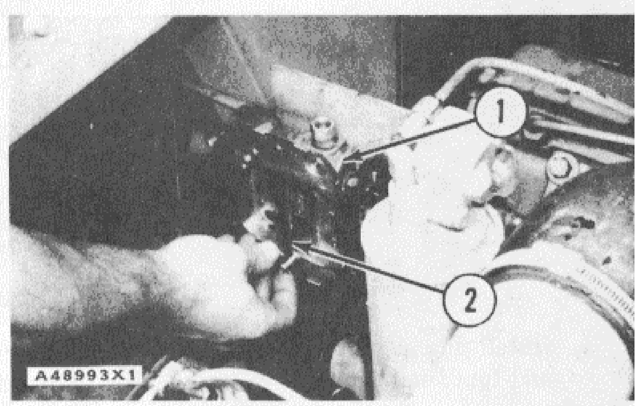
3. Disconnect drain hose (3) from the separator.



4. Remove clamp (4) and element (5) from the base.

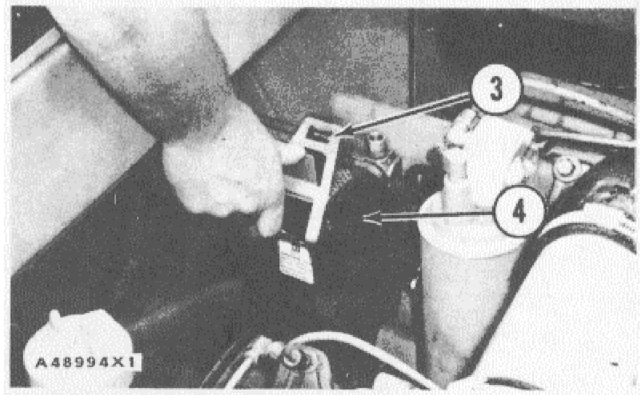
5. Remove bolts (7), the nuts and washers to remove base (6) from the bracket.

INSTALL WATER SEPARATOR



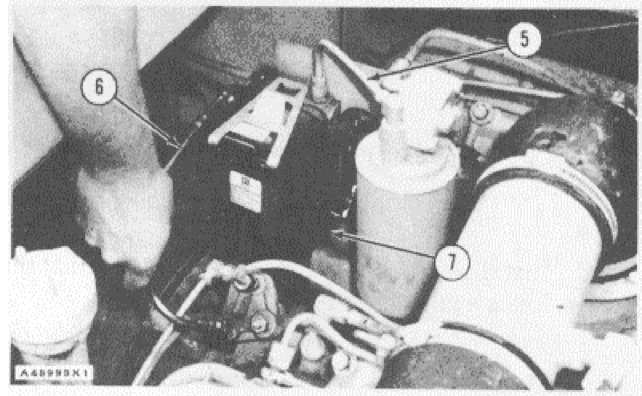
1. Put base (1) in position on the bracket and install bolts (2), the washers and nuts to hold it.

2. Put element (4) in position on the base and install clamp (3) to hold it.



3. Connect drain hose (7) to the base.

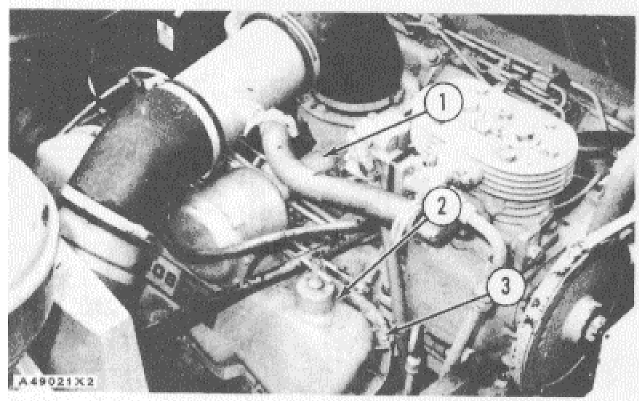
4. Install tube assemblies (5) and (6).



REMOVE AND INSTALL VALVE COVERS

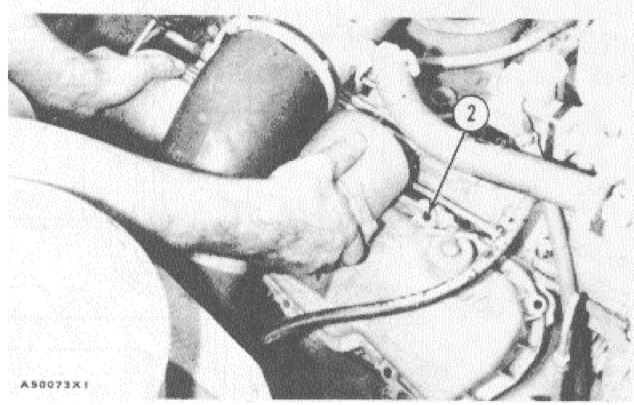
1. Loosen the clamps and remove hose (1) for the crankcase ventilator valve on the right side.

2. Remove bolts (3) and valve covers (2) from the cylinder head.

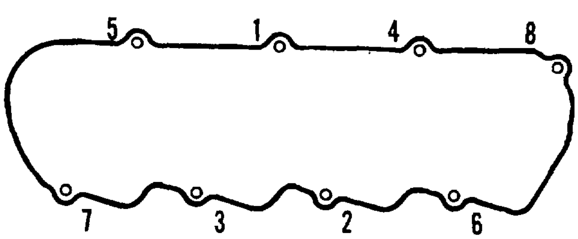


3. Put the gasket and valve cover (2) in position on the cylinder head.

4. Install bolts (3) that hold the valve covers. Tighten the bolts to a torque of 10 + 2 lb. ft. (14 + 3 N m) in the number sequence shown.



5. Install hose (1) for the crankcase ventilator valve on the right side and tighten the clamps to a torque of 20 + 5 lb. in. (2.3 + 0.6 N m).



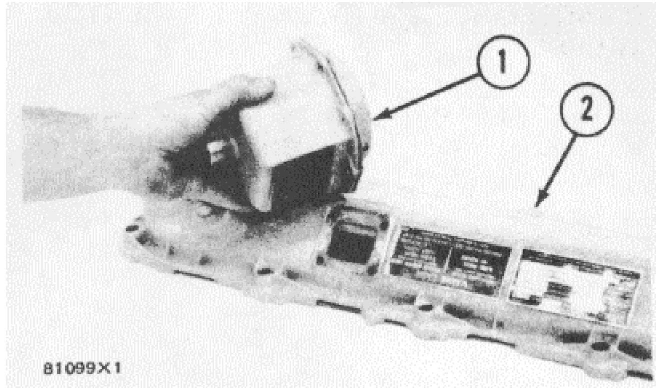
A50074X1

CRANKCASE VENTILATOR VALVE

REMOVE CRANKCASE VENTILATOR VALVE

start by:
a) remove valve cover (right side)

1. Remove the bolts and locks that hold valve (1) to valve cover (2). Remove the valve from the valve cover.

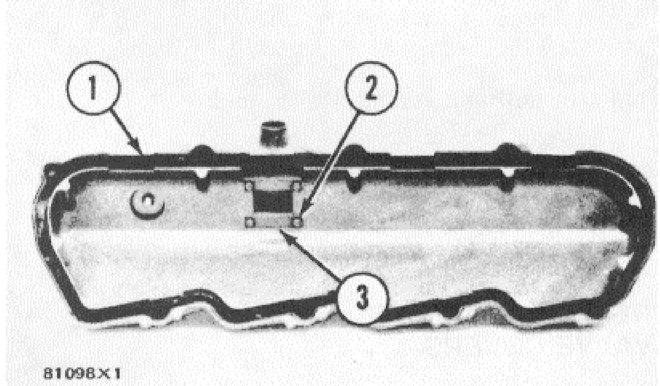


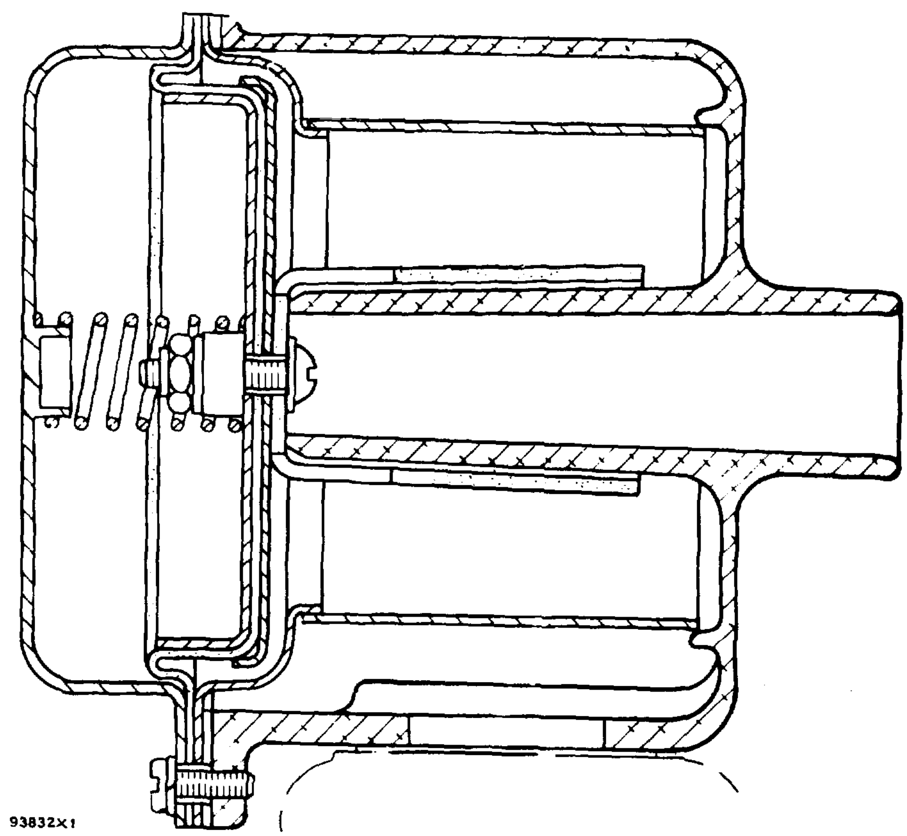
INSTALL CRANKCASE VENTILATOR VALVE

1. Put the valve in position on valve cover (1).

2. Install locks (3) and bolts (2). Bend the locks against the bolts.

end by:
a) install valve cover (right side)



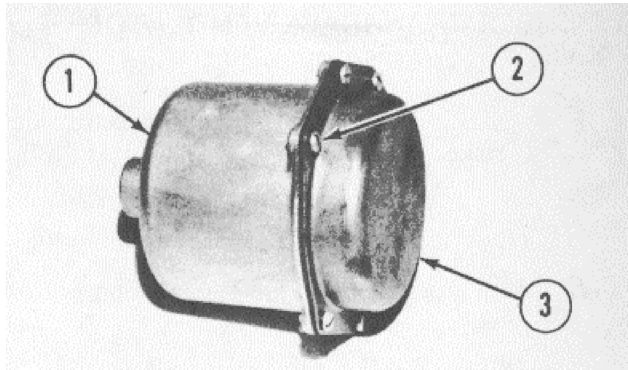


CRANKCASE VENTILATOR VALVE

DISASSEMBLE CRANKCASE VENTILATOR VALVE

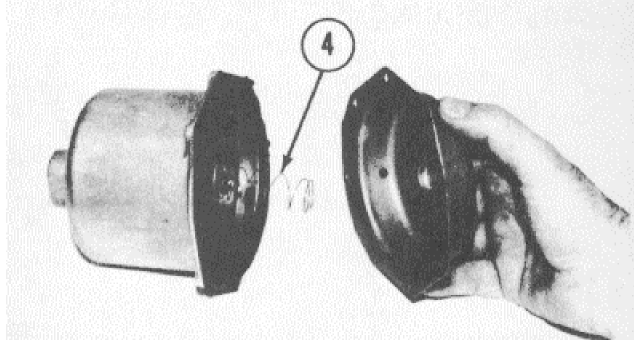
NOTE: The crankcase ventilator valve can be disassembled while installed on the engine. The valve was removed for better photo illustration.

1. Remove screws (2) that hold cover (3) on housing (1).



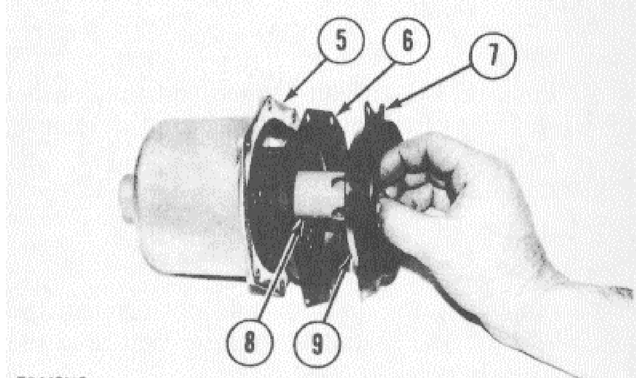
76447X2

2. Remove cover (3) and spring (4) from the housing.



76448X3

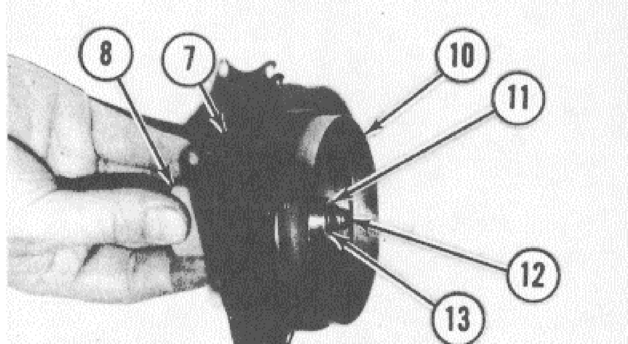
3. Remove the piston, sleeve (8), retainer (9), and diaphragm (7) from the housing as a unit.



76449X2

4. Remove inner sleeve (6) and gasket (5) from the housing.

5. Remove nut (12), washer (13), spacer (I), piston (10), diaphragm (7), and the retainer from sleeve (8).



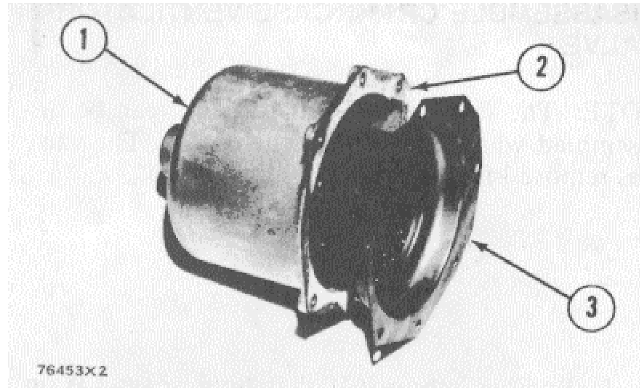
76450X2

CRANKCASE VENTILATOR VALVE

ASSEMBLE CRANKCASE VENTILATOR VALVE

1. Put 5H2471 Gasket Cement on both sides of gasket (2). Install the gasket on housing (1).

2. Install inner sleeve (3) in the housing.

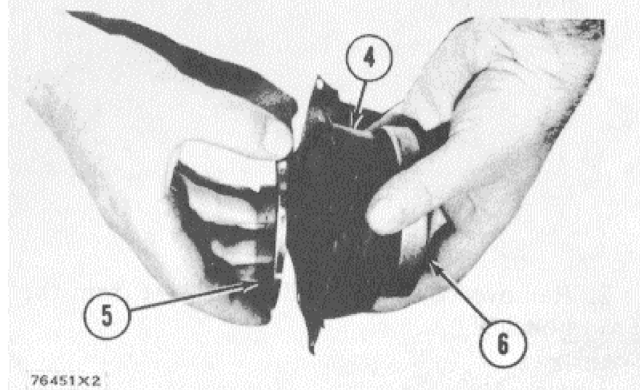


3. Put piston (6) in position next to the side of diaphragm (4) that has identification "PISTON SIDE".

4. Put retainer (5) in the diaphragm.

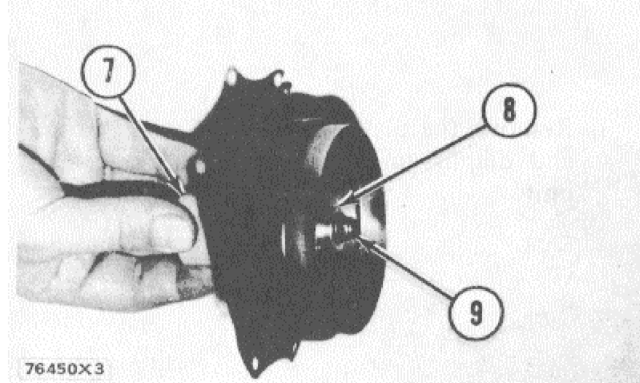
5. Put the screw through sleeve (7), retainer, diaphragm, and the piston.

6. Install spacer (8), washer, and nut (9) on the screw.



7. Put 5H2471 Gasket Cement on the contact surfaces of the diaphragm. Install the sleeve, retainer, diaphragm, and piston in the inner sleeve and housing.

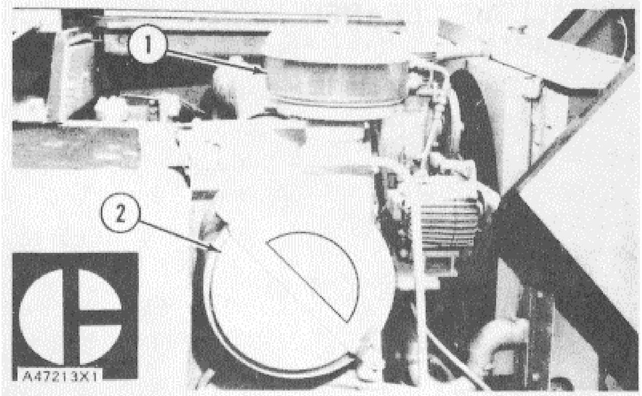
8. Put the spring and cover in position on the housing and install the screws that hold the cover in place.



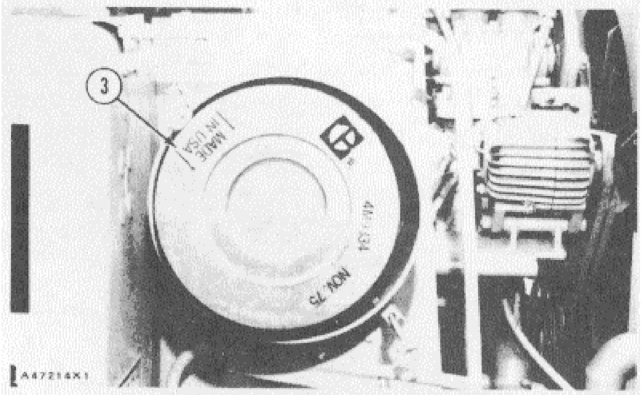
AIR CLEANER ASSEMBLY

REMOVE AIR CLEANER ASSEMBLY

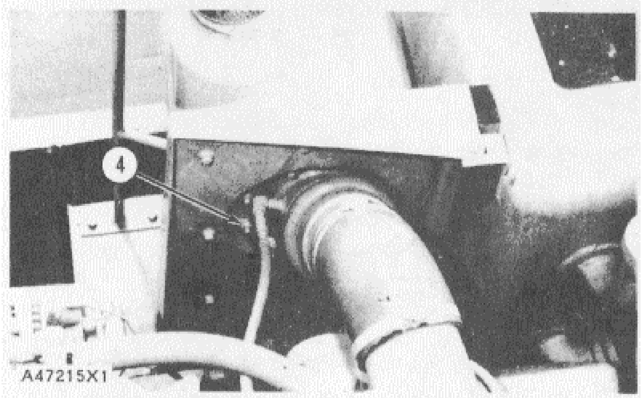
1. Remove precleaner assembly (1) and cup assembly (2) from the air cleaner housing.



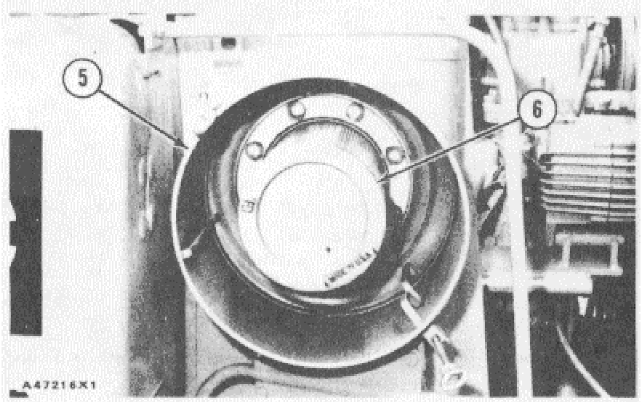
2. Remove the primary filter element (3).



3. Remove nuts (4) that hold the air cleaner housing to the panel housing.



4. Remove housing (5) and secondary filter element (6) from the machine.

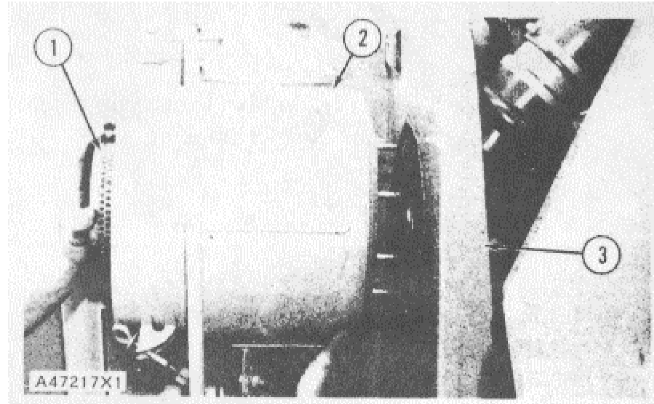


5. Remove filter (6) from housing (5).

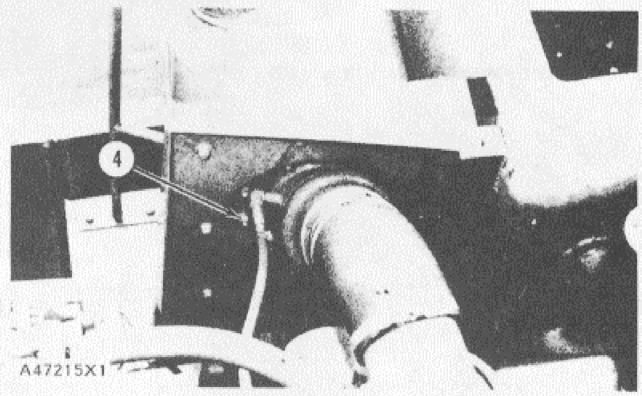
AIR CLEANER ASSEMBLY

INSTALL AIR CLEANER ASSEMBLY

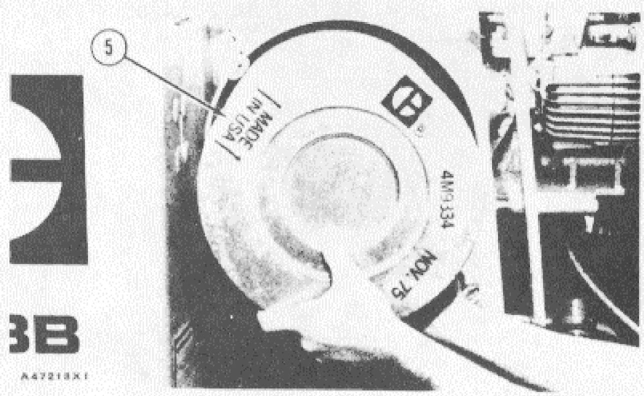
1. Install precleaner (1) in housing (2).



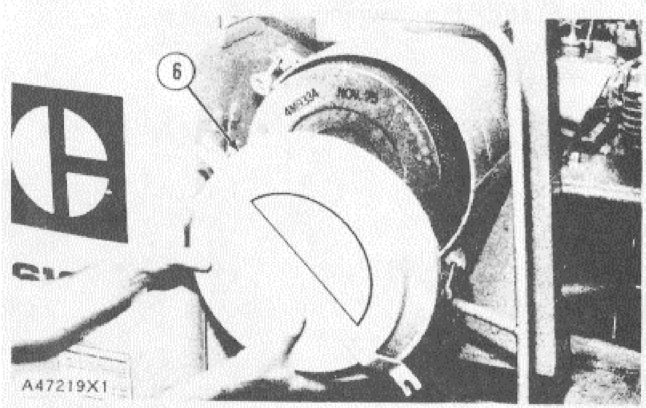
2. Put housing (2) in position on panel assembly (3).



3. Install nuts (4) to hold the air cleaner housing to the panel assembly and tighten them to a torque of 20 +- 5 lb. ft. (25 + 7 N-m).



4. Install element (5) in the air cleaner housing.

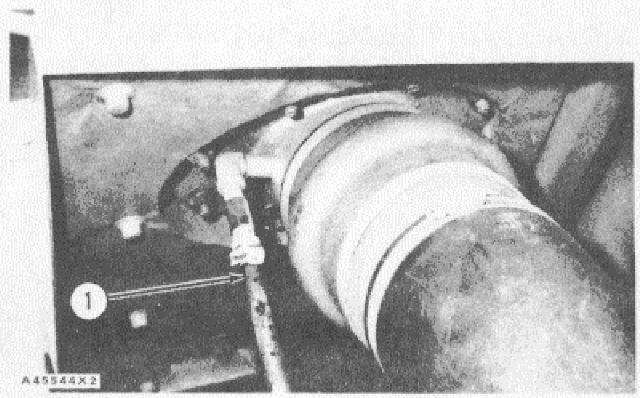


5. Install cup assembly (6) and the precleaner assembly on the air cleaner housing.

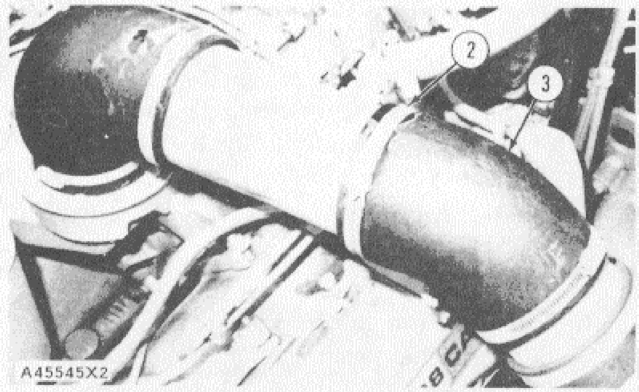
AIR CLEANER HOUSING AND PANEL ASSEMBLY

REMOVE AIR CLEANER HOUSING AND PANEL ASSEMBLY

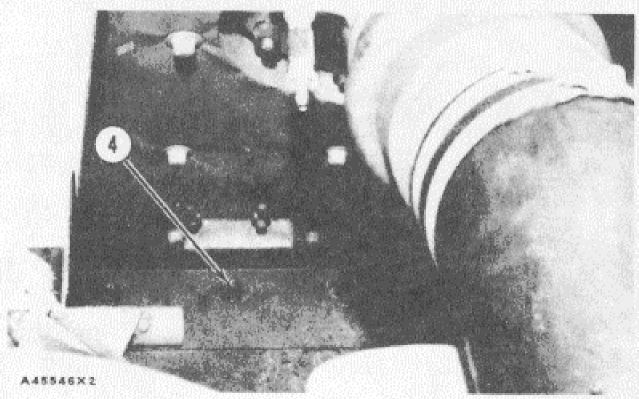
1. Loosen the clamp and disconnect air indicator hose (1) from the air cleaner housing.



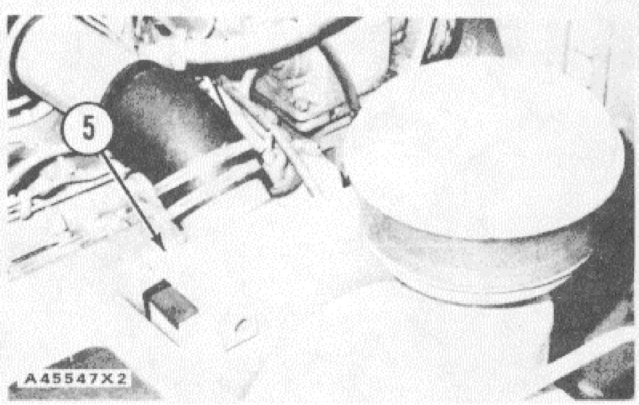
2. Loosen clamp (2) to disconnect hose (3) from the intake manifold.



3. Remove the four nuts (4) and washers that hold the air cleaner panel assembly to the machine.

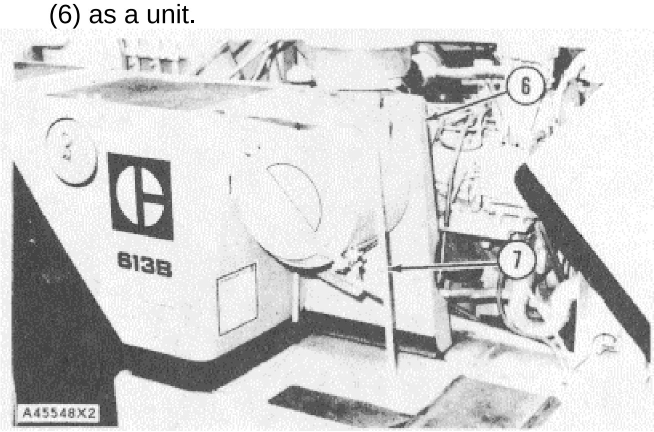


4. Remove bolt (5), the nut and washer that holds the top of the air cleaner panel assembly.



5. Remove the five bolts, the nut and washers that hold handle assembly (7) in position. Remove handle assembly (7).

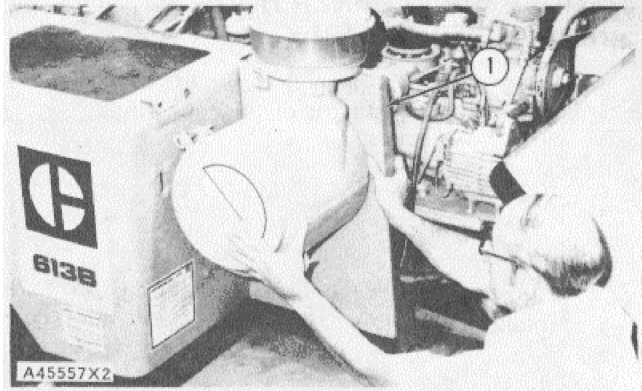
6. Remove the air cleaner housing and panel assembly (6) as a unit.



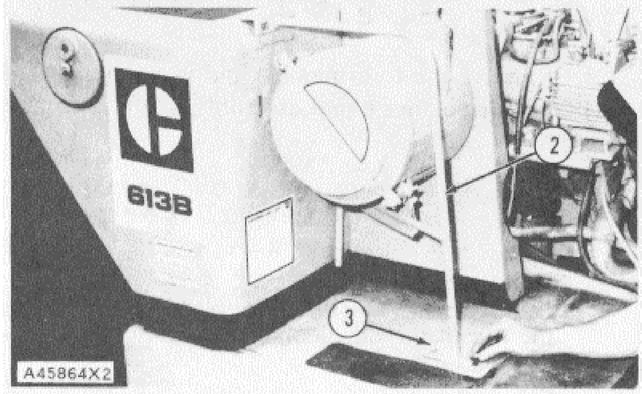
AIR CLEANER HOUSING AND PANEL ASSEMBLY

INSTALL AIR CLEANER HOUSING AND PANEL ASSEMBLY

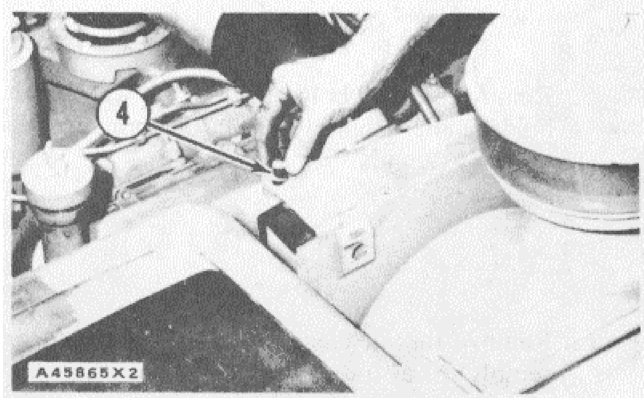
1. Put the air cleaner housing and panel assembly (1) in position on the machine.



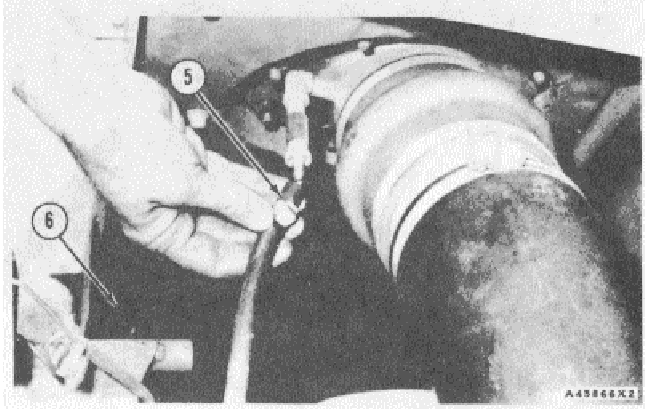
2. Put handle assembly (2) in position and install the five bolts (3), the washers and one nut to hold the handle assembly.



3. Install bolt (4), the washer and nut to hold the top of the panel assembly to the hydraulic tank.

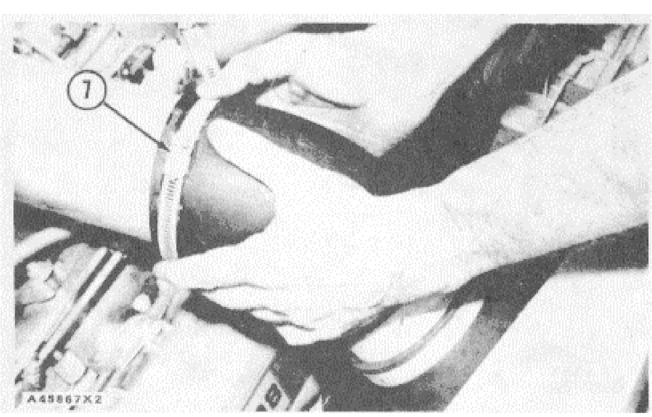


4. Install the four washers and nuts (6) to hold the bottom of the panel assembly in position.



5. Connect air indicator hose (5) to the air cleaner housing and tighten the clamp to a torque of 18 + 5 lb. ft. (24 + 7 N-m).

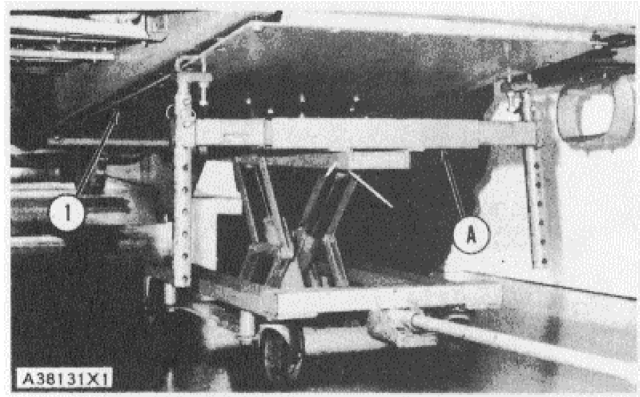
6. Connect the hose for the engine air intake and tighten clamp (7) to a torque of 18 + 5 lb. ft. (24 ± 7 N m).



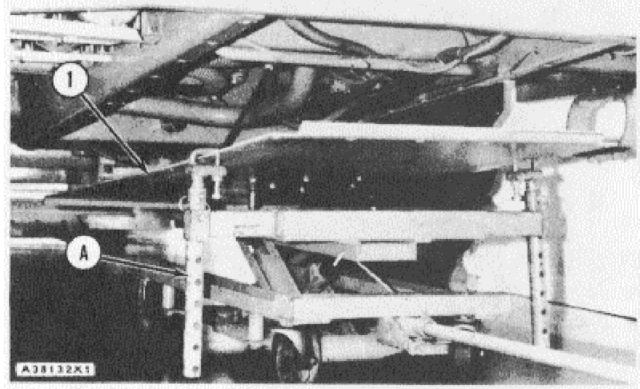
REMOVE AND INSTALL CRANKCASE GUARD

	Tools Needed	A
5P3050	Jack Group	1

1. Remove all but four of the bolts that hold crank-case guard (1) in position. Loosen these four bolts. Do not remove the four bolts.

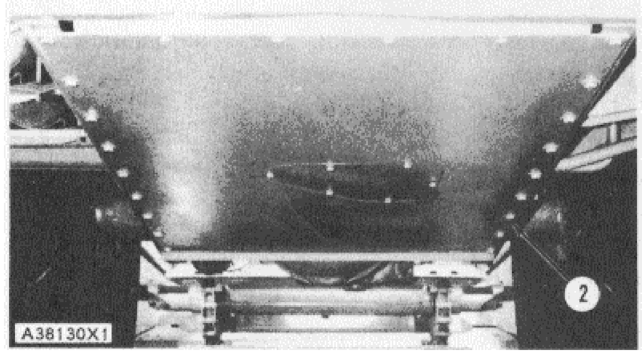


2. Put tool (A) in position and fasten it to crankcase guard (1) as shown. Remove the four bolts that hold the crankcase guard and lower it from the machine with tool (A). The weight of the crank-case guard is 200 lb. (90 kg).



3. Put crankcase guard (1) in position on the machine with tool (A).

4. Install bolts (2). Remove tool (A) and tighten the bolts.

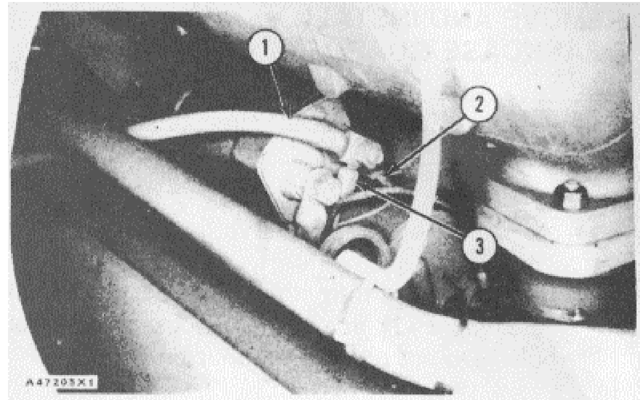


ELECTRIC STARTING MOTOR-

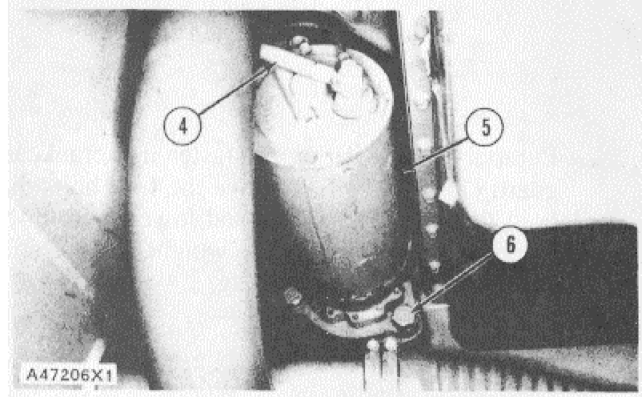
REMOVE ELECTRIC STARTING MOTOR

start by:

a) remove crankcase guard



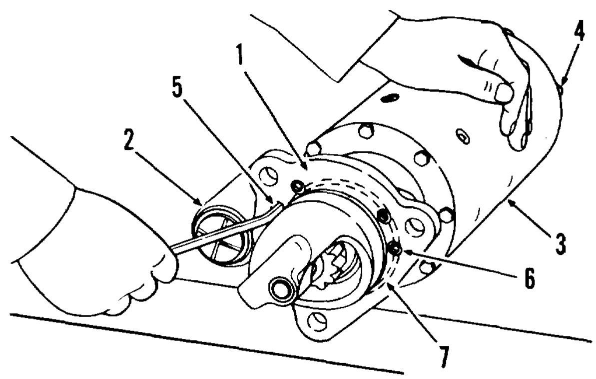
1. Put identification on the electric wires as to their location on the motor. Disconnect wires (1), (2), (3) and (4) from the motor.



2. Remove the three bolts (6) and lower starting motor (5) from the machine. The weight of motor is 60 lb. (27 kg).

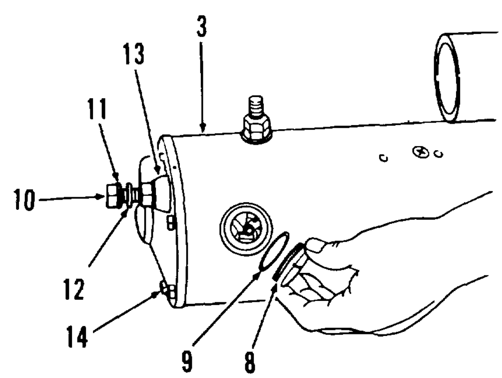
NOTE: On Models 613BSS1 and 613BSNS1 starter receptacle wire must be disconnected from starter and solenoid.

DISASSEMBLE DELCO-REMY STARTING MOTOR (3T8946)



1. Use a suitable marking tool to scribe a line across the drive housing (1), lever housing (2), armature housing (3), and frame assembly (4).

2. Remove five screws (5), screw (6), drive housing (1), and gasket (7) from lever housing (2).

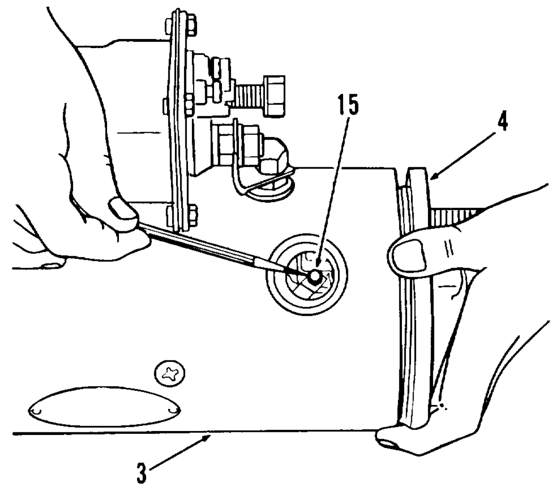


3. Remove three inspection plugs (8) and gaskets (9) from armature housing (3).

4. Remove nut (10), lockwasher (11), washer (12), and insulator assembly (13) from the terminal stud.

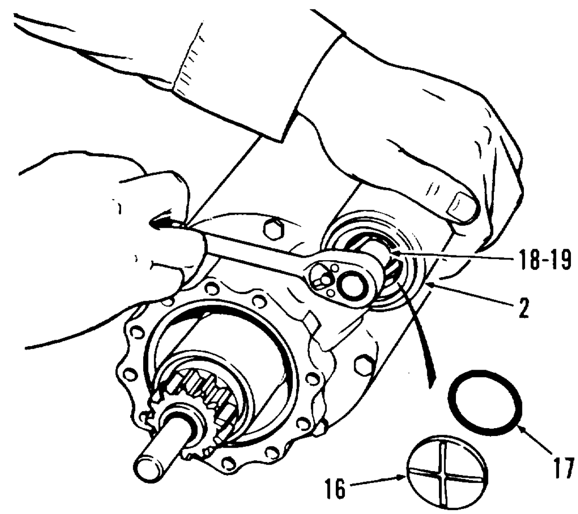
5. Remove six capscrews (14).

6. Disconnect stator wiring by removing three screws (15).Remove frame assembly (4) from armature housing (3).



7. Remove inspection plug (16) and preformed packing (17) from lever housing (2).

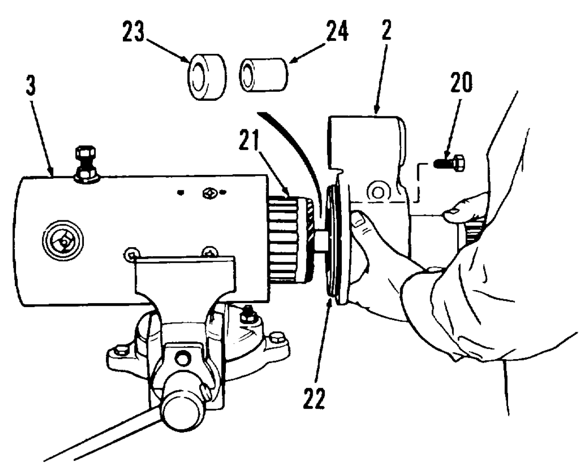
8. Remove nut (18) from shaft of plunger assembly (19).



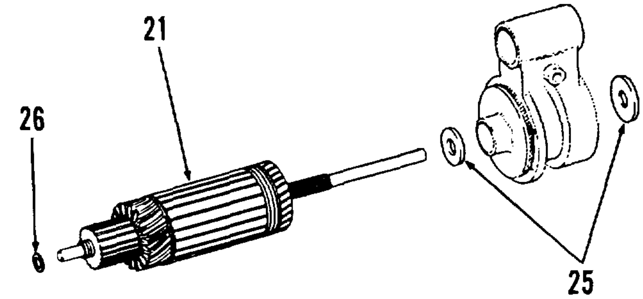
9. Remove seven capscrews (20) and separate lever housing (2) from armature housing (3).

10. Remove armature (21) from armature housing (3).

11. Remove seal (22), seal (23), and bearing (24) from lever housing (2).



12. Remove washers (25) and (26) from armature (21).



13. Remove three screws (27), lockwashers (28), and plate assembly (29) from frame assembly(4).

14. Remove two washers (30) from terminal stud.

15. Remove seal (31) from frame assembly (4).Remove insulator (32) from plate assembly(29).

16. Remove twelve screws (33), lockwashers(34), plate (35), washers (36), insulator (37), plates (38, 39, and 40) to free six brushholders (41).

17. Remove six screws (42) and brushes (43) from brush holders (41).

18. Remove plunger assembly (19) from lever housing (2).

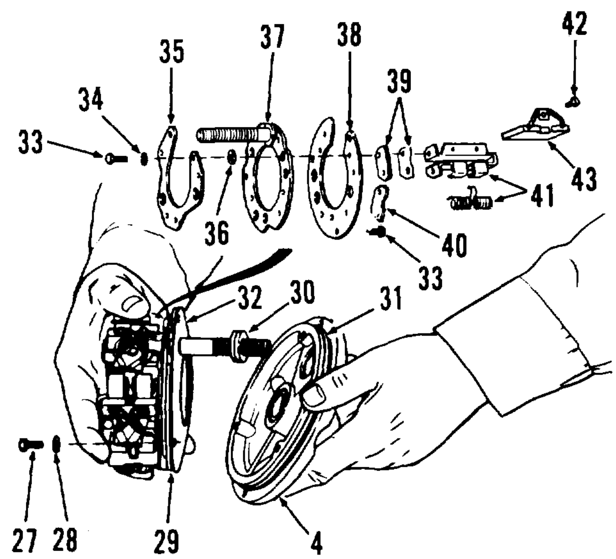
19. Remove retaining ring (43), retainer (44), spring (45), retainer (46), boot (47), and washer (48) from plunger assembly (19).

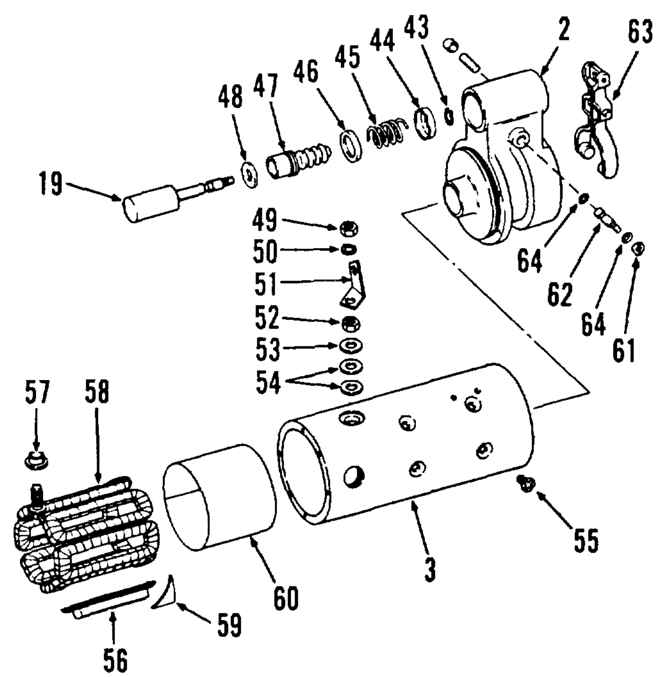
20. Remove nut (49), lockwasher (50), terminal (51), nut (52), three washers (53 and 54) from armature housing (3).

21. Remove twelve screws (55), pole shoes (56), insulator bushing (57), coil assembly (58), three insulators (59), and insulator (60) from armature housing (3).

22. Remove retaining ring (61) and shaft (62) from lever housing (2).

23. Remove lever assembly (63) and two seals (64) from shaft (62).





ASSEMBLE DELCO-REMY STARTING MOTOR (3T8946)

1. Install two seals (1) and lever assembly (2) on shaft (3).

2. Install shaft (3) in lever housing (4) and install retaining ring (5).

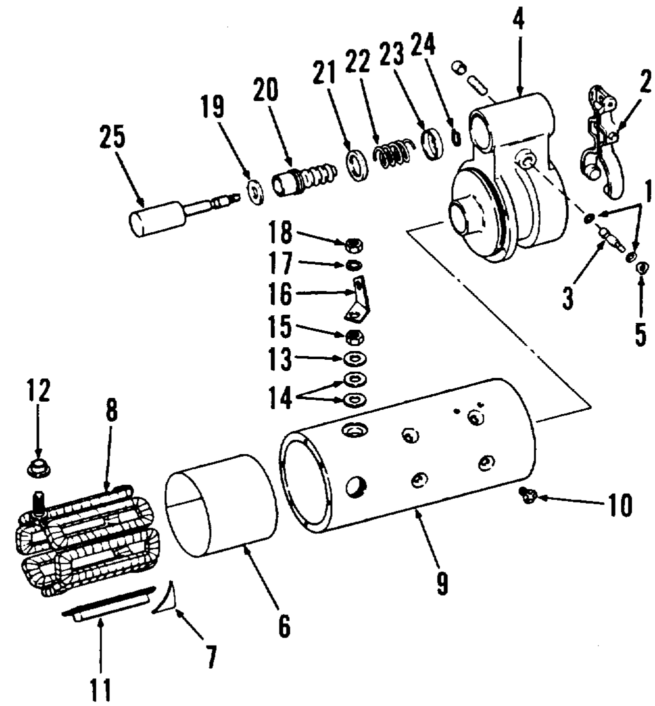
3. Position insulator (6), three insulators (7),and coil assembly (8) in armature housing(9).

4. Apply thread sealant to the threads of twelve screws (10). Install screws (10) and six pole shoes (11) in armature housing (9).

5. Install insulator bushing (12), three washers(13 and 14), nut (15), terminal (16), lockwasher (17), and nut (18) on armature housing (9).

6. Install washer (19), boot (20), retainer (21), spring (22), retainer (23), and retaining ring (24) on plunger assembly (25).

7. Install plunger assembly (25) in lever housing (4).



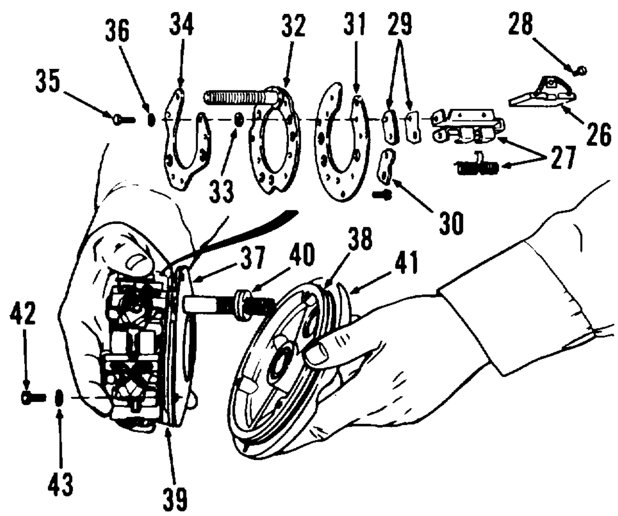
8. Install six brushes (26) on brush holders (27) with screws (28).

9. Install brush holders (27), plates (29, 30 and 31), insulator (32), washers (33) and plate (34) and then install screws (35) and lock-washers (36).

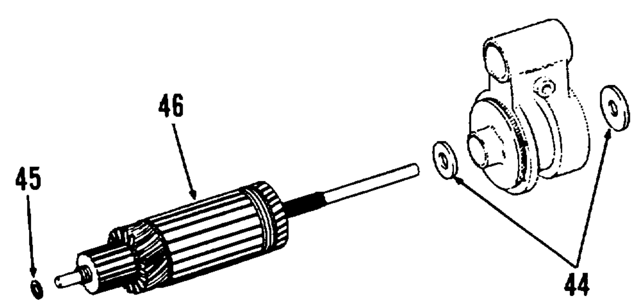
10. Install insulator (37) and seal (38) on plate assembly (39).

11. Install two washers (40) on terminal stud.

12. Install plate assembly (39) to frame assembly (41) with three screws (42) and lockwashers (43).



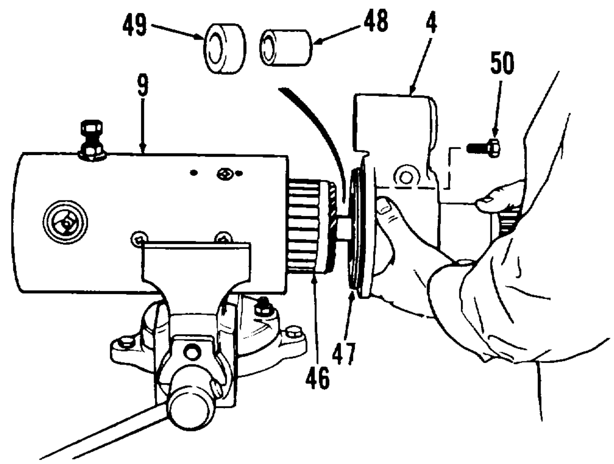
13. Apply a small amount of lubricant to washers (44 and 45) and install washers on armature (46).



14. Install seal (47) on lever housing (4).

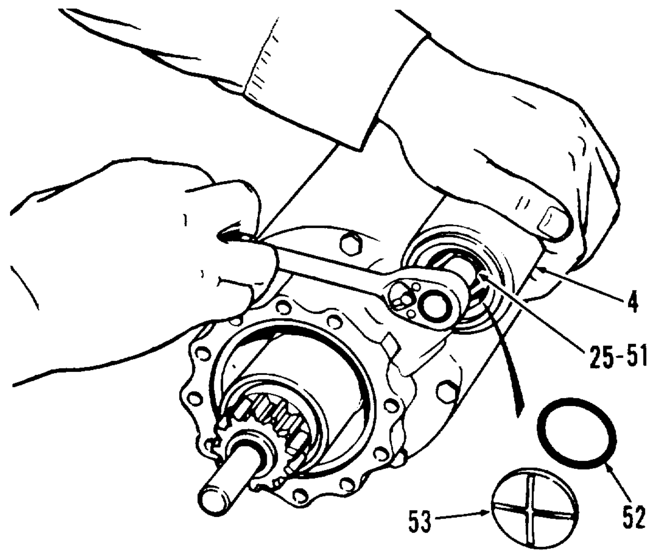
15. Install armature (46) in armature housing (9). Install bearing (48) and seal (49) in lever housing (4).

16. Install lever housing (4) on armature housing (9) with seven capscrews (50).



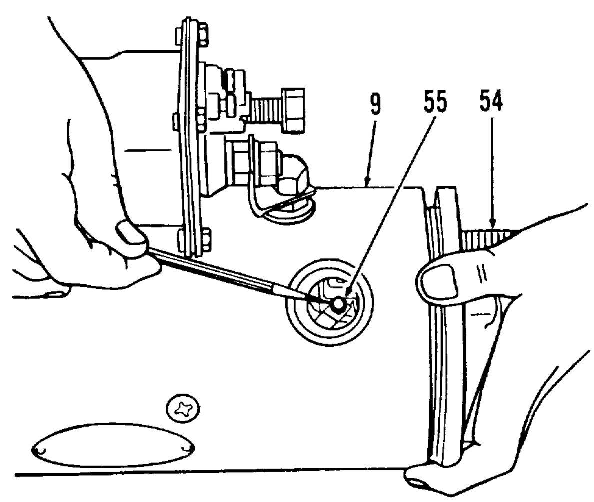
17. Install nut (51) on shaft of plunger assembly (25).

18. Install seal (52) and inspection plug (53) on lever housing (4).



19. Install frame assembly (54) into armature housing (9).

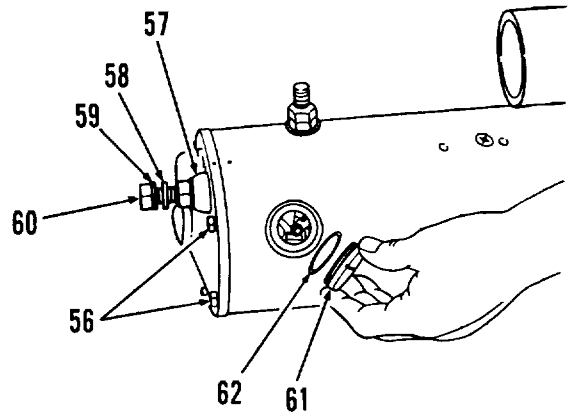
20. Install three screws (55).



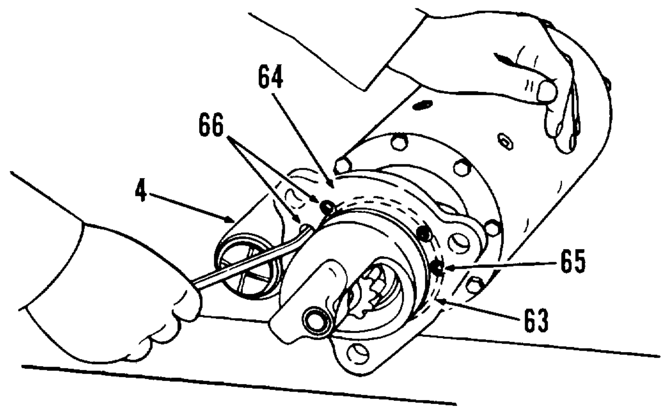
21. Install six capscrews (56).

22. Install insulator assembly (57), washer (58), lockwasher (59), and nut (60).

23. Install three inspection plugs (61) and gaskets (62).



24. Assemble gasket (63) and drive housing (64) to lever housing (4) with one screw (65) and five screws (66).



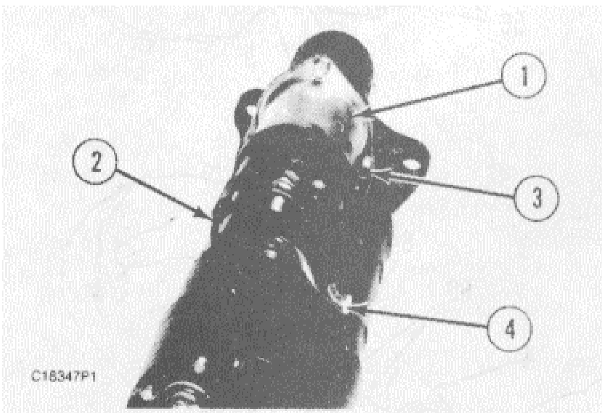
STARTING MOTOR

Disassemble Starting Motor (9G4339)

Tools Needed	A
1 P1855 Retaining Ring Pliers	1

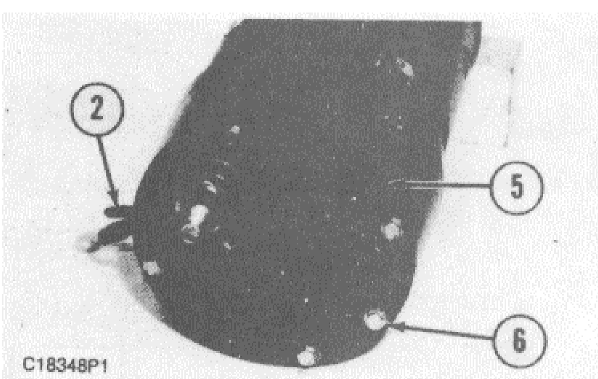
Start By:

a. remove starting motor



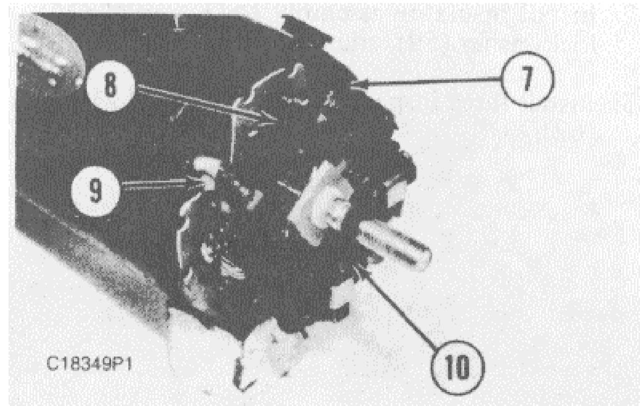
1. Disconnect wire assembly (2) from solenoid assembly (1). Disconnect motor (Mtr) terminal connector (4) from the starting motor housing.

2. Remove three bolts (3) and solenoid assembly from the shift lever housing Do not disassemble the solenoid. The seals inside it are not serviceable



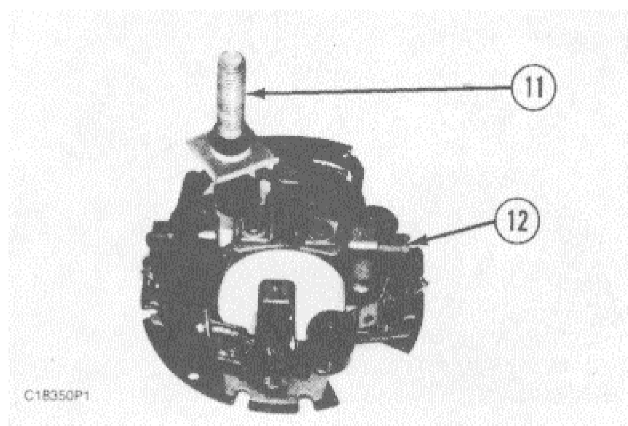
3. Remove the negative (-) terminal nuts, wire assembly (2) and washers Remove six bolts (6) and rear housing assembly (5).

4. Remove the bushing from the rear housing if necessary

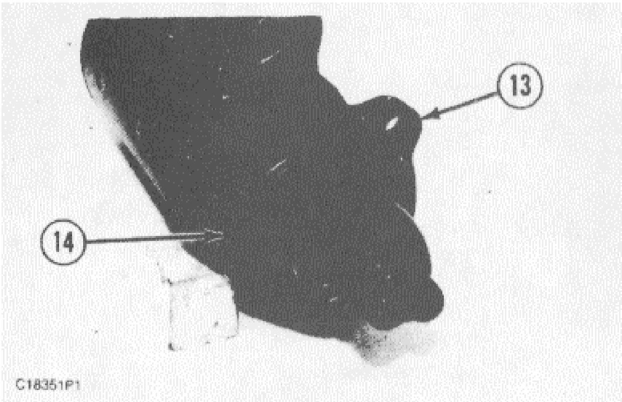


5. Remove washer (10) from the armature shaft. Lift brush springs (8) and pull brushes up off the commutator Position the brush springs on the side of the brushes to hold them In their holders

6. Disconnect field winding leads (9) from brush holder assembly (7) Remove the brush holder assembly



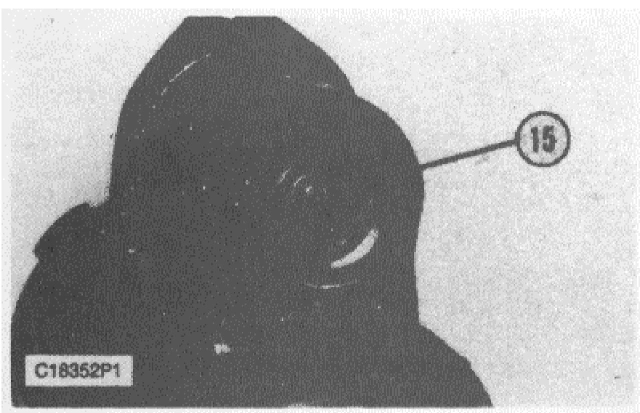
7. Remove brushes (12) and negative (-) terminal (11) from the brush holders.



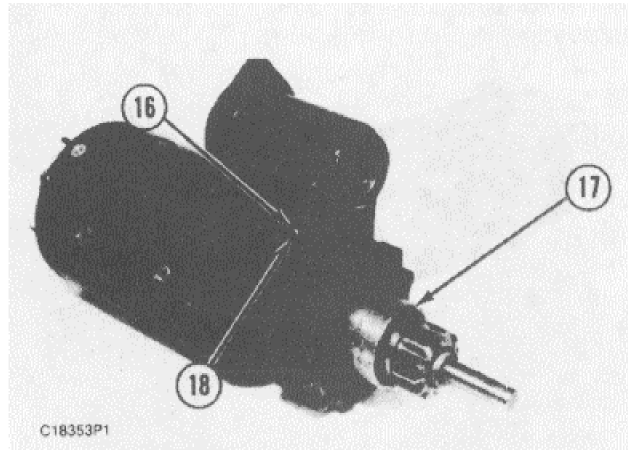
8. Scribe a line on the pinion drive, shift lever and starting motor housings for correct alignment at assembly

9. Remove six bolts (14) and pinion drive housing assembly (13).

10. If necessary remove the O-ring seal and bushing from the drive housing.

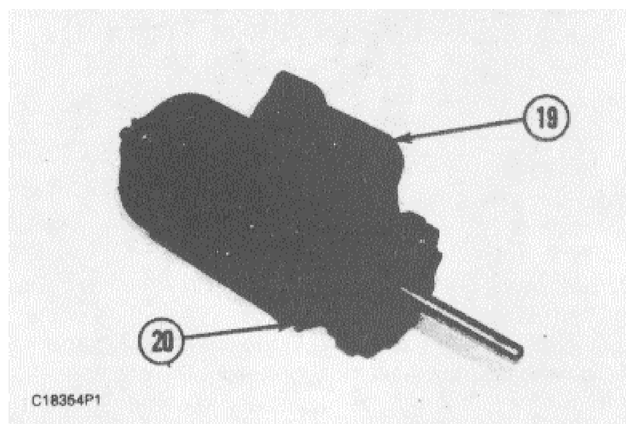


11. Remove the plug, nut (15) and the plunger assembly from the shift lever housing.



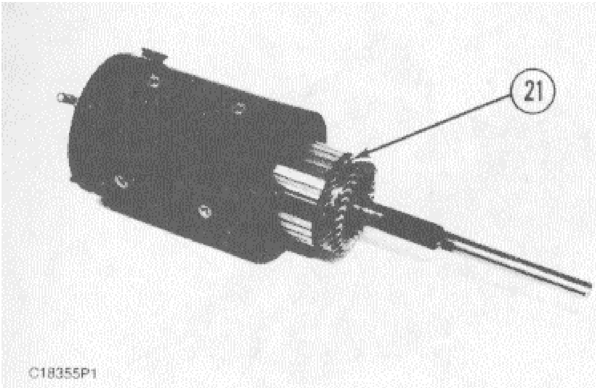
12. Remove retainer (16) with tool (A). Remove shift lever pin (18) and the O-ring seals from the pin if necessary.

13. Remove pinion drive assembly (17) and the shift lever assembly.

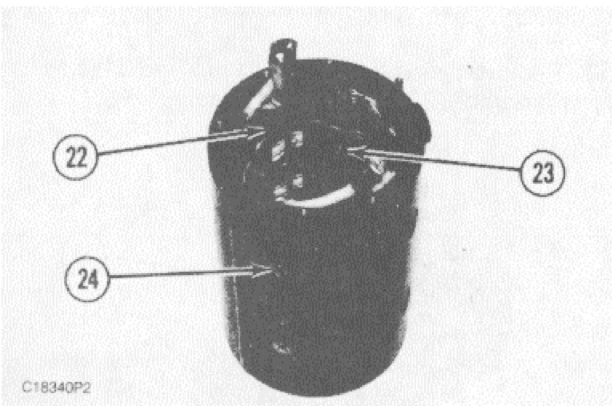


14. Remove the brake disc from the armature shaft. Remove five bolts (20), shift lever housing assembly (19) and the washer. Remove the outside O-ring seals if necessary.

15. Remove the lip-type seal and bushing from the shift lever housing If necessary.



16. Remove armature assembly (21) from the starting motor housing



17. Remove eight screws (24), pole shoes (23) and field winding (coil) assembly (22) from the starting motor housing. It may be necessary to use an impact driver to remove screws (24).

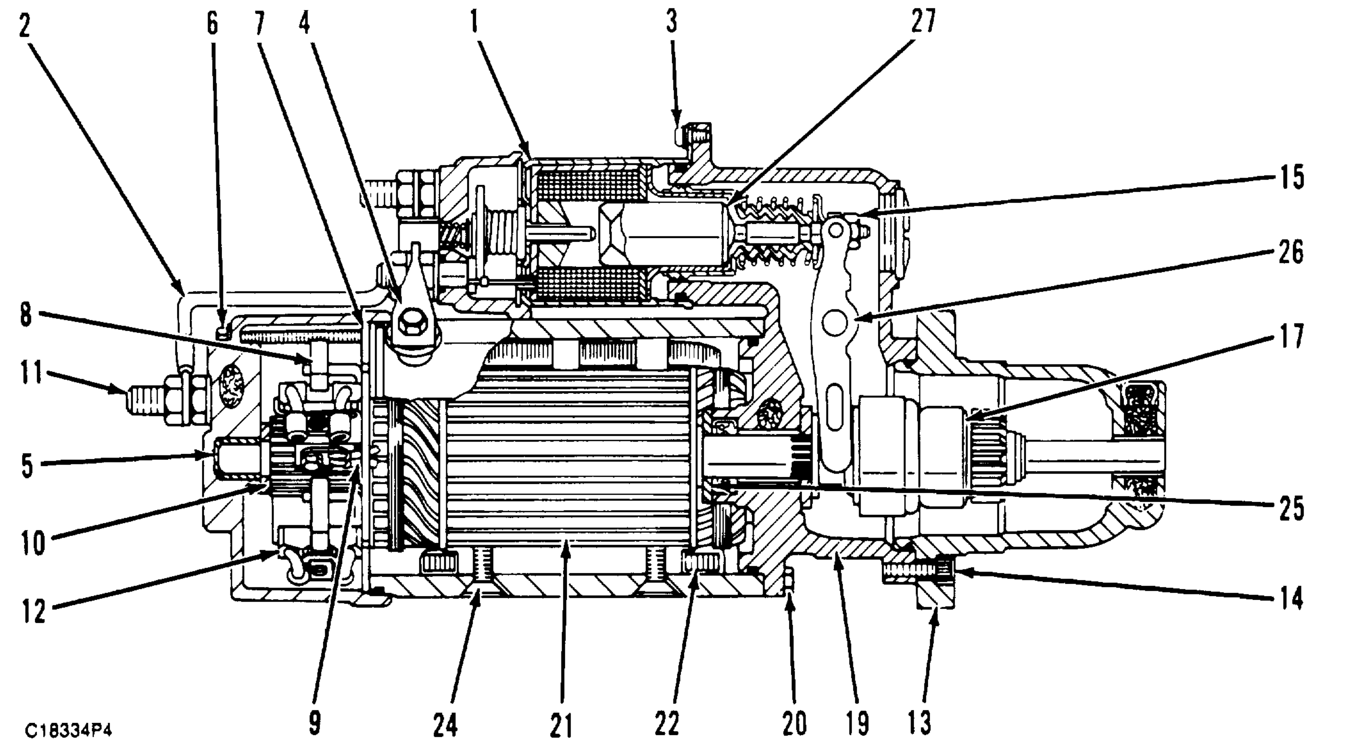
NOTICE

Do not use a liquid cleaning agent to clean the armature assembly, field winding (coil) assembly or pinion drive assembly. A liquid cleaning agent can damage the insulation in the armature and field (coil) winding assemblies and would dissolve the grease in the pinion drive assembly.

18. Clean the armature assembly, field winding (coil) assembly and pinion drive assembly with mineral spirits and a brush

19. If the commutator is dirty, it may be cleaned with No 00 sandpaper. Do not use emery cloth.

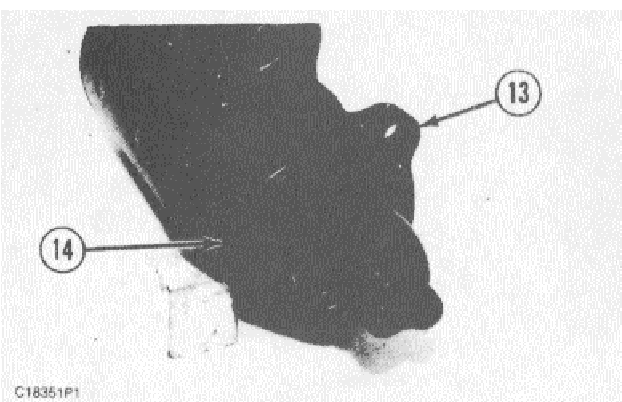
20. Inspect all parts for wear and damage,



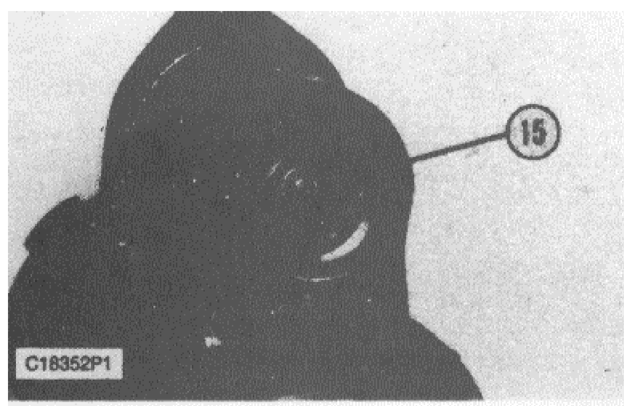
Starting Motor
(1) Solenoid assembly (2) Wire assembly (3) Solenoid bolts (4) Motor (Mtr) terminal connector (5) Rear housing assembly (6) Rear housing bolts (7) Brush holder assembly (8) Brush springs (9) Field winding leads (10) Washer (11) Negative (-) terminal (12) Brushes (f3) Pinion drive housing assembly (14) Pinion drive housing bolts (15) Shift lever nut (17) Pinion drive assembly (19) Shift lever housing assembly (20) Shift lever housing bolts (21) Armature assembly (22) Field winding (coil) assembly (24) Field winding screws (25) Washer (26) Shift lever assembly (27) Plunger assembly

Assemble Starting Motor

Tools Needed	A	B
1P1855 Retaining Ring Pliers	1	
1P510 Driver Group		1

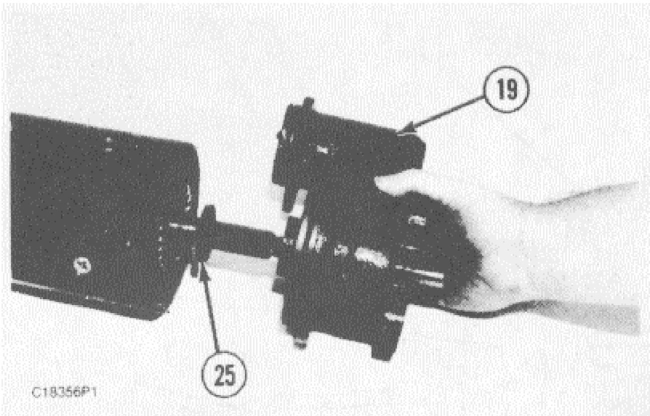


1. Put SAE 20W oil on all bushings, seals and oil wicks.



2. Put field winding (coil) assembly (22) and pole shoes (23) in position in the starting motor housing. Install screws (24) and tighten them to a torque of 44 + 20 N-m (32 + 15 lb, ft.).

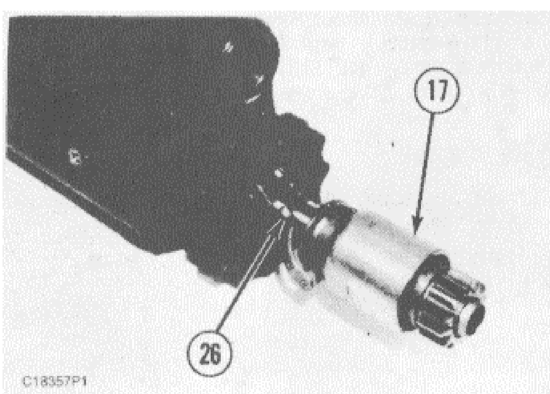
3. Put armature assembly (21) in position in the starting motor housing



4. If removed, install the bushing and lip-type seal, with tooling (B), into the shift lever housing Install the O-ring seals on the outside of the housing

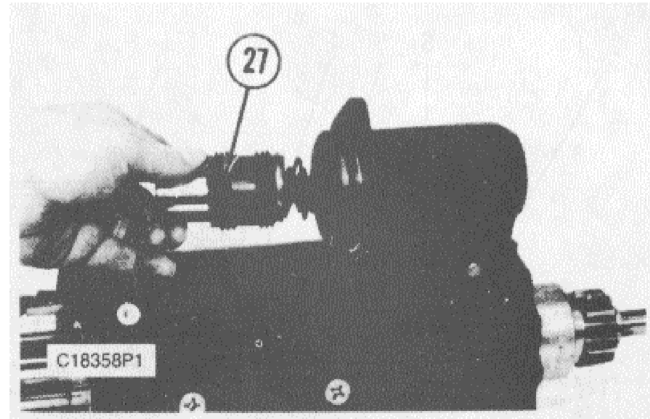
5. Put washer (25) and shift lever housing (19) in position over the armature shaft Make sure to align the marks on the housings made during disassembly.

6. Install the five bolts and tighten them to a torque of 16 3 to 22 0 N-m (12 to 16 lb ft). Install the brake disc on the armature shaft

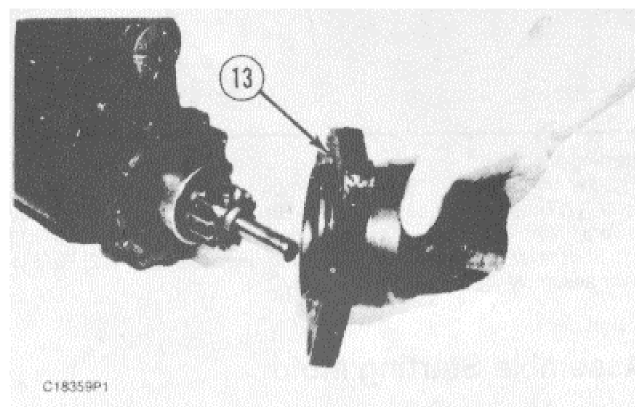


7. Put pinion drive assembly (17) and shift lever assembly (26) Into position on the armature shaft and Into the shift lever housing

8. Install the O-ring seals on the shift lever pin if they were removed Install the pin through the shift lever housing and shift lever Install retainer with tool (A)

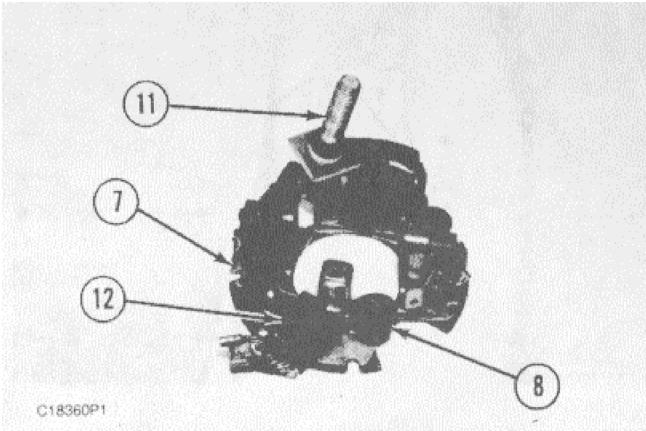


9. Put plunger assembly (27) into the shift lever Install the nut finger tight right now. The plunger assembly will have to be adjusted for the correct pinion clearance after the starting motor has been completely assembled

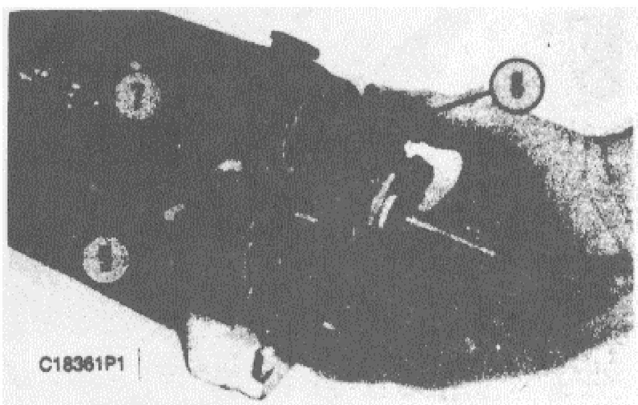


10. If removed, install the bushing into pinion drive housing (13) with tooling (B). Install the outside O-ring seal

11. Put the pinion drive housing assembly into position on the shift lever housing Make sure to align the marks on the housings made during disassembly Install and tighten the six bolts to a torque of 23.7 + 6 1 Nom (17 $\pm$ 5 lb ft.)

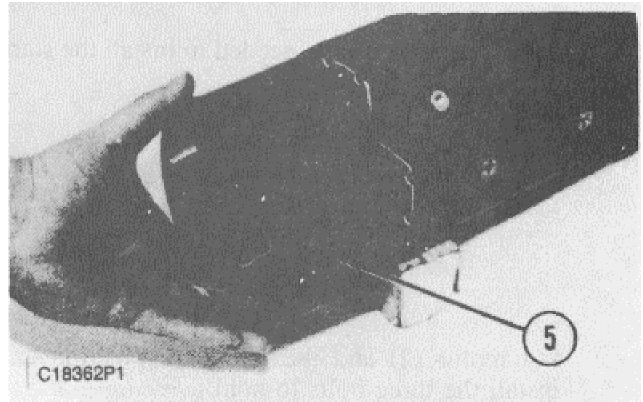


12. Install negative (-) terminal (11) and brushes (12) onto brush holder assembly (7). Put the brushes in position so that springs (8) are against the side of the brushes as shown to hold them in place.



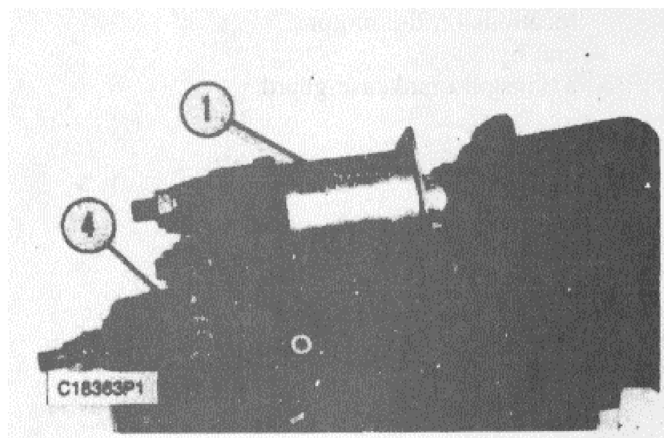
13. Put brush holder assembly (7) into position on the starting motor dowels. Connect field winding leads (9) to the brush holder.

14. Push the brushes down inside their holders so that springs (8) are against the back of each brush to hold them against the commutator. Install the washer on the armature shaft.



15. If removed, install the bushing into the rear housing with tooling (B).

16. Install rear housing assembly (5) onto the starting motor. Install the six bolts and tighten them to a torque of 4.5 to 6.8 N-m (40 to 60 Ib.in.).



17. Install the washers, nuts and wire assembly on the negative (-) terminal. Tighten the nuts to a torque of 30.5 ± 3.5 N-m (22 ± 3 Ib.ft.).

18. Put solenoid assembly (1) into position over the plunger assembly. Install the three bolts and tighten them to a torque of 14.0 to 21 5 N-m (124 to 190 lb in.).

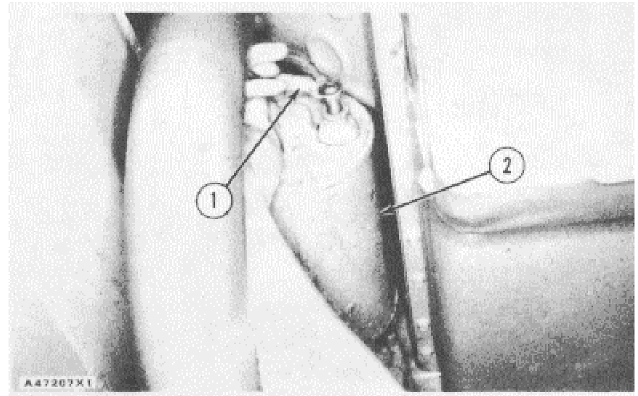
19. Connect connector (4) to the starting motor housing field terminal Tighten the bolt to a torque of 9 6 + 1.1 N-m (85 + 10 Ib.in.). Connect the wire assembly to the ground (G) terminal of the solenoid. Tighten the nut to a torque of 2.6 ± 0.8 N-m (23 ± 7 Ib.in.).

20. Check pinion clearance. See Pinion Clearance Adjustment in Testing and Adjusting

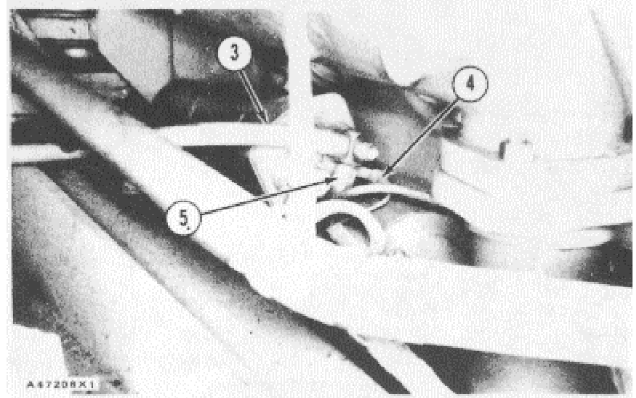
a) install starting motor

INSTALL STARTING MOTOR

NOTE: Two persons can be needed to install the starting motor.



1. Put motor (2) and the gasket in position and install the three bolts to hold it.



NOTE: On Models 613BSS1 and 613BSNS1 starter receptacle wire must be connected to starter and solenoid.

2. Connect wires (I), (3), (4) and (5) to their correct locations on the motor.end by:
   a) install crankcase guard

OIL FILTER BASE AND ENGINE OIL COOLER

REMOVE OIL FILTER BASE AND ENGINE OIL COOLER

	Tools Needed	A
2P8250	Strap Wrench	1

start by:
a) remove crankcase guard

NOTE: The radiator is removed for better photo illustration of the removal and installation of the oil filter base and engine oil cooler.

1. Drain the coolant from the cooling system.

2. Disconnect hoses (I) from the cylinder block.

3. Remove oil filters (3) from the filter base with tool (A).

4. Disconnect oil pressure line (2) from the filter base.

5. Remove four bolts (5) and the washers to remove oil filter base and engine oil cooler (4) as a unit.

INSTALL OIL FILTER BASE AND ENGINE OIL COOLER

1. Inspect the O-ring seals in the oil filter base. Install new seals if needed. Put oil on the seals.

2. Put oil filter base and engine oil cooler (1) in position on the engine. Install bolts (3) and the washers that hold it in place.

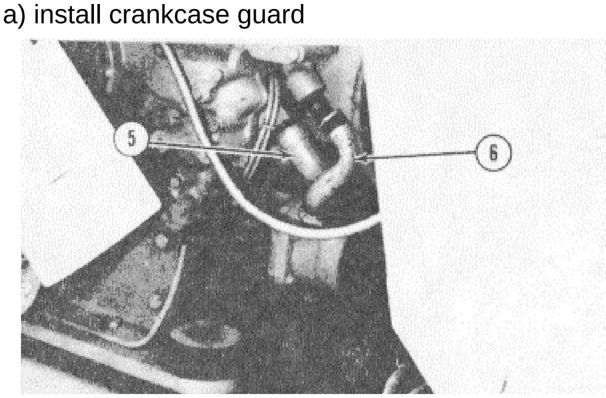
3. Install two oil filters (4) and connect oil pressure line (2) to the oil filter base.

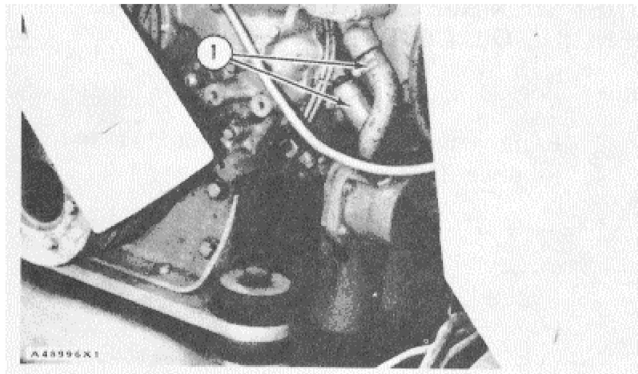
4. Connect hoses (5) and (6) to the cylinder block.

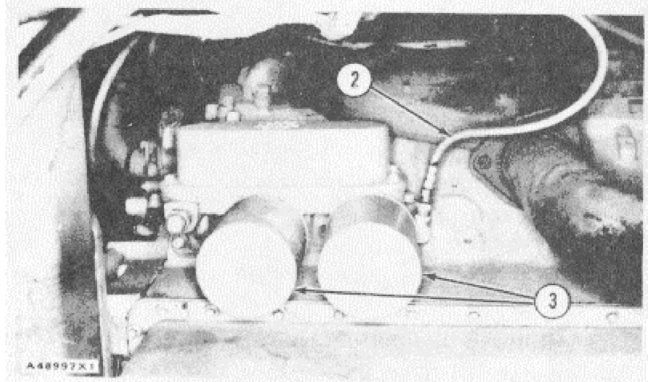
5. Fill the cooling system with coolant to the correct level.

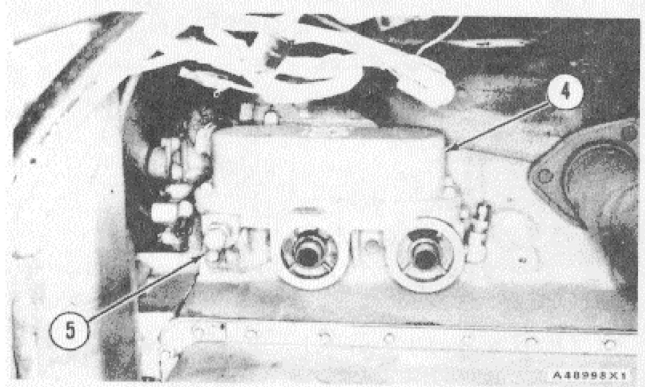
6. Start and run the engine. Make a check of the engine oil level and add engine oil to the correct level

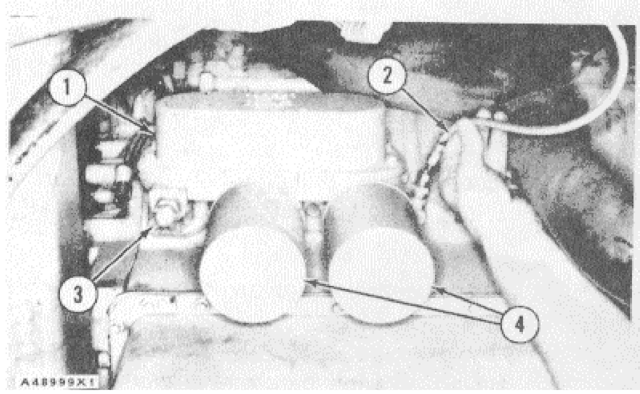
end by:
a) install crankcase guard











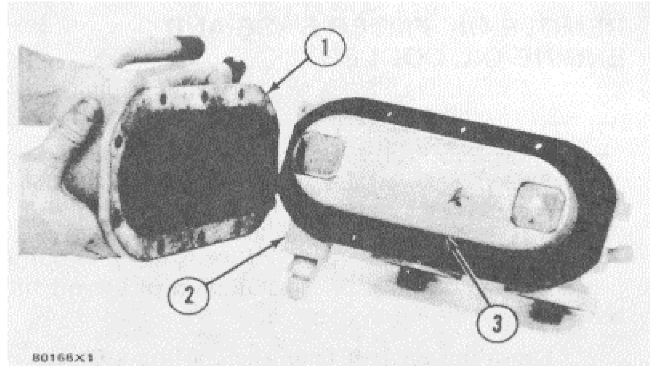
OIL FILTER BASE AND ENGINE OIL COOLER

DISASSEMBLE OIL FILTER BASE AND ENGINE OIL COOLER

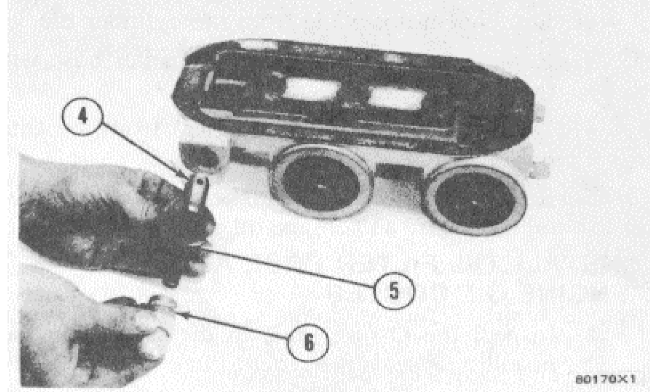
start by:

a)remove oil filter base and engine oil cooler

1. Remove the bolts that hold cover (I) to base (2). Remove the cover.



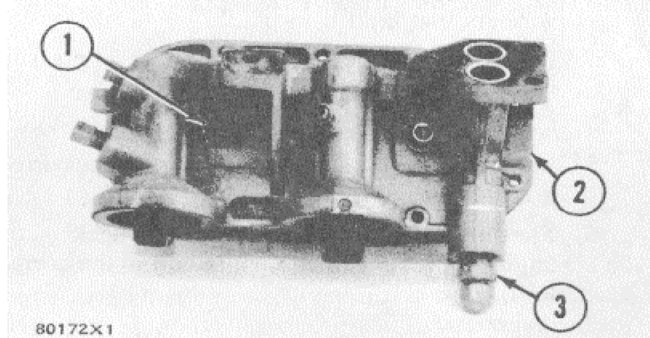
2. Remove the three nuts that hold core (3) to the base. Remove the core.



3. Remove the cap and fitting (6), spring (5), and valve (4) from the base.

ASSEMBLE OIL FILTER BASE AND ENGINE OIL COOLER

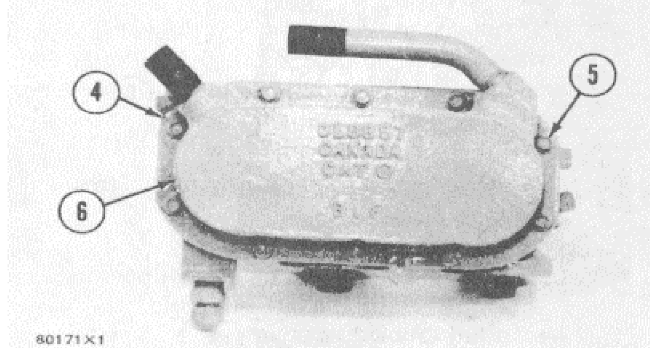
1. Install the valve, spring, fitting (3) and cap in base (2). Tighten fitting (3) to a torque of 19 + 4 lb.ft. (25 $^{+}$ 5 N.m). Tighten the cap to a torque of 15 + 4 lb.f t. (20 + 5 N.m).



2. Inspect the gasket that goes between the oil filter base and the core. Install a new gasket if needed.

NOTE: The gasket must be installed with point (4) (indexing point) in the position shown.

3. Install the core in the base. Install nuts (I). Tighten the nuts to a torque of 16 $^{+}$ 2 lb.ft. (21 +3 N.m).



4. Inspect the gasket that goes between the core and cover (6). Install a new gasket if needed.

5. Put the cover in position on the base. Install bolts (5).

end by:

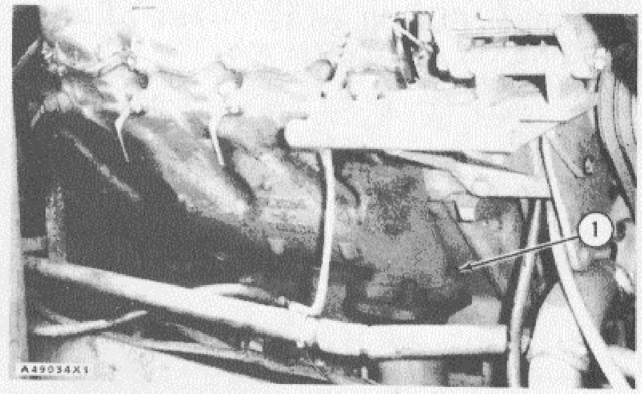
a) install oil filter base and engine oil cooler

EXHAUST MANIFOLDS

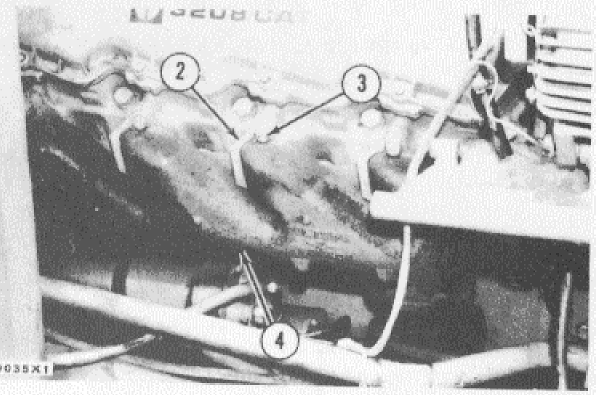
REMOVE EXHAUST MANIFOLDS

start by:
a)remove crankcase guard
b)remove air cleaner housing and panel assembly (for right exhaust manifold)

1. To remove the left exhaust manifold tilt the cab.
See this procedure in REMOVE ENGINE.



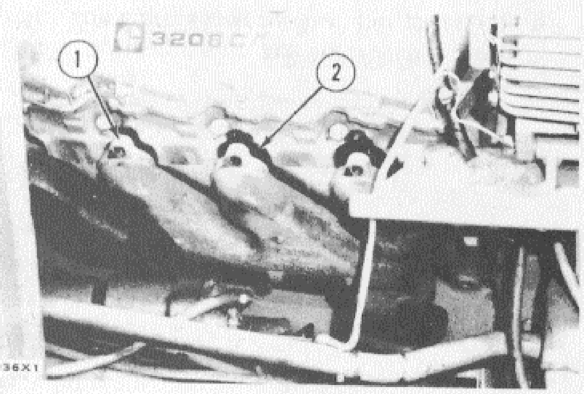
2. Remove nuts (1) and the bolts to disconnect the exhaust pipe assembly from the exhaust manifold.



3. Bend the tabs of locks (2) from bolts (3) and remove the bolts, locks, exhaust manifold (4) and the gaskets from the engine.

INSTALL EXHAUST MANIFOLDS

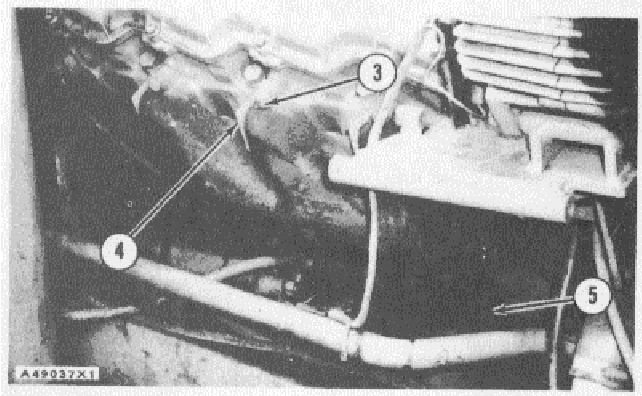
1. Put gaskets (2) and exhaust manifold (1) in position on the engine.



2. Put 9M3710 Anti-Seize Compound on the threads of bolts (3) and install locks (4) and the bolts. Tighten the bolts to a torque of 32 + 5 lb.ft. (43 + 7 N.m). Bend the tabs of the locks on the bolts.

NOTE: Locks must be bent on a flat side of the bolt head. Bolts must be turned no more than 30° of a turn for the alignment of the locks with a flat side of the bolt head after they are tightened. Do not loosen the bolts to make this alignment.

3. Put exhaust pipe assembly (5) in position on the exhaust manifold. Put 9M37 10 Anti-Seize Compound on the threads of the bolts. Install the bolts and nuts to hold the pipe assembly to the manifold.



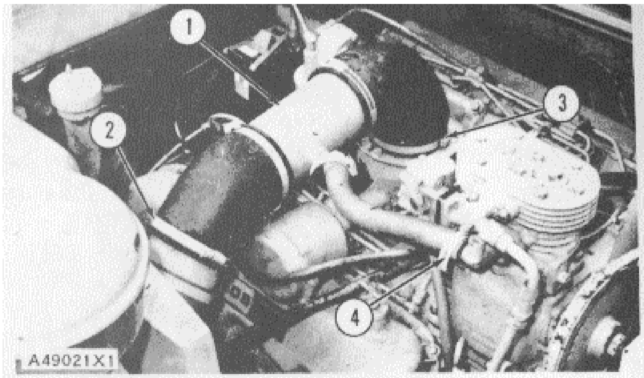
4Lower the cab see INSTALL ENGINE for this procedure.

end by:
a)install air cleaner housing and panel assembly (for right exhaust manifold)
b)Install crankcase guard

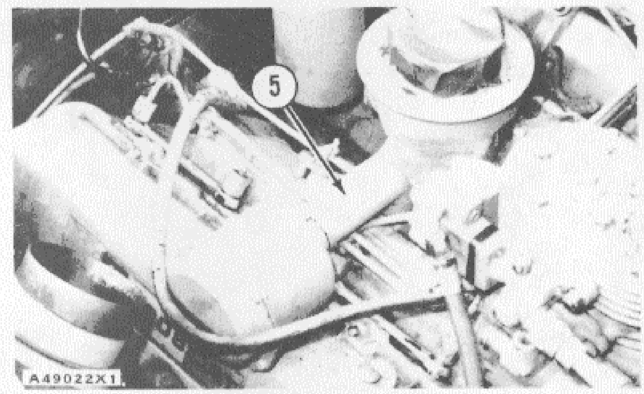
FUEL INJECTION LINES AND AIR INLET MANIFOLD

REMOVE FUEL INJECTION LINES AND AIR INLET MANIFOLD

1. Loosen clamps (2), (3) and (4) to remove tube assembly (1) and the hoses from the engine.

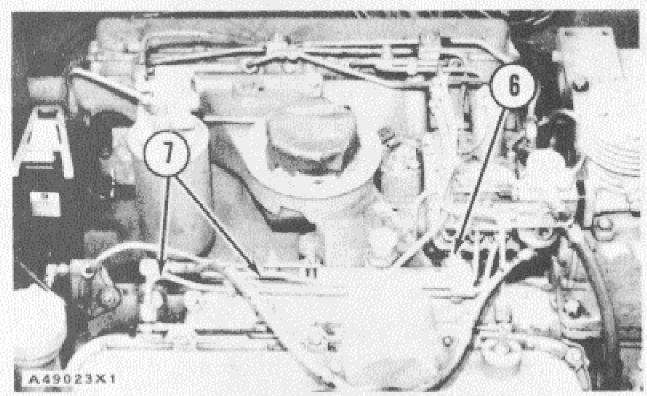


2. Loosen the clamps and remove hose (5) from the crankcase ventilator 'valve and air inlet manifold.



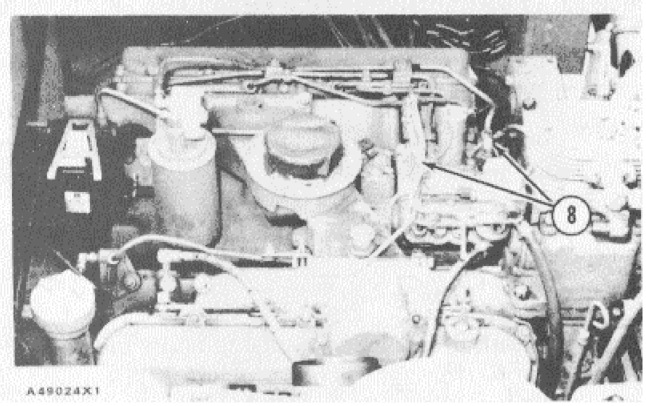
3. Thoroughly clean the area around each fuel line connection before an) fuel lines are removed.

4. Put identification of the fuel injection lines as to their location on the fuel injection pumps and adapters.



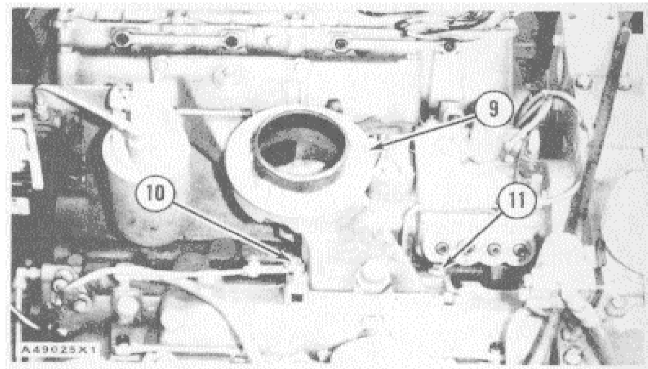
5. Disconnect fuel injection lines (7) from the adapters and the fuel injection pump housing. Re- move bolt (6) and remove fuel injection lines (7).CAUTION: Put protection caps (5F2807) and plugs (2F2990) on the lines and pumps to keep dirt and foreign material out of the fuel system.

6. Disconnect fuel injection lines (8) from the fuel injection pump housing, adapters and the fuel filter and remove them from the engine.

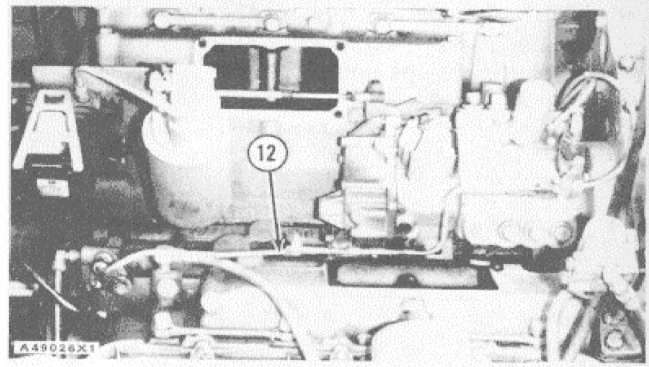


FUEL INJECTION LINES AND AIR INLET MANIFOLD

7. Loosen bolt (I). Remove the five bolts (10) and one nut and remove air inlet manifold (9).



8. Disconnect return line (12) from the fuel injection pump housing and junction block to remove it from the engine.



9. Put tape over the openings in the cylinder heads to keep dirt and foreign materials out of the engine.

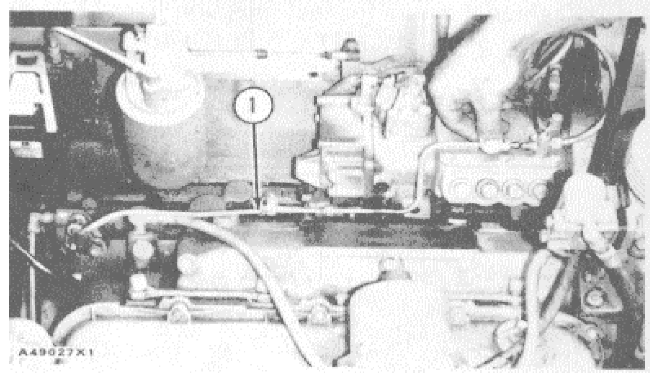
INSTALL FUEL INJECTION LINES AND AIR INLET MANIFOLD

1. Remove the plugs and caps from the fuel lines.

2. Put return line (I) in position and connect it to the fuel injection pump housing and the junction block.

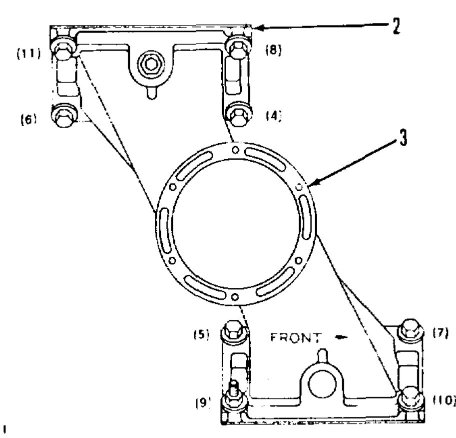
3. Remove the tape from the openings in the cylinder heads.

4. Put air inlet manifold (3) and gaskets (2) in posi-tion on the engine and install the bolts and one nut that hold it in place.



NOTE: If the adapters in the air inlet manifold were removed, put 8H4137 Sealer on the threads of the adapters and tighten them to a torque of 9 + 3 lb.ft. (12 ± 4 N.m).

5. Tighten the bolts (6) and (7) to a torque of 15 + 5 lb.ft. (20 $^{+}$ 7 N.m) then tighten the bolts and one nut in number sequence shown to a torque of 32 + 5 Ib.ft. (43 + 7 N.m). Remove bolt (10) to install the fuel line bracket.



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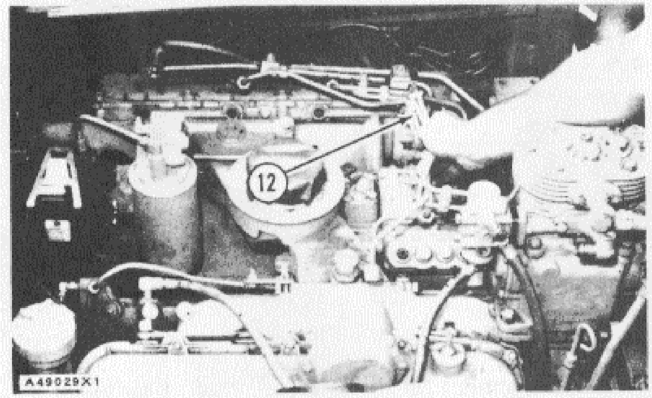
FUEL INJECTION LINES AND AIR INLET MANIFOLD

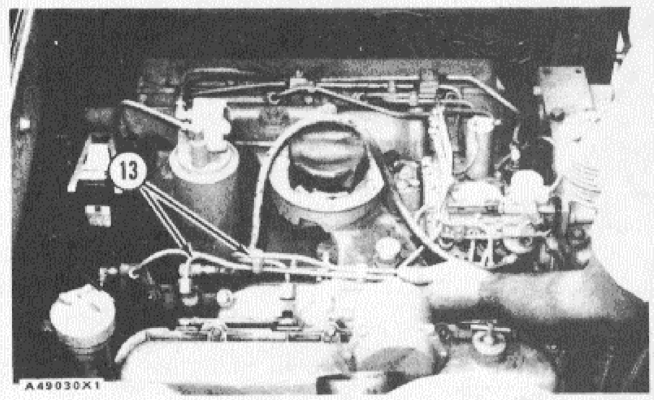
6. Make sure the fuel injection lines are clean and dry.

7. Put fuel injection lines (12) in position on the engine and connect them to their respective fuel injection pumps, adapters and fuel filter base.



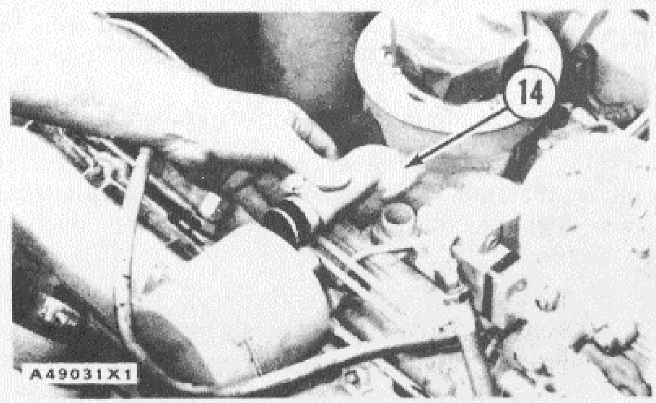
8. Put fuel injection lines (13) in position on the engine and connect them to their respective fuel injection pumps and adapters.

9. Install the bolt through the bracket for fuel injection lines (13) that holds the air inlet manifold.



10. Tighten the nuts for fuel injection lines (12) and (13) to a torque of 30 ± 5 lb.ft. (40 + 7 N.m).

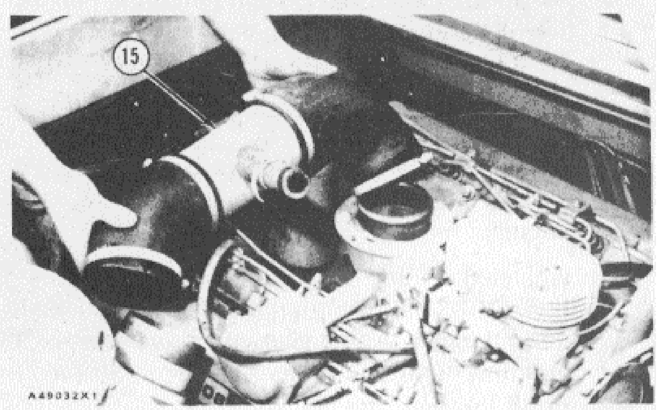
11. Install hose (14) between the air inlet manifold and the crankcase ventilator valve. Tighten the clamps to a torque of 20 ± 5 lb.in. (2.3 + 0.6 N.m).



12. Put tube assembly (15) in position with the hoses and tighten the clamps to a torque of 18 + 5 lb.ft. (24 + 7 N.m).

13. Remove (bleed) the air from the fuel system.

CAUTION: If new fuel lines are used for replacement, remove the identification tags from the lines. The tags can cause wear on the fuel injection lines.



FUEL INJECTION PUMP HOUSING AND GOVERNOR

REMOVE FUEL INJECTION PUMP HOUSING AND GOVERNOR

Tools Needed		A	B
3P1544	Timing Pin	1	
5P2371	Plate1		
S1616	Bolt (1/4"-20 NC x 1" long)2		
Flat Washer 1/4"2			

start by:
a) remove tachometer drive
b) remove fuel injection lines and air inlet manifold

1. Remove the vee belts from the front of the engine.

2. Disconnect control cable (1) from the governor control lever.

3. Remove bolt (2) from the governor housing.

4. Turn the crankshaft clockwise, as seen from the front of the engine, until tool (A) can be installed in the groove (slot) in the fuel injection pump camshaft.

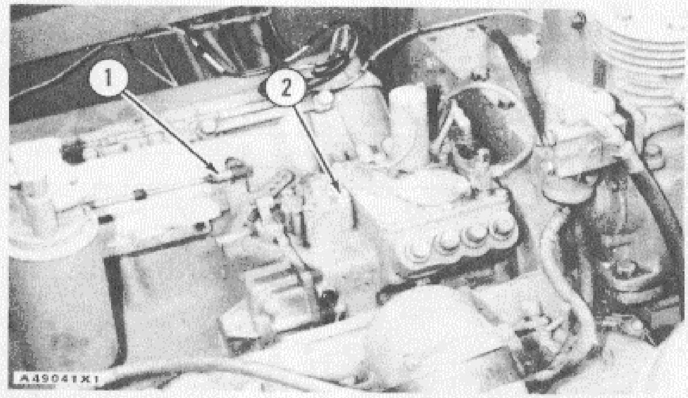
5. Install tooling (B) into the camshaft drive gear for the fuel injection pump. Turn the bolts evenly until the drive gear is free of the camshaft. Remove tooling (B).

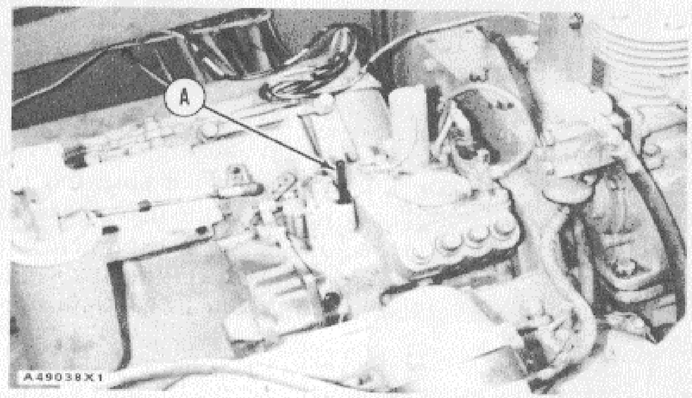
NOTE: If the engine is in time with the fuel injection pump, the crankshaft need not be turned to install the bolt in Step 6.

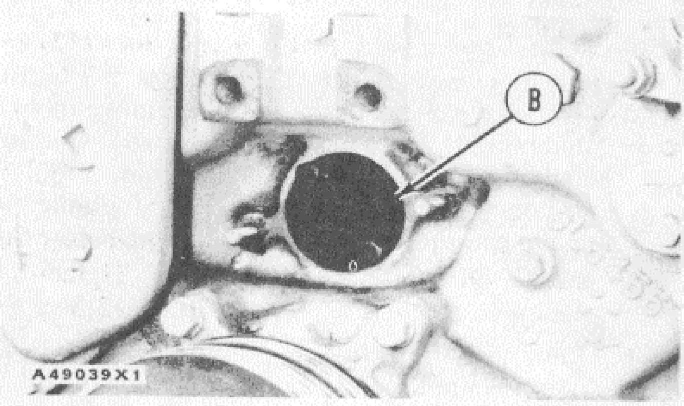
6. Remove plug (3) from the timing gear cover and install a 5/16"-18 NC bolt 2 1/2 in. long. Cover bolt (4) can be used. Turn the crankshaft clockwise, as seen from the front of the engine, until the bolt can be installed into the timing gear and is in the center of the timing hole. The camshaft for the fuel injection pump is now in correct time to the engine.

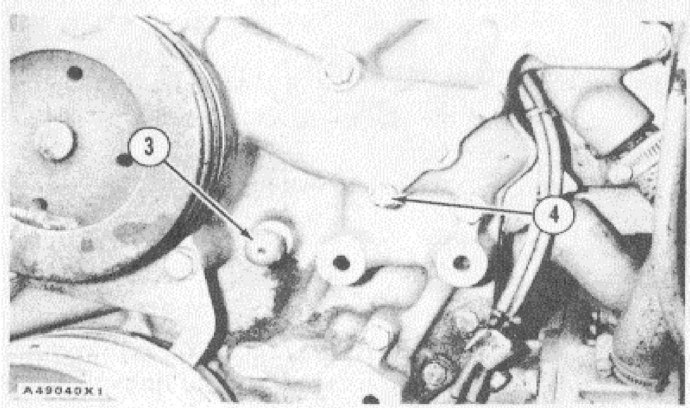
7. Remove the two bolts and washers that hold the base of the fuel injection pump housing to the engine.

8. Pull the fuel injection pump housing and governor out of the timing gear cover and remove the unit and fuel drain (bleed) lines.









INSTALL FUEL INJECTION PUMP HOUSING AND GOVERNOR

Tools Needed		A
3P1544	Timing Pin	1

1. Turn the fuel injection pump camshaft until tool (A) can be installed in the groove of the camshaft.

2. Put the large O-ring seal in position on the front of the fuel injection pump housing and put the small O-ring seal in the top of the cylinder block. Put clean engine oil on the O-ring seals.

3. Put the fuel injection pump housing and governor in position on the engine. Make sure the fuel injection pump camshaft is in the drive gear and the bolt holes in the housing are in alignment with the bolt holes in the engine. Install the two bolts and washers that hold the unit in position.

4. Install washer (1) and the sleeve for the tachometer drive. Tighten the sleeve to a torque of 110 ±10 lb.ft. (149 + 14 N.m).

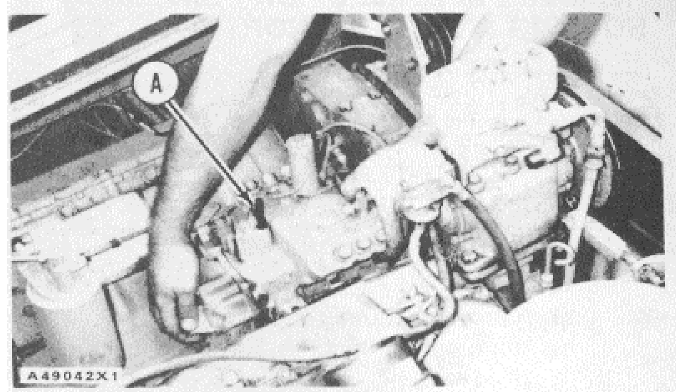
5. To make a check of the timing, remove tool (A) and bolt (3). Turn the crankshaft two revolutions and install tool (A) and bolt (3) again. If tool (A) or bolt (3) can not be installed, the fuel injection pump camshaft must be put into time before Step 6 is done.

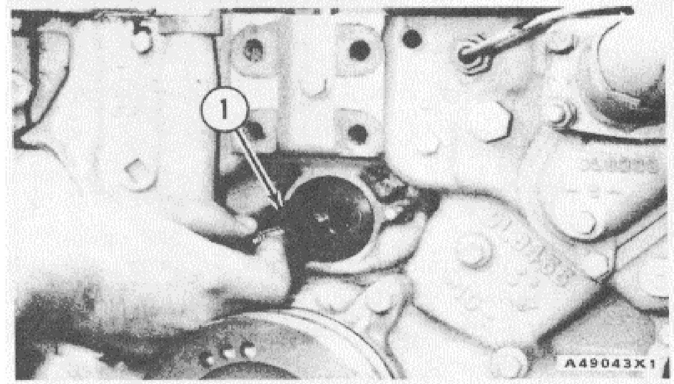
6. Remove bolt (3) from the timing gear and install it in cover hole (2). Install the plug into the timing hole.

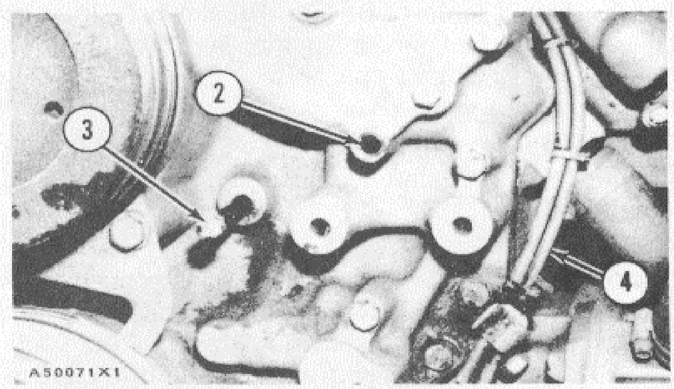
7. Put the fuel drain (bleed) lines (4) in the clip on the side of the engine.

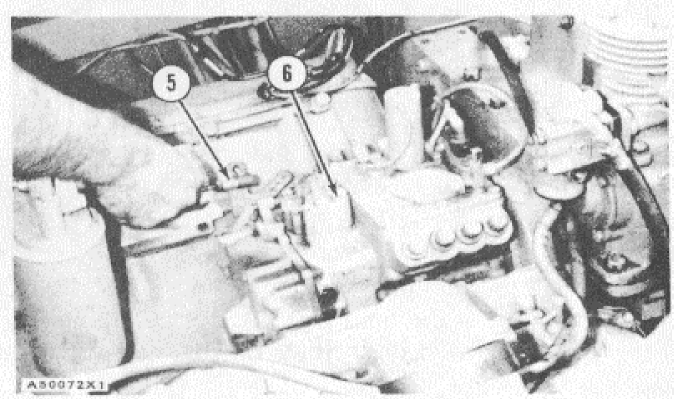
8. Remove tool (A) and install the seal and bolt (6).

9. Connect governor control linkage (5) to the governor control lever end by:
    a) install fuel injection lines and air inlet manifold
    b) install tachometer drive







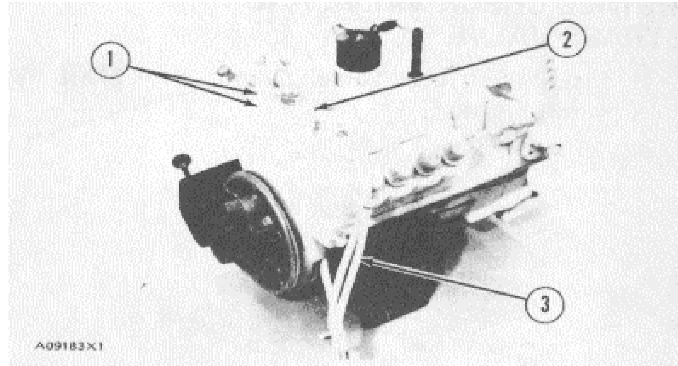


CHECK VALVE AND BYPASS VALVE

REMOVE CHECK VALVE AND BYPASS VALVE

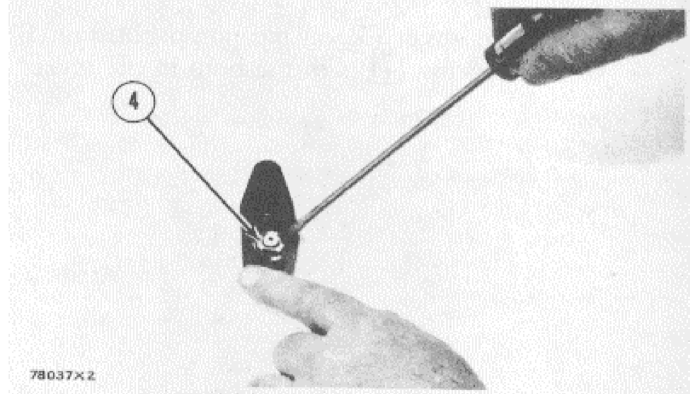
CAUTION: Before any service work is to be done on the fuel system, the outer surface of the injection pump housing must be clean.

NOTE: Illustrations show fuel injection pump housing and governor removed from engine. Service work can be done with it installed on engine.

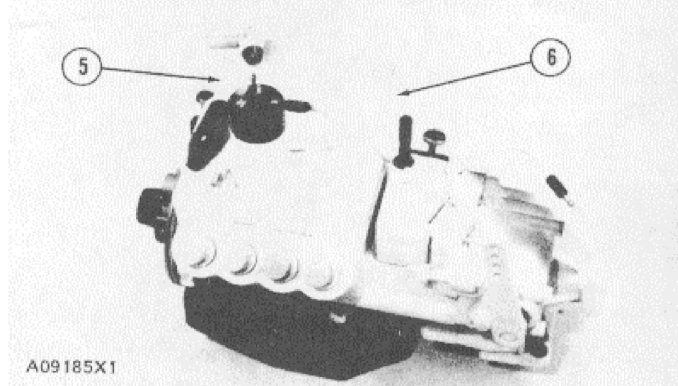


1. Remove fuel lines (3). Remove two bolts (2) and remove flange and flange assembly (1).

2. Remove the check valve (4) from the flange assembly.

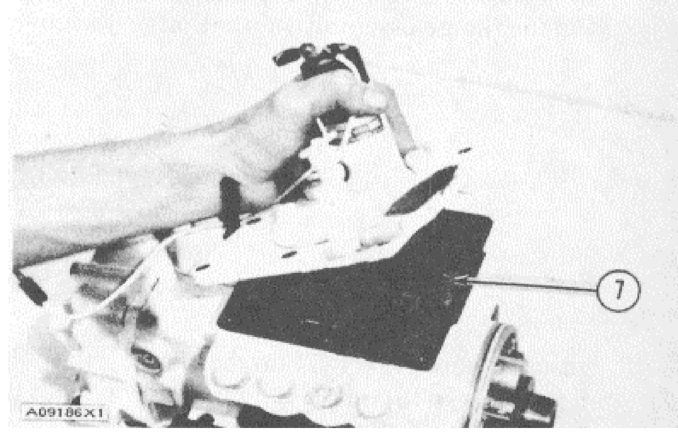


3. Remove the seven bolts (6) that hold the cover (5) to the pump housing.



4. Remove the cover (5) from the pump housing.

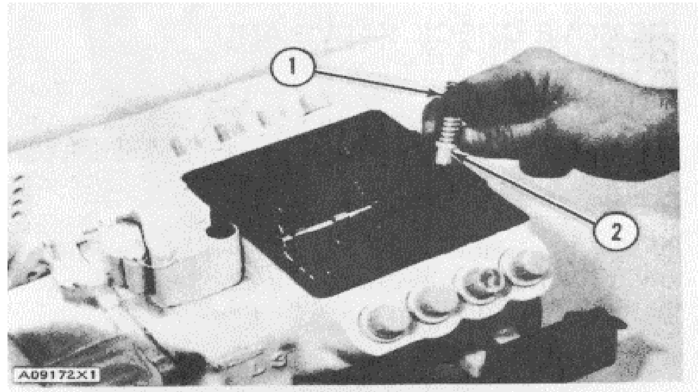
5. Remove the spring (7) and the bypass valve from the pump housing.



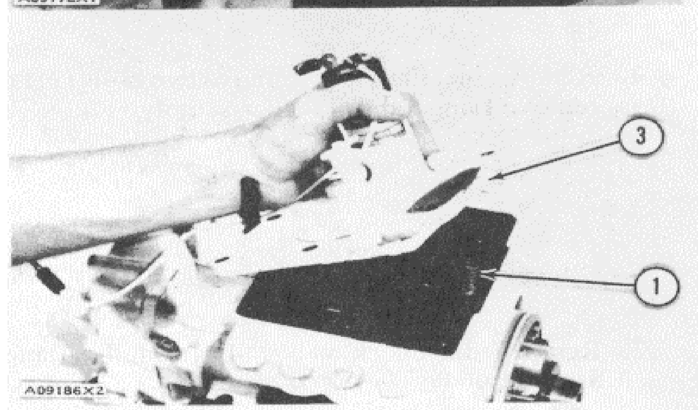
CHECK VALVE AND BYPASS VALVE

INSTALL CHECK VALVE AND BYPASS VALVE

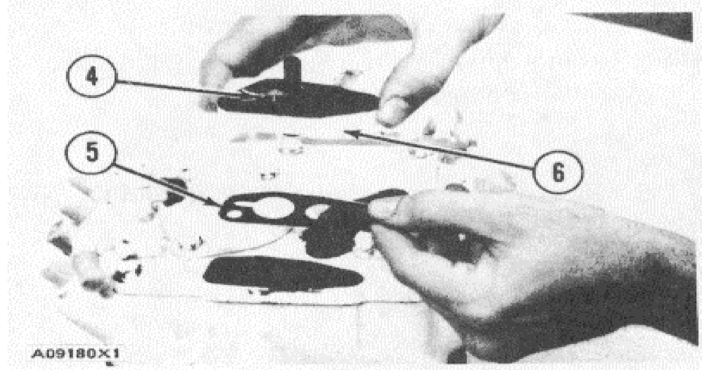
1. Install the bypass valve (2) and spring (l) in the pump housing.



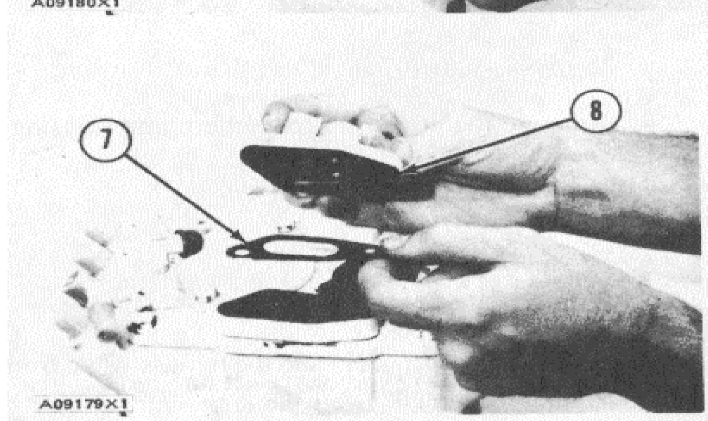
2. Install the cover (3) on the pump housing. Be sure the spring (1) is in the bore in the lever.



3. Install the seven bolts that hold the cover to the pump housing.



4. Install a new gasket (5) on the cover. Install a new check valve (4) in the flange assembly (6). Put the flange assembly in position on the cover.



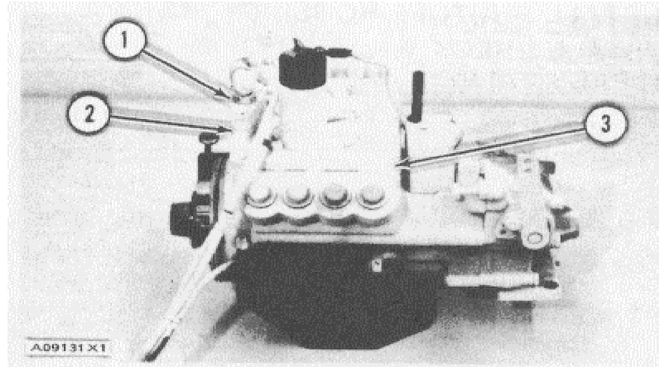
5. Install a new gasket (7) on the flange assembly. Install flange (8) on the flange assembly with the bolts that hold them to the cover.

SHUTOFF HOUSING

REMOVE SHUTOFF HOUSING

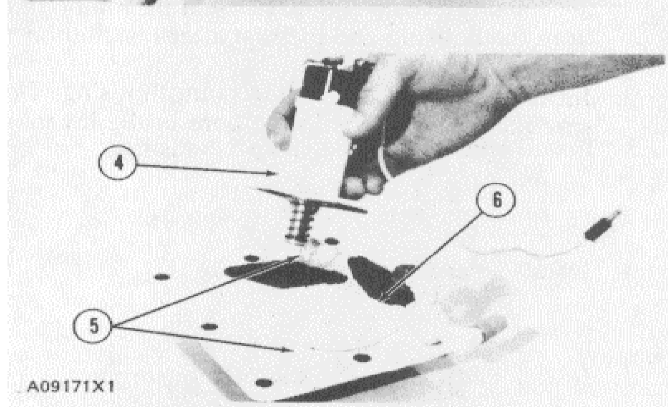
CAUTION: Before any service work is to be done on the fuel system, the outer surface of the injection pump housing must be clean.

NOTE: Illustrations show fuel injection pump housing and governor removed from engine. Service work can be done with it installed on engine.



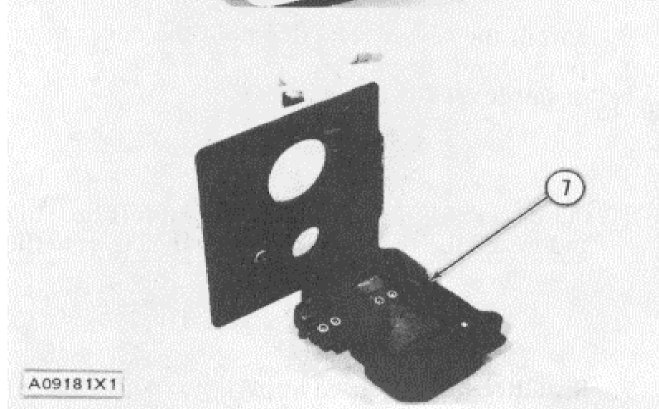
1. Remove flange (1) and flange assembly (2) from the cover (3).

2. Remove the seven bolts and remove cover (3) from the pump housing.



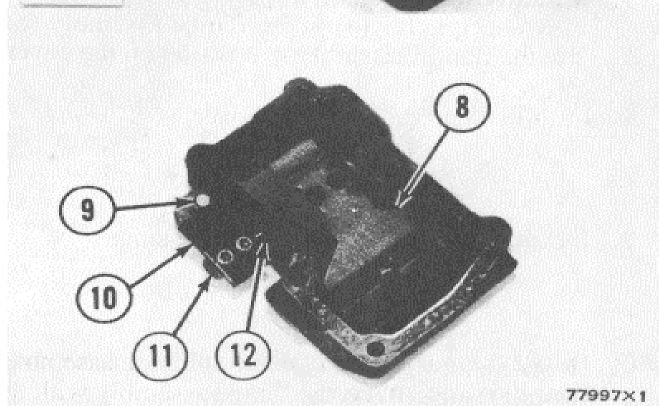
3. Remove solenoid (4) from the cover.

4. Remove cover (6).



5. Remove two bolts (5) that hold the cover to shutoff housing (7).

6. Remove the cover from the shutoff housing (7).



7. Remove lever (10) from shaft (11).

8. Remove shaft (9) from the shutoff housing.

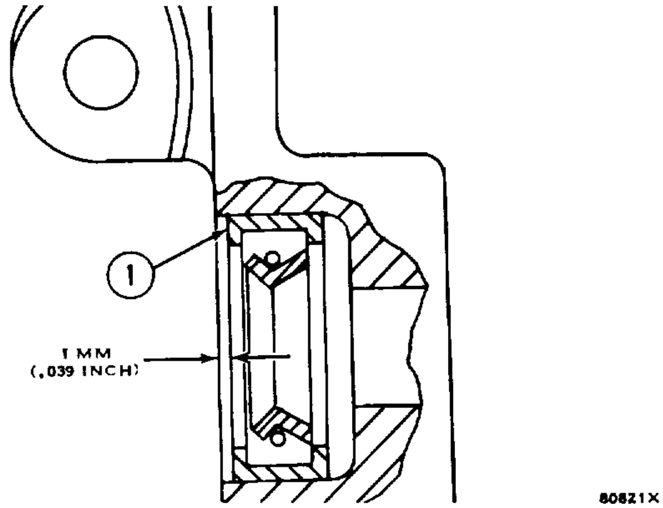
9. Remove lever (8) from shaft (11).

10. Remove shaft (11) from the shutoff housing.

11. Remove seal (12) from the shutoff housing.

SHUTOFF HOUSING

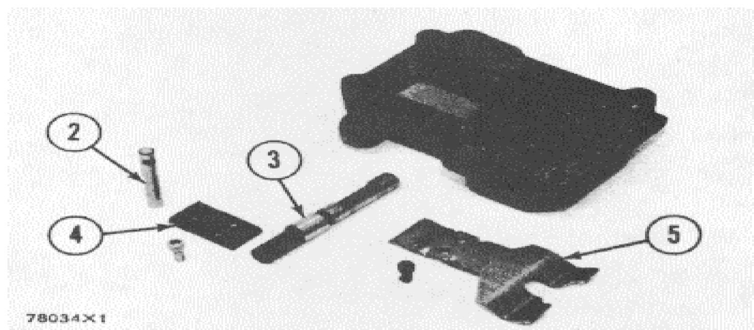
INSTALL SHUTOFF HOUSING



Tools Needed	A	
1P529	Handle	1
1P460	Plate	1

1. Put 5S1454 Sealing Compound on the outside diameter of the seal and install the seal (I) with tooling (A) in the shutoff housing with the lip toward the outside. The outer face of the seal must be .039 in. (1.0 mm) below the surface of the housing. Remove the extra sealing compound from the housing and the seal after installation.

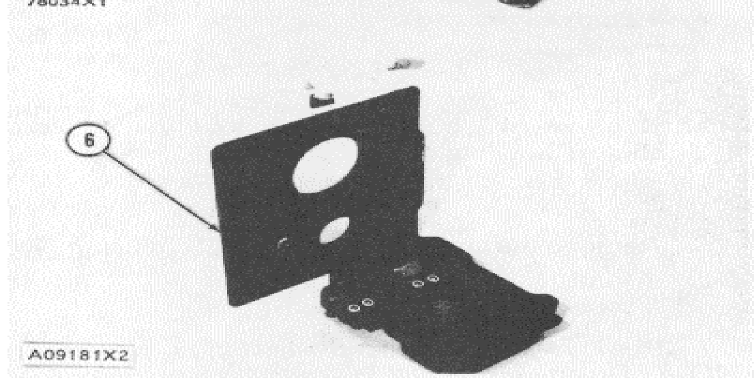
2. Install shaft (3) in the shutoff housing.



3. Install lever (5) on shaft (3).

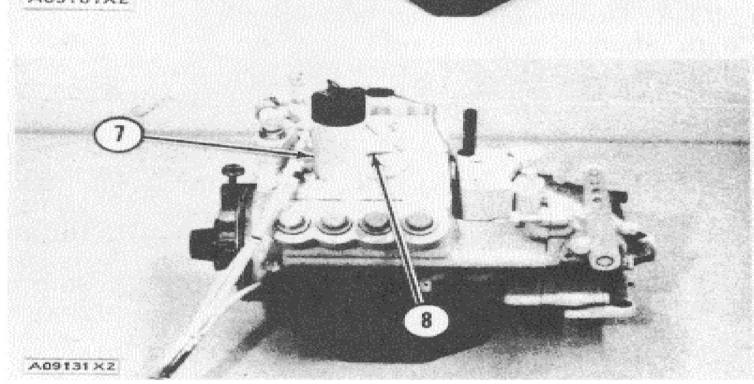
4. Install shaft (2) in the shutoff housing.

5. Install lever (4) on shaft (3).



6. Put cover (6) in position on the shutoff housing and install the two bolts that hold the cover to the housing.

7. Install cover (8) on cover (6).



8. Install solenoid (7) on the cover.

9. Install cover (6) on the pump housing.

10. Install the gasket, flange assembly, gasket and flange on the cover.

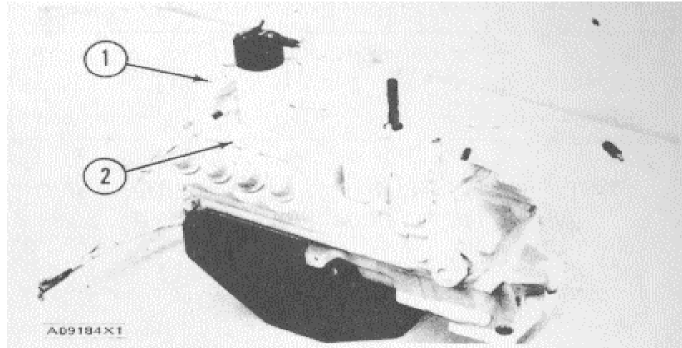
FUEL INJECTION PUMPS

REMOVE FUEL INJECTION PUMPS

	Tools Needed	A
8S2243	Wrench	1
8S2244	Extractor	1

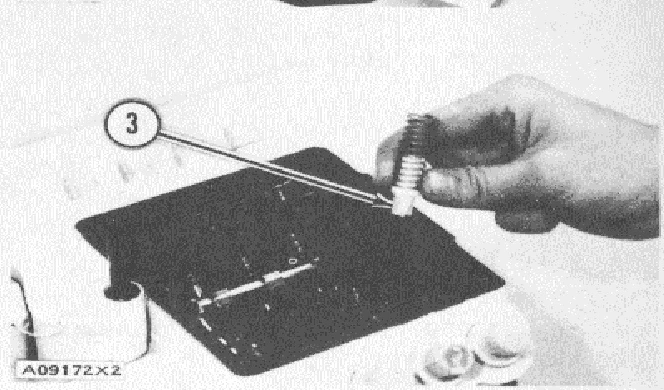
CAUTION: Before any service work is to be done on this fuel system, the outer surface of the injection pump housing must be clean.

NOTE: The fuel injection pump housing and governor has been removed from the engine for illustration purposes.

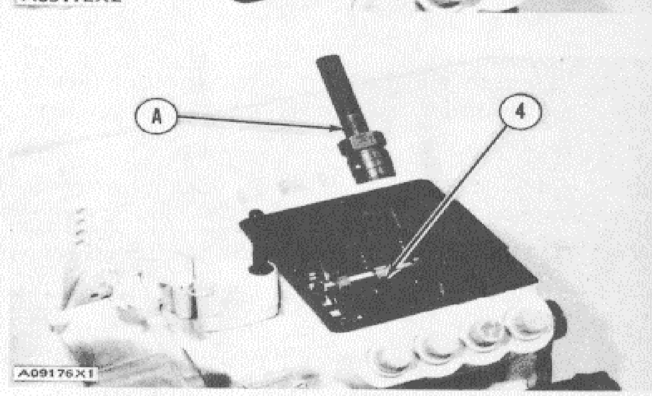


1. Remove the flange (1) and the flange assembly from the cover.

2. Remove the cover (2) from the pump housing.

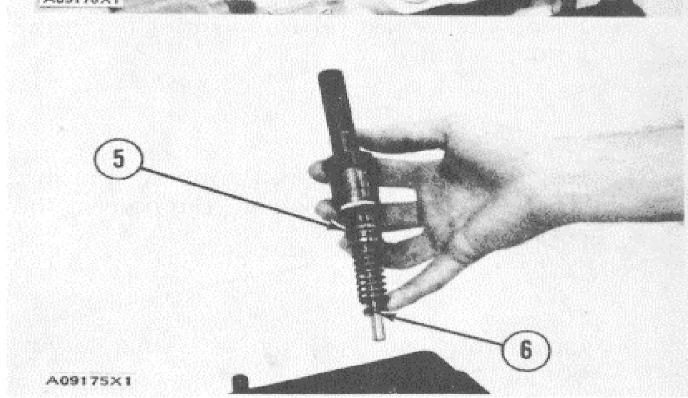


3. Remove the bypass valve (3) and springs from the pump housing.



4. Install tooling (A) on the fuel injection pump and loosen the bushing from the pump housing.

NOTE: Do not loosen the screws (4) that hold the levers to the shaft when the pumps are removed or installed. If the levers are moved, fuel pump calibration will be changed.



5. Remove the fuel injection pump (5) from the pump housing. The sleeve (6) on the plunger will slide off the lever as the pump is removed.

6. Do Steps 4 and 5 for the remainder of the pumps.

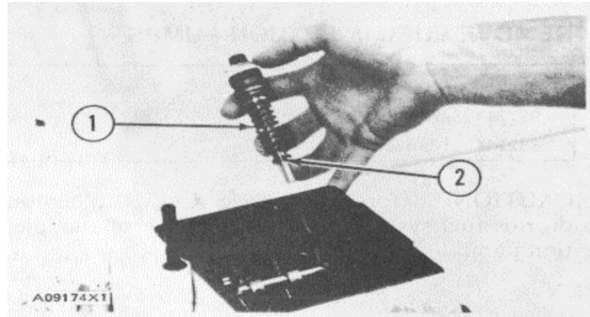
FUEL INJECTION PUMPS

INSTALL FUEL INJECTION PUMPS

	Tools Needed	A
8S2243	Wrench	1
8S2244	Extractor	1

1. Turn the camshaft until the lifter for the pump to be installed is at its lowest position.

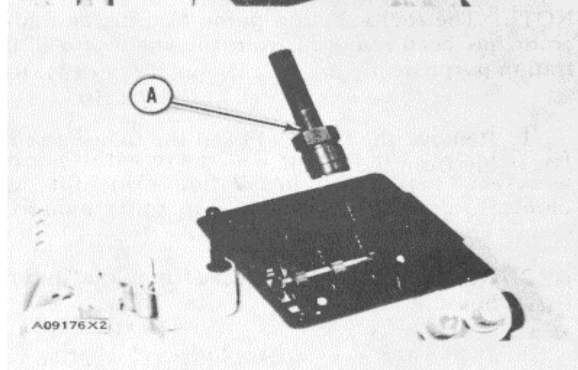
2. Install the fuel injection pump (1) in the bore of the pump housing.



3. The sleeve (2) will be engaged with the lever when the pump is installed correctly.

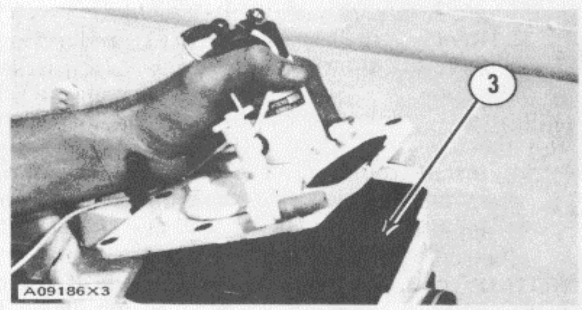
CAUTION: If the levers have been moved on the shaft, fuel pump calibration must be made. (See Testing and Adjusting).

4. Tighten the bushing with tooling (A) to a torque of 70 + 5 lb. ft. (94.9 ± 6.8 N.m).



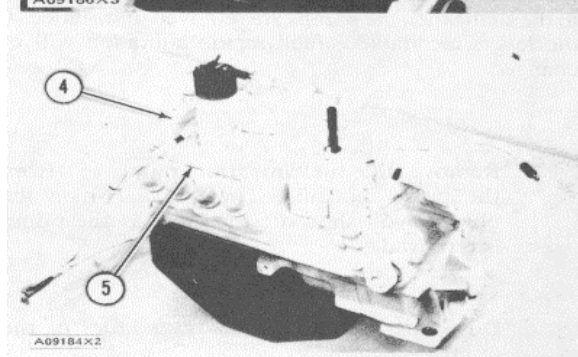
5. Do Steps I through 4 for the remainder of the pumps.

6. Install the bypass valve and spring (3) in the pump housing.



7. Install the cover (5) on the pump housing. Be sure the spring (3) is in the bore in the cover.

8. Install the flange (4) and the flange assembly on the cover.



DISASSEMBLE FUEL INJECTION PUMPS

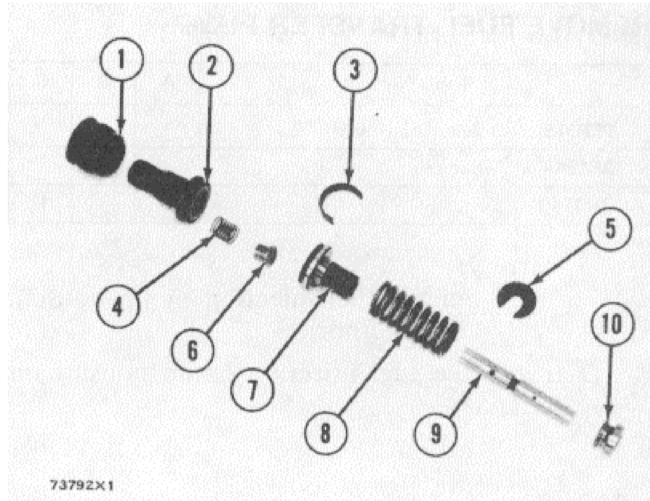
start by:
a) remove fuel injection pumps

1. Remove the bushing (1) and seal from the bonnet (2).

2. Remove the ring (3) from the bonnet and barrel (7). Remove the check valve (6) and spring (4) from the bonnet.

3. Remove the spring (8) and washer (5). Remove the plunger (9) and sleeve (10).

NOTE: Keep the plunger and sleeve with their respective barrel for installation. Do not use plungers, sleeves and barrels with other plungers, sleeves and barrels.



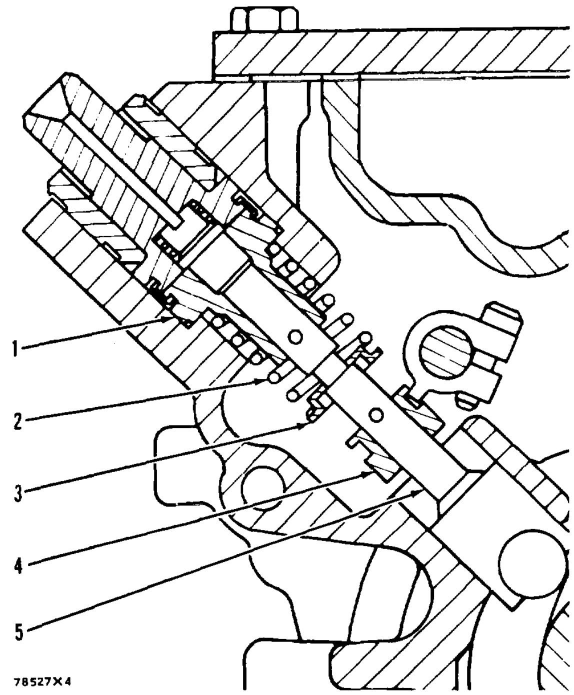
ASSEMBLE FUEL INJECTION PUMPS

1. Install the sleeve (4), plunger (5), spring (2) and washer (3) on the barrel (1).

NOTE: Be sure the sleeve and plunger are installed in their original barrel and the large hole in the plunger is up. The sleeve must be installed with the thin flange up.

2. Install the check valve and spring in the bonnet. Connect the barrel and bonnet and install the ring. Install the seal and bushing on the bonnet.

end by:
a) install fuel injection pumps



FUEL TRANSFER PUMP

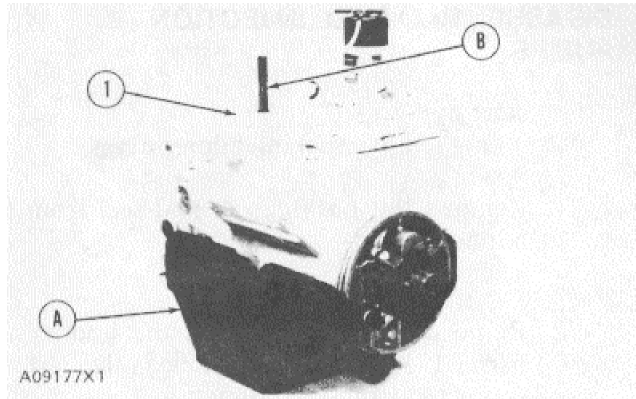
REMOVE FUEL TRANSFER PUMP

Tools Needed		A	B	C
2P8315	Bracket Assembly	1		
3P1544	Timing Pin		1	
2H3740	Bolt			1

start by:

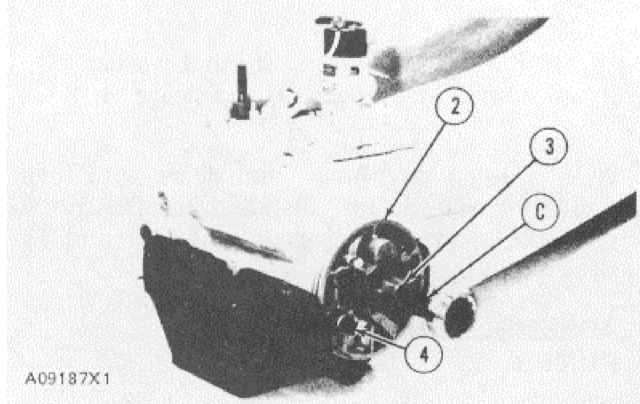
a) remove fuel injection pump housing and governor

1. Install the fuel injection pump housing on tool (A).



2. Remove a bolt from cover (1). Turn the injection pump camshaft until tool (B) can be installed ill the camshaft.

3. Install tool (C) in the threads of the sleeve (3). Tighten the bolt until the sleeve can be removed.

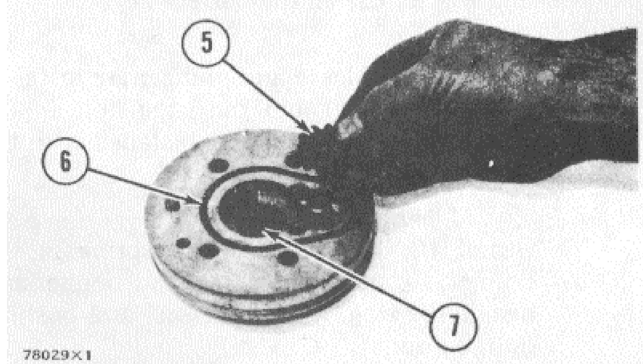


4. Remove the four bolts (4) that hold the body to the housing.

5. Remove the body (2) from the housing.

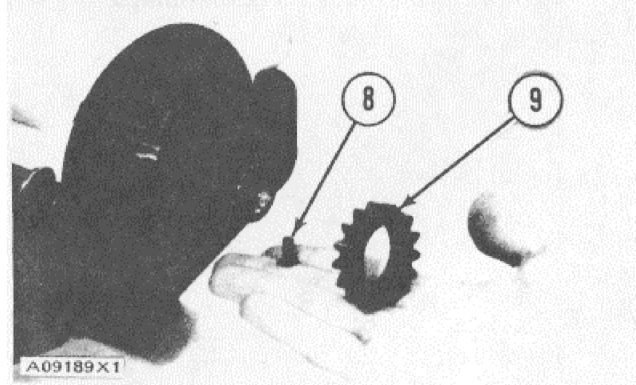
6. Remove the idler gear (5) from the body.

7. Remove the O-ring seal (6) from the body. Remove the two lip type seals (7) from the body.



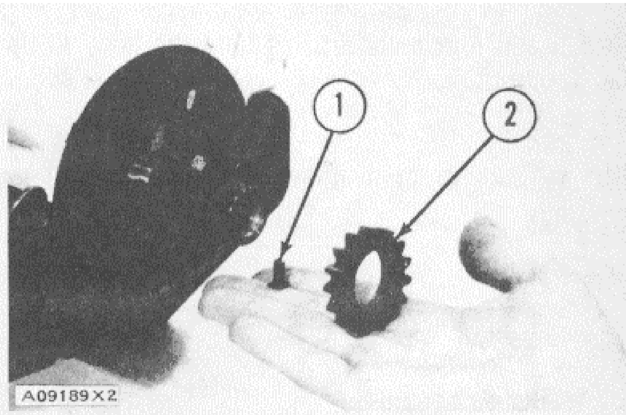
8. Remove the drive gear (9) from the shaft.

9. Remove the key (8) from the shaft.

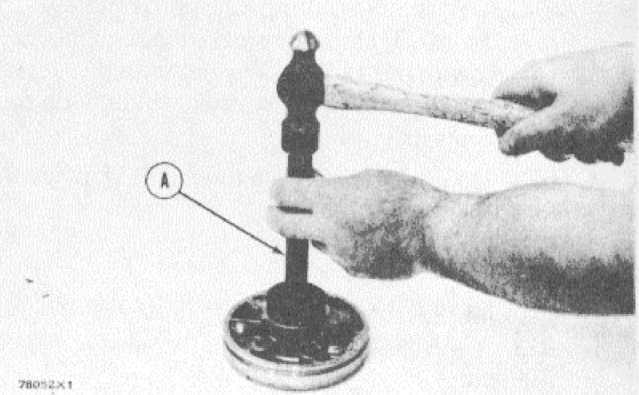


INSTALL FUEL TRANSFER PUMP

	Tools Needed	A	B	C	D
1P529	Handle	1	1		
1P463	Drive Plate	1			
5P318	Drive Plate	1			
5P319	Drive Plate		1		
S1603	Bolt (½" - 20 NF x 1 ½" long)			1	
484280	Washer			1	
3P1544	Timing Pin				1

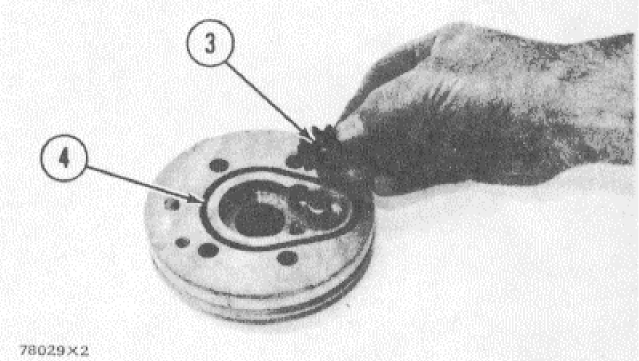


1. Install key (1) and drive gear (2) on the shaft.



2. Put 5S 1454 Sealing Compound on the outside of the seals.

3. Install the inner seal in the body with the lip of the seal toward the inside with tooling (A).

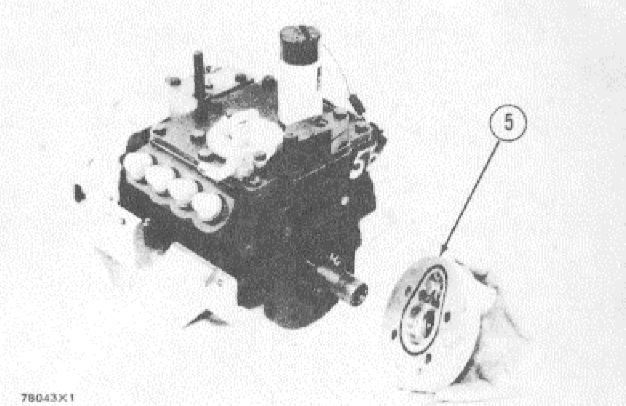


4. Install the outer seal in the body with the lip of the seal toward the outside with tooling (B).

5. If necessary, install new dowels in the body until they extend .2 in. (5.08 mm) from the inside surface.

6. Remove the extra sealing compound from the body and the seals after installation.

7. Install O-ring seal (4) and idler gear (3) in the body.



8. Install body (5) on the housing.

FUEL TRANSFER PUMP

9. Install four bolts (7) that hold the body to the housing.

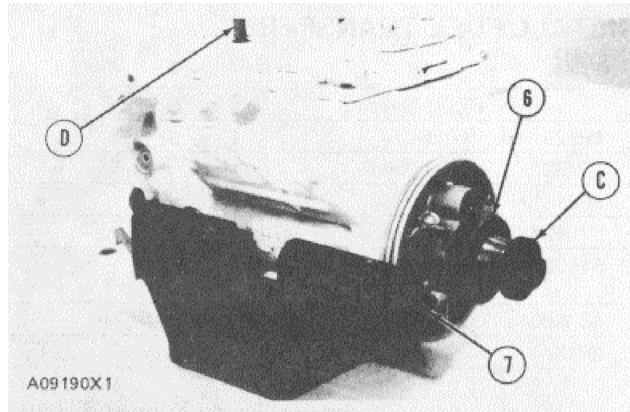
10. Put tool (D) in position so the camshaft will not turn.

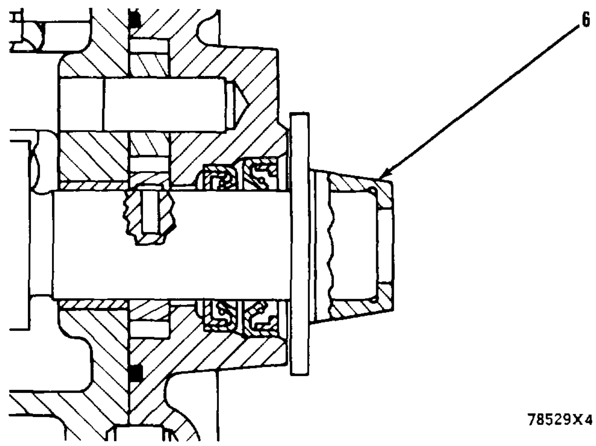
1. Put sleeve (6) on the camshaft.

12. Tighten the sleeve into position on the shaft with 4B4280 Washer of tooling (C) approximately' .25 in. (6.4 mm). Tighten the sleeve the remainder of the way with the 4N337'1- Washer until the sleeve is at bottom. This is the washer which is on the tachometer drive shaft

CAUTION: Do not hit the sleeve to instal1. Damage to governor will result.

13. The end play of the camshaft must be .023 + .018 in. (0.58 - 0.46 mm) after sleeve (6) is installed.
    end by:
    a) install fuel injection pump housing and governor



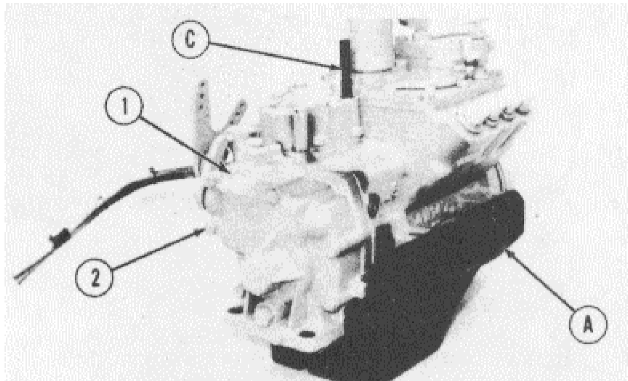


GOVERNOR

DISASSEMBLE GOVERNOR

	Tools Needed	A	B	C	D
2P8315	Bracket Assembly	1			
5P302	Bar		1		
3P1544	Timing Pin			1	
1P1855	Pliers				1

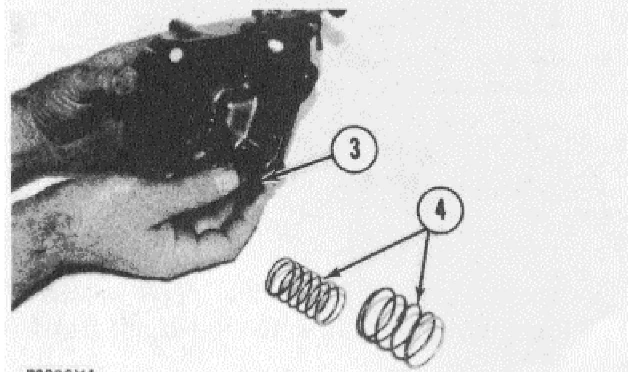
start by:
a) remove fuel injection pump housing and governor



A51861X1

1. Install the fuel injection pump housing on tool (A).

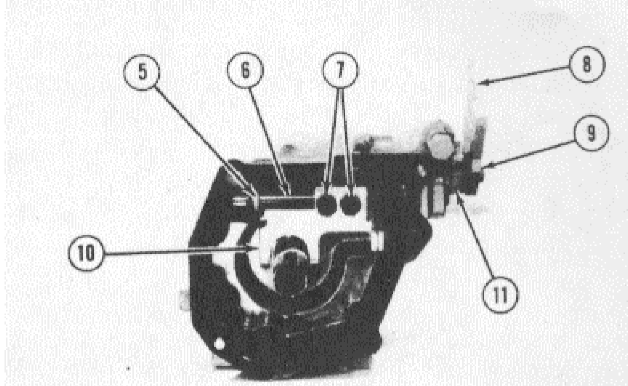
NOTE: Tool (C) was installed in the groove (slot) in the fuel injection pump camshaft when the fuel injection pump housing and governor were removed.



78006X1

2. Remove bolts (2), housing assembly (1) and the gasket from the fuel injection pump housing.

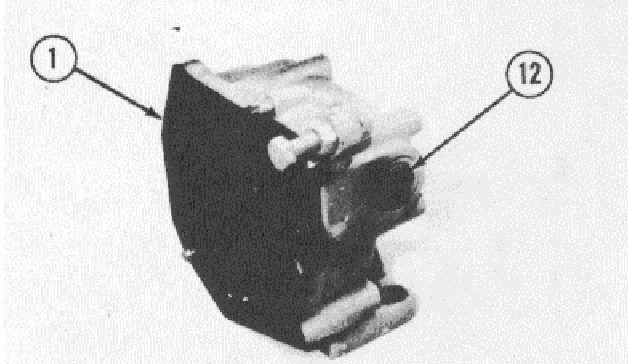
3. Remove the two springs (4) and seat (3) from the governor housing.



A51863X1

4. Remove two bolts (7) that hold lever (10) to shaft (6). Pull shaft (6) out of the governor housing and remove washers (5) and lever (10).

5. If necessary, remove bolt (9) from shaft (6) and remove lever (8), spring (11) and the lever assembly from the shaft.



A51864X1

6. Remove seal (12) from governor housing (1).

GOVERNOR

7. Remove seat assembly (14) and spring (16) from the flyweight shaft.

8. Remove seal (15) and the wire. Remove the bolts, cover (13) and the gasket.

9. If necessary, use tool (D) to remove ring (21) from seat (18). Remove ring (20) and spool (19) from seat (18). Remove seat (18) and springs (17) from seat assembly (14).

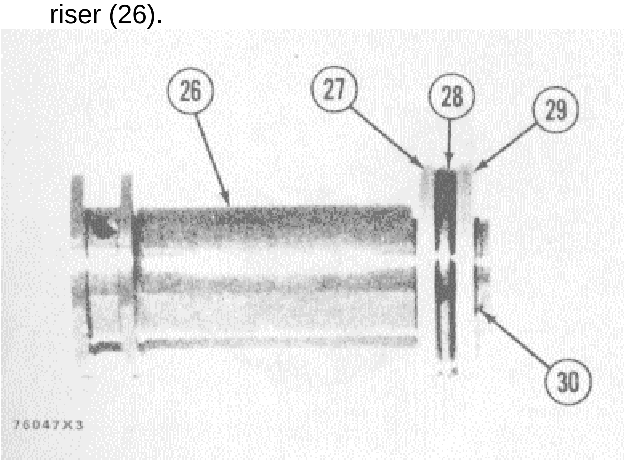
10. Remove shaft (22) from the top of the fuel injection pump housing. Remove lever assembly (23).

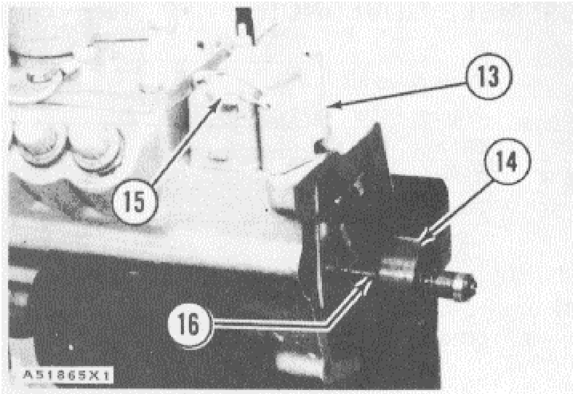
11. Remove riser (25) from the flyweight shaft.

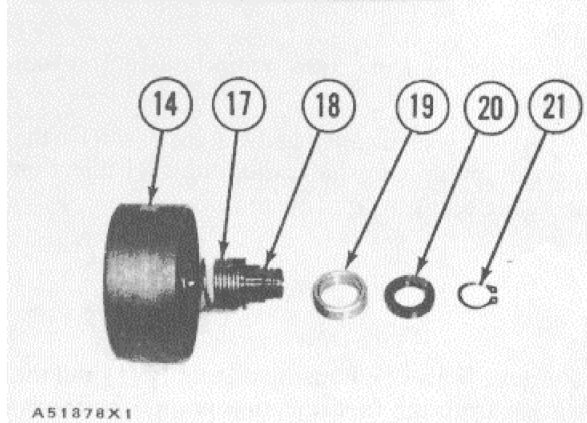
12. Remove tool (C), the bolts, cover assembly (24) and the gasket from the fuel injection pump housing.

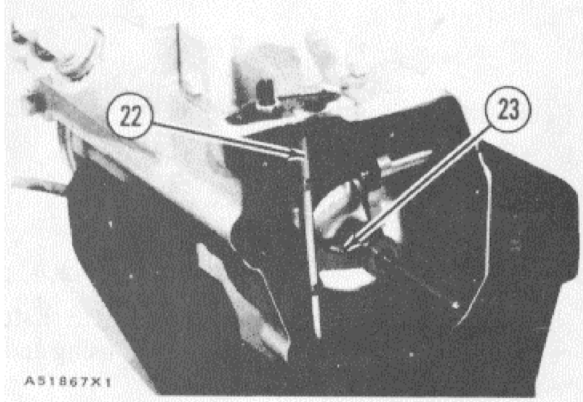
13. Remove ring (30) from riser (26).

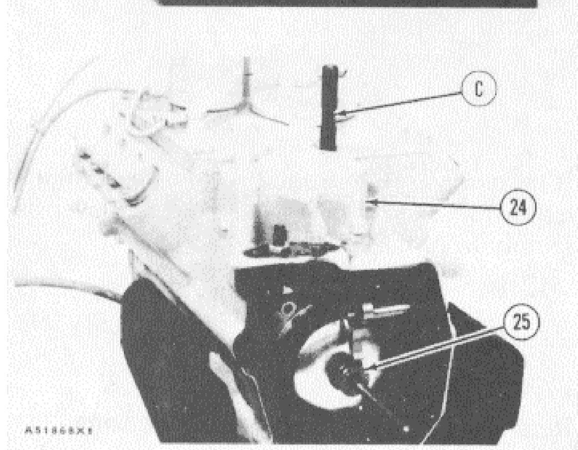
14. Remove race (29), bearing (28) and race (27) from riser (26).







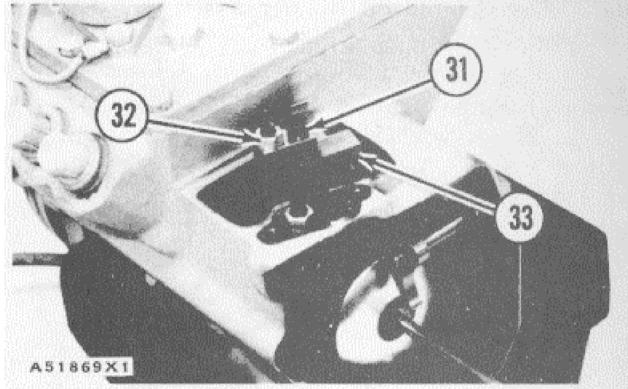




GOVERNOR

15. Remove nut (32), bolt (31) and torque control group (33) from the fuel injection pump housing.

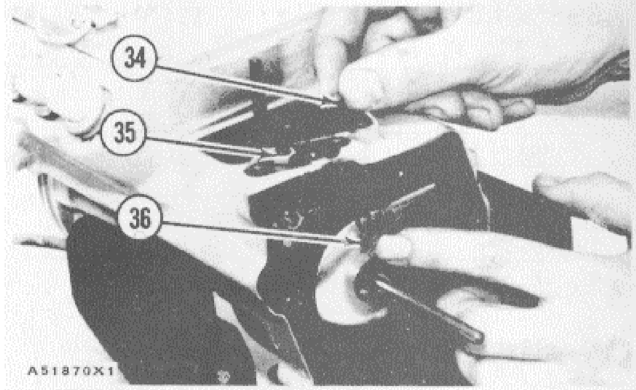
NOTE: Keep all of the parts of the torque control group together for installation purposes.



16. Push lever (36) toward the front of the fuel injection pump housing and remove pin (34).

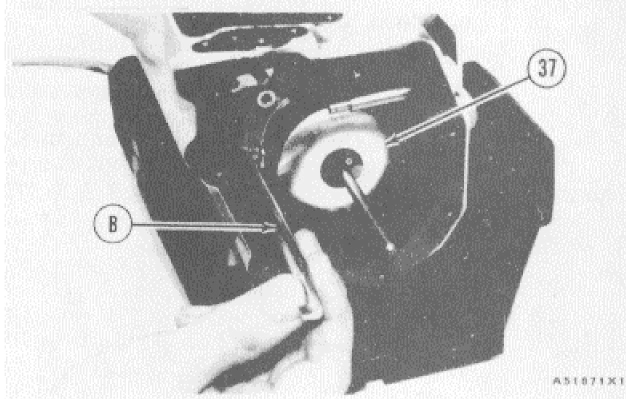
17. Remove nut (35) and the screw from the fuel injection pump housing.

18. Remove the ring that holds lever (36) and remove the lever from the dowe1.



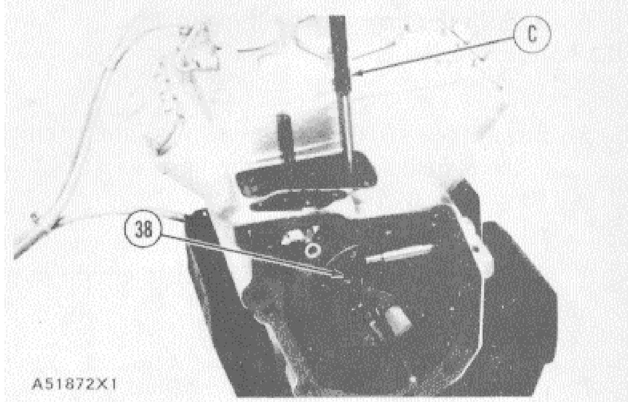
19. Remove shield (37) from the camshaft with tool (B).

CAUTION: Pull on the shield only a small amount in each location, so it will not have distortion or damage. The metal of the shield is moved (staked) around the camshaft and the shield can be damaged when it is removed. If the shield has damage, use a new part for replacement.



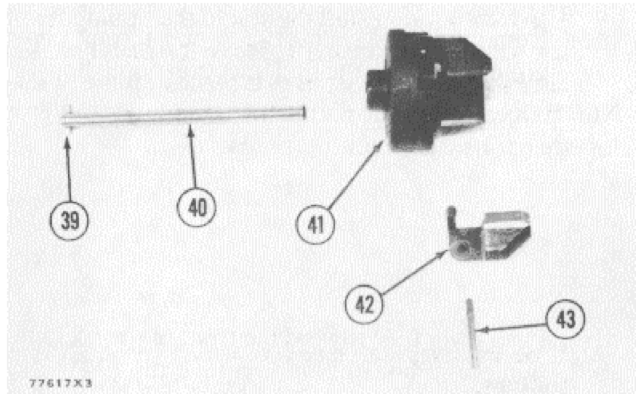
20. Install tool (C) to hold the camshaft.

21. Remove bolts (38) that hold the flyweight assembly to the camshaft. Remove the flyweight assembly.



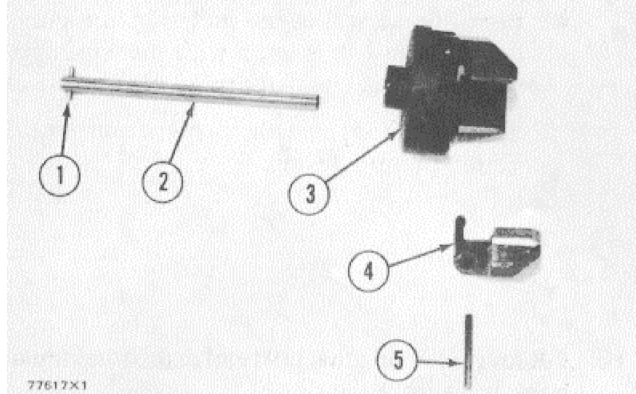
GOVERNOR

22. Disassemble the fl)weight assembly as follows:
    a) Remove shaft (40) from carrier (41).
    b) Remove dowel (39) from shaft (40).
    c) Remove dowels (43) and weights (42) from carrier (41).



ASSEMBLE GOVERNOR

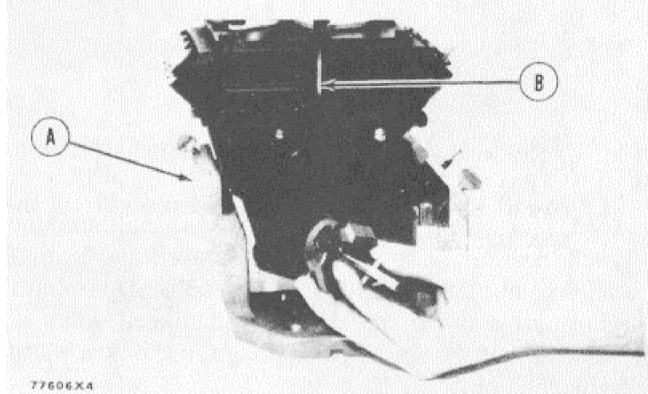
	Tools Needed	A	B	C	D	E
2P8315	Bracket Assembly	1				
3P1544	Timing Pin		1			
5P301	Driver			1		
1P510	Driver Group				1	
1P1855	Pliers					1



1. Assemble the flyweight assembly as follows:
    a) Put weights (4) in position on carrier (3) and install dowels (5) to hold the weights.
    b) Install dowel (1) in shaft (2).
    c) Install shaft (2) in carrier (3).

2. Install the fuel injection pump housing in tool (A).

3. Install tool (B) to hold the camshaft.



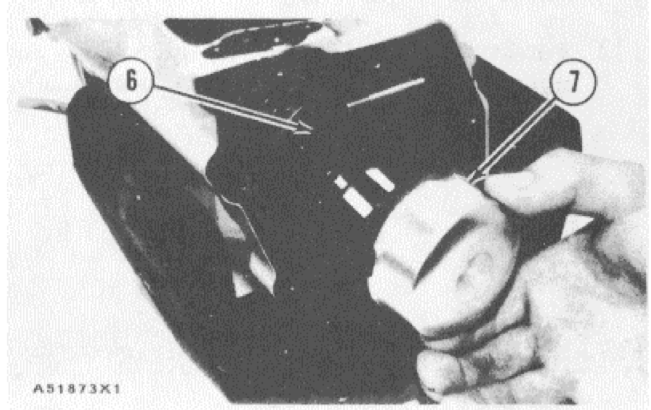
4. Put the flyweight assembly in position on the camshaft.

NOTE: Be sure the pin that holds the flyweight shaft is in position in the back of the flyweight carrier before the bolts are installed.

5. Install bolts (6) that hold the flyweight assembly to the camshaft. Tighten the bolts to a torque of 10 -+ ’ lb. ft. (14 + 3 N m).

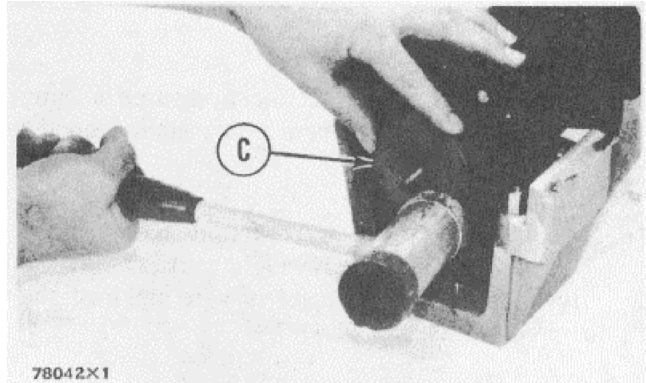
6. Remove tool (B) from the fuel injection pump housing.

7. Put shield (7) in position over the flyweights.



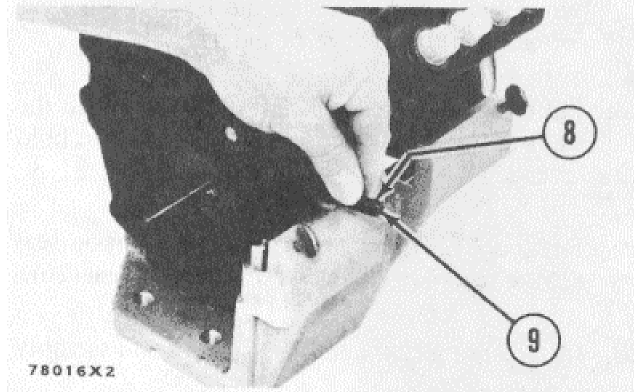
GOVERNOR

8. Use tool (C) to install the shield the remainder of the way on the camshaft. Move the metal (stake) around the camshaft in two places on the shield 180" + $^{5^{\circ}}$ apart.

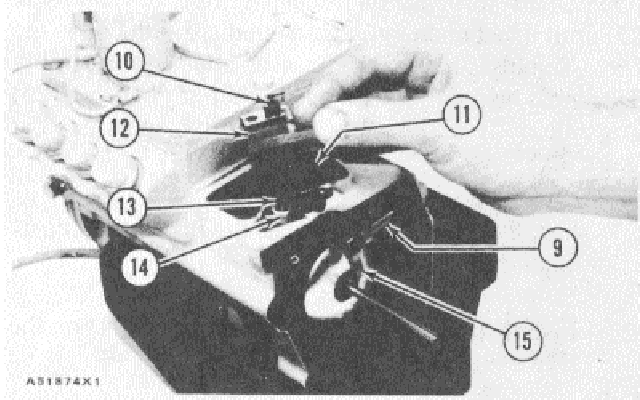


TYPICAL EXAMPLE

9. If necessary install a new dowel (9) or seal (8) as follows:
   a) Put O-ring seal (8) on dowel (9).
   b) Install the dowel in the fuel injection pump housing until it is even with the machined surface of the counterbore on the outside of the housing.

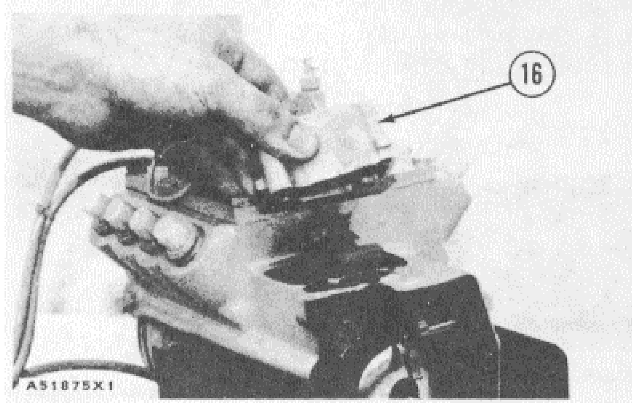


10. Put lever(15) on dowel (9) and install the ring to hold it.



11. Install screw (13), nut(14) and pin (I 1) in the fuel injection pump housing.

12. Put torque control group (12) in position and tighten bolt (10) and the nut to hold the control group.



13. Install the gasket and cover (16) on the fuel injection pump housing.

GOVERNOR

14. Install race (18), bearing (19), race (20) and ring (2I) on riser (17).

15. Install tool (B) in the fuel injection pump housing to keep it in time when it is installed on the engine.

16. Install riser (17) on the fly)weight shaft with the bearing toward the flyweight carrier. Lift the flyweights up with a piece of wire and push the riser forward.

17. Put lever (23) in position in the fuel injection pump housing. Make sure the lever is engaged correctly in the groove of the riser.

18. Put the O-ring seal on shaft (22) and install the shaft in the fuel injection pump housing to hold lever (23).

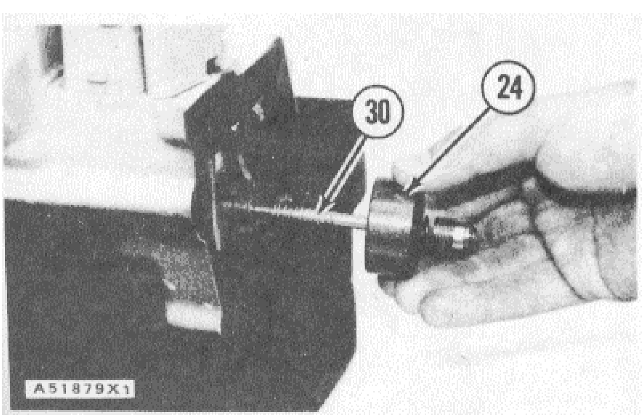
19. Put spool (27) and ring (28) in position on seat (26). Use tool (E) to install ring (29) on seat (26).

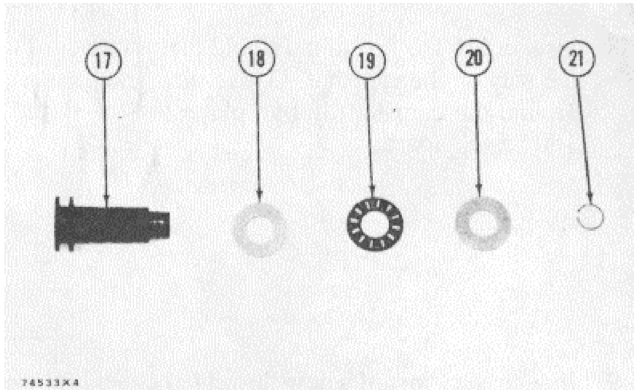
20. Install spring (25) and seat (26) in seat assembly (24).

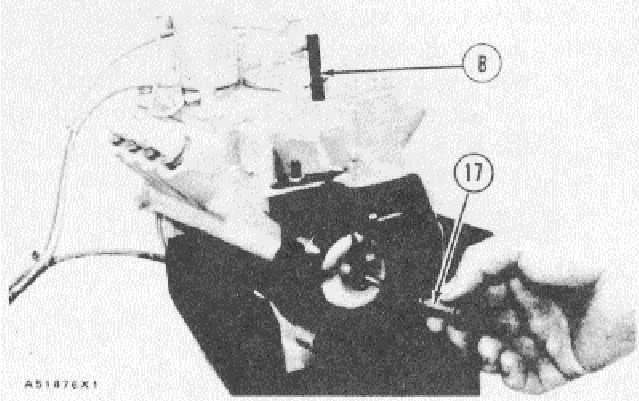
NOTE: Turn spring (25) on seat assembly (24) and seat (26) until it just makes contact with the shoulders on the seat assembly and seat. The seat and seat assembly faces must be parallel with each other after spring (25) is installed. If not, remove the spring and install it again.

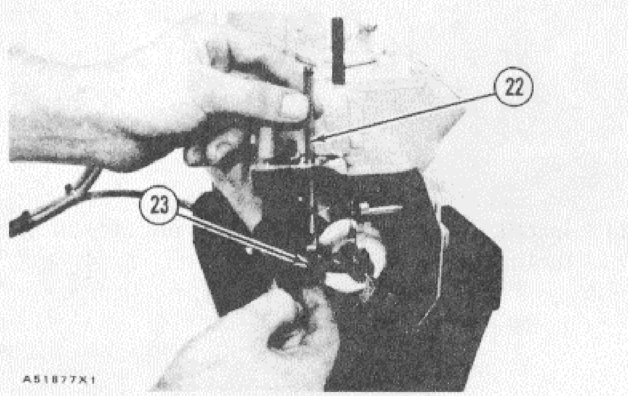
21. Install the small cover over the high idle adjustment.

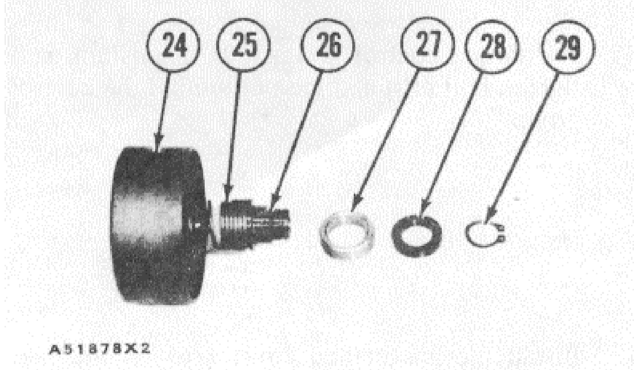
22. Install spring (30) and seat assembly (24) on the fl) weight shaft.





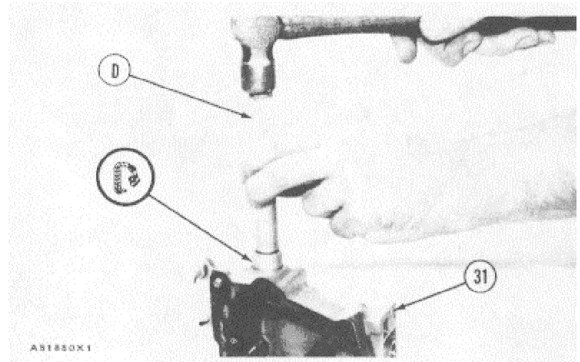






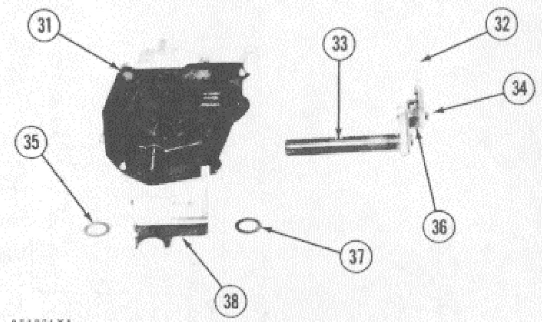
GOVERNOR

23. Put 5S1454 Sealing Compound on the outside diameter of the seal. Use tool group (D) to install the seal in governor housing assembly (31) with the lip of the seal toward the inside as shown. Remove the sealing compound from housing assembly (31) after the seal is installed.



24. Put the lever assembly, spring (36) and lever (32) in position on shaft assembly (33). Put 9M3710 Anti-Seize Compound on the outside diameter of the spacer and install the spacer and bolt (34) to hold lever (32) in position.

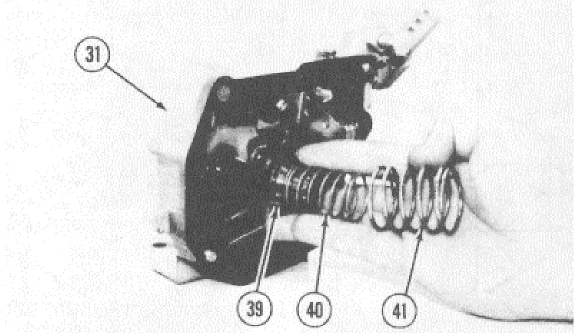
25. Put lever assembly (38) in position in housing assembly (31) with washers (35) and (37) on each side of the lever assembly.



26. Install shaft assembly (33) in housing assembly (3 1) and install the two bolts to hold lever assembly (38) to the shaft assembly.

27. Install seat (39), springs (40) and (41) in housing assembly (31).

CAUTION: Both springs must make full contact on seat (39) before they are installed in the governor hous- ing assembly. If the springs do not make full contact on the seat, high idle speed will not be correct and low idle governor surge can be the result. Low idle setting without stability can also result.

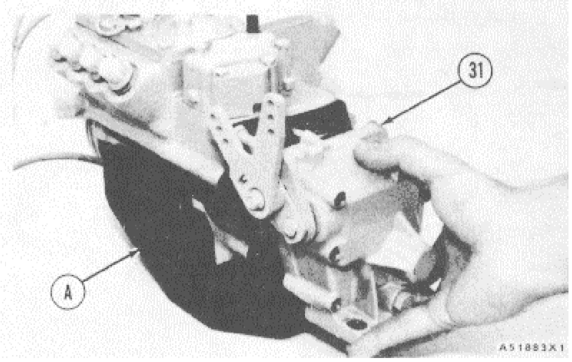


28. Install the gasket and housing assembly (31) on the fuel injection pump housing.

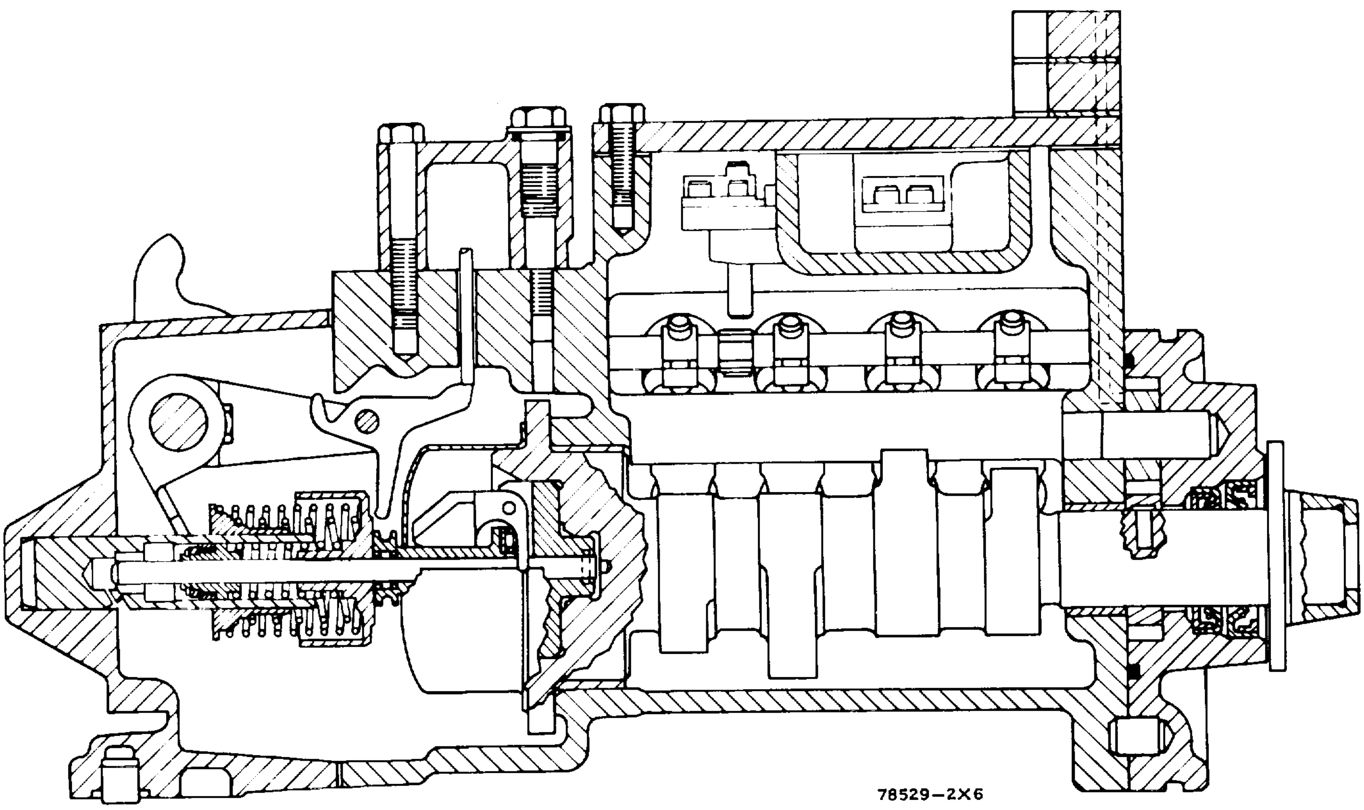
29. Remove the fuel injection pump housing from tool (A).

end by:

a) make an adjustment of the fuel system setting (See FUEL SYSTEM in TESTING AND ADJUSTING)
b) install fuel injection pump housing and gov- ernor

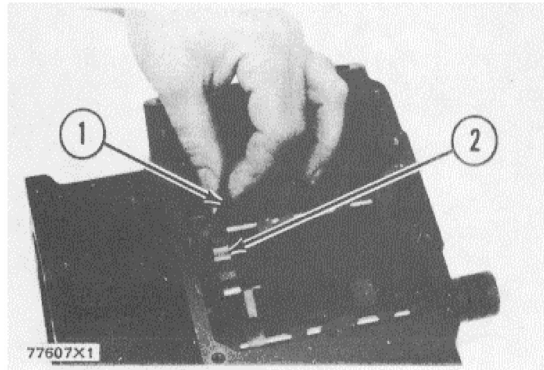


FUEL INJECTION PUMP HOUSING AND GOVERNOR



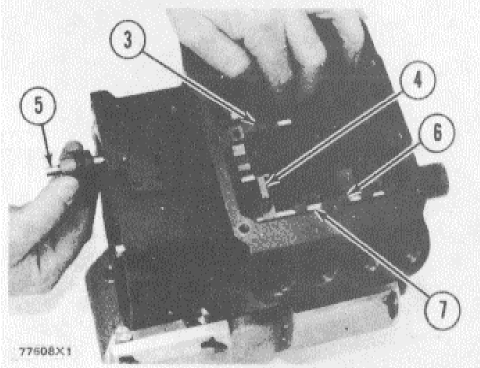
FUEL INJECTION PUMP HOUSING

DISASSEMBLE FUEL INJECTION PUMP HOUSING



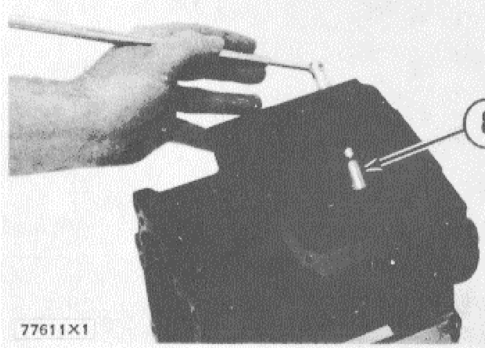
start by:
a) remove fuel injection pumps
b) disassemble governor
c) remove fuel tranfer pump

1. Loosen the screws that hold the sleeve levers to the shaft assembly.



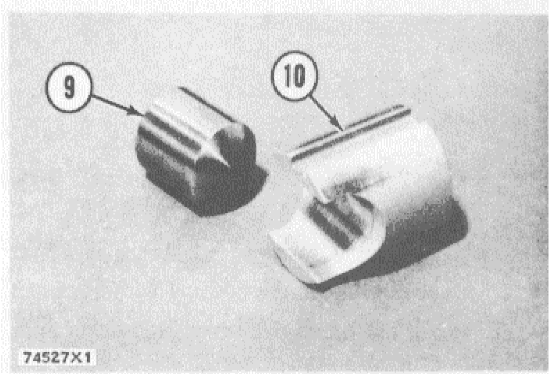
2. Remove screw (1) that holds lever assembly (2) to the shaft assembly.

3. Remove shaft assembly (5) from the housing and remove sleeve levers (3) and lever assembly (2).



4. Loosen the screws that hold sleeve levers (6) to the shaft.

5. Remove the screw that holds lever (4) to the shaft.



6. Remove shaft (7) from the housing and remove sleeve levers.

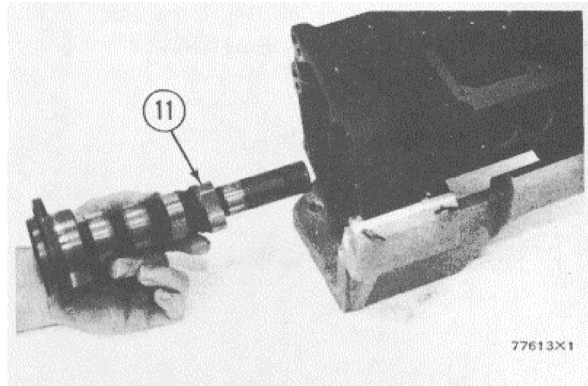
7. Remove the lifter and roller assemblies (8) from the housing with a magnet.

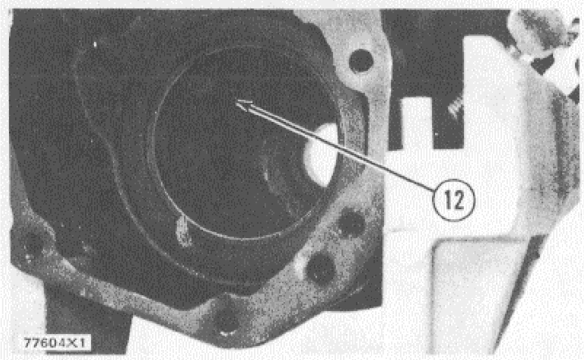
NOTE: Put identification on the lifters (10) and rollers (9) for installation in their respective bores in the housing.

FUEL INJECTION PUMP HOUSING

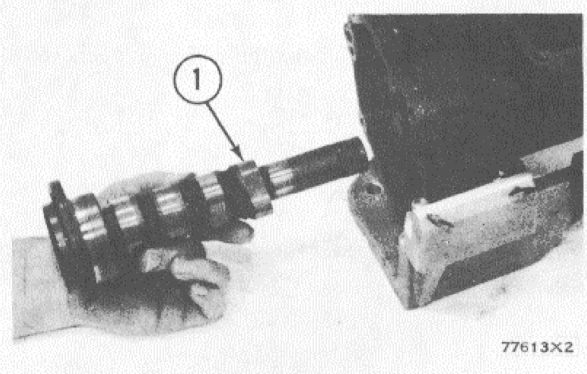
8. Remove camshaft (11 I) from the housing.

CAUTION: Do not use a force to remove the camshaft. Turn the camshaft to pull it by bosses (12) in the housing.



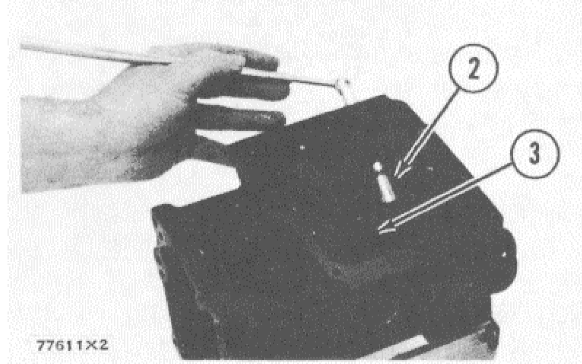


ASSEMBLE FUEL INJECTION PUMP HOUSING



1. Install the camshaft (I) in the housing.

CAUTION: Do not use a force to install the camshaft. Turn the camshaft to push it b) the bosses in the housing.

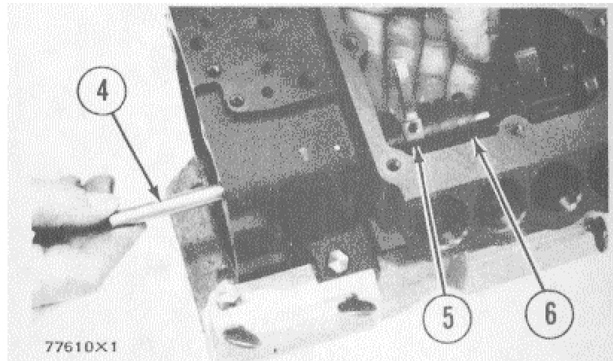


2. Install the lifter and roller assemblies (2) in their respective bores in the housing , with a magnet.

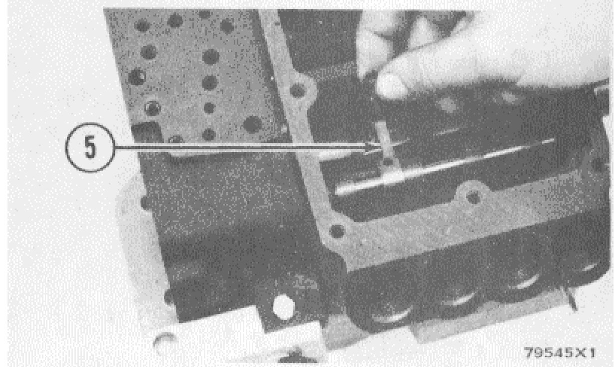
NOTE: Install the lifters with their grooves in alignment with pins (3) in the housing.

FUEL INJECTION PUMP HOUSING

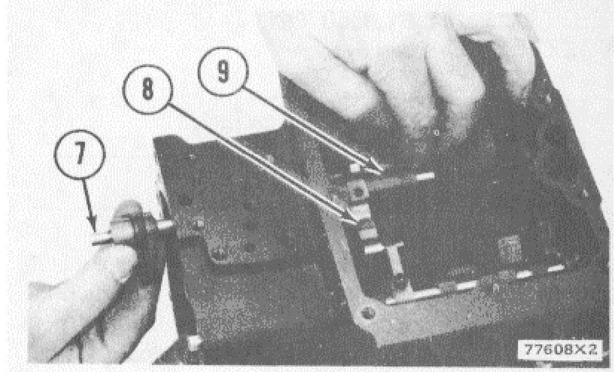
3. Put shaft (4) in the housing. Slide sleeve levers (6) and lever (5) on to the shaft in the sequence shown. Push the shaft into position in the housing.



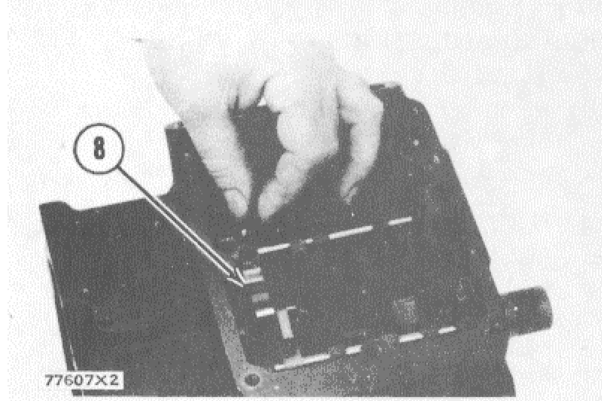
4. Install the screw that holds lever (5) to the shaft. Tighten the screw to a torque of 24 + 2 lb. in. (2.8 ± .2 N m).



5. Put shaft assembly (7) in the housing. Slide sleeve levers (9) and lever assembly (8) on to the shaft in the sequence shown. Push the shaft assembly into position in the housing.



6. Install the screw that holds lever assembly (8) to the shaft assembly. Tighten the screw to a torque of 24 + 2 lb.in. (2.8 ± 0.2 N.m).
   end by:
   a) make adjustments to the sleeve control shafts (see TESTING AND ADJUSTING)
   b) install fuel transfer pump
   c) assemble governor
   d) install fuel injection pumps



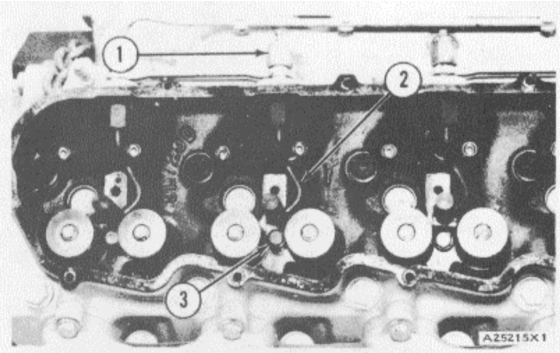
FUEL INJECTION NOZZLES

REMOVE FUEL INJECTION NOZZLES

start by:

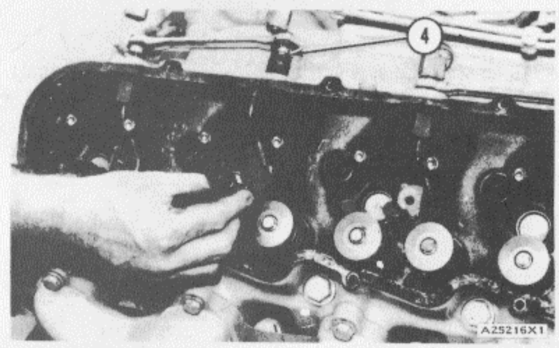
a) remove rocker shafts

1. Thoroughly clean the area around each fuel line connection. Disconnect fuel injection line (1) from the adapter. Disconnect fuel injection nozzle (2) from the adapter.



2. Remove clamp (3) and the spacer that holds the fuel injection nozzle in place.

CAUTION: Never use force to remove the fuel injection nozzles. If necessary, turn and pull the fuel injection nozzle out of the cylinder head.

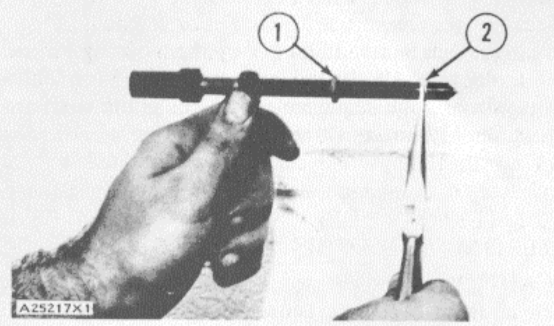


3. Remove adapter (4) from the cylinder head. Remove the fuel injection nozzle.

INSTALL FUEL INJECTION NOZZLES

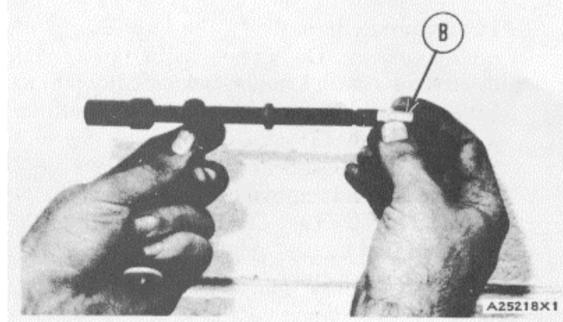
	Tools Needed	A	B
8S2242	Nozzle Test Group	1	
8S2252	Carbon Seal		
	Installation Tool		1

CAUTION: Before the fuel injection nozzles are installed check for fuel leakage, the pressure at which the injection nozzle opens, and the amount of fuel (spray pattern) that comes out of the nozzle with tool (A). See TESTING FUEL INJECTION NOZZLES in TESTING AND ADJUSTING.



1. Remove carbon seal dam (2) with pliers. Remove compression seal (1).

2. Install a new compression seal on the nozzle. Install a new carbon seal dam with tool (B).



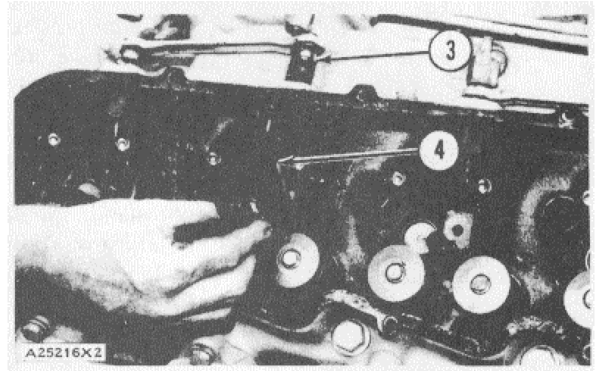
3. Make sure the bore in the cylinder head and the fuel inlet fittings are clean.

FUEL INJECTION NOZZLES

4. Install new O-ring seals on adapter (3) and fuel injection nozzle (4).
5. Install the fuel injection nozzle in the head. Push and turn to install the nozzle into its correct position. Never put lubricant on the nozzle or bore in the cylinder head.
6. Install the adapter in the head. Connect the nozzle and fuel injection line to the adapter. Tighten the nuts to a torque of 30 ± 5 lb.ft. (40 ± 7 N. m).
7. Install the spacer and clamp that hold the nozzle to the cylinder head.

   end by:

   a) install rocker shafts



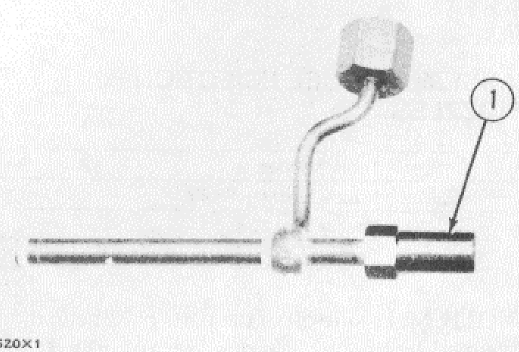
DISASSEMBLE FUEL INJECTION NOZZLES

	Tools Needed	A	B	C	D
8S2242	Nozzle Test Group	1			
8S2250	Nozzle Holding Tool		1		
5P958	Valve Retractor			1	
— 5P4813	Socket				1

start by:

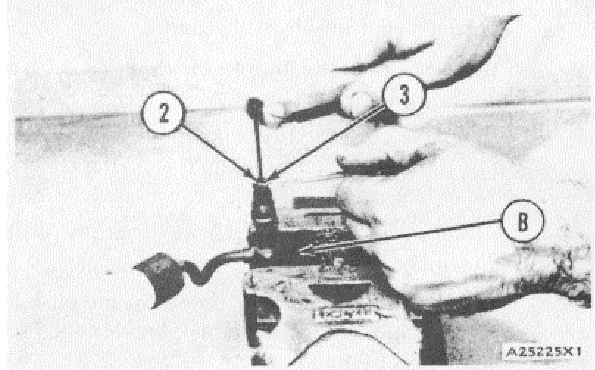
a) remove fuel injection nozzles

NOTE: Do not disassemble any nozzle until a test has shown it is needed. Check each nozzle with tool (A) for leakage, the pressure at which the nozzle opens, and the shape and amount of fuel (spray pattern) that comes out of the nozzle. Do not clean or make an adjustment to any nozzle that has a large (excessive) amount of return leakage. Excessive return leakage can be an indication of nozzle failures that can not be corrected with an adjustment or cleaning and can cause engine damage. See TESTING FUEL INJECTION NOZZLES in TESTING AND ADJUSTING.



CAUTION: Keep the work area and all tools extra clean. Be careful not to cause damage to the parts while the nozzles are disassembled and assembled.

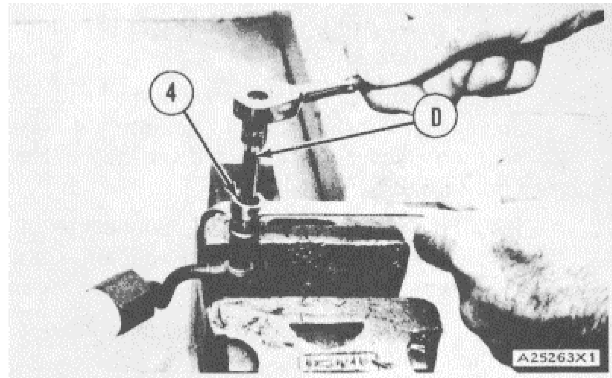
1. Remove cap (1) from the fuel injection nozzle.
2. Put the nozzle in tool (B). Put tool (B) and the nozzle in a vise. Do not put any part of a nozzle directly in a vise. Loosen locknut (2) while the lift adjustment screw is held. Turn the lift adjustment screw (3) counterclockwise one turn. Hold the lift adjustment screw (3) with a 5/64" hex wrench and remove the locknut (2).



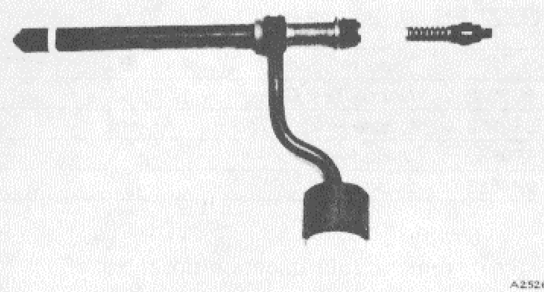
CAUTION: If the lift adjustment screw is not turned counterclockwise one turn, the valve can be bent or the seat for the valve can be damaged when the pressure adjustment screw is turned.

FUEL INJECTION NOZZLES

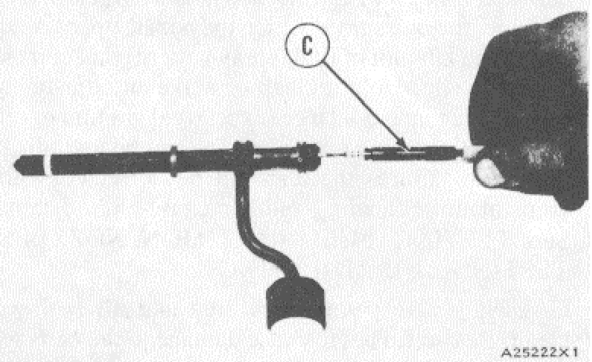
3. Loosen the locknut (4) that holds the pressure adjustment ,screw. Use tool (D) to hold the pressure adjustment screw.



4. While the nozzle is held in one hand, tilt the nozzle and remove the pressure adjusting screw and locknut, spring, seat and valve.



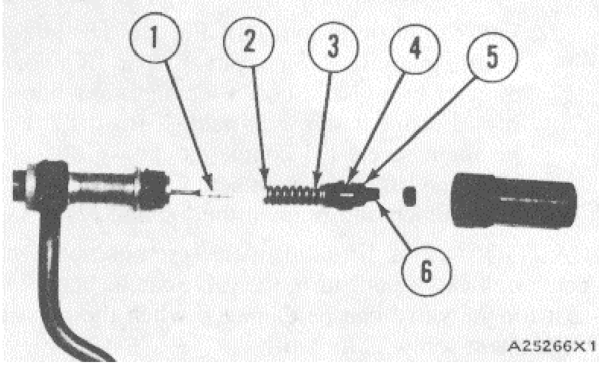
5. If the valve does not slide out of the nozzle, install tool (C) and remove valve as follows:
   a) Push valve into nozzle with tool (C) until valve is against bottom of nozzle.
   b) Push down on body of tool (C) to engage collet on valve with tool (C).
   c) Turn nut counterclockwise and remove valve from the nozzle body. Put the parts in solvent to loosen carbon and deposits of foreign material. The body is assembled with an epoxy material and must not be in contact with the solvent for more than one to two hours.



ASSEMBLE FUEL INJECTION NOZZLES

	Tools Needed	A	B	C
8S2250	Nozzle Holding Tool	1		
8S2242	Nozzle Test Group		1	
9S5031	Socket			1

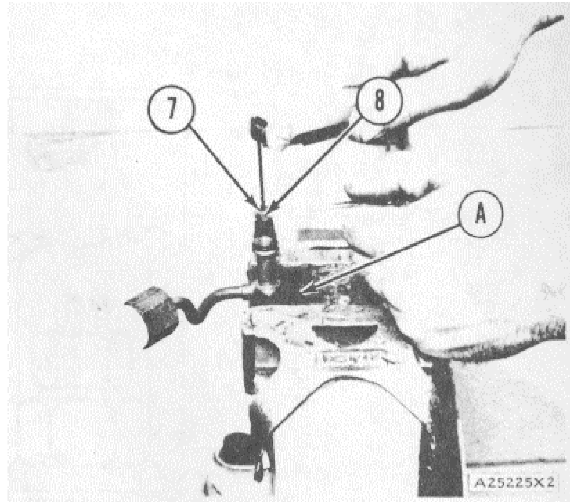
NOTE: sure all of the parts have been thoroughly cleaned before the nozzles are assembled. Flush the body to remove an)- debris or lapping compound.



1. Put clean fuel on all of the parts.
2. Put valve (1) in position in the body as shown.
3. Install lift adjustment screw (6) into pressure screw' (5). Turn the lift adjustment screw two or three turns. Install the locknut (4) on the pressure adjustment screw (5).
4. Put spring (3), and seat (2) in position on the adjustment screw(5).
5. Put seat (2) in contact with the and push the into position in the body. Tighten the pressure screw b) hand.

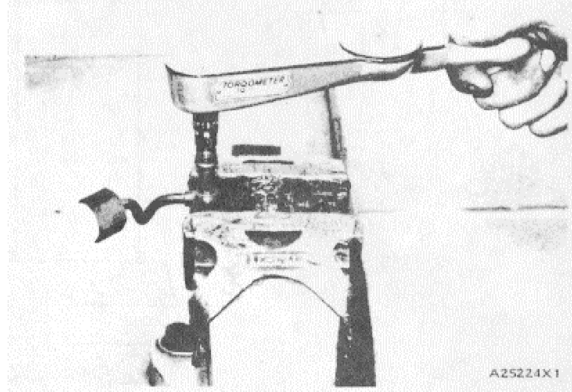
FUEL INJECTION NOZZLES

6. Make an adjustment to the opening pressure of the nozzle as controlled b) the pressure adjustment screw with tool (B). See TESTING FUEL INJECTION NOZZLES, OPENING PRESSURE TEST in TESTING AND ADJUSTING.



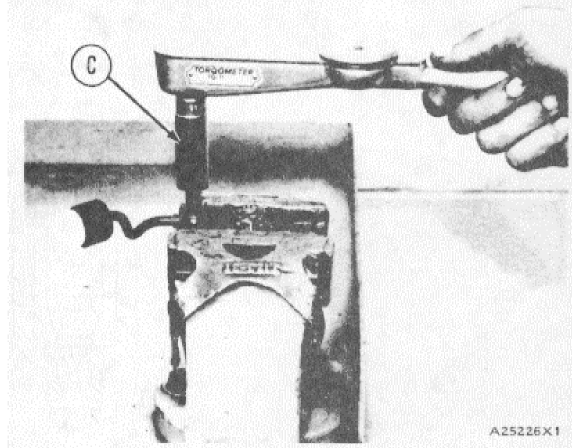
7. Make an adjustment to the valve lift as controlled by the lift adjustment screw with tool (B). See TESTING FUEL INJECTION NOZZLES, VALVE LIFT ADJUSTMENT in TESTING AND ADJUSTING.

8. Put the nozzle in position on tool (A). Put tool (A) and the nozzle in a vise. Hold the lift adjustment screw (7) with a 5/64" hex wrench and tighten the locknut (8) until the adjustment screw will not turn.



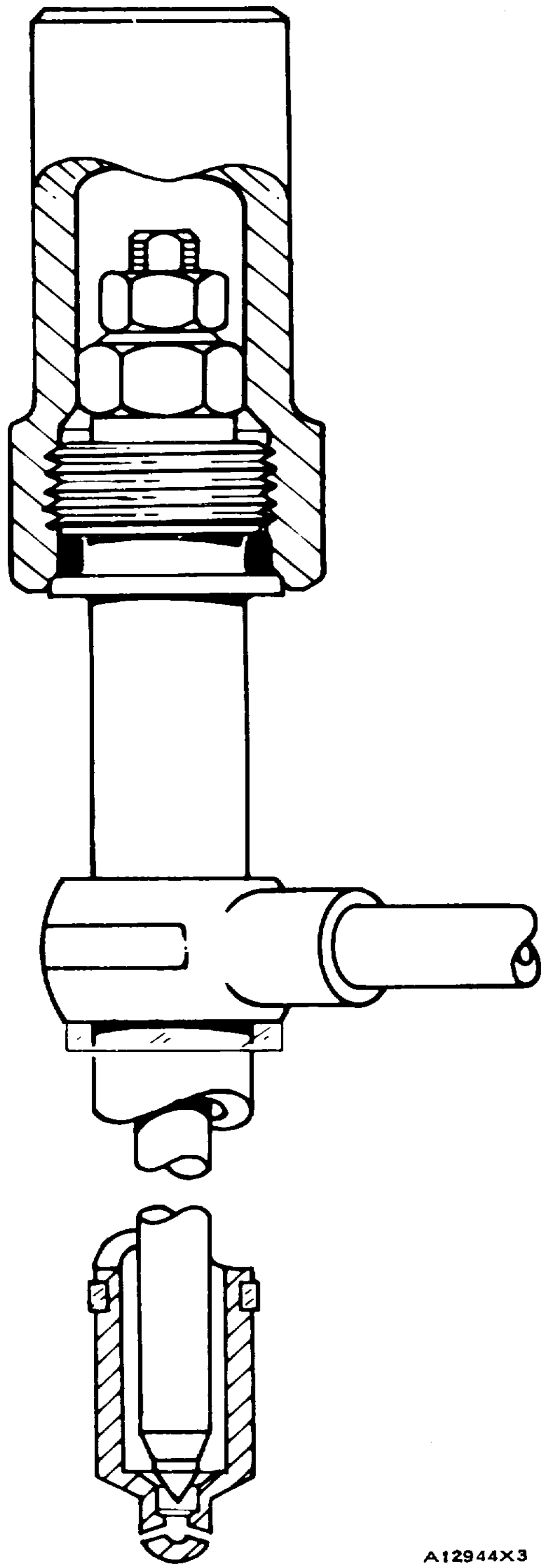
9. Tighten the locknut for pressure adjustment screw to a torque of 70 to 80 lb.in. (8.0 to 9.1 N m).

10. Tighten the locknut for the pressure adjustment screw to a torque of 35 to 45 lb.in. (4.0 to 5.1 N.m).



11. Install the cap on the fuel injection nozzle. Use tool (C) to tighten the cap to a torque of 110 to 120 Ib.in. (12.4 to 13.6 N-m).
end by:
a) install fuel injection nozzle

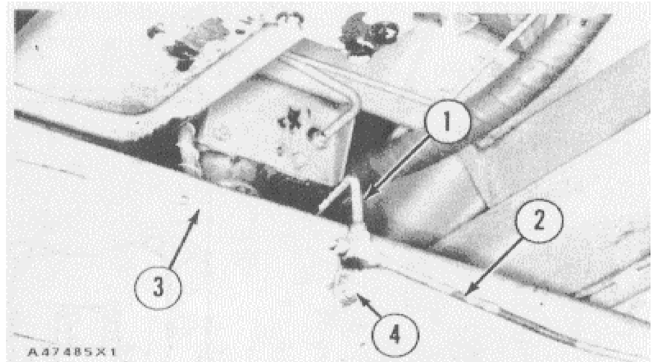
FUEL INJECTION NOZZLES



LOWER FUEL TANK

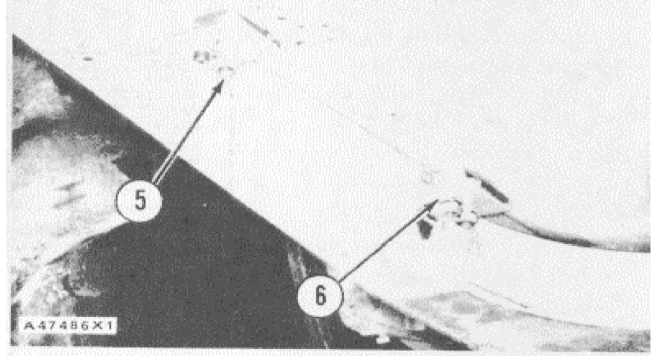
REMOVE LOWER FUEL TANK

1. Make preparations to remove fuel tank.
   a) Remove rear cover assembly. Make reference to REMOVE EJECTOR CYLINDER in SYSTEMS DISASSEMBLY AND ASSEMBLY, CAPTER 4.
   b) Put the ejector in rear position.
   c) Remove the drain plug on the bottom of the tank and drain it. The capacity of the tank is 65 gal. (246 litre).



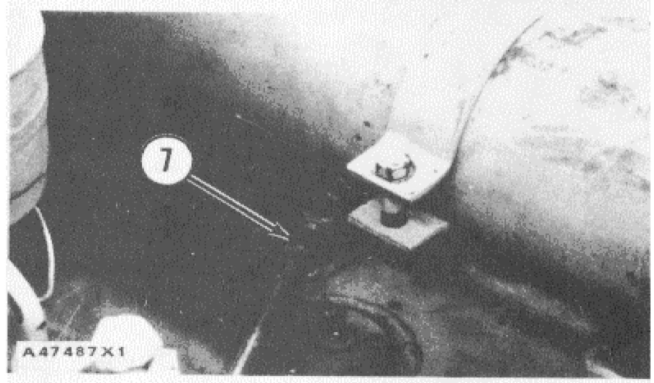
VIEW FROM UNDER SCRAPER

2. Disconnect brake line (I) from the tee. Disconnect brake lines (2) and (3) from fittings found on each side of the frame. Remove three bolts (4) from the clips. Remove the lines.

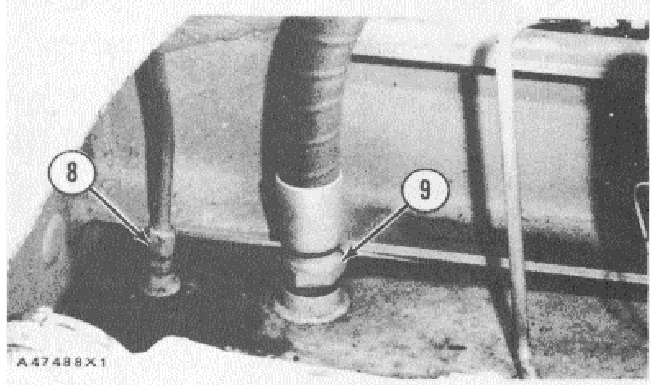


VIEW FROM UNDER SCRAPER

3. Remove eight bolts (5) from tank brackets (6). Make sure the plates between the tank and the brackets are removed and installed in same position.



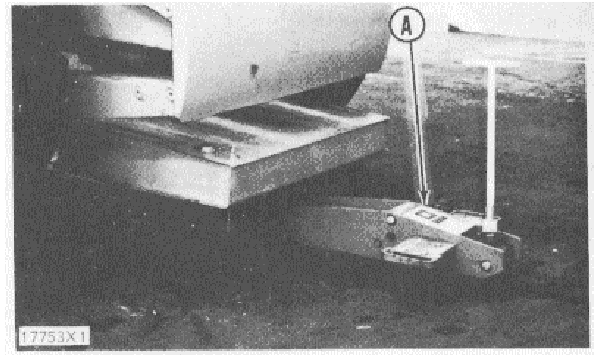
4. Disconnect fuel line (7) from fitting on top of the tank.



5. Disconnect tube (8) and hose (9) from the top of tank.

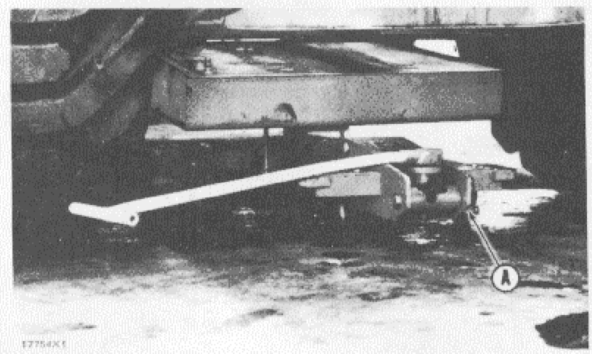
LOWER FUEL TANK

6. Put OTC Model 1790 Lo-Lift Transmission Jack (A) in position on the front side of cross frame. Slide tank forward over cross frame and on the jack. Lower the jack and remove from the rear as shown. The weight of the tank is 130 lb. (59 kg).

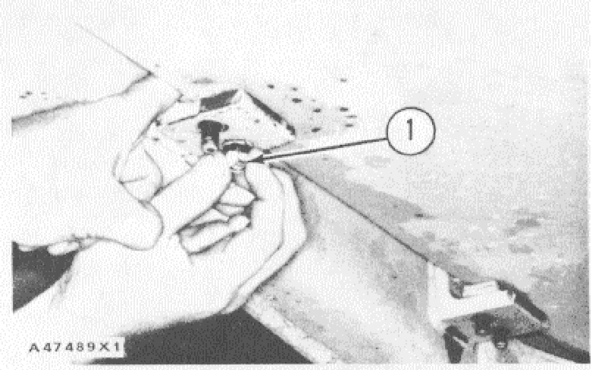


INSTALL LOWER FUEL TANK

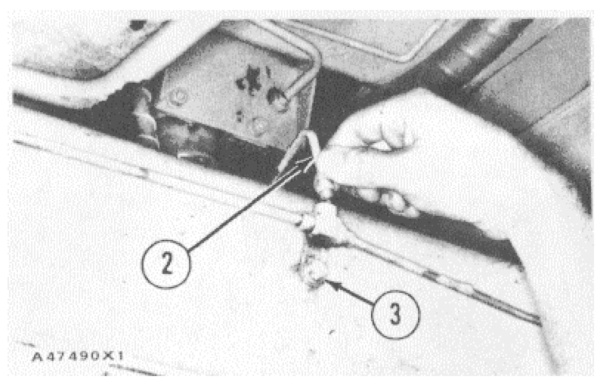
1. Put the fuel tank 1 transmission jack (A) and put tank in position under scraper. Lift the jack and slide the tank in position.



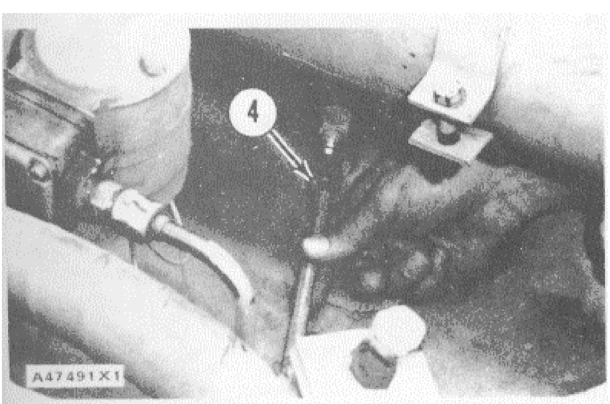
2. Put the plates in position and install bolts and nuts (1).



3. Connect brake lines and install bolts on each side of the frame. Install bolt (3) and connect brake line (2) to the junction.



4. Connect fuel line (4) to the fitting on top of tank.

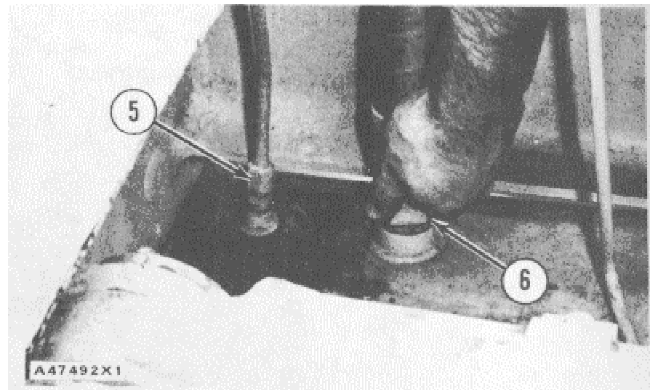


LOWER FUEL TANK, ELECTRIC FUEL PUMP

5. Connect tube (5) and hose (6) to the top of the tank.

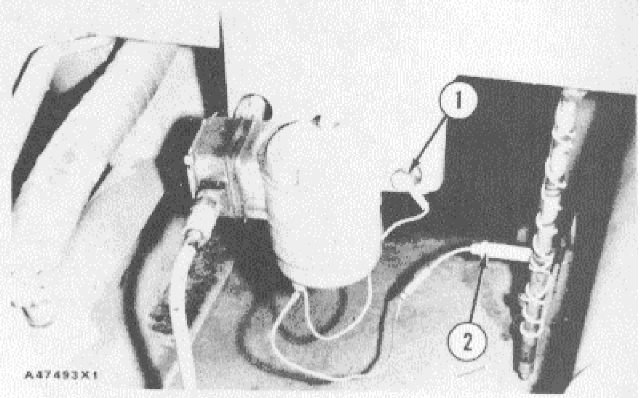
6. Remove (bleed) the air from the system.

7. Install the rear cover assembly. Make reference to INSTALL EJECTOR CYLINDER in SYSTEMS DISASSEMBLY AND ASSEMBLY, CHAPTER 4.

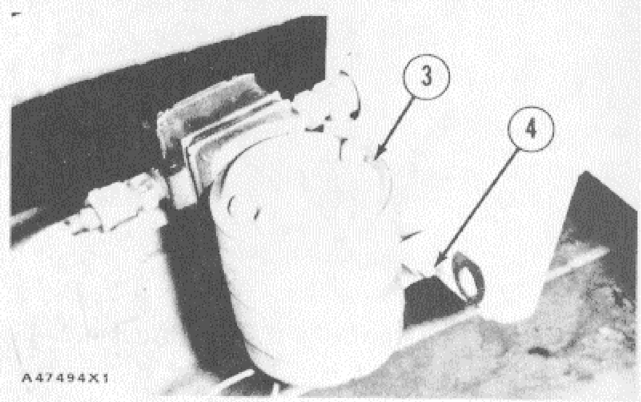


REMOVE ELECTRIC FUEL PUMP

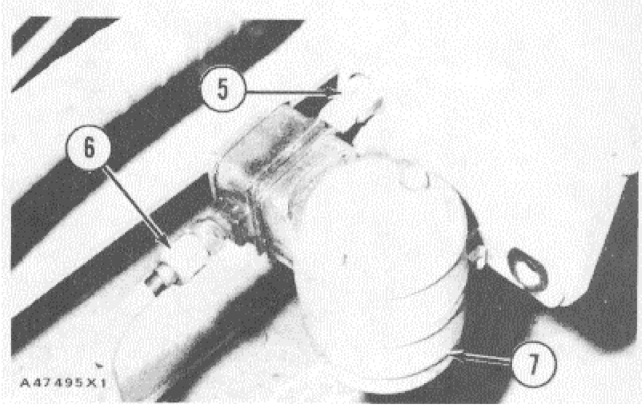
1. Remove the back-up alarm and cover from the scraper as a unit. The weight of the unit is 135 lb. (61 kg).



2. Remove bolt (I) and ground wire. Disconnect fuse terminal (2).



3. Loosen screw (4) enough to remove pump (3).



4. Disconnect lines (5) and (6) from the pump.

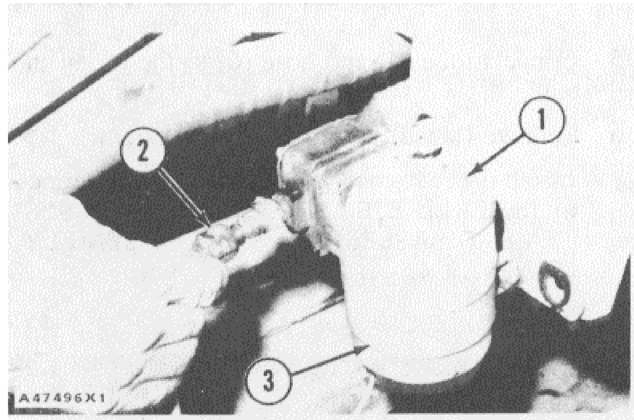
NOTE: Put a plug in line (6).

5. Remove the pump from bracket (7).

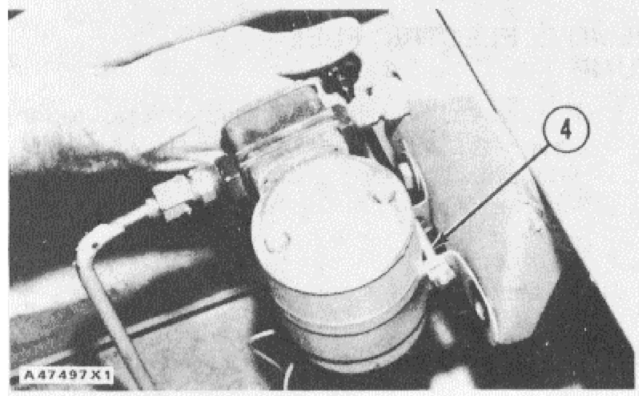
ELECTRIC FUEL PUMP

INSTALL ELECTRIC FUEL PUMP

1. Install pump (1) in bracket (3). Connect lines (2) to the pump.

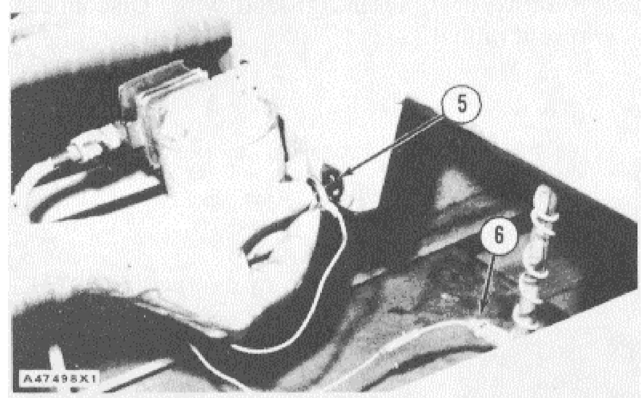


2. Tighten screw (4) on the bracket.



3. Connect fuse terminal (6).

4. Put the ground wire on bolt (5) and install the bolt in the bracket.



ELECTRIC FUEL PUMP 613BSSI AND 613BSNS1

REMOVE AND INSTALL ELECTRIC FUEL PUMP

1. Remove the back-up alarm and cover from the scraper as an assembly. The weight of this assembly is 135 lbs (61 kg).

2. Disconnect the brown electrical lead (2) and the black electrical lead (3) at the fuel pump (4) connectors.

NOTE: Use a small container to catch any fuel remaining in the fuel lines as the fuel pump is removed.

3. Disconnect the fuel pump inlet (5) and outlet (6) fuel lines. Plug the fuel inlet line (5) with a plug.

4. Remove nut (7), washer (8), and bolt (9) from clamp (10). Push fuel pump (4) out of clamp (10). If the fuel pump cannot be easily removed from the clamp, remove bolt (11), washer (12), and clamp (10) with the fuel pump assembly.

5. If removed, install clamp (10) with bolt (I1) and washer (12).

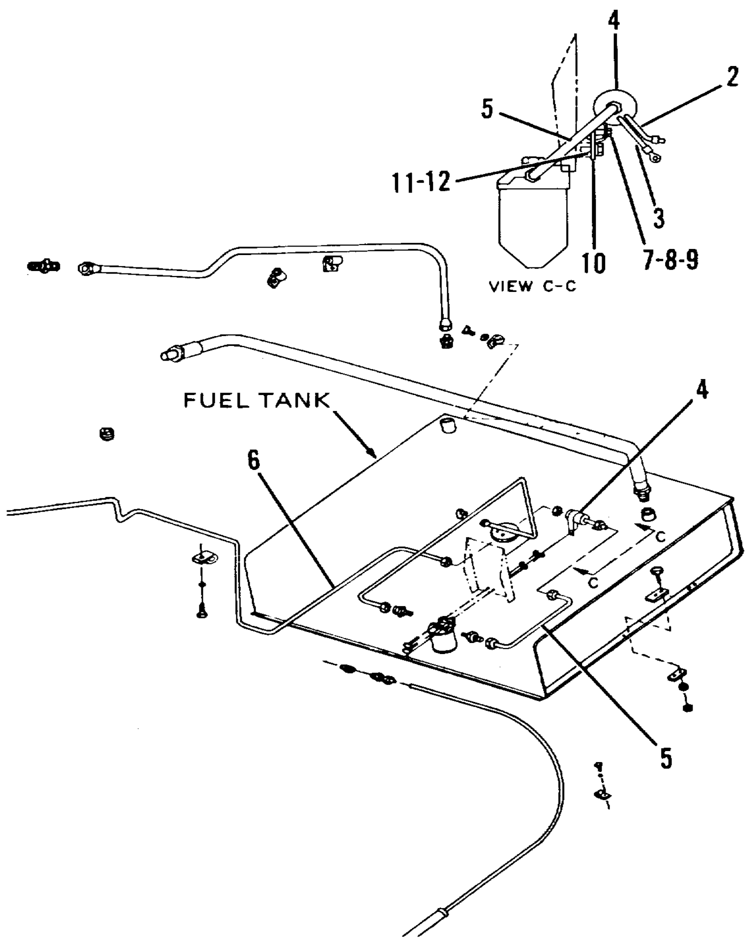
6. Position fuel pump (4) in clamp (10) and secure with bolt (9), washer (8) and nut (7).

7. Connect fuel pump outlet (6) and inlet (5) fuel lines to the fuel pump.

8. Connect electrical leads (3) and (2) at the fuel pump (4) connectors.

9. After installing pump, check for leakage of fuel at the pump fittings.

10. Install back-up alarm and cover as an assembly.

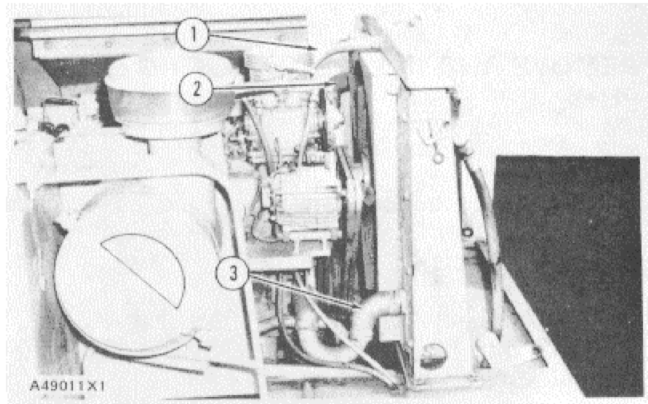


RADIATOR AND TORQUE CONVERTER OIL COOLER

REMOVE RADIATOR AND TORQUE CONVERTER OIL COOLER

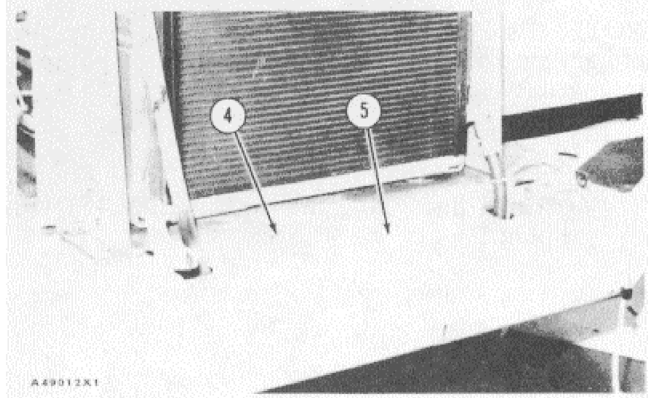
start by:
a) remove hood
b) remove crankcase guard

1. Drain the coolant from the cooling system.



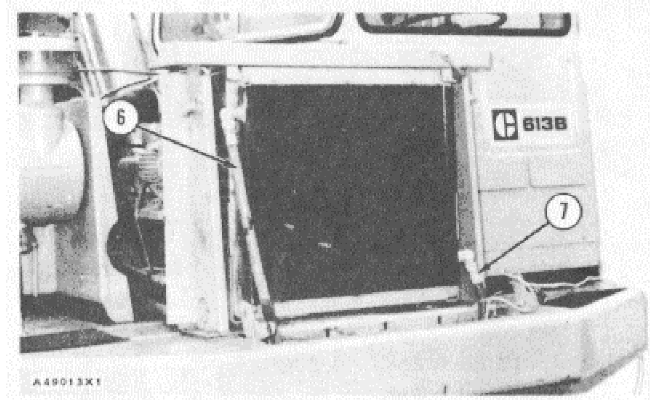
2. Disconnect hoses (I), (2) and (3) from the radiator.

3. Remove bolts (4) and panel (5) from the tractor frame.



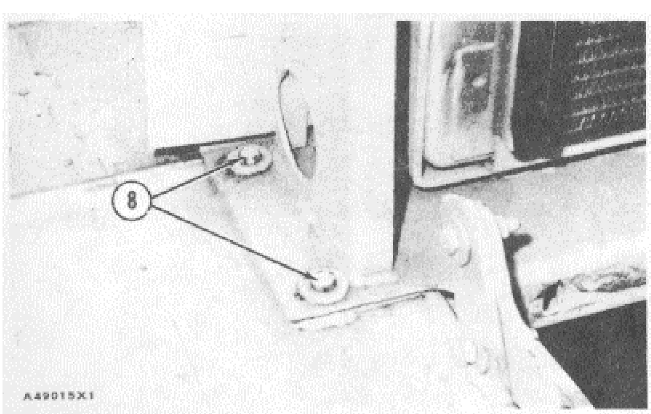
4. Disconnect hose assemblies (6) and (7) from the torque converter oil cooler.

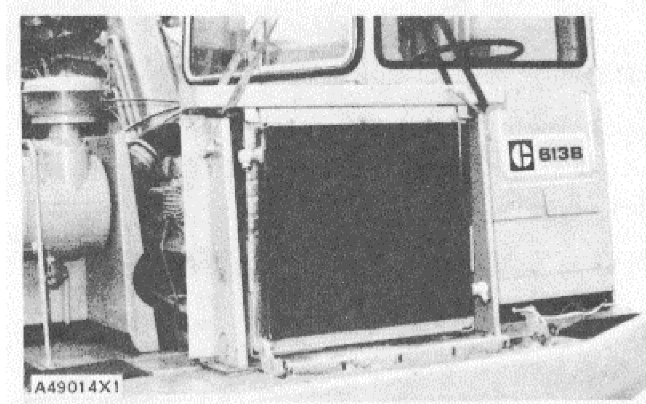
5. Fasten a hoist to the radiator.



6. Remove bolts (8), the nuts and washers that hold each side of the radiator. Remove the radiator and torque converter oil cooler as a unit. The weight of the unit is 235 lb. (106 kg).

7. Remove the four washers used as spacers between the tractor frame and radiator.





RADIATOR AND TORQUE CONVERTER OIL COOLER

INSTALL RADIATOR AND TORQUE CONVERTER OIL COOLER

1. Fasten a hoist to the radiator and torque converter oil cooler and put the unit in position on the machine.

2. Install washers (2) between the radiator and frame and install bolts (1), the washers and nuts to hold the radiator in position.

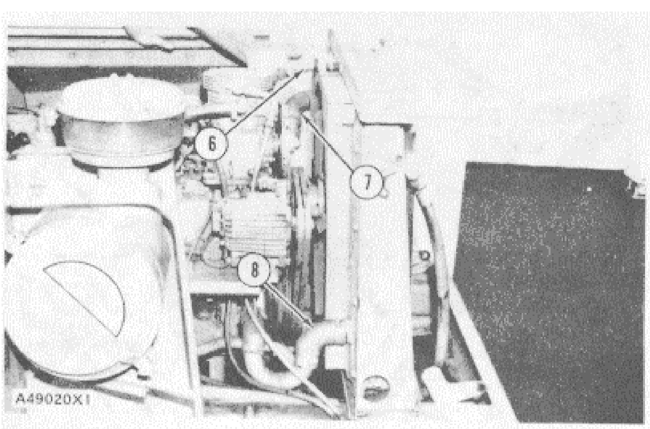
3. Remove the hoist from the radiator frame.

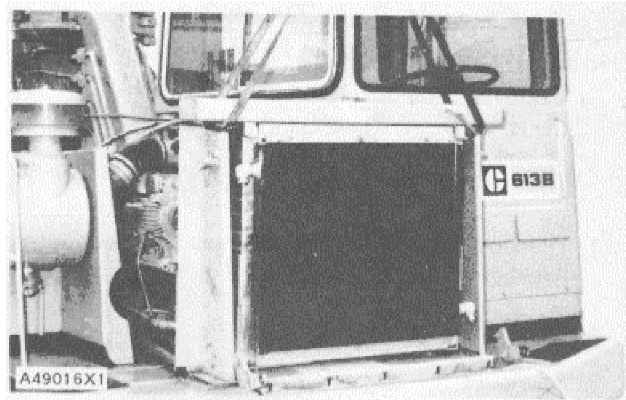
4. Connect hose assemblies (3) and (4) to the torque converter oil cooler.

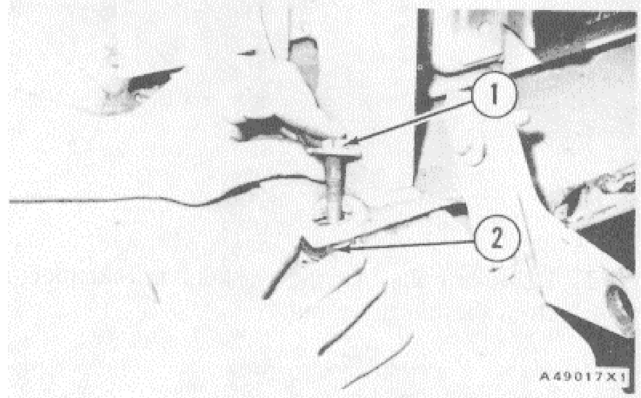
5. Put panel (5) in position and install the bolts to hold it.

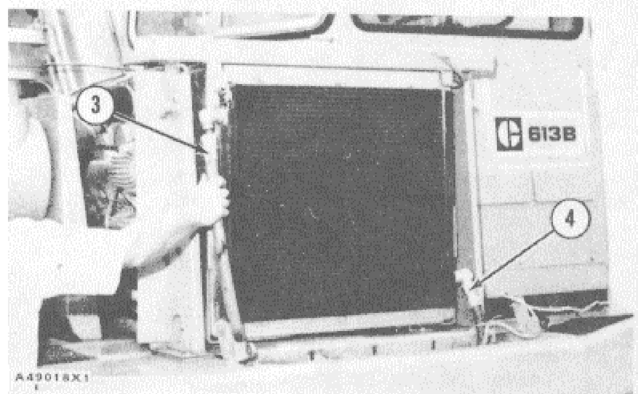
6. Connect hoses (6), (7) and (8) to the radiator.

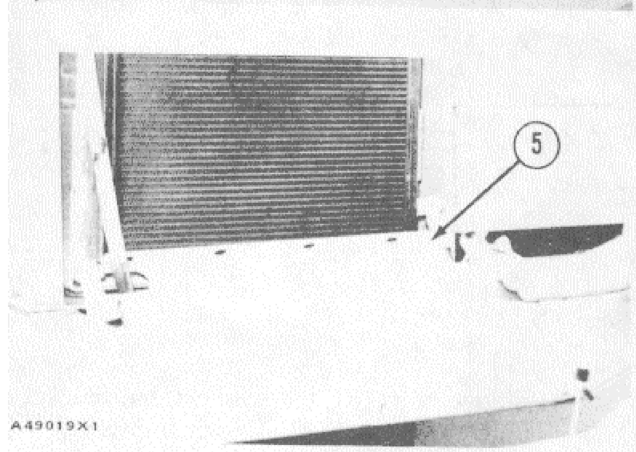
7. Fill the cooling system with coolant to the correct leve1.
   end by:
   a) install crankcase guard
   b) install hood









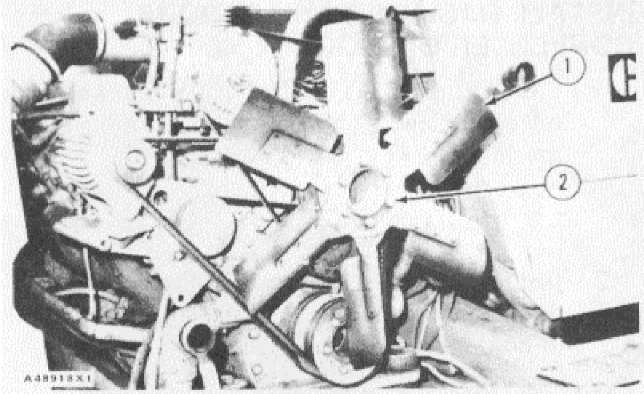


FAN AND FAN DRIVE

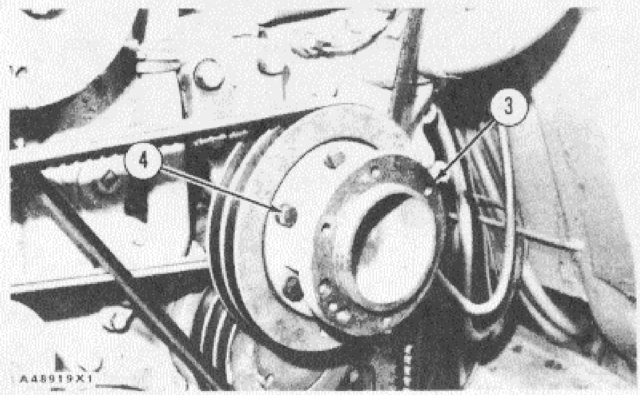
REMOVE FAN AND FAN DRIVE

start by:
a) remove radiator and torque converter oil cooler

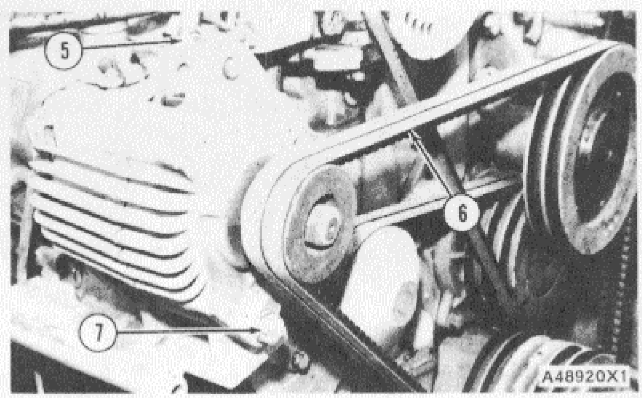
1. Remove bolts (2), the washers and fan (I) from the fan drive adapter.



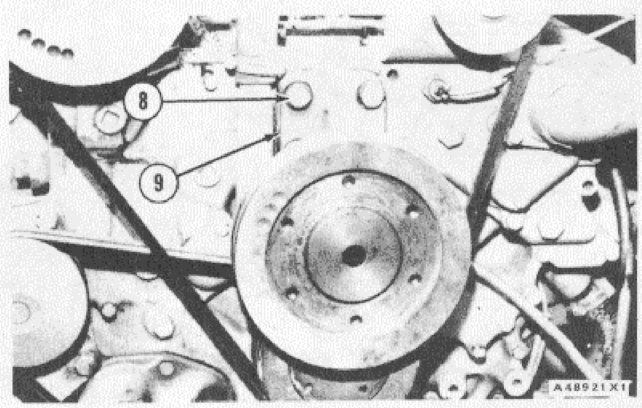
2. Remove bolts (4), the washers and adapter (3) from the fan drive pulley.



3. Loosen adjustment nuts (5) and bolt (7) for the alternator and remove two vee belts (6).



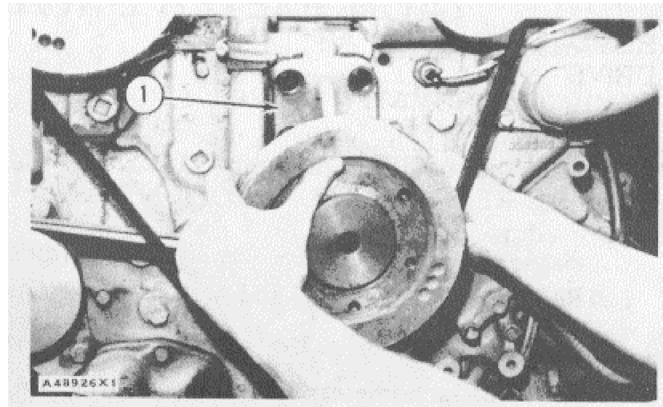
4. Remove bolts (8), the washers and bracket assembly (9) from the timing gear cover.



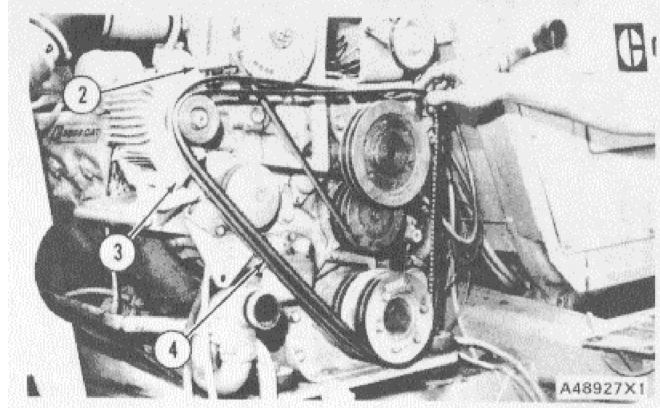
FAN AND FAN DRIVE

INSTALL FAN AND FAN DRIVE

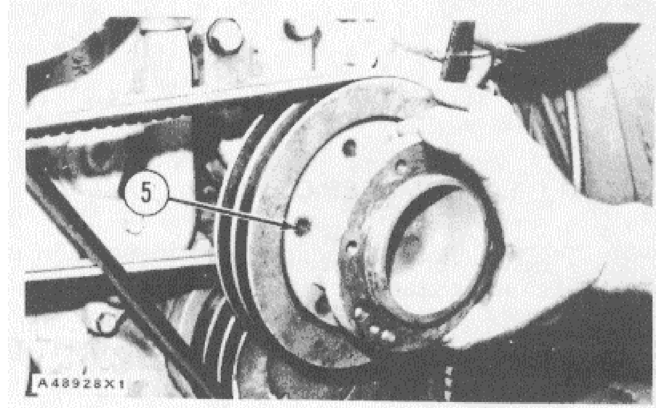
1. Put bracket assembly (I) in position on the timing gear cover and install the bolts and washers that hold it.



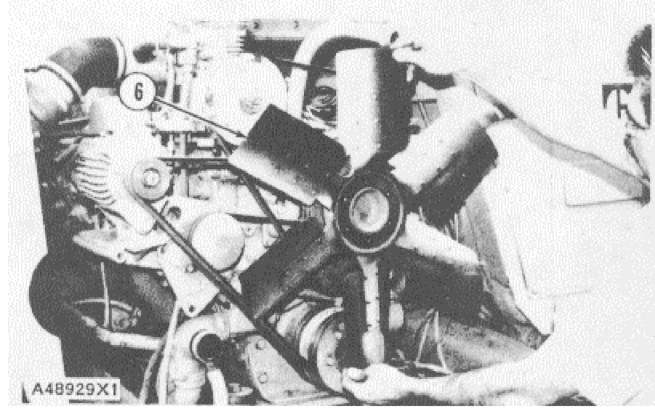
2. Install vee belts (4) and tighten adjustment nuts on rod (2) to hold the correct tension on the vee belts. To get the correct belt tension use a tension gauge such as Burroughs Tool Company Part No. BT-33-96-4-16 or an equivalent. The correct gauge indication is 120 + 5.



3. Tighten bolt (3) for the alternator.



4. Put adapter (5) on the fan drive pulley and install the bolts and washers to hold it.



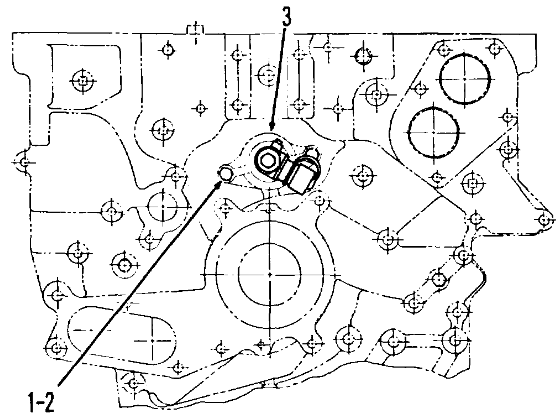
5. Put fan (6) in position and install the bolts and washers that hold it in position.
   end by:
   a) install radiator and torque converter oil cooler

TACHOMETER DRIVE (613BSNS1, 613BSS1)

REMOVE TACHOMETER DRIVE

NOTE: Put the fuel injection pump in time with the engine. See REMOVE FUEL INJECTION PUMP for this procedure.

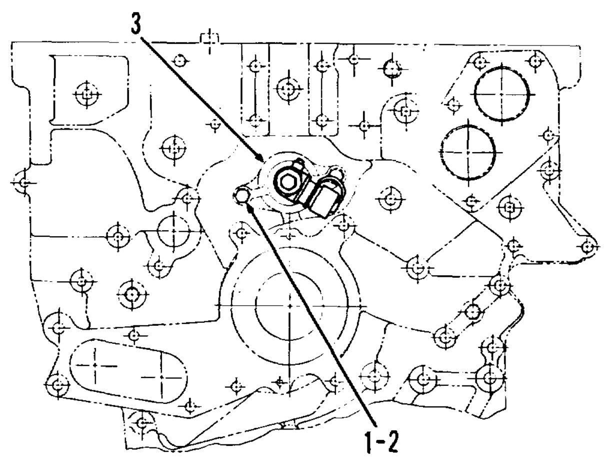
1. Remove two nuts (1), and washers (2) from adapter.
2. Remove tachometer adapter (3) from the timing gear cover.



FRONT HOUSING ASSEMBLY

INSTALL TACHOMETER DRIVE

1. Place tachometer adapter (3) in position in the timing gear cover.
2. Install the two washers (2) and nuts (1) to hold the adapter.

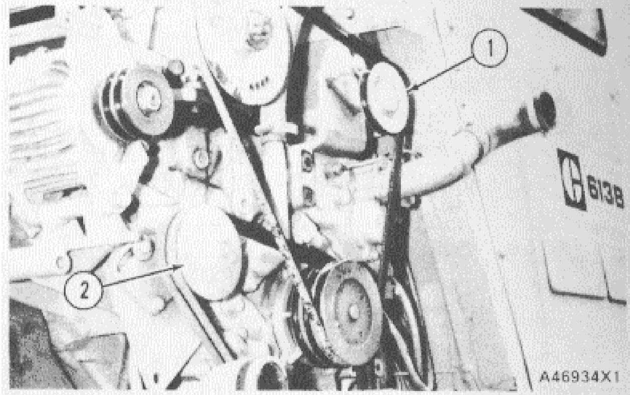


WATER PUMP

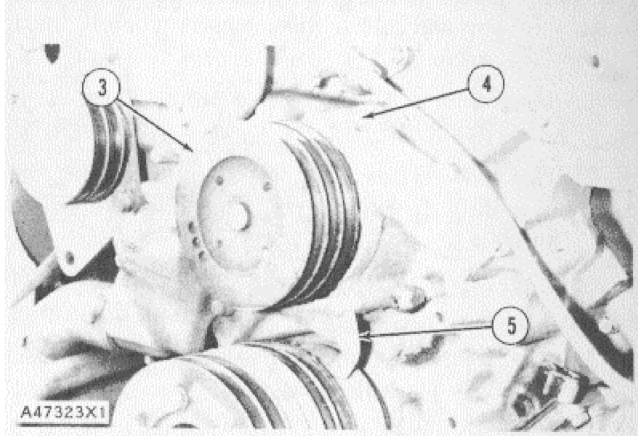
REMOVE WATER PUMP

start by:
a) remove fan and fan drive

1. Drain the coolant from the cylinder block.



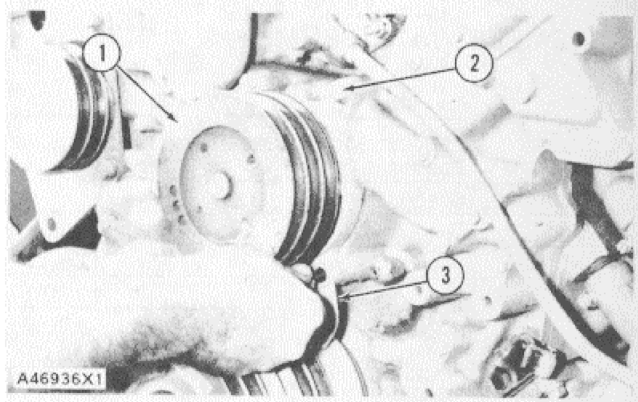
2. Loosen belt tighteners (1) and (2) and remove the three vee belts from the water pump.



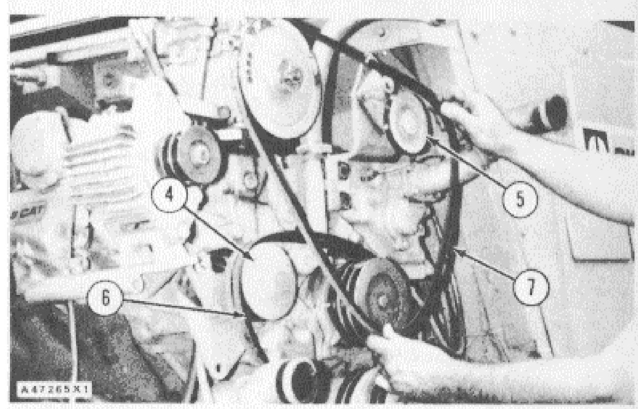
3. Remove the four bolts (4) that hold water pump (3). Remove pointer (5) and the water pump.

INSTALL WATER PUMP

1. Put the gasket and water pump (I) in position in the timing gear cover.



2. Install pointer (3) and bolts (2) that hold the water pump.

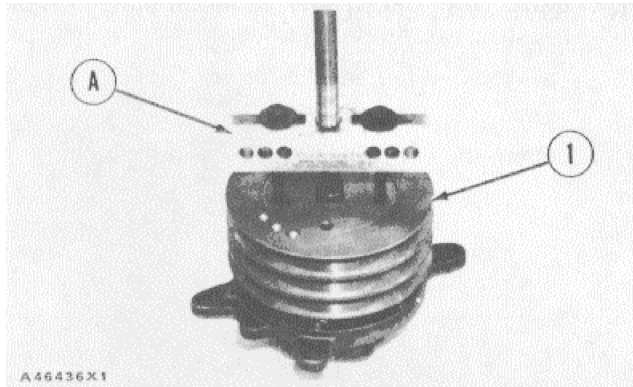


3. Put the air compressor and water pump vee belts (6) and (7) in position and make an adjustment to belt tighteners (4) and (5) to get the correct belt tension. To get the correct tension use a tension gauge such as Burroughs Tool Company Part No. BT-33-96-4- 16 or an equivalent. The correct gauge indication is 120 + 5.

end by:
a) install fan and fan drive

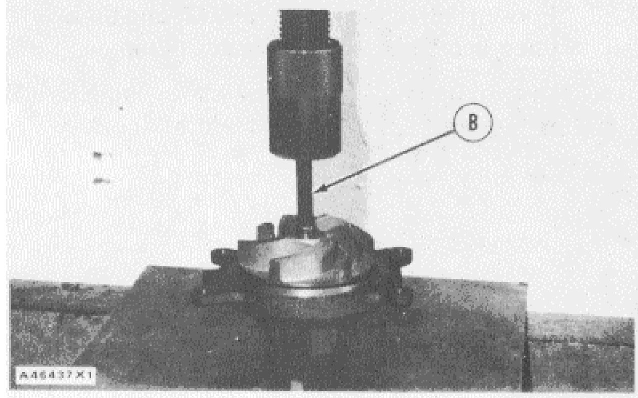
DISASSEMBLE WATER PUMP

	Tools Needed	A	B
5F7465	Puller Assembly	1	
9N869	Washer	2	
1F5842	Bolt (5/16"-18 NC x 3 ’4" long)	2	
5P7356	Spacer	1	
5P7354	Pin		1



start by:
a) remove water pump

NOTE: Make a replacement of the shaft assembly, seal assembly’, cup and seat with new parts A hell the water pump is assembled. Use tooling (A) to remove pulley (I) from the shaft assembly.

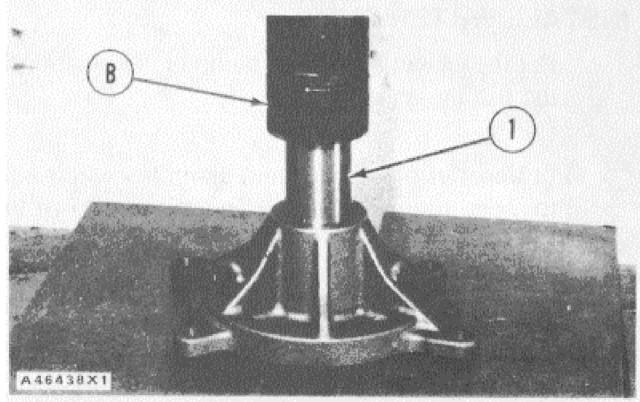


2. Use tool (B) and a press to remove the shaft assembly from the impeller and housing as

⚠WARNING: The press must have a guard. The guard has been removed for photo illustration.

3. Use a hammer and punch to remove the seal assembly from the housing.

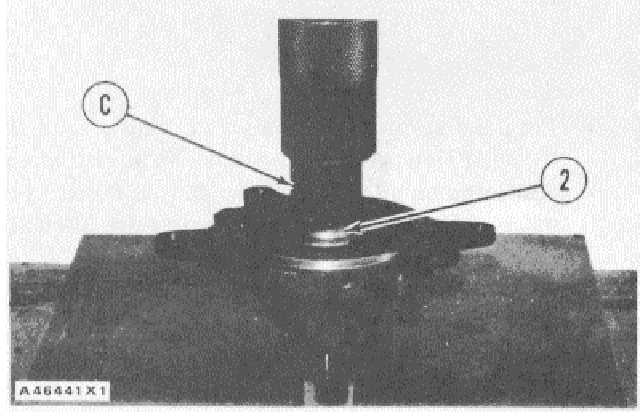
4. Remove the seat and cup from the impeller.



ASSEMBLE WATER PUMP

	Tools Needed	A	B	C	D	E	F
5P7346	Plate	1					
5P7347	Spacer		1				
5P7348	Spacer			1			
5P7352	Spacer				1		
5P7353	Spacer					1	
5P7355	Plate						1

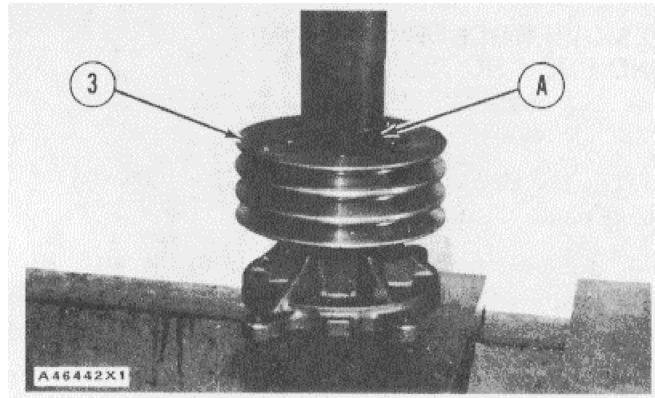
1. Use a press and tool (B) to install shaft assembly (1) in the housing as shown.



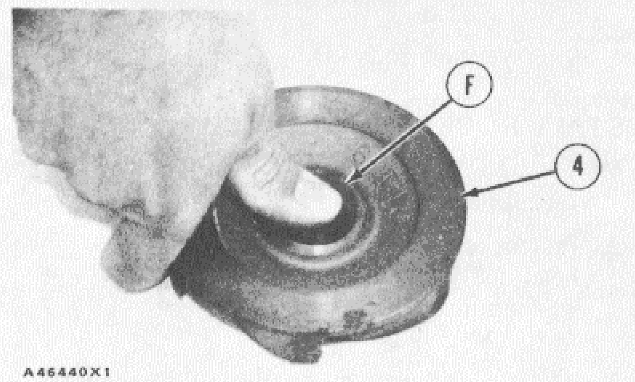
2. Use a press and tool (C) to install seal assembly (2) in the housing as shown.

WATER PUMP

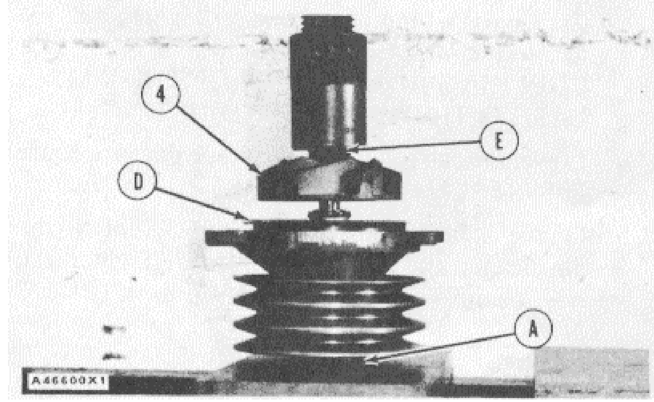
3. Use a press and tool (A) to install pulley (3) on the shaft assembly as shown.



4. Put the cup and seat in position in impeller (4) and use tool (F) to install them by hand.



5. Put impeller (4) on the shaft assembly and use a press and tooling (A), (D) and (E) as shown to push the impeller on to the shaft assembly until tool (D) can just be moved between the housing and impeller.
   end by:
   a) install water pump



ROCKER SHAFTS AND PUSH RODS

REMOVE ROCKER SHAFTS AND PUSH RODS

start by:
a) remove valve covers

NOTE: The air cleaner panel assembly is removed for better photo illustration.

1. Remove the tube assembly from the air inlet manifold and air cleaner for the right side.

2. For the left side tilt the cab. See this procedure in RENMOVE ENGINE.

3. Remove bolts (2) and rocker shaft (1) from the cylinder head.

4. Remove push rods (3).

INSTALL ROCKER SHAFTS AND PUSH RODS

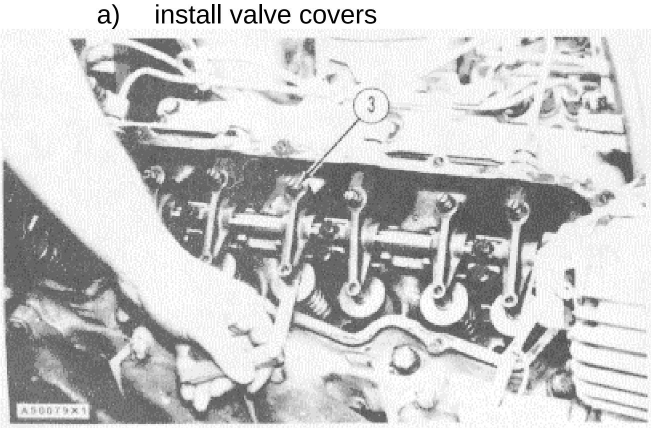
1. Install push rods (I) in the engine.

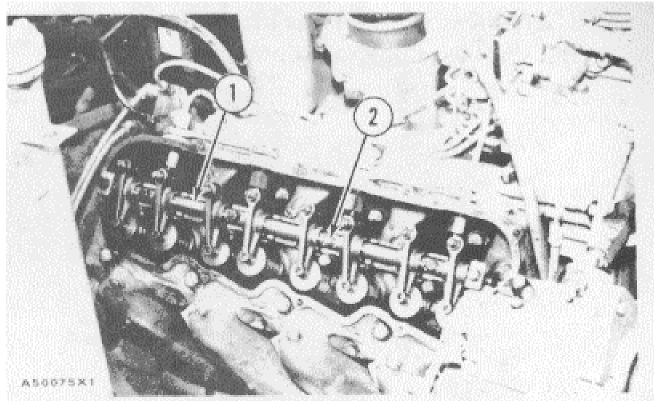
2. Put rocker shaft (2) in position on the cylinder head and install the bolts that hold it in place. Tighten the bolts evenly to a torque of 18 + 5 lb. ft. (24 + 7 N m).

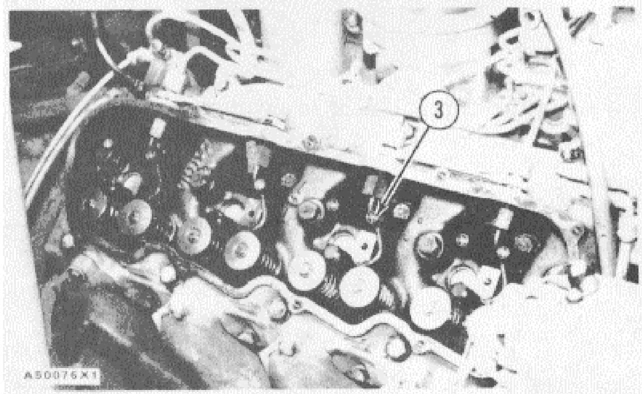
3. Make an adjustment of the valves to have a clearance of .015 in. (0.38 11m1) for intake and .025 in. (0.64 mm) for exhaust. Tighten nuts (3) to a torque of 24 + 5 lb. ft. (30 + 7 N m). See CHECKING ADJUSTMENT OF THE VALIVE LASH in TESTING AND ADJUSTING.

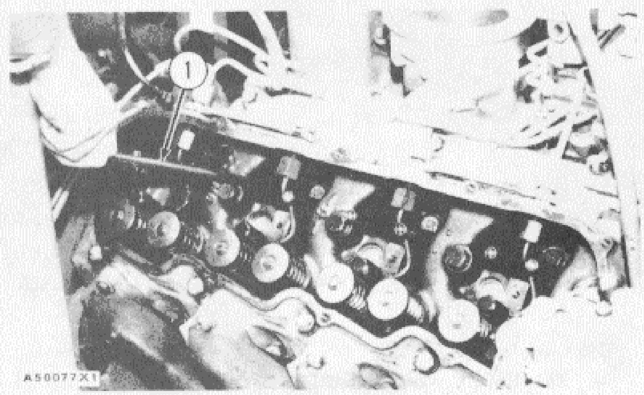
4. Lower the cab for the left side. See this procedure in INSTALL ENGINE.

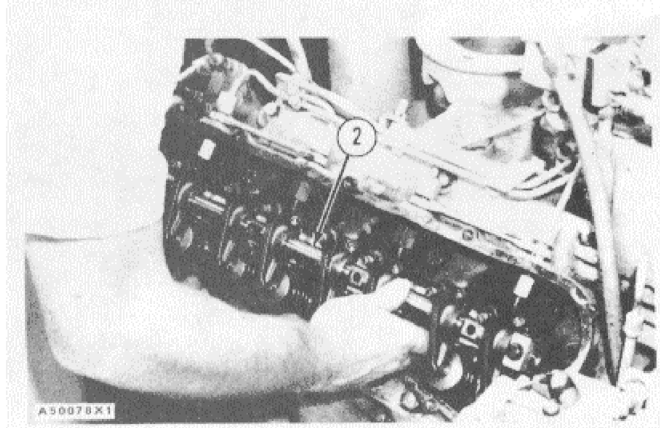
5. On the right side install the tube assembly to the air cleaner and air inlet manifold. Tighten the hose clamps to a torque of 18 -+ 5 lb. ft. (24 + 7 N m).
end by:
a) install valve covers







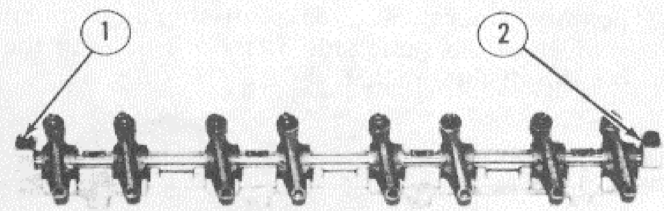




DISASSEMBLE ROCKER SHAFTS

start by:
a) remove rocker shafts and push rods

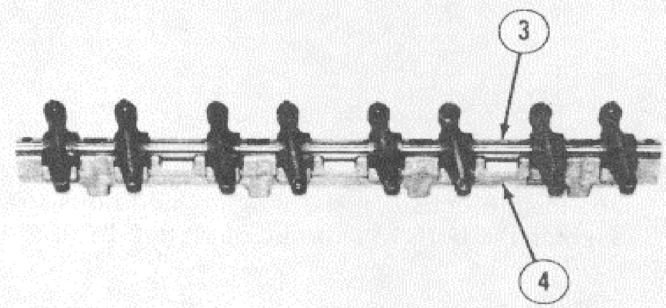
1. Remove bolts (I), locks (2) and tile washers from each end of the rocker shaft.



A50080X1

2. Remove shaft (3) from bracket (4).

3. Remove rocker arm assemblies (7) and the washers from shaft (3).



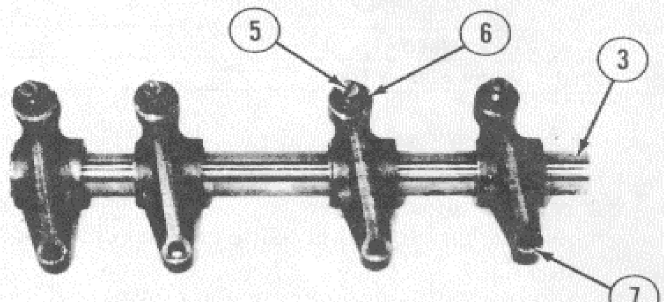
A50081X1

4. Remove screw (5) and nut (6) from rocker arm assemblies (7).

ASSEMBLE ROCKER SHAFTS

1. Make sure the oil holes in the rocker arm assemblies, rocker shaft and bracket are clean and free of all dirt and foreign material.

2. Measure the bore of the bushing in each of the rocker arms. The bore must be .8603 $^{+}$ .0008 in. (21.852 -t 0.020 mm). The maximum permissible bore is .8630 in. (21.920 mm).

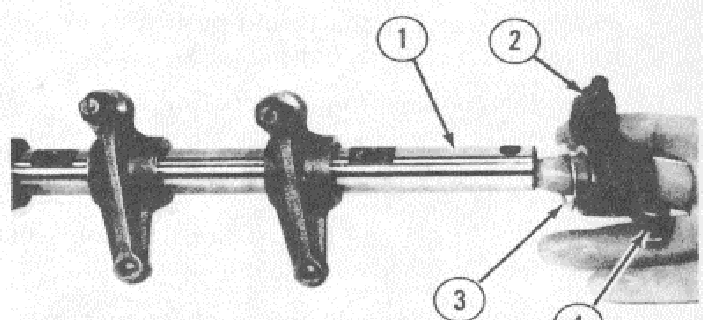


A50082X1

NOTE: Make a replacement of the arm and bushing as a unit if the bore is not correct. The arms and bushings can not be ordered separately.

3. Measure the diameter of the shaft at each of the rocker arm locations. The diameter must be .8580 to .8588 in. (21.793 to 21.814 mm). The minimum permissible diameter is .8570 in. (21.768 mm).

4. Install the screws and nuts (2) into rocker arm assemblies (4). Turn the screws until they are .44 in. (I 1 .2 mm) below the bottom of the rocker arm assemblies.

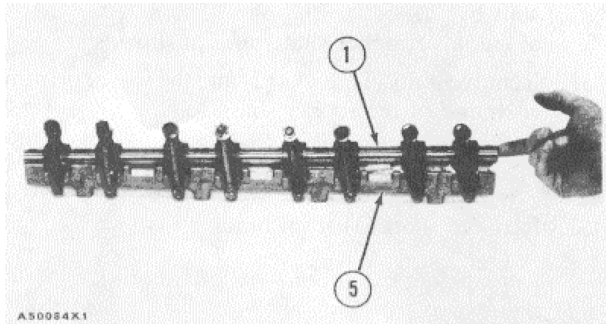


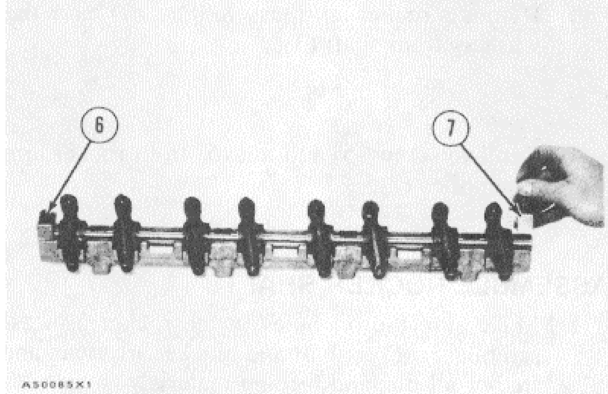
A50083X1

5. Install the rocker arm assemblies and washers (3) on shaft (I) as shown.

6. Put shaft (I) and the rocker arm assemblies in position on bracket (5) with the adjustment screws on the same side as the oil hole on the bottom of the bracket.

7. Make sure the flat surfaces on shaft (I) are turned up. Install locks (7), the washers and bolts (6). Tighten the bolts to a torque of 18 ± 5 lb. ft. (24 ± 7 N m). end by:
   a) install rocker shafts and push rods





REMOVE CYLINDER HEADS

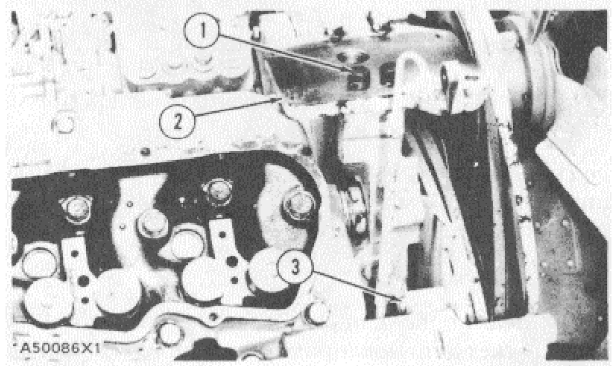
	Tools Needed	A
5P7308	Water Sleeve Tool	1

start by:
a) remove alternator
b) remove air compressor
c) remove air cleaner housing and panel assembly
d) remove belt tightener (water pump)
e) remove exhaust manifolds
f) remove fuel injection lines and air inlet manifold
g) remove rocker shafts and push rods
h) remove fuel injection nozzles

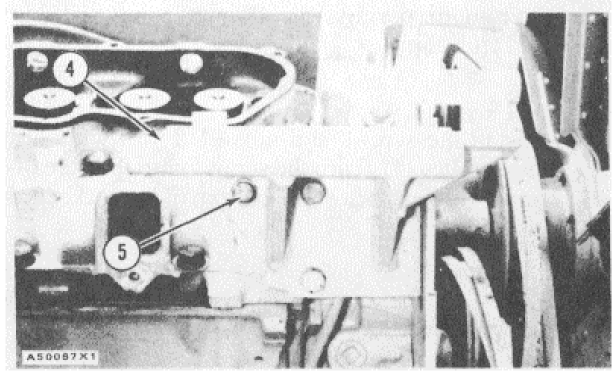
1. Drain the coolant from the cooling system.

2. Remove bolts (1), the washers, plate (2) and the gasket from the timing gear cover.

3. Remove bolt (3) and the washer that holds the guide for the oil level gauge.

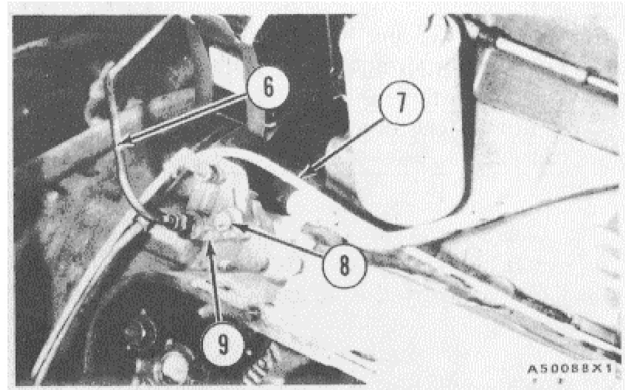


4. Remove bolts (5) and the washers to remove alternator bracket (4) from the engine.

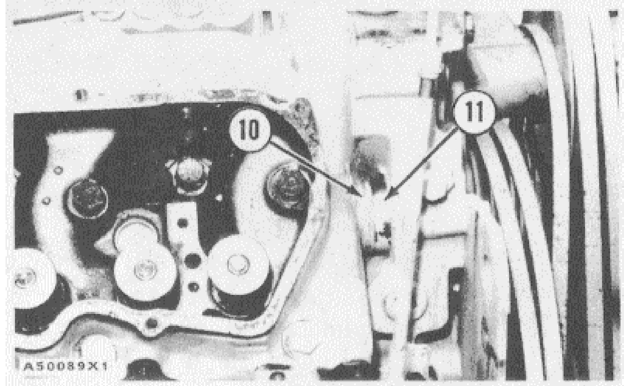


CYLINDER HEADS

5. Remove tube assemblies (6) and (7) from the engine.

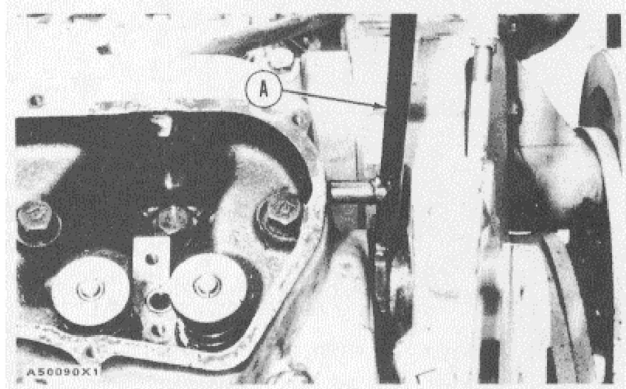


6. Remove nut (8) and move junction block (9) to the rear of the machine. NOTE: Make sure all fuel line openings are covered to keep dirt and foreign material out of the fuel system.

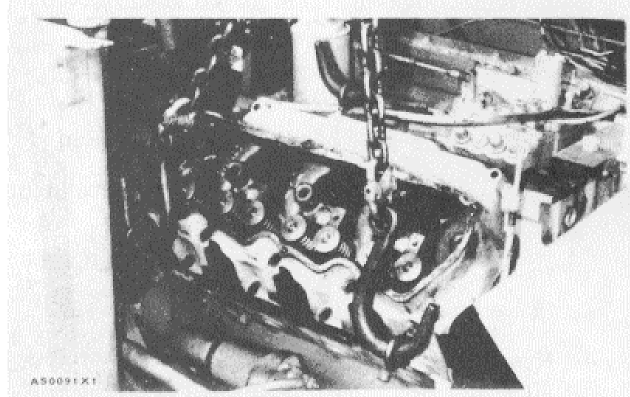


7. Remove clamp (I 11) from water sleeves (10) in each cylinder head. Push the water sleeves into the timing gear cover with tool (A).

CAUTION: Make sure the fuel injection nozzles are removed before the cylinder heads are removed. The fuel injection nozzles go through the cylinder heads and the nozzle tips can be broken off if the nozzles are not removed from the heads.



8. Install a locknut on each eyebolt and install two 3/8" x 16 NC and one 7/16" x 14 NC forged eyebolts in the cylinder head as shown.

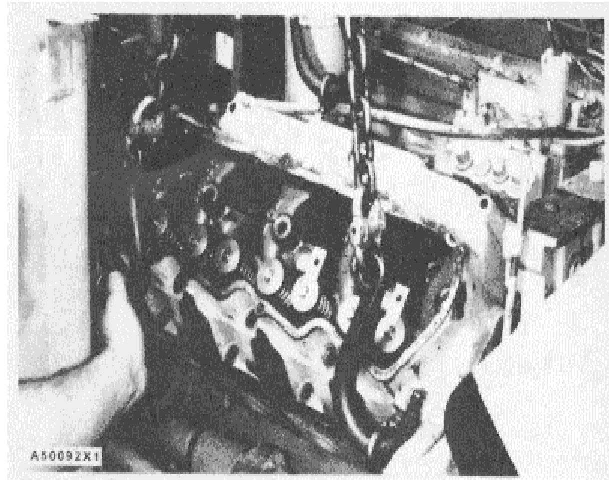


9. Fasten a hoist to the cylinder head and remove the bolts that hold it in position. Remove the cylinder head and gasket. The weight of the cylinder head is 120 lb. (54 kg).

CYLINDER HEADS

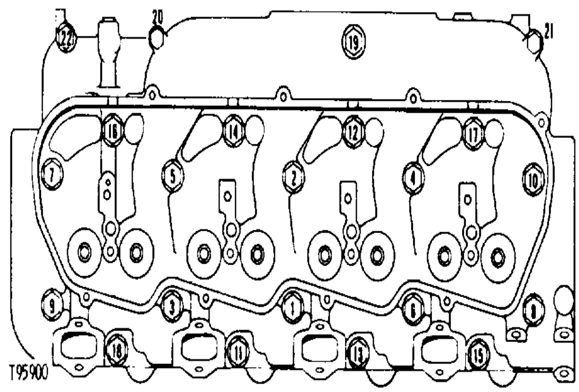
INSTALL CYLINDER HEADS

Tools Needed	A
5P7308 Water Sleeve Tool	1



1. Clean the contact surfaces of the cylinder head and cylinder block. Make sure the surfaces are clean and dry). Install a new cylinder head gasket.

NOTE: Clean the bore in the cylinder head f)r the water sleeves. Put oil on the seals)of the 'water sleeves.



2. Install a locknut on each eyebolt and install two, 3/8" x 16 NC and one 7/16" x 14 NC forged eyebolts ill the cylinder head and fasten a hoist as .shown. Put the cylinder head in position on the cylinder block.

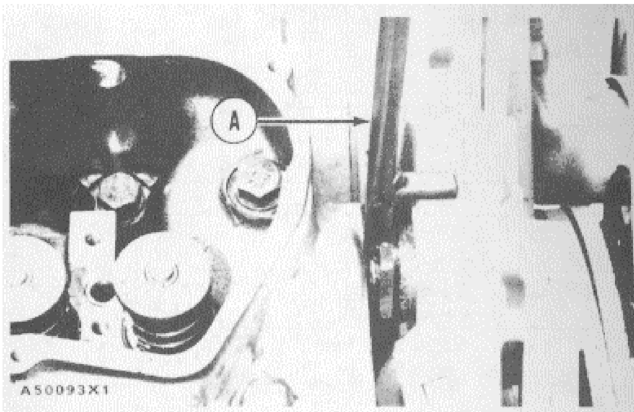
3. Put 9N13710 Anti-Seize Compound on the bolt threads and install the bolts that hold the cylinder head in place. Tighten the bolts in the cylinder head according to the following HEAD BOLT CHART.

	HEAD BOLT CHART	
	Tightening Procedure	BOLTS
Step 1	Tighten bolts 1 thru 18 in number sequence to:	60 + 10 lb.ft. (80 + 14 N m)
Step 2	Tighten bolts 1 thru 18 in number sequence to:	110 + 5 lb.ft. (149 + 7 N m)
Step 3.	Again tighten bolts 1 thru 18 number sequence to:	110 + 5 lb ft. (149 + 7 N m)
Torque for head bolts 19 thru 22 (tighten in number sequence to)		32 + 5 lb.ft. (43 + 7 N m)

CYLINDER HEADS

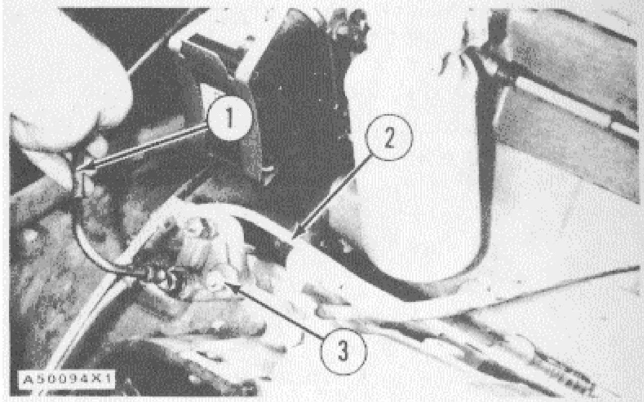
4. Install water sleeves into cylinder heads tool (A). Install the clamps on the water sleeves.

5. Put the fuel line junction block in position and install nut (3) to hold it.



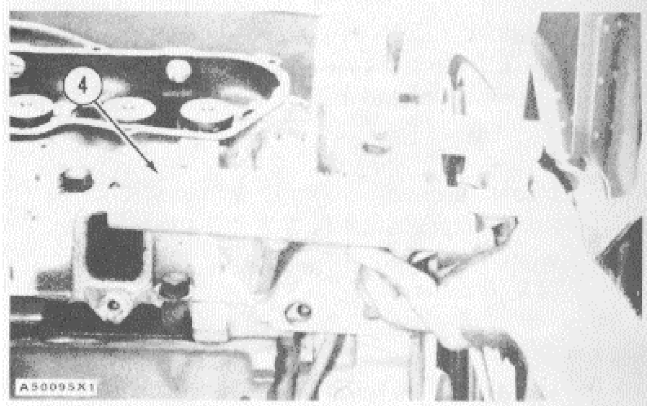
6. Install fuel lines (l) and (2) on the engine.

7. Put alternator bracket (4) in position and install the three bolts and washers to hold it.



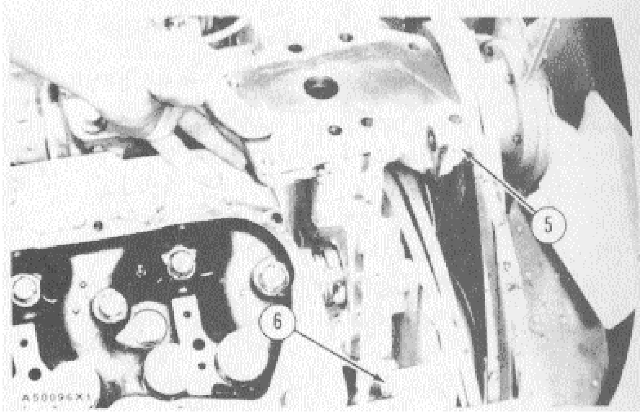
8. Install bolt (6) and the washer to hold the guide for the oil level gauge.

9 . Put the gasket and plate (5) for the air compressor in position on the timing gear cover and install the four bolts and washers to hold it.



10. Fill the cooling system with coolant to the correct level.

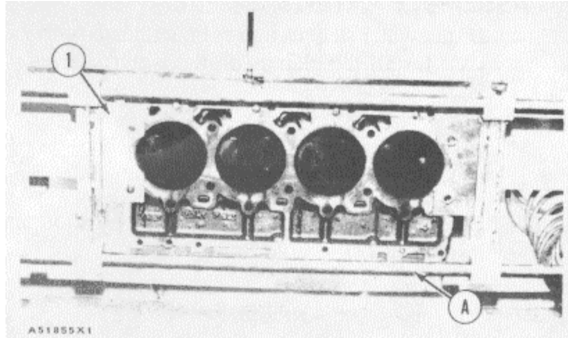
end by:
a) install fuel injection nozzles
b) install rocker shafts and push rods
c) install fuel injection lines and air inlet manifold
d) install exhaust manifold
e) install belt tightener (water pump)
f) install air cleaner housing and panel assembly
g) install air compressor install alternator



CYLINDER HEADS

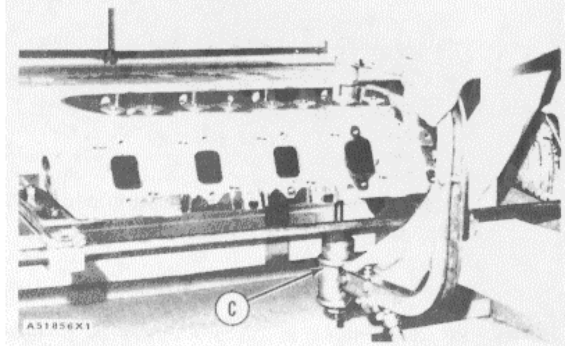
DISASSEMBLE CYLINDER HEADS

	Tools Needed	A	B	C	D
FT806	Cylinder Head				
	Stand	1			
FT967	Adapter Plate	2			
8S2263	Valve Spring				
	Tester		1		
5S 1 330	Valve Spring				
	Compressor			1	
8S7170	Valve Seat Insert				
	Puller Group				1



start by:
a) remove cylinder heads

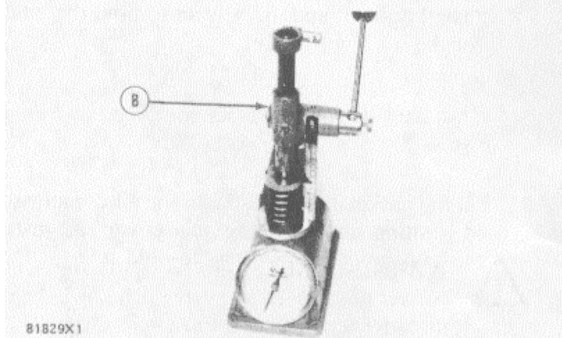
1. Fasten a hoist and put the cylinder head in position on tool (A). Use adapter plates (I) from tooling (A) to hold the head in place.



2. Put the valve springs under compression with tool (C).

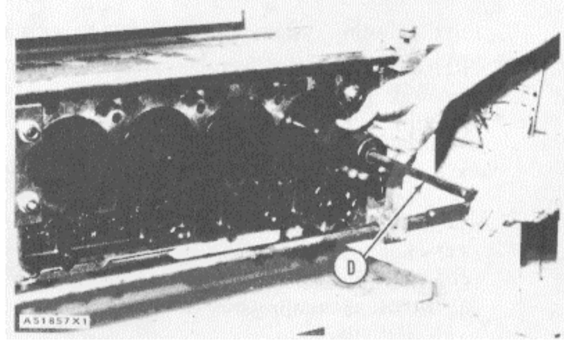
3.Remove the locks from the valves.

4. Remove tool (C), retainer, spring, washer and valve from the cylinder head. Put identification on the valve as to its location in the cylinder head.



5. Check the valve spring force with tool (B). Spring force must be 35 ± 5 lb. (155 -± 22 N) when the length of the spring force is 1.715 in. (43.56 mm).

6. Do Steps 2 through 5 for the remainder of the valves.



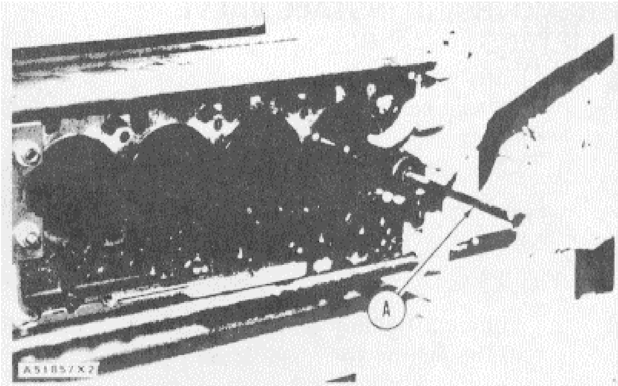
7. Remove the valve seat inserts with tooling (D).

NOTE: The valve guides are part of the cylinder head. Measure the bore in each valve guide .75 in. (19.0 1mm) from the outside edge on both ends of each valve guide. The bore must be .3745 $^{+}$ .0005 in. (9.512 ± 0.013 mm). The maximum permissible bore is .3760 in. mm).Valve guides worn more than the maximum specification can be made to the original size by knurling.

CYLINDER HEADS

ASSEMBLE CYLINDER HEADS

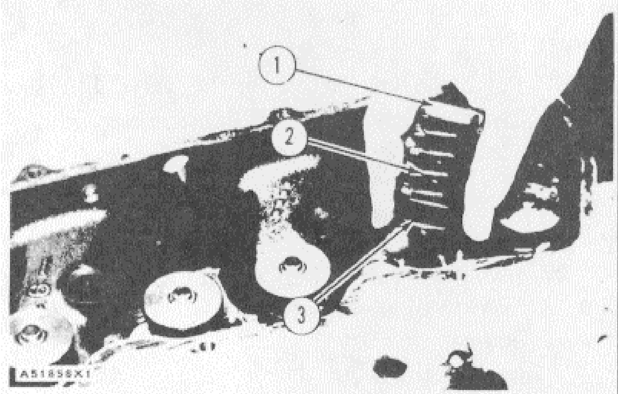
	Tools Needed	A	B	C
8S7170	Valve Seat Insert			
	Puller Group	1		
5S1322	Valve Keeper Inserter		1	
5P1330	Valve Spring Compressor			1



1. Clean and remove burrs and all foreign material from the salve seat bores.

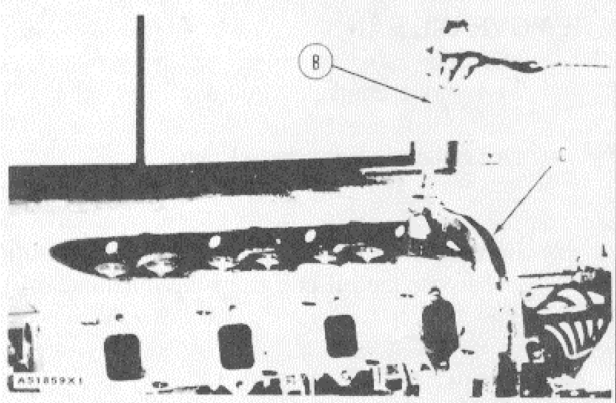
2. Lower the temperature of the valve seat inserts and install them with tooling (A).

CAUTION: Do not make the diameter of the extractor (part of tooling A) in valve seat insert larger when the insert is installed in the cylinder head.



3. Grind the valve inserts according to specifications given in ENGINE SPECIFICATIONS.

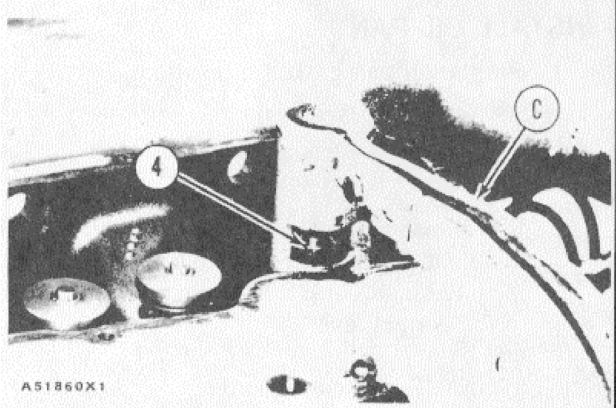
4. Put clean engine oil on the valve stem. Install the sale, washer (3). spring (2) and retainer (I) in the cylinder head.



5. Put the valve spring under compression with tool (C).

6. Install the locks on the valve stem with tool (B).

WARNING: Make sure locks (4) are in their correct position on the valve. The locks can be thrown from the valve when tool (C) is released if the locks are not in their correct position on the valve.



7. Remove tool (C) and hit the valve with a rubber hammer to be sure the locks are in their correct position.

8. Do Steps 4 through 7 for the remainder of the valves.

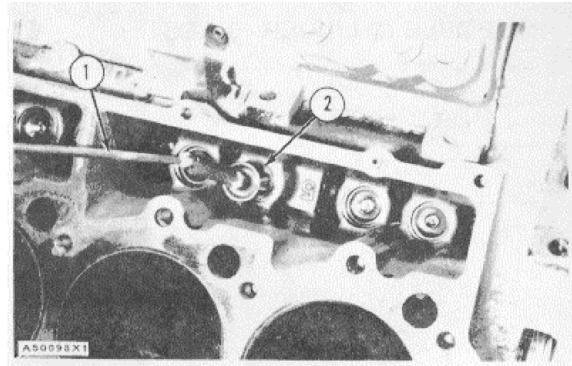
end by:

a) install cylinder heads

VALVE LIFTERS, OIL PAN

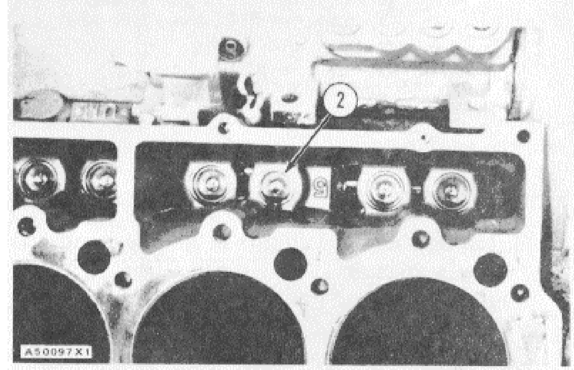
REMOVE AND INSTALL VALVE LIFTERS

start by:
a) remove cylinder heads



1. Remove valve lifters (2) with magnet (I).

2. Put identification on each lifter as to its location in the engine for installation purposes.



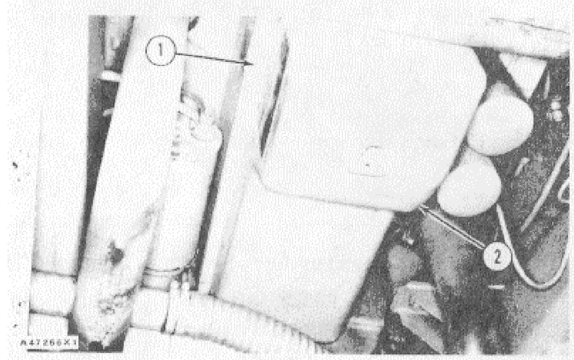
3. Put clean engine oil on the valve lifters and camshaft lobes.

4. Install the valve lifters (2) in their original positions in the cylinder block.

end by:
a) install cylinder heads

REMOVE OIL PAN

start by:
a) remove crankcase guard

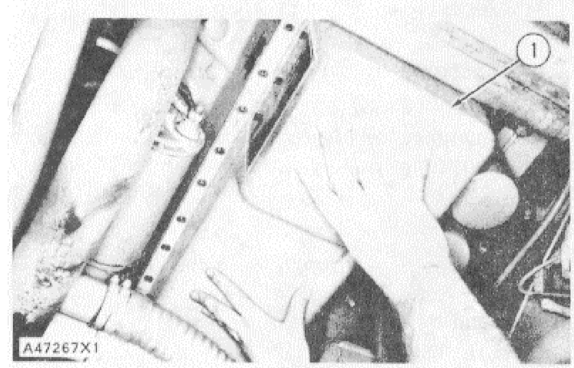


1. Drain the oil from the oil pan.

2. Remove bolts (I) that hold oil pan (2) in position and lower the oil pan from the machine.

3.Remove the oil pan gasket.

INSTALL OIL PAN



1. Put the oil pan gasket in position.

2. Lift oil pan (I) into position and install the bolts to hold it. Tighten the bolts to a torque of 17 ±_3 Ib.ft. (23 ± N m). Fill the engine with clean oil to the correct level.

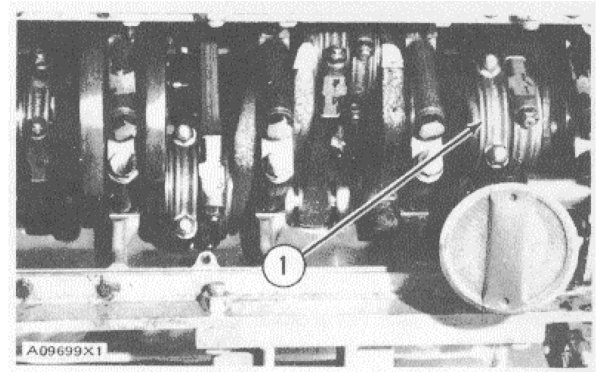
end by:
a) install crankcase guard

CONNECTING ROD BEARINGS

REMOVE AND INSTALL CONNECTING ROD BEARINGS

	Tools Needed	A
5B1161	Wire	*

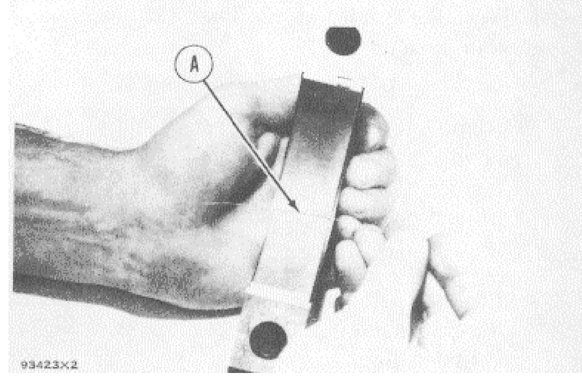
start by:
a) remove oil pan



1. Turn the crankshaft until two pistons are at bottom center. Remove connecting rod caps (1) from the two connecting rods. Remove the lower half of the bearings from the caps.

2. Push the connecting rods away from the crankshaft and remove the upper half of the bearings.

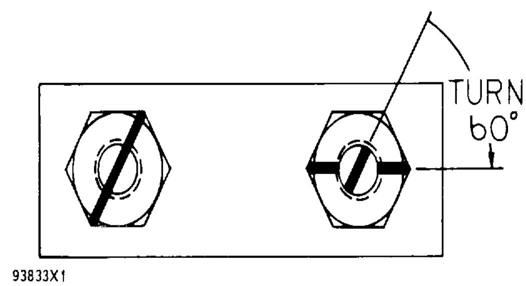
CAUTION: Be careful not to damage the crankshaft journals. Do not turn the crankshaft while any of the connecting rod caps are removed.



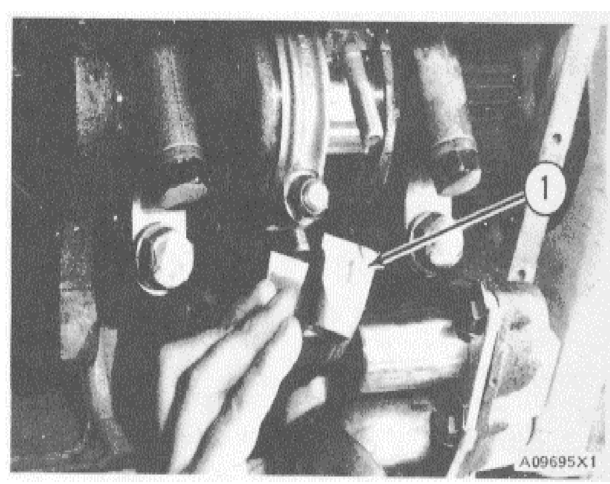
3. Clean the surfaces "where the bearings fit. Install the upper half of the new bearings in the rods. Put clean SAE 30 oil on the bearings and crankshaft journals. Put the connecting rods in position on the crankshaft.

4. Clean the surfaces the bearings fit. Install the lower half of the new bearings in the caps. Put clean SAE 30 oil on the bearings, bolt threads and contact surfaces of the nuts.

CAUTION: When the connecting rod caps are installed make sure that the numbers on the side of the caps are next to and respective with the number on the side of the connecting rods.



5. Check the bearing clearance with wire (A). Put the caps (I) in position on the connecting rods and install the nuts. Tighten the nuts to a torque of 30 ± 3 lb.ft. (40 ± 4 N m). Put a mark on each nut and the end of each bolt. Tighten the nuts 60° ±_5° more



6. Remove the cap. Measure the thickness of the w-ire. The rod bearing clearance must be .0030 ± .0015 in. (0.076 - 0.038 r1m1). The maximum permissible clearance is .007 in. (0.18 1mm).

7. Put the caps in position on the connecting rods and install the nuts. Tighten the nuts to a torque of 30 ± 3 Ib.ft. (40 -± 4 N m). Put a mark on each nut and the end of each bolt. Tighten the nuts 60° ± 5° more.

8. Do Steps I through 7 again for the other bearings.

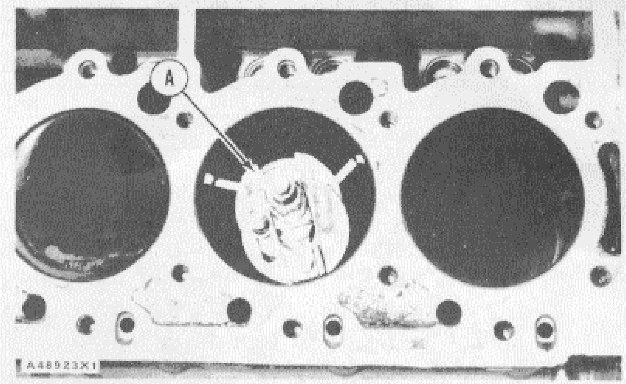
end by:
a) install oil pan

PISTONS

REMOVE PISTONS

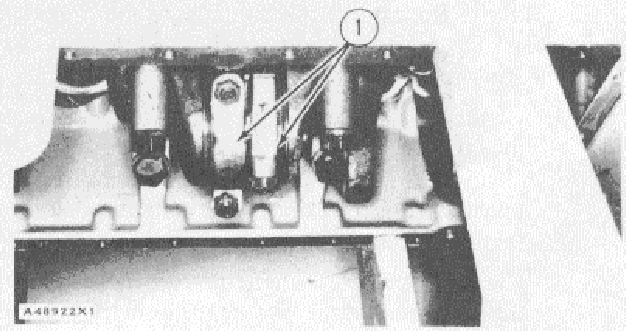
	Tools Needed	A
8S2269	Ridge Reamer	1

start by:
a) remove cylinder heads
b) remove oil pan



1 Remove the carbon from the top inside surface of the cylinders with tool (A).

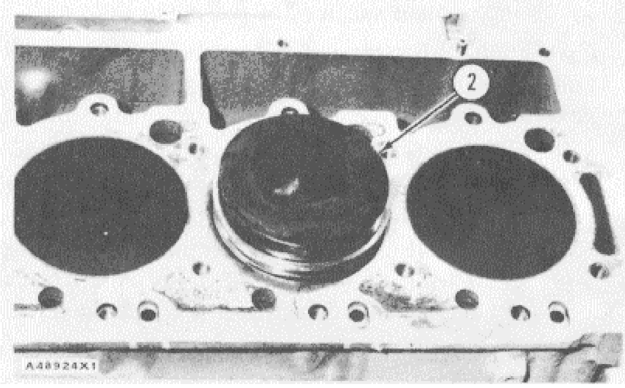
2. Turn the crankshaft until pistons arc at bottom center.



3. Remove connecting rod caps (I) from the two connecting rods. Put pieces of rubber hose or tape on the threads of the connecting rod bolts as protection for the crankshaft.

4. Push the pistons and connecting rods away) from the crankshaft until the piston rings are above the cylinder block.

5. Remove the two pistons (2) and the connecting rods. Keep each connecting rod cap with its respective connecting rod and piston. Put identification on each connecting rod as to its location for use at installation.



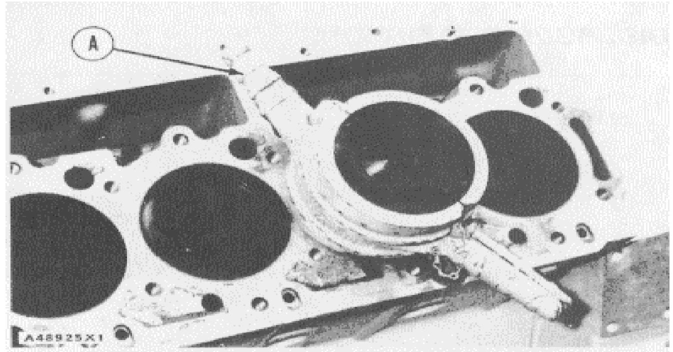
CAUTION: Do not turn the crankshaft while any of the connecting rods are in the engine & without the caps installed.

6. Do Steps 2 through 5 for the remainder of the pistons.

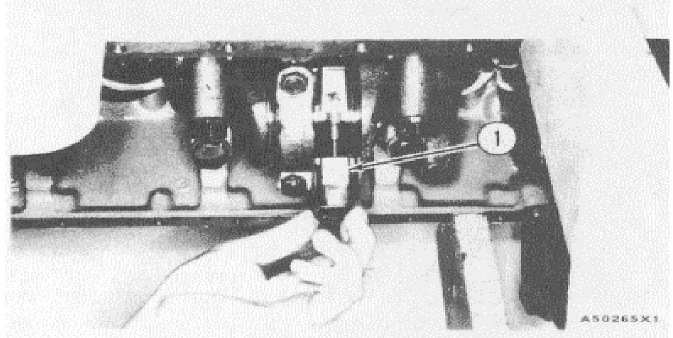
PISTONS

INSTALL PISTONS

Tools Needed		A	B
5P3524	Ring Compressor	1	
5B1161	Wire		*

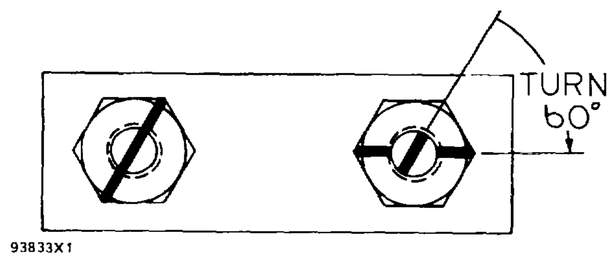


1. Put clean engine oil on the piston rings, connecting rod bearings, cylinder walls and crankshaft bearing journals.
2. Turn the crankshaft until the bearing journal for the pistons to be installed is at bottom center.
3. Make sure the piston ring gaps are at least 120° apart on the piston.
4. Use tool (A) and install the piston in position in the same cylinder bore from which it was removed. The hole (crater) in the top of the piston must be toward (nearest) the center of the engine.



NOTE: For more detail about the installation of connecting rod bearings see REMOVE AND INSTALL CONNECTING ROD BEARINGS.

5. Check the bearing clearances with tool (B).
6. Put clean engine oil on the threads of the bolts and contact surfaces of the nuts for the connecting rod caps.



CAUTION: When the connecting rod caps are installed, make sure that the number on the side of the cap is next to and respective with the number on the side of the connecting rod.

7. Put the cap (1) in position on the connecting rod and install the nuts. Tighten the nuts to a torque of 30 + 3 lb.ft. (40 + 4 N.m). Put a mark on each nut and the end of each bolt. Tighten the nuts 60 + 5° more.
8. Check the side clearance between two connecting rods on the same crankshaft journal. Clearance must be .003 to .033 in. (0.076 to 0.838 mm) for new rods.
9. Do Steps I through 8 for the remainder of the pistons. end by:
   a) install cylinder heads
   b) install oil pan

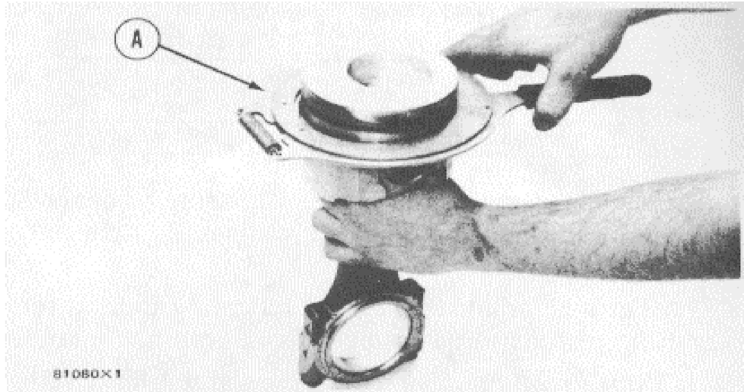
PISTONS

DISASSEMBLE PISTONS

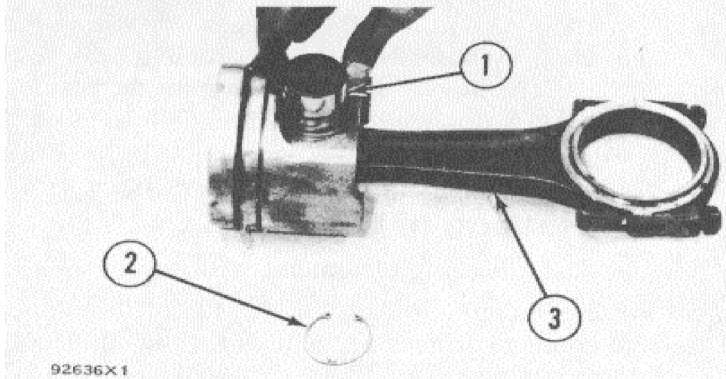
Tools Needed		A
5F9059	Ring Expander	1

start by:
a) remove pistons

1. Remove the rings from the piston the tool (A).



2. Remove snap ring (2). pin (I) and connecting rod (3) from the piston.

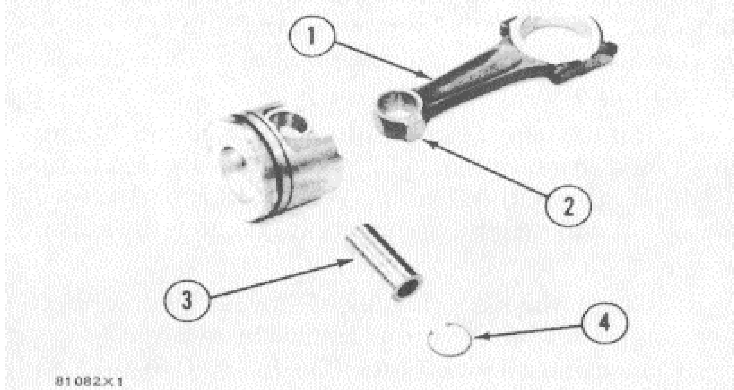


ASSEMBLE PISTONS

Tools Needed		A	B
852304	Piston Ring Groove Cleaner	1	
5F9059	Ring Expander		1

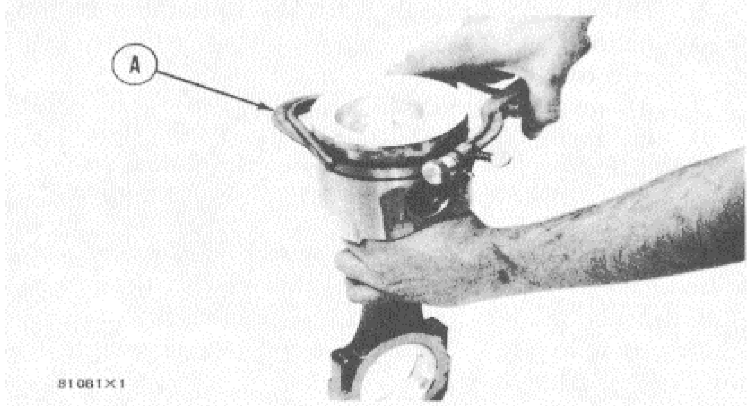
1. Install connecting rod (I) in the piston with boss (2) on the same side as the hole (crater) in the top of the piston.

2. Install piston pin (3) and snap ring (4).



3 When old pistons are to be used, clean the piston grooves 'with tool (A).
4. Install the spring for the oil ring. Install the oil ring with tool (B). The gap in the ring must be approximately 180° from the oil ring spring connections.

5. Install the compression ring *with tool (B). The side of the ring that has the identification "TOP"' must be toward the top of the piston. The gaps in the rings must be approximately 120° apart.



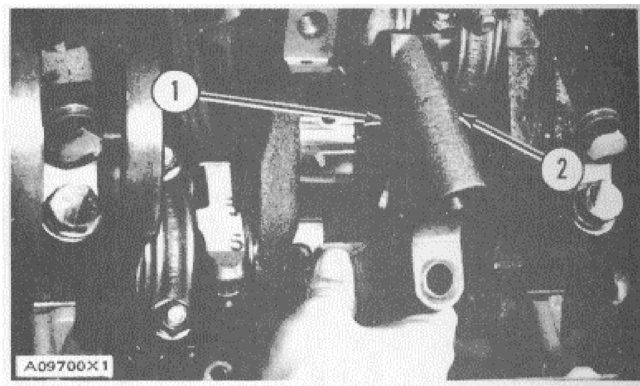
NOTE: Compression rings that do not have identification must be installed *with the edge that has bevel toward the top of the piston.

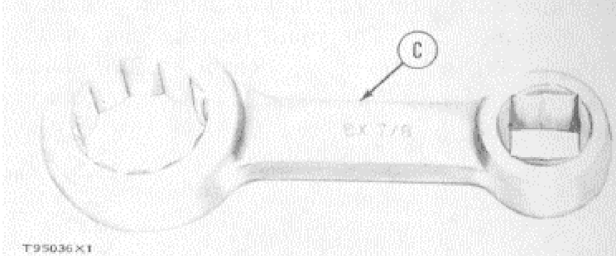
end by:
a) install pistons

CRANKSHAFT MAIN BEARINGS

REMOVE AND INSTALL CRANKSHAFT MAIN BEARINGS

Tools Needed		A	B	C	D
2P5518	Bearing Tool	1			
5B1161	Wire		*		
8S5131	Adapter			1	
8S2328	Dial Test Indicator				1
Group1					





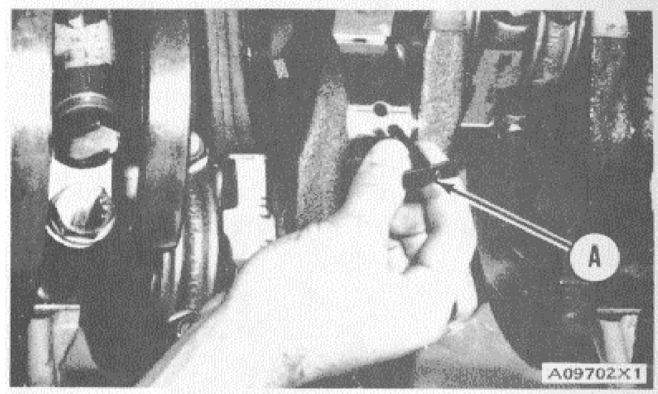
start by:

a) remove oil pan

1. Check each main bearing cap for its location on the engine. Each cap has a number which gives the location of that cap. Make a note that the number on each cap is toward the front of the cylinder block.

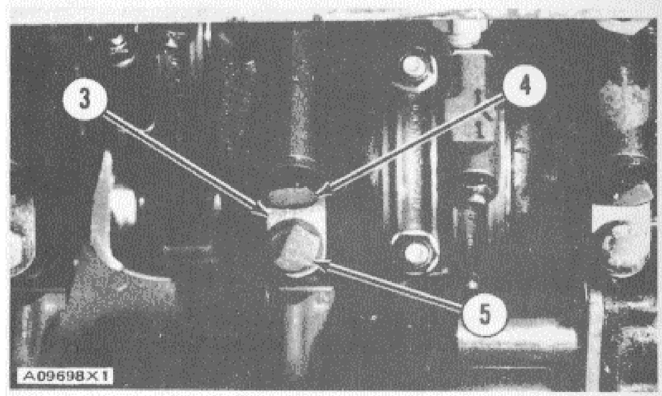
2. Remove the bolts and washers that hold main bearing cap (2) in place. Remove the bearing cap and the lower half of the main bearing. 3. Remove bearing (1) from the bearing cap.

NOTE: When the No. I main bearing cap is removed or installed use tool (C) to remove and install the bolts that hold it.



4. Turn the crankshaft until tool (A) can be installed in the oil hole in the crankshaft journal. Install tool (A). Turn the crankshaft in the direction which will push the upper main bearing out, tab end first.

CAUTION: If the crankshaft is turned in the wrong direction, the tab of the bearing will be pushed between the crankshaft and the cylinder block. This will cause damage to the crankshaft and block.



5. Put clean engine oil on the lower bearings. Install lower bearings in the bearing caps.

6. Put clean engine oil on the upper bearings (the bearing with the oil hole). Install upper bearings in the cylinder block with tool (A).

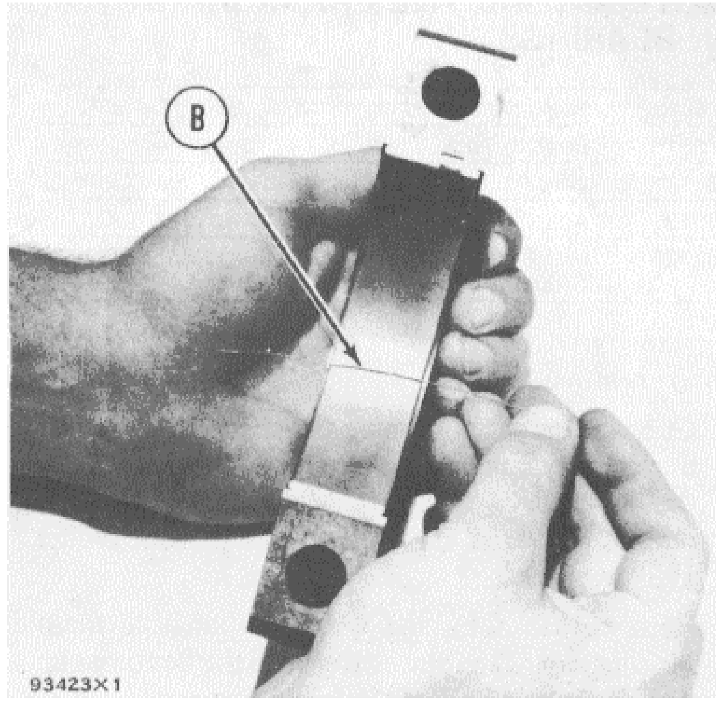
NOTE: Be sure the tab on the back of the bearings fits in the groove of the caps and cylinder block.

CAUTION: When bearing caps are installed, make sure the number on the side of the cap is next to and respective with the number on the engine block.

NOTE: When the bearing clearance is checked the crankshaft will have to be lifted up against the upper halves of the main bearings and held to get a measurement with wire (B). The wire will not hold the weight of the crankshaft.

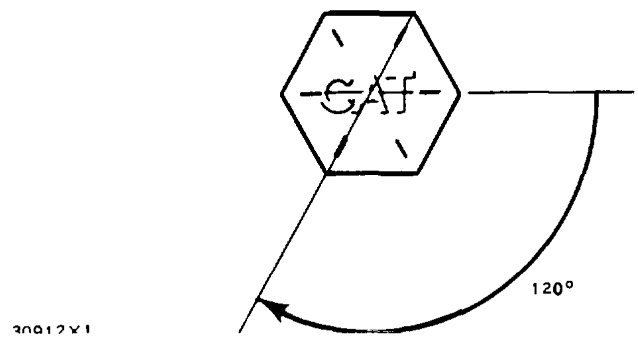
CRANKSHAFT MAIN BEARINGS

7. Check the bearing clearance with tool (B) as follows: Put cap (3) in position and install the bolts. Tighten bolt (5) to a torque of 30 ± 3 lb.ft. (40 -+ 4 N m). Tighten bolt (4) to a torque of 30 ± 3 Ib.ft. (40 ± 4 N m). Put a mark on both bolt heads and the bearing cap. Tighten bolt (4) 120° ± 5° more. Tighten bolt (5) 120° ± 5° more.



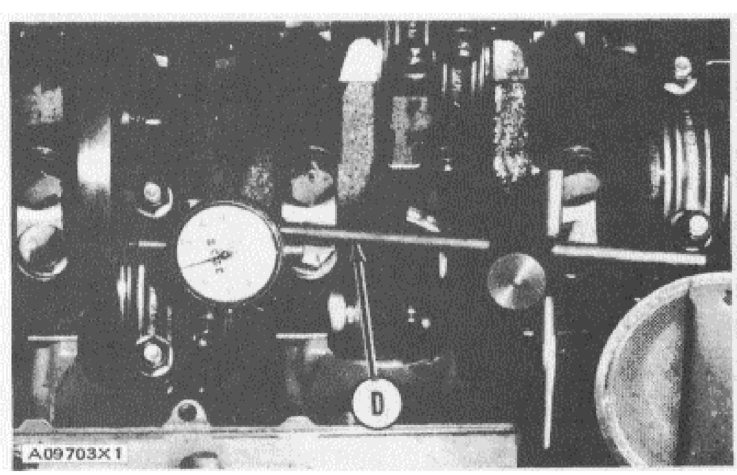
8. Remove the bearing cap and measure the thickness of the wire. The main bearing clearance must be .002 to .005 in. (0.05 to 0.13 mm). The maximum permissible clearance is .006 in. (0.15 mm).

9. Put clean SAE 30 oil on the bolt threads, washer faces and lower half of the main bearing. Put the bearing cap and lower half of the main bearing in position on the engine. Install the bolts. Tighten bolt (5) to a torque of 30 ± 3 lb.ft. (40 ± 4 N m). Tighten bolt (4) to a torque of 30 + 3 Ib.ft. (40 + 4 N.m). Put a mark on both bolt heads and the cap. Tighten bolt (4) 120° + 5° more. Tighten bolt (5) 120° ± 5° more.



10. Do Steps I through 9 for the remainder of the bearings.

11. Check the crankshaft end play with tooling (D). The end play is controlled by the thrust bearing on No. 4 main bearing. The end play with new bearings must be .006 ± .003 in. (0.15 ± 0.08 mm). The maximum permissible end play with used bearings is .014 in. (0.36 mm).



end by:
a) install oil pan

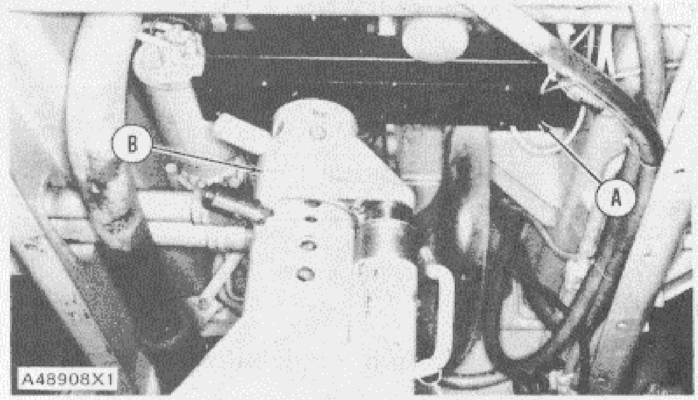
ENGINE FRONT SUPPORT

REMOVE AND INSTALL ENGINE FRONT SUPPORT

	Tools Needed	A	B
FT1321	Support Beam	1	
1H5514	Bolt(5/16"-18NCx 1 5/8in long)	4	
8S7630	Stand		1
8S7611	Tube		1
8S7615	Pin		2
8S7625	Collar		1
8S7650	Cylinder		1
5P3100	Pump Group		1

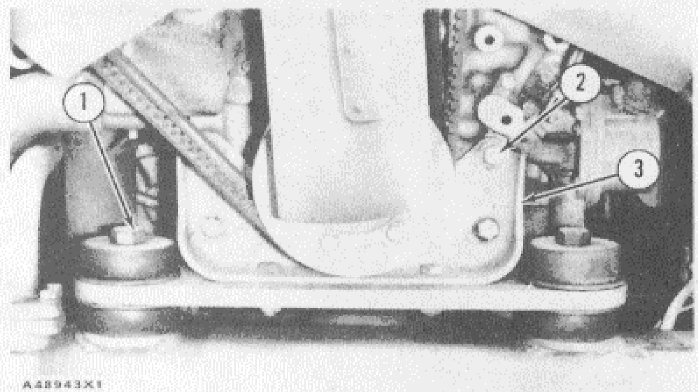
start by:
a) remove radiator
b) remove oil pan

1. Remove the rear oil filter from the engine oil cooler and put tooling (A) in position under engine.



2. Put tooling (B) in position under tooling (A) as shown.

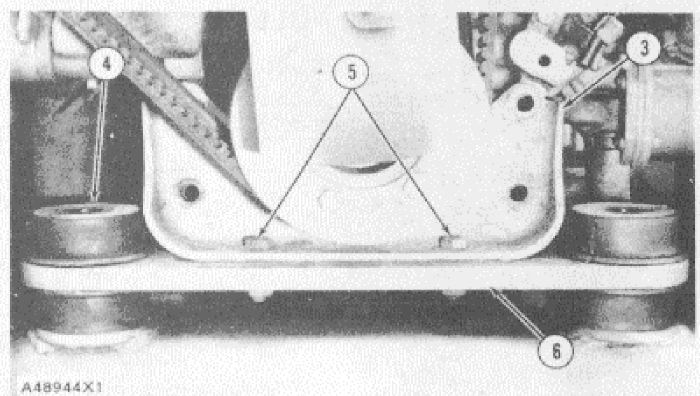
3. Remove two bolts (I) that hold the support to the frame.



4. With tooling (B) lift the engine enough to take the weight of the engine off of the front support.

5. Remove four bolts (2) and the washers that hold support (3) to the timing gear cover.

6. Remove two bolts (5), the nuts and washers that hold supports (3) and (6) together.

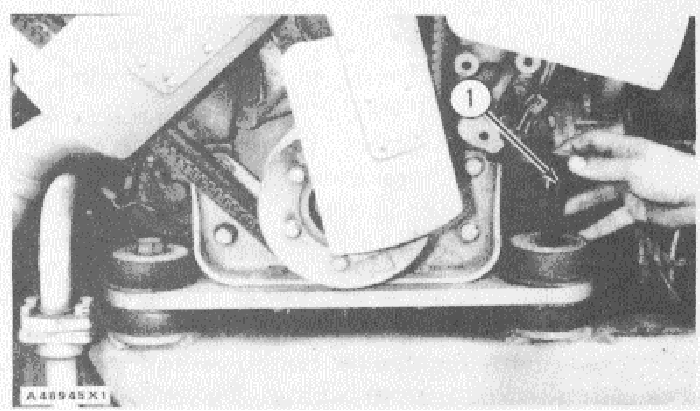


7. Remove support (6) and mount assemblies (4). Remove support (3).

8. Put support (3) in position and install bolts (2) and the washers to hold it to the timing gear cover.

9. Put the lower half of mount assemblies (4) in position on the tractor frame.

10. Put support (6) in position and install bolts (5), the nuts and washers to hold the supports together.



11. Install the upper half of mount assemblies (4) and bolts (I).

12. Lower the engine with tooling (B) and tighten bolts (1).

13. Remove tooling (A) and (B) and install the rear oil filter on the engine oil cooler.

end by:
a) install oil pan
b) install radiator

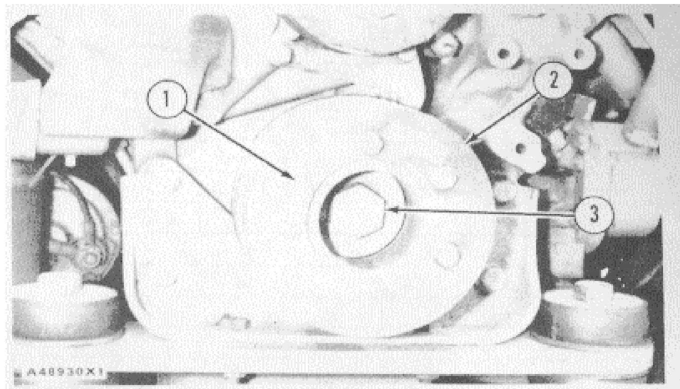
CRANKSHAFT PULLEY

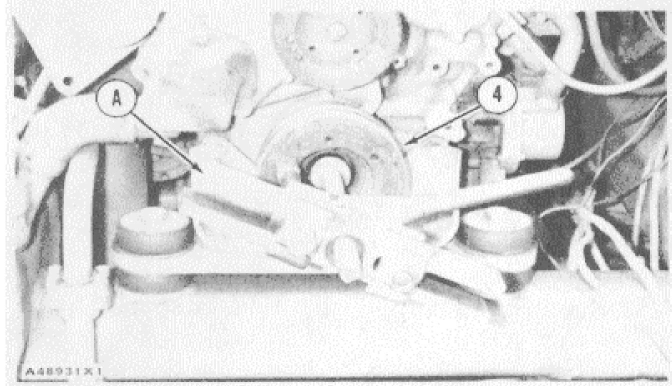
REMOVE CRANKSHAFT PULLEY

Tools Needed	A	
8B7548	Puller Assembly	1
8B7557	Adapter	2
8H684	Ratchet Box Wrench	1
8B7561	Step Plate	1

start by:
a) remove radiator

1. Remove the fan from the fan drive.
2. Remove all vee belts from the front of the engine.
3. Remove bolts (1), the washers and pulley) (2) from the pulley assembly.
4. Remove bolt (3) and the washer from the crankshaft.
5. Use tooling (A) to pull pulley assembly (4) from the crankshaft.

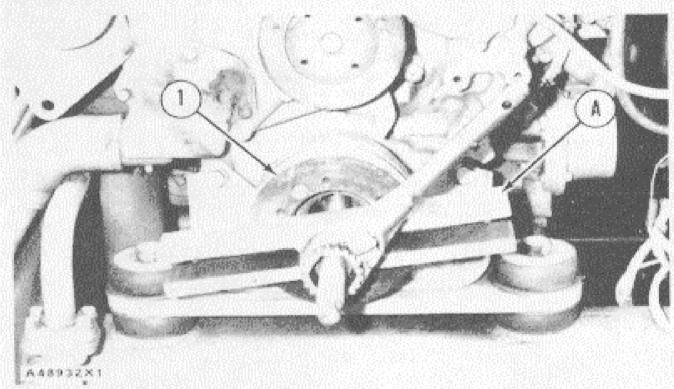


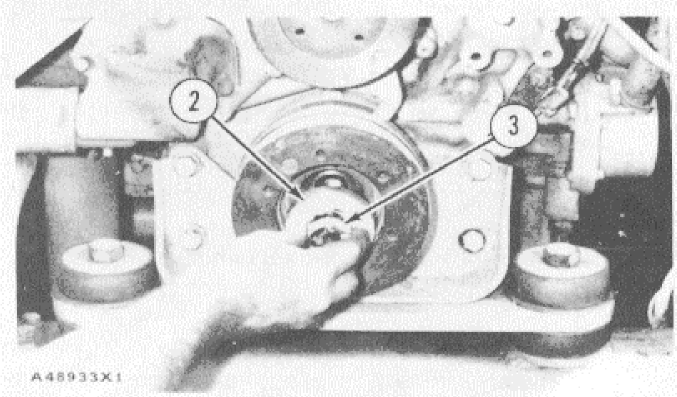


INSTALL CRANKSHAFT PULLEY

Tools Needed	A	
8B7548	Puller Assembly (without legs)	1
8H684	Ratchet Box Wrench	1

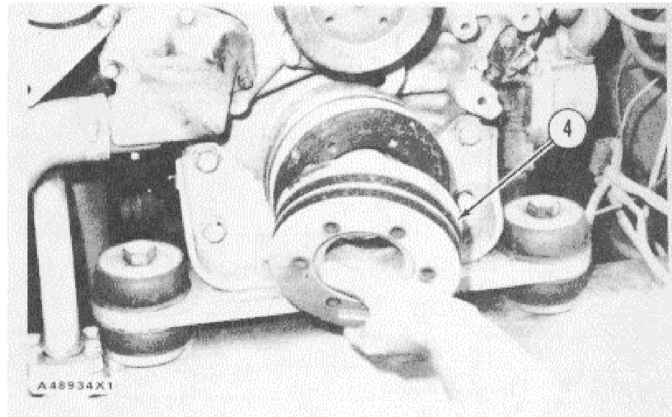
1. Put clean engine oil on the lip of the front crank, , haft seal and sealing, surface of the crankshaft pulley.
2. Put crank, haft pulley- (I) in position on end of crankshaft.
3. Install the screw of tooling (A) in the end of the crankshaft. Put crossbar of tooling (A) on screw and against the pulley. Use tooling (A) to push the pulley- on to crankshaft until it makes contact crankshaft gear inside timing gear housing. Remove tooling (A).
4. Install washer (2) and bolts (3) in the end of the crankshaft. Tighten the bolt to a torque of 460 ± 60 lb.ft. (624 ± 80 N.m).





CRANKSHAFT PULLEY, CRANKSHAFT FRONT SEAL

5. Put pulley (4) in position on the pulley assembly and install the washers and bolts that hold it.

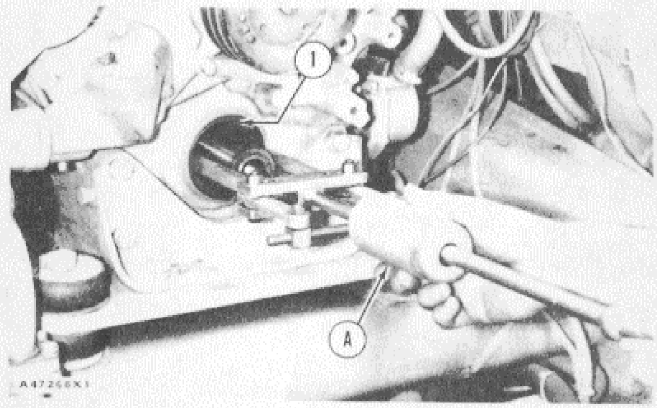


6. Install the vee belts on the front of the engine. Make an adjustment of the belt tension with a belt tension gauge such as Burroughs Tool Company Part No. BT-33-96-4-16 or an equivalent. The correct gauge indication is 120 ± 5.

7. Put the fan in position on the fan drive and install the bolts and , washers that hold it.

end by:
a) install radiator

REMOVE CRANKSHAFT FRONT SEAL

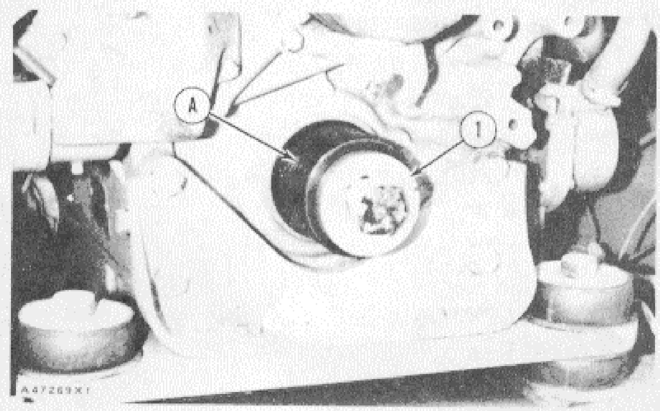


Tools Needed	A	
8B7554	Bearing Cup Puller Attachment	1
9S7786	Leg 2	
1P74	Slide Hammer	1

start by:
a) remove crankshaft pulley

1. Remove front seal (I) with tooling (A).

INSTALL CRANKSHAFT FRONT SEAL



Tools Needed	A	
5P4194	Installer Assembly	1
2H3745	Bolt (1"-14 NF x 2 3, 4 in long)	1

1. Put 7F2770 Cement on the outer metal surface of the front seal. Put the seal in position on the short end of the installer assembly (A). The lip of the seal must be toward the inside of the engine.

NOTE: If a new wear surface for the front seal is needed, put the spacer from tooling (A) between the seal and flange of the installer assembly.

2. Put the seal and installer assembly in position on the end of the crankshaft. Install washer (I) that is used to hold the crankshaft pulley and the 2H3745 Bolt. Tighten the bolt until the installer assembly makes contact with the crankshaft gear. Remove tooling (A) and washer (1).
   end by:
   a). install crankshaft pulley

TIMING GEAR COVER AND OIL PUMP

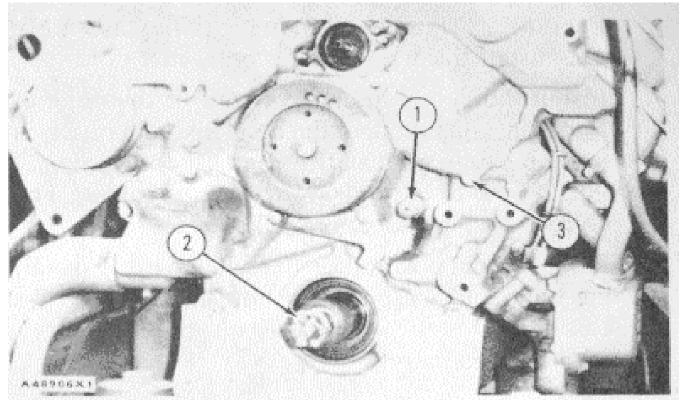
REMOVE TIMING GEAR COVER AND OIL PUMP

Tools Needed		A	B
FT1321	Support Beam	1	
1H5514	Bolt (5/16"-18NCx 1 5/8in long)	4	
8S7630	Stand		1
8S7611	Tube		1
8S7615	Pin		2
8S7625	Collar		1
5S7650	Cylinder		1
5P3100	Pump Group		1

start by:
a) remove air compressor
b) remove tachometer drive
c) remove crankshaft pulley
d) remove oil pan

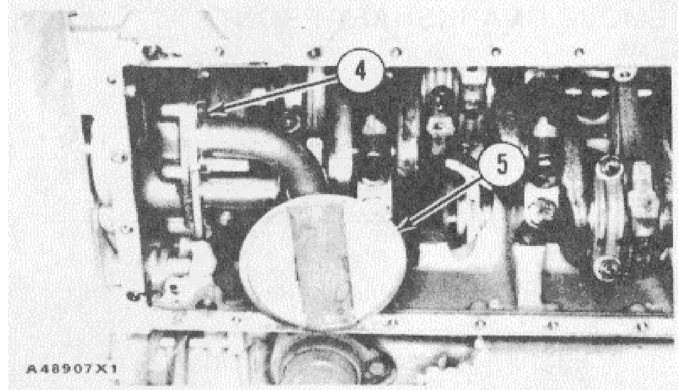
1. Install crankshaft pulley bolt (2) in the end of the crankshaft.

2. Remove plug (1) from the timing gear cover and install a 5/16"-18 NC x 2 ½/2 in. long bolt in its place. Cover bolt (3) can be used. Turn the crankshaft (clockwise as seen from the front of the engine) until the bolt can be installed into the timing gear and is in the center of the timing hole.



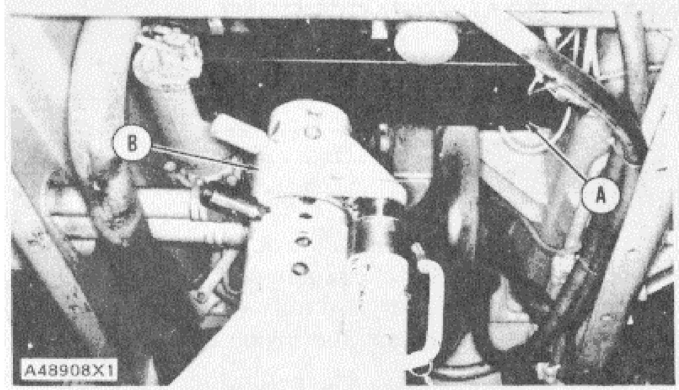
NOTE: This operation is used to make an alignment of the marks on the timing gears and to put the crankshaft in a position to install tooling (A).

3. Bend the tabs of the locks from the four bolts (4) that hold suction bell assembly (5) to the oil pump. Remove the bolts and bell assembly (5) from the oil pump.



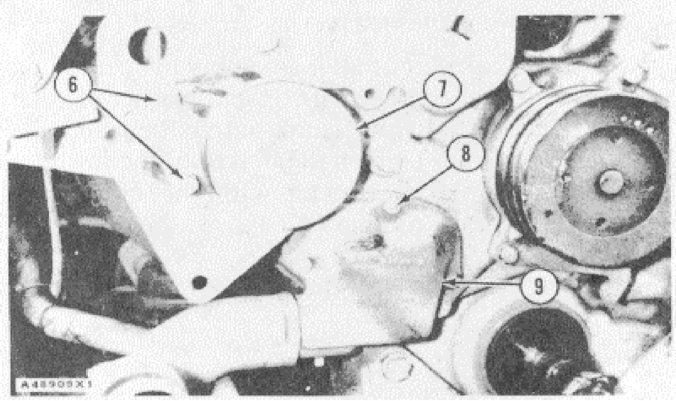
4. Remove the rear oil filter from the engine oil cooler and put tooling (A) in position under the engine.

5. Put tooling (B) in position under tooling (A) as shown.

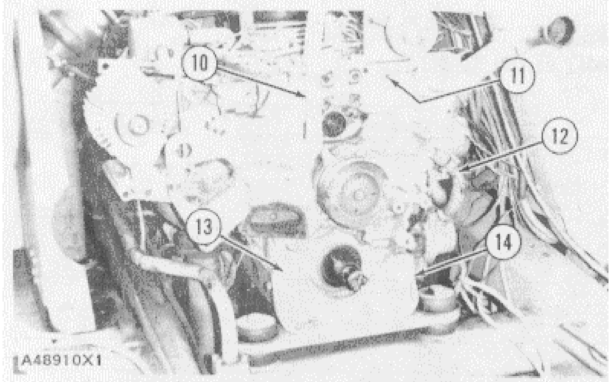


6. Remove two bolts (6), the washers and belt tightener (7).

7. Remove the three bolts (8), elbow (9) and the gasket.



TIMING GEAR COVER AND OIL PUMP



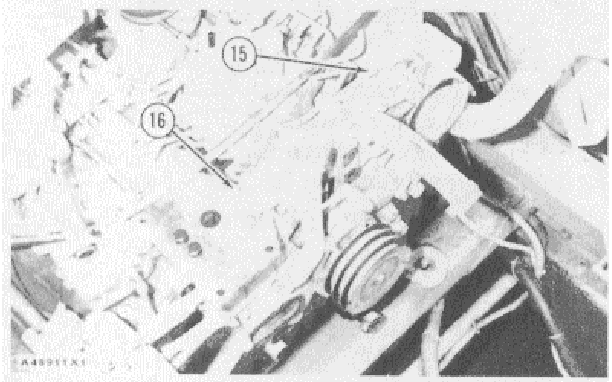
8. Loosen the clamp and disconnect hose (12) from the timing gear cover.

9. Remove water temperature sending unit (11) from the timing gear cover.

10. Remove the two bolts, connector (10) and the gasket.

11. Remove the two bolts that hold front support (14) to the tractor frame.

12. With tooling (B) lift the engine enough to take the weight off of support (14).

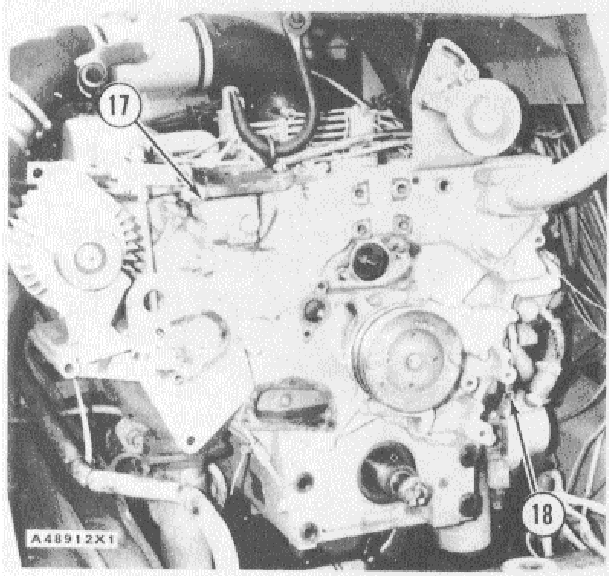


13. Remove four bolts (13) and support (14).

14. Make a replacement of bolts (15) and (16) on the top of the timing gear cover with two 7/16" x 14 NC forged eyebolts.

15. Remove the bolt that holds clip (18) for the fuel bleed lines.

16. Fasten a hoist to the timing gear cover.



17. Remove the bolts and one nut that hold the timing gear cover (17). Put identification on the bolts as to their location for correct installation.

18. Remove the bolt used to make an alignment of the timing gears.

CAUTION: Do not cause damage to the crankshaft front seal when the timing gear cover is removed and installed.

19. Pull timing gear cover (17) from the dowels on the cylinder block to remove the water sleeves from the cylinder heads. Remove the timing gear cover and oil pump. The weight of the timing gear cover and oil pump is 130 lb. (59 kg).

TIMING GEAR COVER AND OIL PUMP

INSTALL TIMING GEAR COVER AND OIL PUMP

Tools Needed		A	B	C
FT1321	Support Beam	1		
1H5514	Bolt			
(5/16"-18 NC x 1 5/8 in long)		4		
8S7630	Stand		1	
8S7611	Tube		1	
8S7615	Pin		2	
857625	Collar		1	
8S7650	Cylinder		1	
5P3100	Pump Group		1	
5P7308	Water Sleeve Tool			1

1. Clean the contact surfaces of the cylinder block and timing gear cover. Install the timing gear cover gasket on the cylinder block. Cut the gasket even with the cylinder block pan rail.

NOTE: Make sure the water sleeves are installed in the timing gear cover. Put oil on the seals.

2. Install two 7/16"-14 NC forged eyebolts in the timing gear cover. Fasten a hoist and put timing gear cover and the oil pump in position on the engine. Make sure the oil pump gear and crankshaft gear are in alignment.

3. If necessary use tool (C) to push the water sleeves into the cylinder heads.

4. Install the bolts and nut that hold the timing gear cover.

5. Remove the hoist and make a replacement of eyebolts (1) with the original bolts.

6. Install the clip to hold the fuel bleed lines.

7. Put the front support in position and install bolts (5) and the that hold it to the timing gear cover.

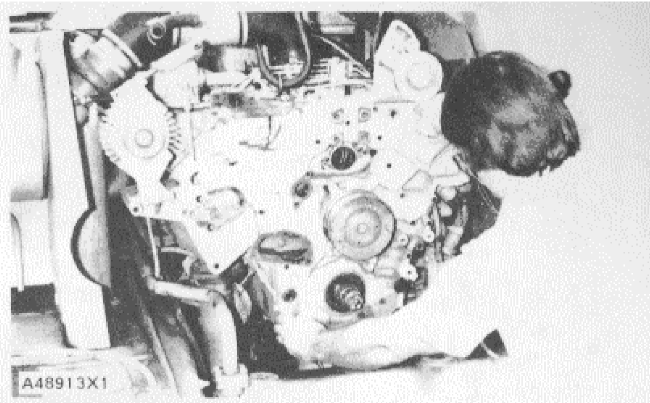
8. Put mount assemblies (7) in position and install bolts (6) and the washers. Lower the engine with tooling (A) and (B) and tighten bolts (6).

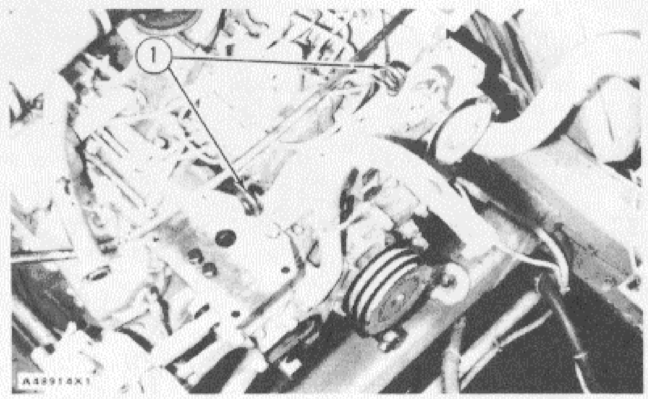
9. Remove tooling (A) and (B).

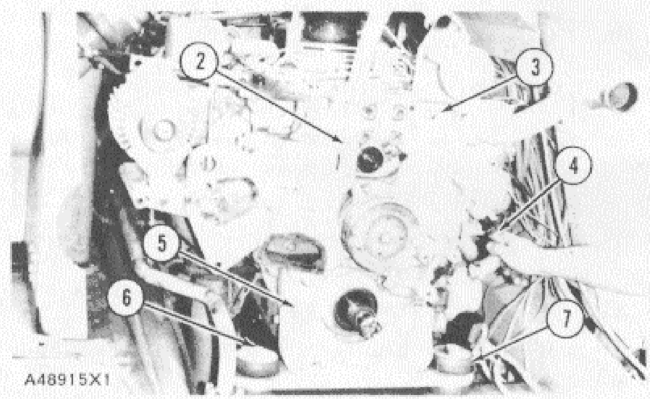
10. Install the gasket and connector (2).

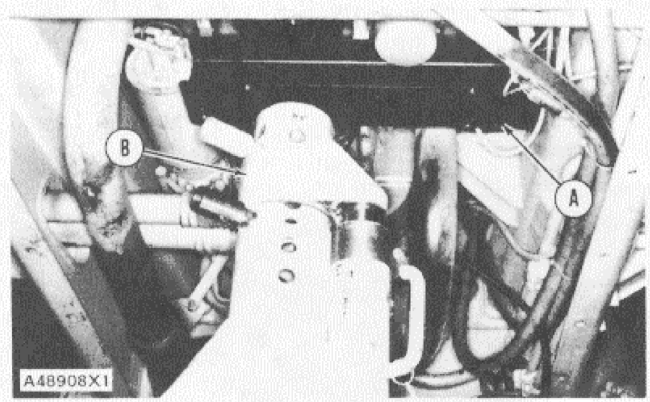
11. Install water temperature sending unit (3).

12. Connect hose (4) to the timing gear cover.





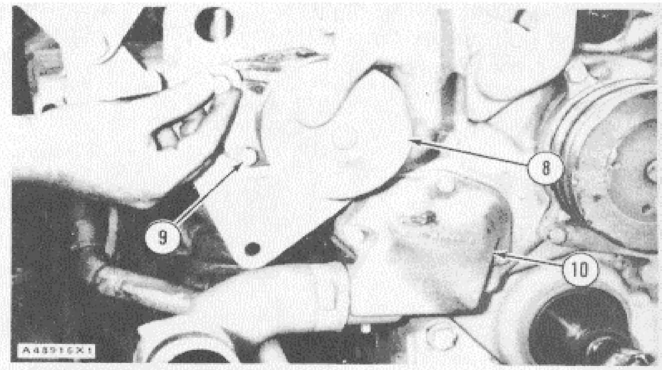




TIMING GEAR COVER AND OIL PUMP, GOVERNOR AND FUEL INJECTION PUMP DRIVE

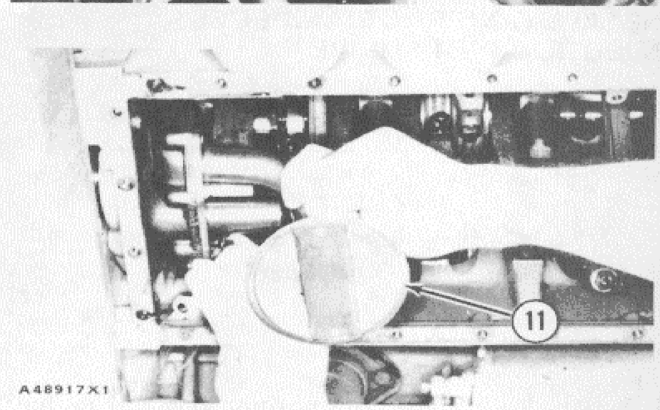
13. Install the gasket and elbow (10).

14. Install idler pulley (8), the washers and bolts (9) to hold the pulley in position.



15. Install the rear oil filter on the oil cooler.

16. Put suction bell assembly (11) in position and install the bolts and locks that hold it to the oil pump.



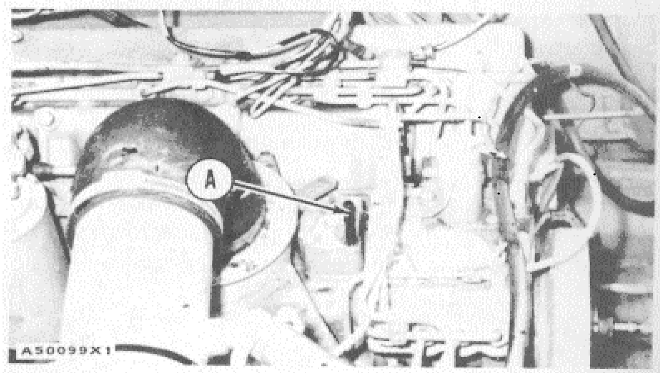
17. Remove the crankshaft pulley bolt from the crankshaft.
    end by:
    a) install oil pan
    b) install crankshaft pulley
    c) install tachometer drive
    d) install air compressor

REMOVE GOVERNOR AND FUEL INJECTION PUMP DRIVE

	Tools Needed	A	B
3P1544	Timing Pin	1	
5P2371	Plate		1
S1616	Bolt (1/4"-20 NC x 1 in. long)		2

start by:
    a) remove timing gear cover and oil pump

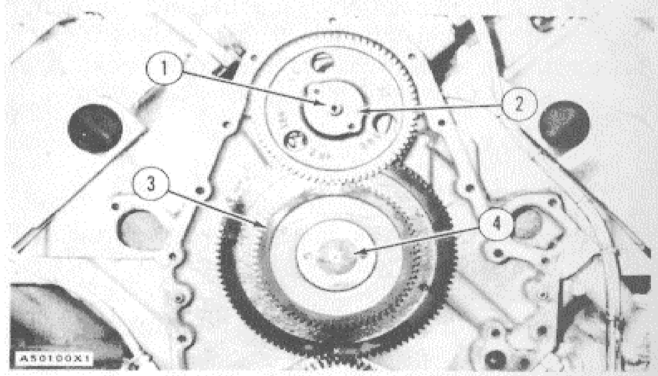
1. Remove the bolt and seal from the governor housing and install tool (A).



2. Turn the crankshaft clockwise, as seen from the front of the engine, until tool (A) can be installed in the groove (slot) in the fuel injection pump camshaft.

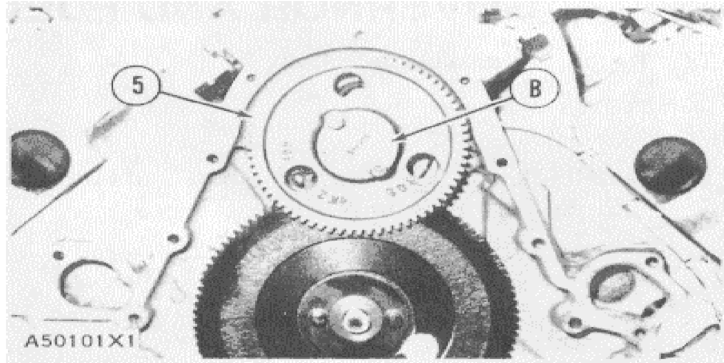
3. Remove sleeve (I) and washer (2) from the fuel injection pump camshaft.

4. Remove the screw and washer (4) to remove drive gear (3) from the camshaft.



GOVERNOR AND FUEL INJECTION PUMP DRIVE

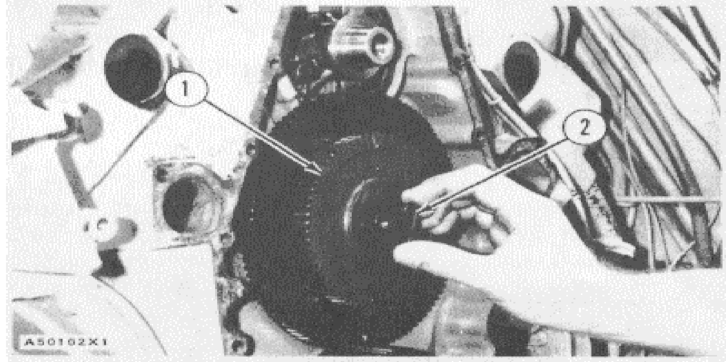
5. Install tooling (B) into driven gear (5). Turn the bolts evenly until gear (5) is free of the fuel injection pump camshaft. Remove gear (5). Remove tooling (B) from gear (5).



INSTALL GOVERNOR AND FUEL INJECTION PUMP DRIVE

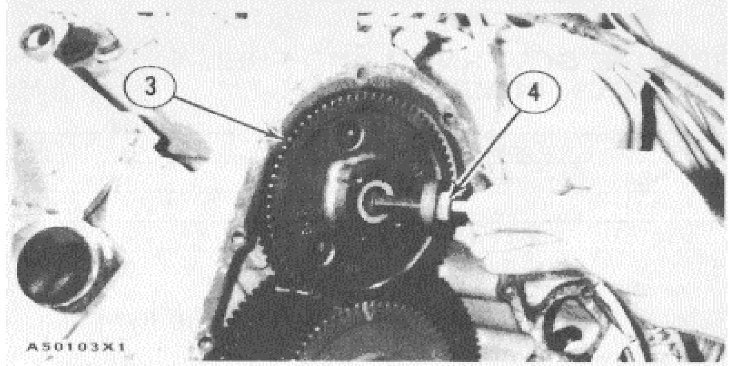
	Tools Needed	A
3P1544	Timing Pin	1

1. Put 5P960 Multipurpose Type Grease on the dowels of the camshaft gear.

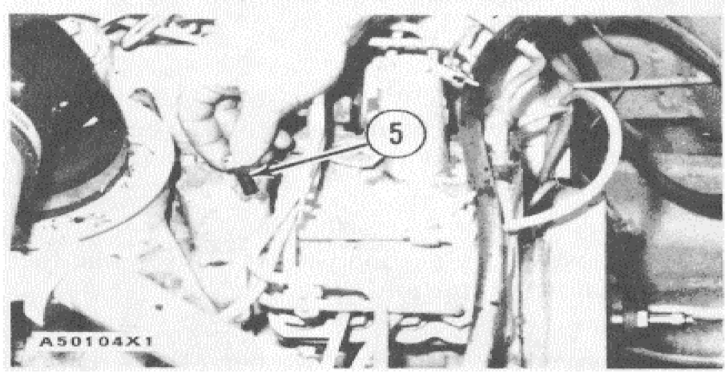


2. Put drive gear (1) in position on the camshaft gear.

3. Install washer (2), the pin and the screw to hold gear (1). Tighten the screw to 70 ± 5 lb. in. (8.0 ± 0.6 N•m). Move the metal (stake) on the outside face of gear (1) in two places around the screw to hold it in position.



4. Put gear (3) in position on the fuel injection pump camshaft and install the washer and sleeve (4) for the tachometer drive. Tighten the sleeve to a torque of 110 ± 10 lb. ft. (149 ± 14 N•m).



5. Remove tool (A) and install bolt (5) and the seal in the governor housing.
   end by:
   a) install timing gear cover and oil pump

CAMSHAFT

REMOVE CAMSHAFT

start by:
a) remove valve lifters
b) remove governor and fuel injection pump drive*

*NOTE: The small gear (2) on the front of the camshaft does not have to be removed to remove the camshaft.

1. Remove thrust pin (1) that holds the camshaft in place from the rear of the cylinder block.

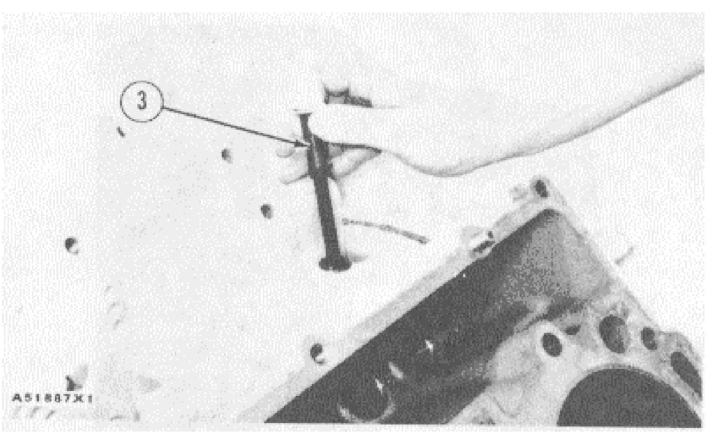
2. Remove the camshaft from the cylinder block. Be careful not to cause damage to the camshaft bearings or journals.

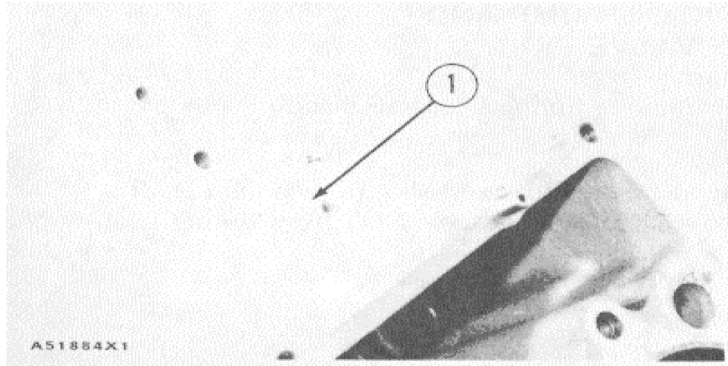
3. If it is necessary to remove gear (2) and gear assemble) (3) from the camshaft see REMOVE GOVERNOR AND FUEL INJECTION PUMP DRIVE to remove gear (2). Use a press to remove gear assembly (3) from the camshaft.

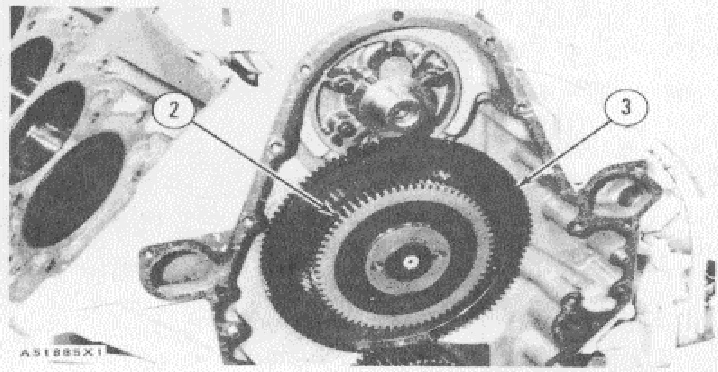
INSTALL CAMSHAFT

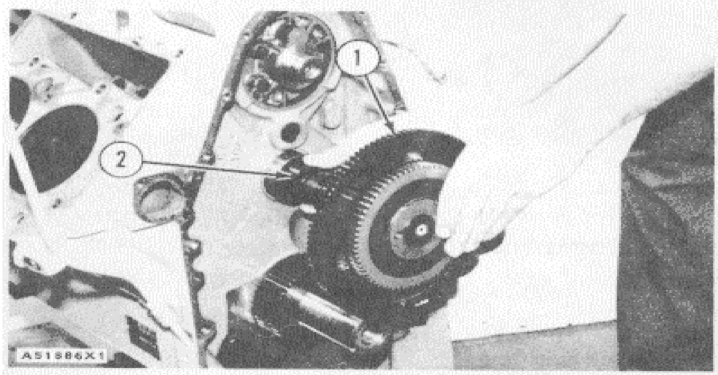
1. Install camshaft gear (1) on the camshaft if it was removed. Heat the gear to a maximum temperature of 600°F (315°C). Put the gear in position on the camshaft. Put clean engine oil on the camshaft lobes and journals. Install camshaft (2) and the gears as a unit. Make sure the timing marks on the crankshaft gear and camshaft gear are in alignment.
2. Install thrust pin (3). Tighten the pin to a torque of 35 ± 5 lb. ft. (45 ± 7 N•m).

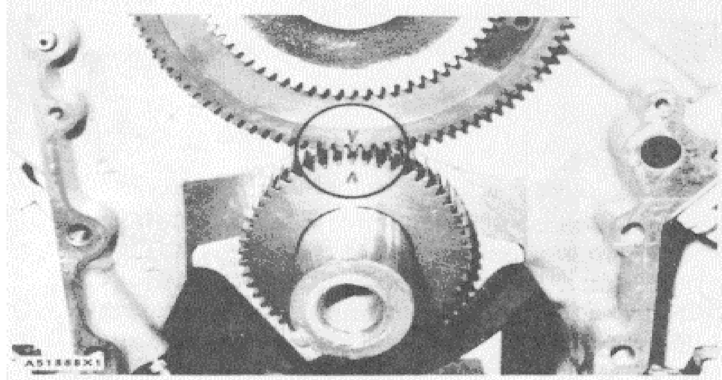
end by:
a) install valve lifters
b) install governor and fuel injection pump drive









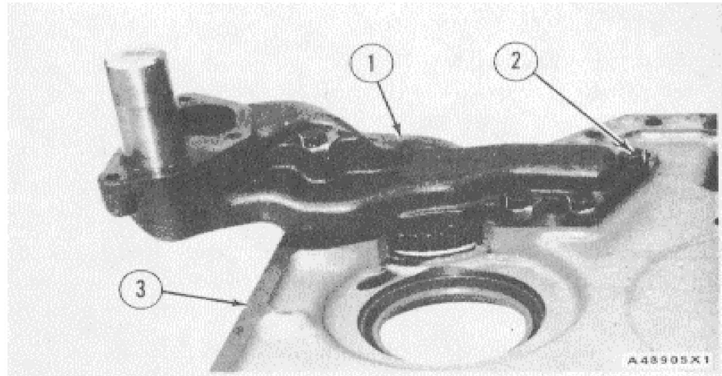


OIL PUMP AND RELIEF VALVE

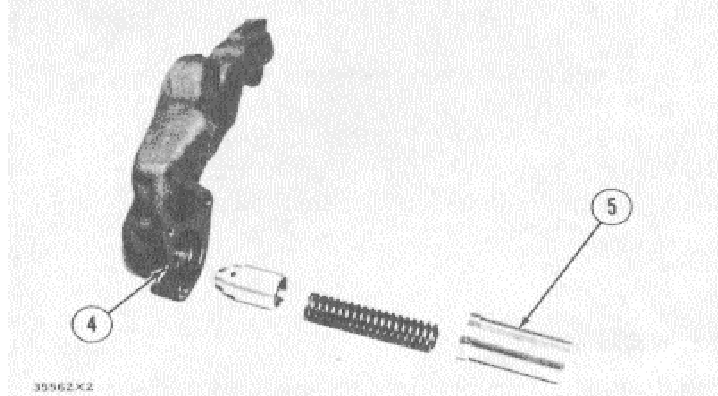
REMOVE OIL PUMP AND RELIEF VALVE

start by:
a) remove timing gear cover and oil pump

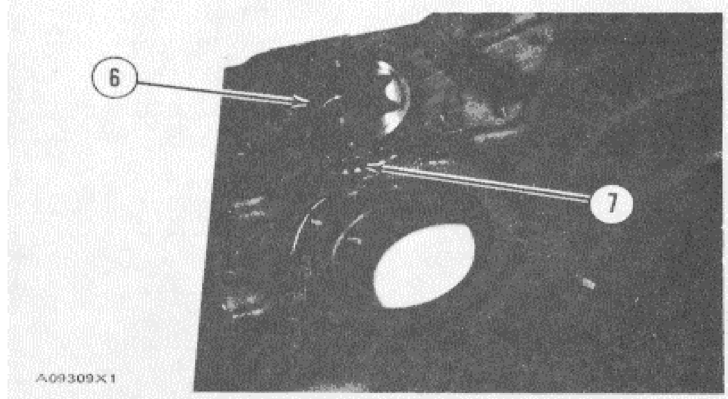
1. Bend the tabs of the locks from bolts (2). Remove the bolts and cover (I) from timing gear cover (3).



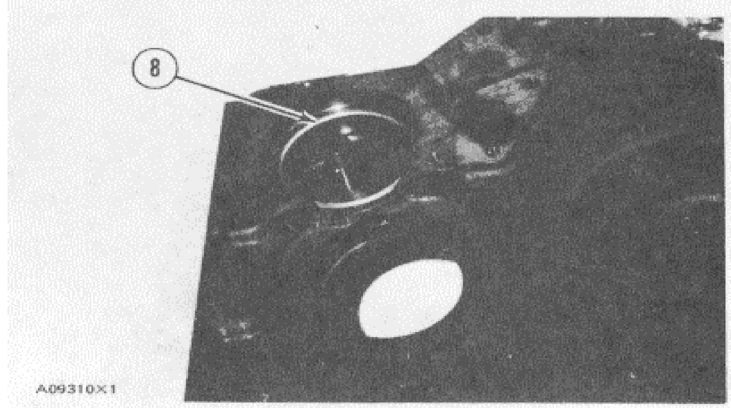
2. Loosen setscrew (4) and remove guide (5), relief valve spring and plunger.



3. Remove inner rotor (6) and outer rotor (7) from the timing gear cover.



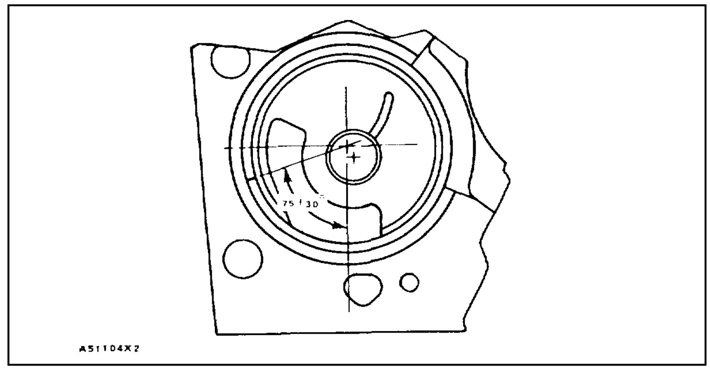
4. Measure the inside diameter of bearing (8). The inside diameter must be 2.804 ± .002 in. (71.22 ± 0.05 mm). If a replacement of the bearing is needed, put a mark on the timing gear cover as to the location of the joint in the bearing and remove the bearing.



OIL PUMP AND RELIEF VALVE

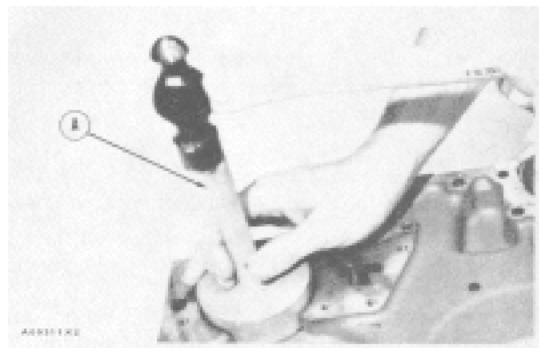
INSTALL OIL PUMP AND RELIEF VALVE

	Tools Needed	A
8S2285	Drive Assembly	1



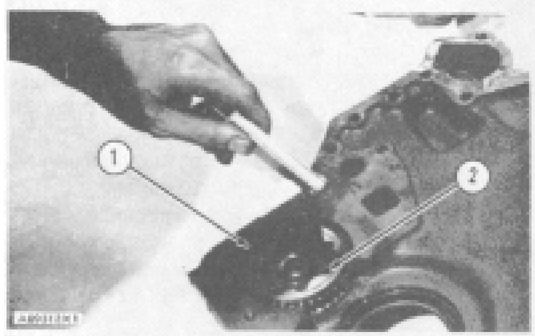
1. Thoroughly clean all of the parts. Put oil on all of the parts.

2. If the bearing was removed from the timing gear cover, install a nest bearing with tool (A). Make sure the joint in the bearing is installed in the position as shown in illustration.



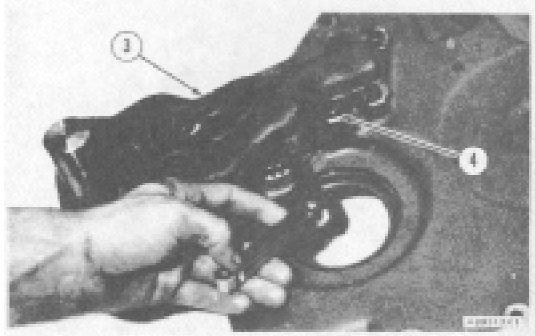
3. Install inner rotor (2) and outer rotor (I) in the timing gear cover.

4. Measure the clearance between the rotors with a feeler gauge. The clearance must be .002 to .006 in. (0.05 to 0. 15 mm). The maximum permissible clearance is .009 in. (0.23 mm).
   NOTE: Make a replacement of BOTH rotors if the clearance is not correct. The rotors can not be ordered separately.



5. Put the plunger and spring in position and push the guide into the cover with a press until the lip on the guide is even with the finished surface on the cover. Make sure the flat surface on the guide is in alignment with the setscrew. Tighten the setscrew.

6. Put cover (3) in position on the timing gear cover. Install the locks and bolts (4).



7. Check the oil pump end clearance with a feeler gauge. The end clearance must be .004 + .002 in. (0.10 $\pm$ 0.05 mm).

NOTE: If the clearance is not correct, make a replacement of BOTH rotors or cover (3). The rotors can not be ordered seperately.

end by:

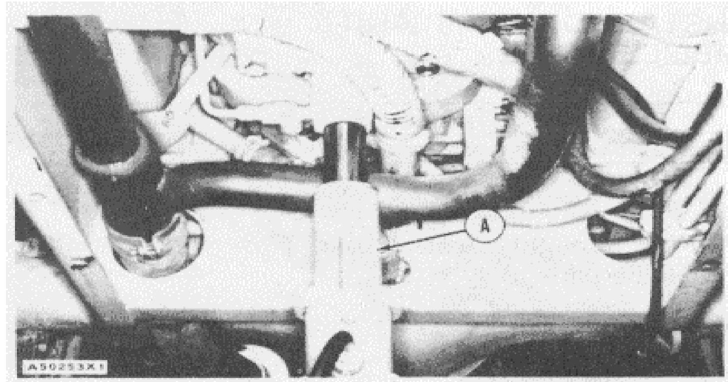
a) install timing gear cover and oil pump

ENGINE REAR SUPPORTS
SUPPORTS

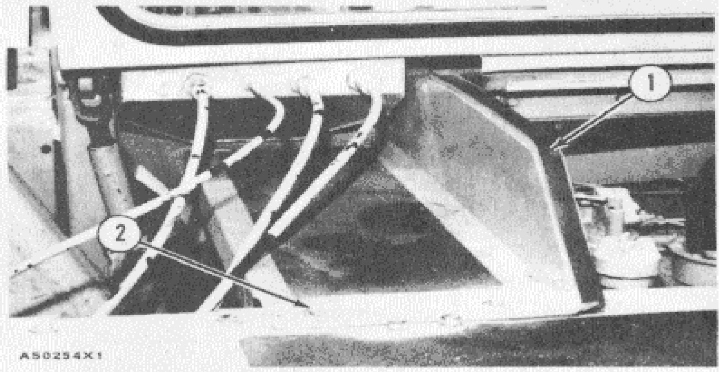
	Tools Needed	A
8S7630	Stand	1
8S7611	Tube	1
8S7615	Pin	2
8S7625	Collar	1
8S7650	Cylinder	1
5P3100	Pump Group	1

start by:
a) remove crankcase guard

WARNING: Remove and install only one support at a time so the engine will not move off of tooling (A).

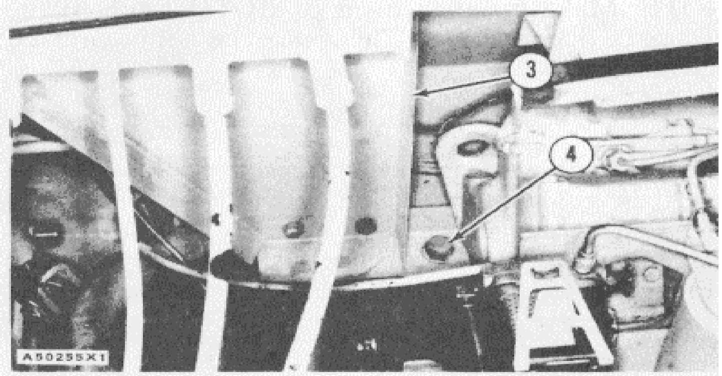


1. Put tooling (A) in position under the torque converter.

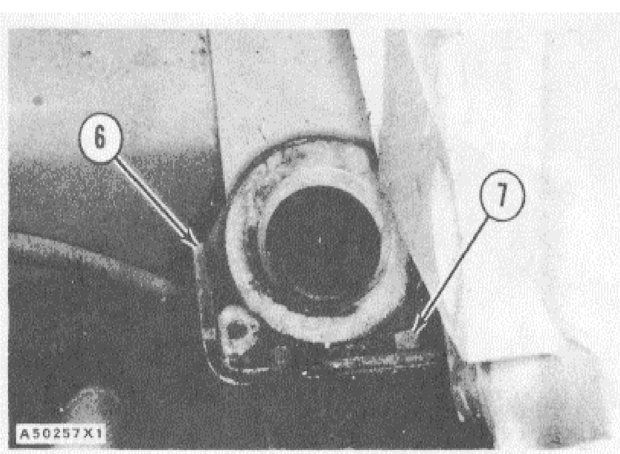


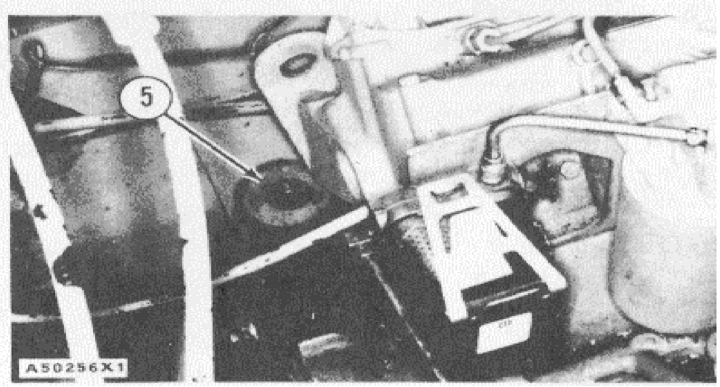
2. Remove the four bolts (2) and the washer to remove panel assembly (1) from the machine.

3. Remove the left rear engine support as follows:



a) Remove bolt (4) and the nut from the left rear support. Remote bracket (3) from the machine.
b) Remove the upper half of the mount assembly (5) from the support assembly.
c) Use tooling (A) to lift the engine enough to take the weight off of support assembly (6). Remove bolts (7), the washers, support assembly (6) and the lower half of the mount assembly.

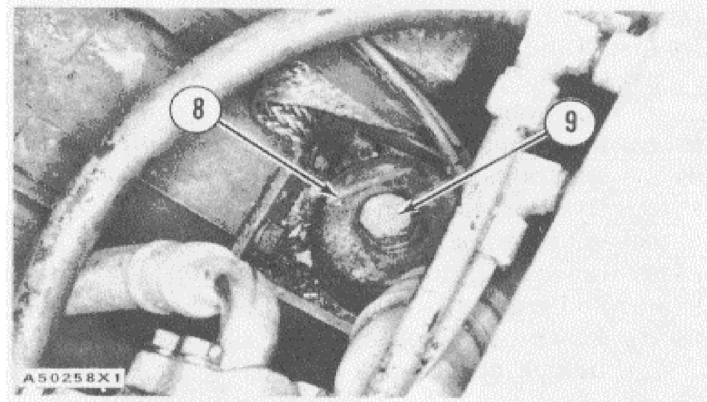


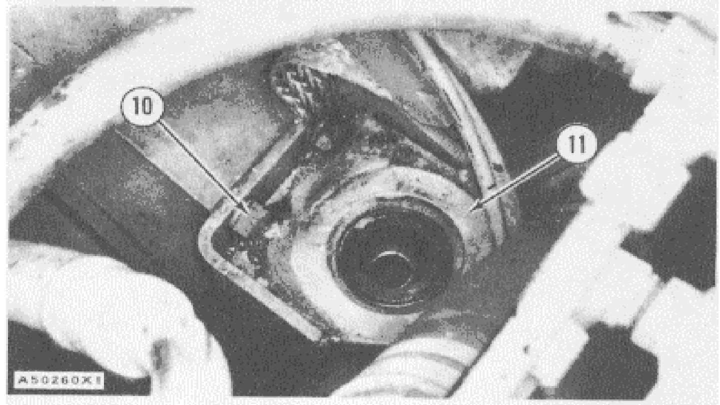


ENGINE REAR SUPPORTS

4. Remove the engine support for the right rear as follows:
   a) Remove bolt (9) and the nut from the support
   b) Remove the upper half of mount assembly

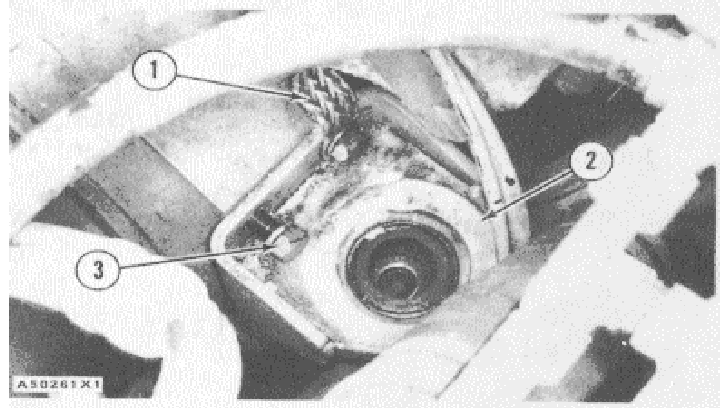
   c) Use tooling (A) to lift the engine enough to take the weight off of support assembly (11). Remove bolts (10), the washers, support assembly (11) and the lower half of the mount assembly.



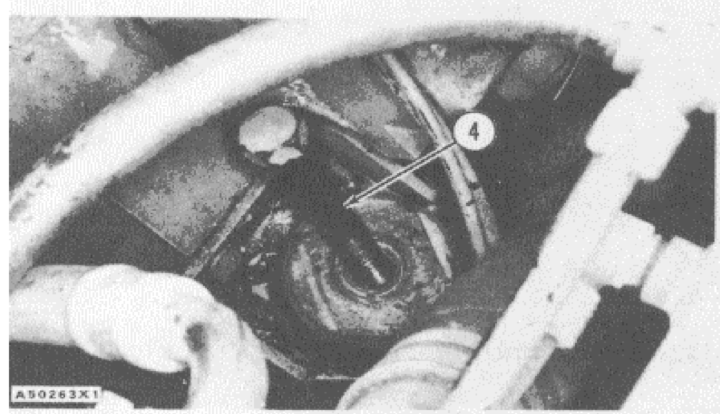


INSTALL ENGINE REAR SUPPORTS

	Tools Needed	A
~~8S7630~~	~~Stand~~	~~1~~
8S7611	Tube	1
8S7615	Pin	2
~~8S7625~~	~~Collar~~	~~1~~
8S7650	Cylinder	1
5P3100	Pump Group	1

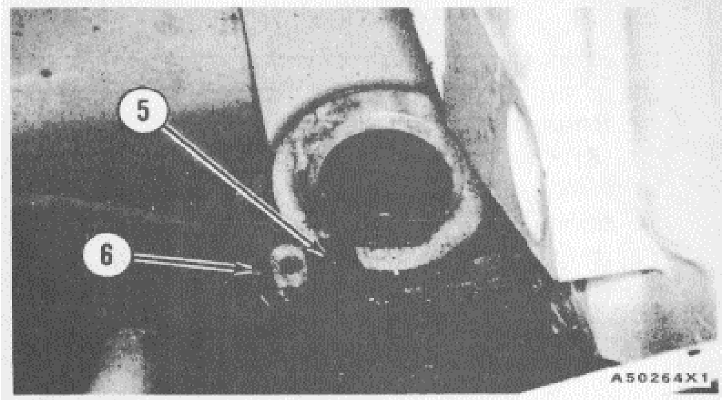


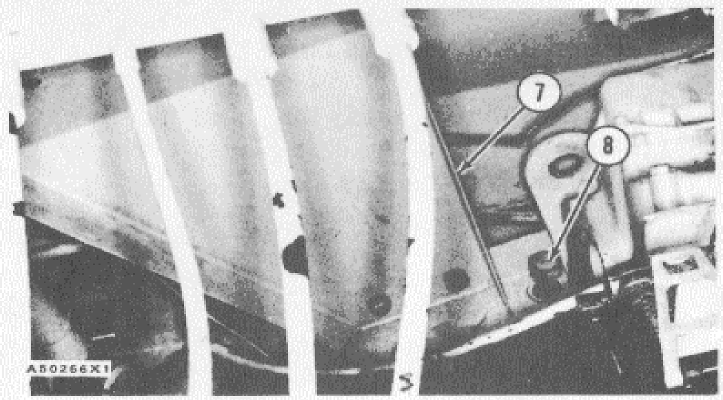
1. Install the right rear engine support as follows:
   a) Put the lower half of the mount assembly in position on the tractor frame.
   b) Put support assembly (2) in position and install bolts (3) and the washers to hold it to the flywheel housing. Make sure ground cable (1) is in position before the bolts are tight-end
   c) Put the upper half of the mount assembly in position and install bolt (4) and the nut.
   d) Lower the engine with tooling (A) and tighten bolt (4).



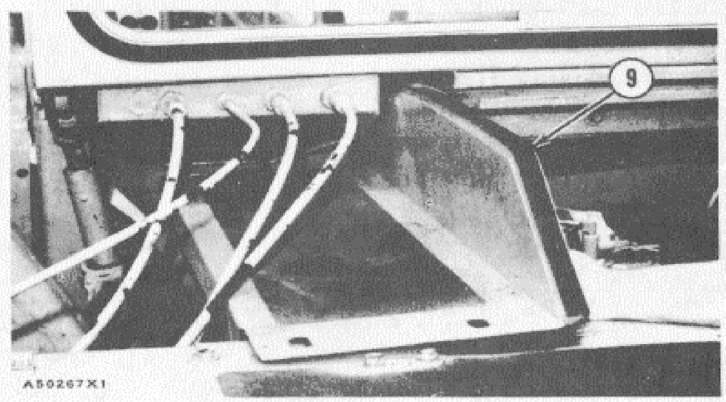
ENGINE REAR SUPPORTS

2. Install the left rear engine support as follows:
   a) Put the lower half of the mount assembly in position on the tractor frame.
   b) Put support assembly (6) in position and install bolts (5) and the washers to hold it to the flywheel housing.
   c) Put the upper half of the mount assembly and brace assembly (7) in position. Install bolt (8) and the nut.
   d) Lower the engine with tooling (A) and tighten bolt (8).

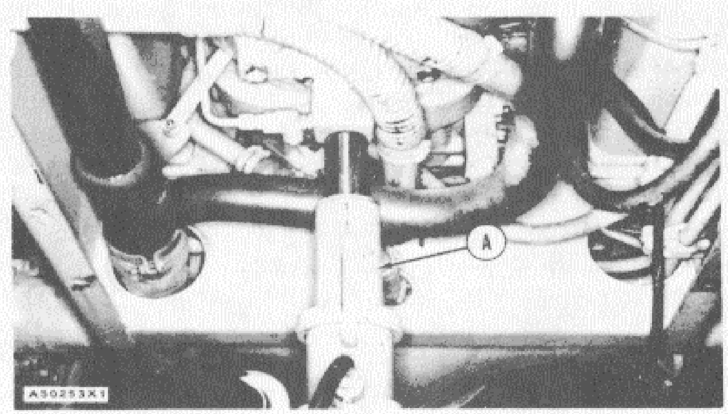




3. Put panel assembly (9) in position and install the four bolts, washers and two nuts to hold it.



4. Remove tooling (A) from under the machine.
   end by:
   a) install crankcase guard



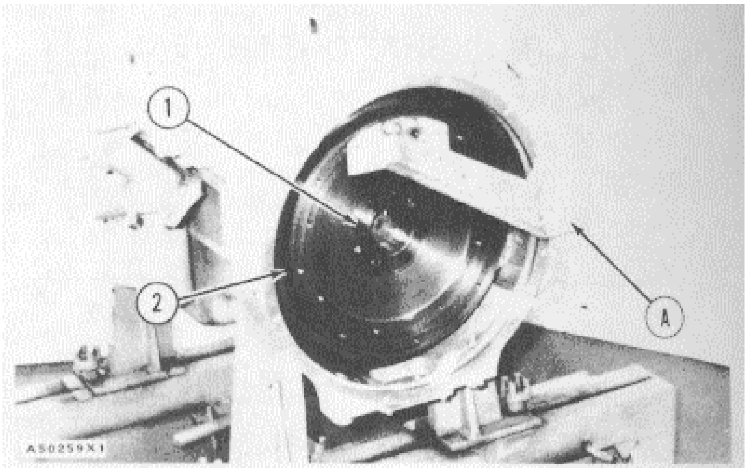
FLYWHEEL

REMOVE FLYWHEEL

	Tools Needed	A
FT121	Lifting Bracket	1
S509	Bolt (3/8"-16 NC x 1 in long)	1

start by:
a) remove torque converter*

*This operation is in the POWER TRAIN DISASSEMBLY AND ASSEMBLY section.
NOTE: The engine is removed for better photo illustration of the removal and installation of the flywheel.



1. Fasten tool (A) and a hoist to flywheel (2).

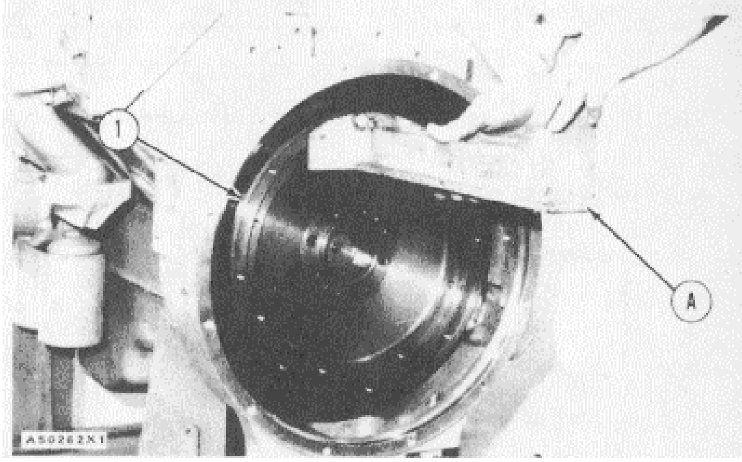
2. Remove the bolts (1) that hold the flywheel. Remove the flywheel. The weight of the flywheel is 65 lb. (29 kg).

INSTALL FLYWHEEL

	Tools Needed	A
FT121	Lifting Bracket	1
S509	Bolt (3/8"-16 NC x 1 in long)	1

1. Install tooling (A) on the flywheel. Fasten a hoist and put flywheel (1) in position on the crankshaft. Make sure the marks on the flywheel and crankshaft are in alignment.
2. Put 8H5 137 Gasket Sealer on the bolt threads and install the bolts. Tighten the bolts to a torque of 55 ± 5 lb. ft. (75 ± 7 N•m).

NOTE: Make sure that the correct sealant is put on the bolt threads. The holes for the bolts in the crankshaft flange are drilled through so the holes are open to the oil in the engine. Leakage along the bolt threads can be the result if the correct sealant is not used.
CAUTION: When a new flywheel is installed, check the thickness of the new flywheel at the bolt holes in relation to the thickness of the old flywheel. Install the correct length bolts so they will be full) engaged in the crankshaft flange. Bolts that are too long will make contact with the block on the back side of the crankshaft flange and pull crankshaft back. This will cause the crankshaft thrust bearing to fail.
end by:
a) install torque converter*
*NOTE: This operation is in the POWER TRAIN DISASSEMBLY AND ASSEMBLY.



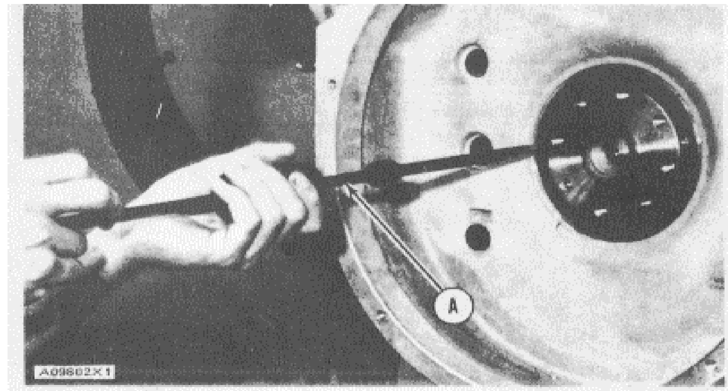
CRANKSHAFT REAR SEAL AND WEAR SLEEVE

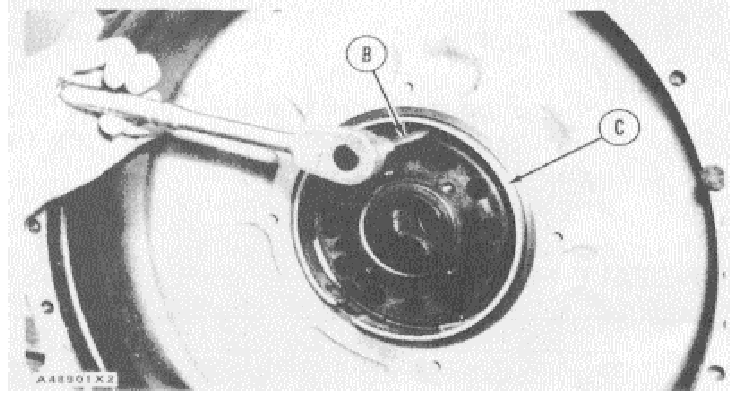
REMOVE CRANKSHAFT REAR SEAL AND WEAR SLEEVE

Tools Needed		A	B	C
1P3075	Puller Assembly	1		
5P7312	Distorter		1	
5P7338	Ring			1

start by:
a) remove flywheel

1. Remove the crankshaft rear seal from the flywheel housing with tooling (A).
2. Install tool (C) in the rear seal bore.
3. Install tool (B) betwveen tool (C) and the wear sleeve. Turn tool (B) until the edge of the tool makes a flat place (crease) in the wear sleeve. Do this in two or more places until the sleeve is loose.
4. Remove tool (C) and the wear sleeve b) hand.





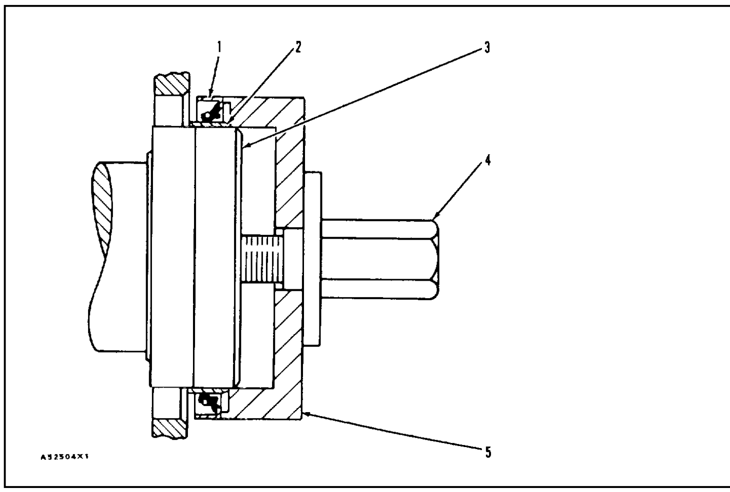
INSTALL CRANKSHAFT REAR SEAL AND WEAR SLEEVE

	Tools Needed	A
5P7293	Installer	1
5P290	Locator	1
1P5515	Bolt	2
9S8858	Nut	1

1. Install the crankshaft rear seal and wear sleeve with tooling (A) as follows:
   a) Clean and make a preparation of the wear sleeve inside diameter and crankshaft outside diameter with 8M8060 Quick Cure Primer. Make an application of 9S3265 Retaining Compound to crankshaft outside diameter and wear sleeve inside diameter before the wear sleeve is installed on the crankshaft.
   b) Install locator (3) and the bolts on the rear of the crankshaft.
   c) Put clean engine oil on the lip of seal (I) and install the seal on wear sleeve (2).
   d) Put 7F2770 Cement on the outer metal surface of the seal.
   e) Put the wear sleeve (2) and seal (1) in position on locator (3) with the outside diameter bevel of the wear sleeve toward the outside.

NOTE: Make sure the lip of the seal is toward the front of the engine before the seal is pushed in position as shown.

   f) Put installer (5) in position on the locator.
   g) Put clean engine oil on the face of nut (4) and install it on the locator. Tighten the nut until installer (5) is at bottom.



   h) Remove tooling (A) and check the wear sleeve and seal for the correct position after installation.

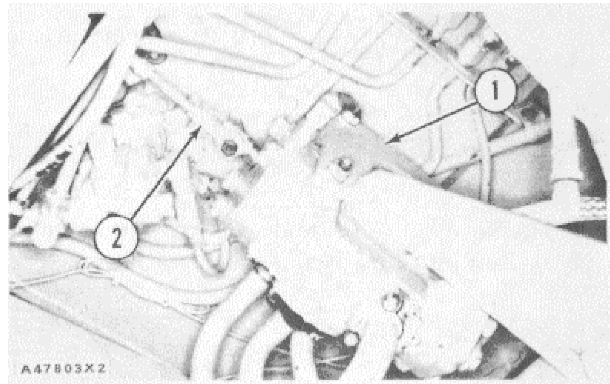
end by:
a) install flywheel

ENGINE

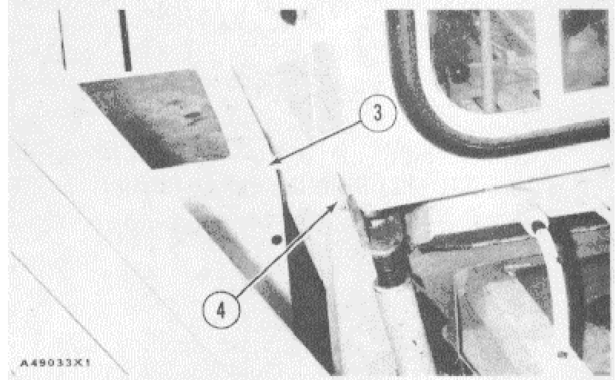
REMOVE ENGINE

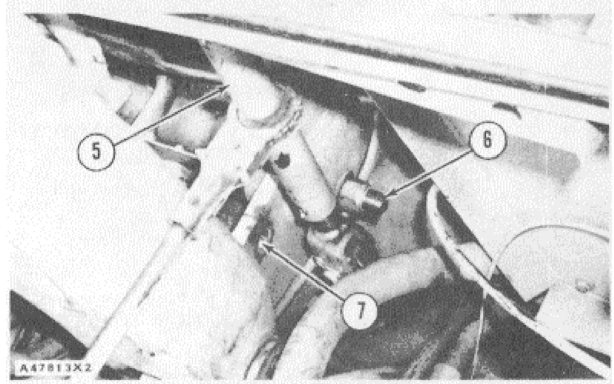
	Tools Needed	A
8S7620	Base Assembly	1
BS7650	Cylinder	1
8S7615	Pin	1
5P3100	Pump Group	1

start by:
a) remove radiator
b) remove oil pan

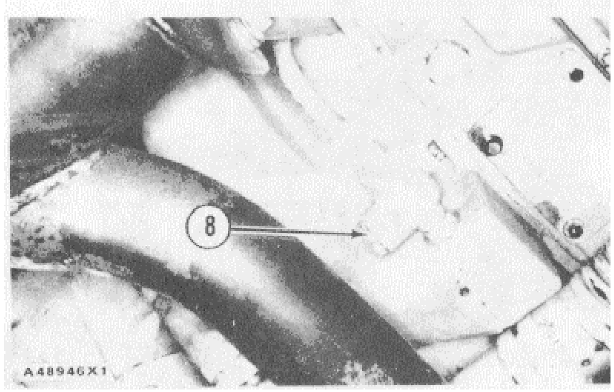


1. Tilt the cab as follows:
   a) Disconnect steering linkage (2) from steering control valve (1).
   b) Remove the four bolts and nuts that hold left rear fender (3) to the cab.
   c) Remove the panel assembly that is the support for the rear of the hood.
   d) Remove pin (4) that holds the jack assembly to the cab.
   e) Remove the pin that holds jack assembly (5) to the storage bracket and put the jack assembly in position on the tractor frame. Install the storage pin through the jack assembly and hole (7) in the frame.
   f) Put the top portion of the jack assembly in position on the cab and install the pin to hold it.
   g) Remove bolt (6), the nut and the storage bracket.
   h) Remove the bolt and nut that holds the right front corner of the cab to the frame.
   j) Tilt the cab with jack assembly (5).





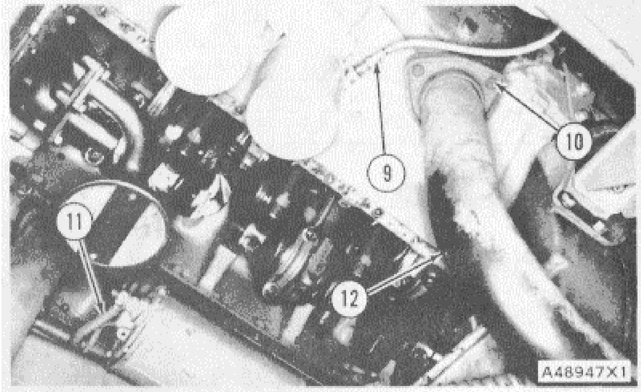
2. Remove the oil level gauge from the engine.



3. Remove plug (8) and drain the oil from the torque converter. The torque converter capacity is 6.5 U.S. gal. (24.6 litre).

ENGINE

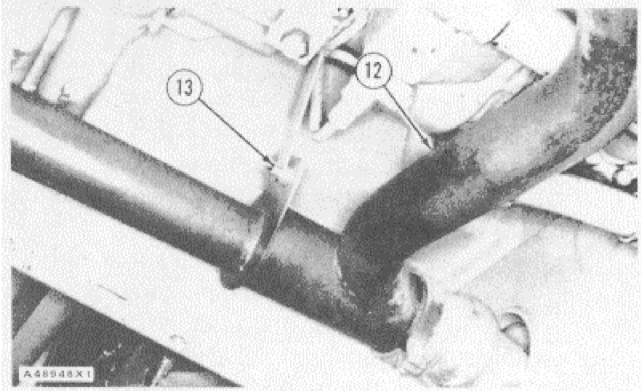
4. Disconnect oil pressure line (9) from the oil filter base.



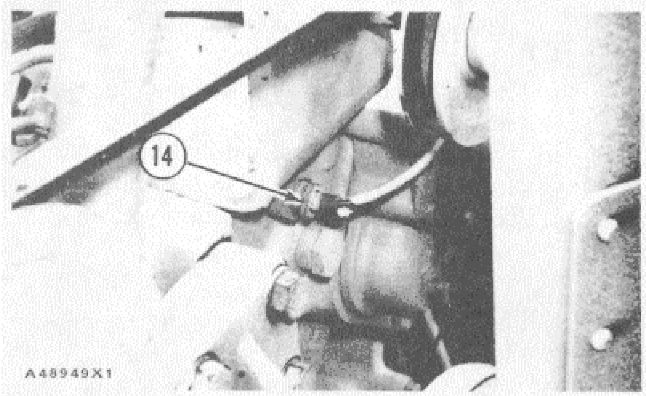
5. Remove bolts (10) to disconnect pipe assembly (12) from both sides of the engine.

6. Disconnect batter) cable (11) from the starter.

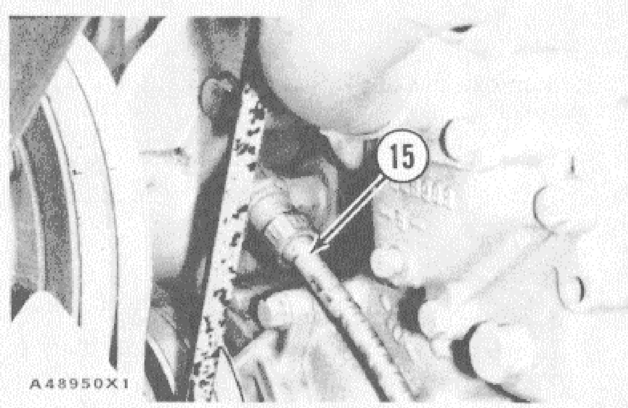
7. Remove bolt (13) and the nut and lower pipe assembl3 (12) from tile exhaust manifolds,.



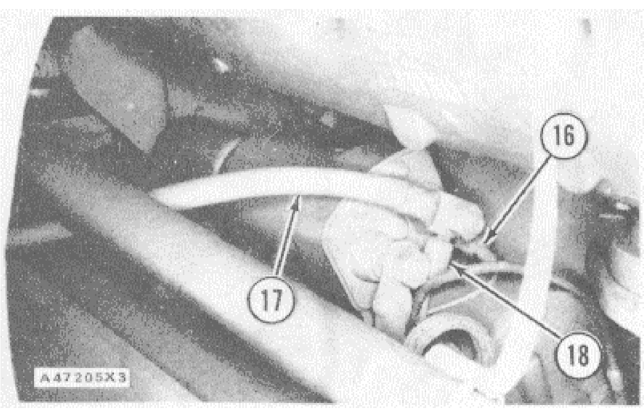
8. Remove water temperature sending unit (14) from the timing gear cover.



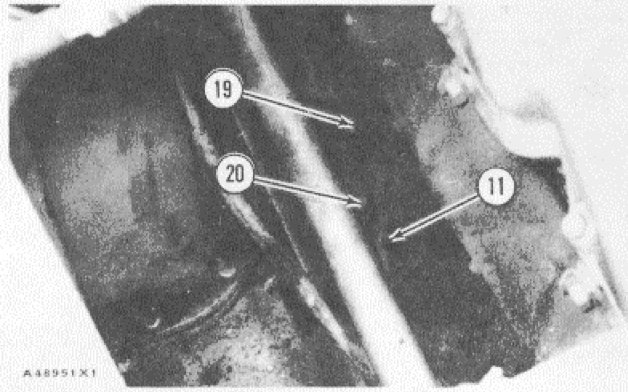
9. Disconnect tachometer drive cable (15) from the tachometer drive.



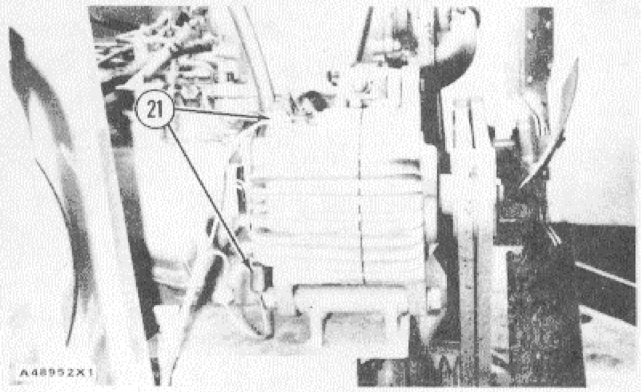
10. Put identification on the electric wires as to their location on the starting motor. Disconnect wires (16), (17) and (18) from the starting motor.



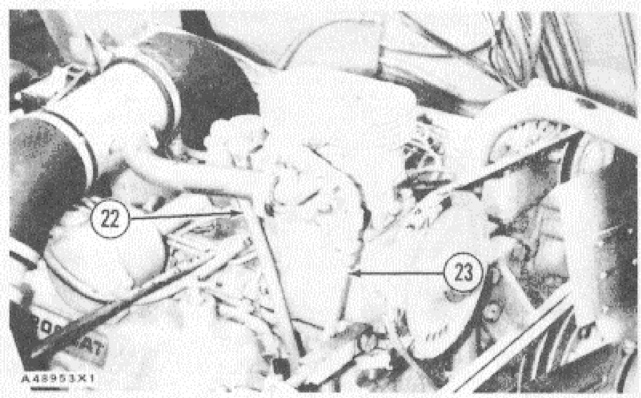
11. Remove the bolt from the frame at the base of the hydraulic tank to disconnect ground cable (19), alternator wire (20) and starting motor w ire (1).



12. Put identification on electric wires as to their location on the alternator and disconnect wires (21).

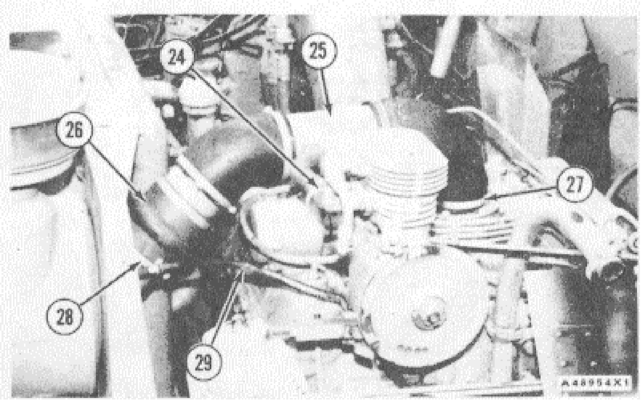


13. Disconnect hose (22) from the air compressor governor. Disconnect hose assembly (23) from the air compressor.



14. Loosen the clamp and disconnect hose (29) from the air cleaner housing.

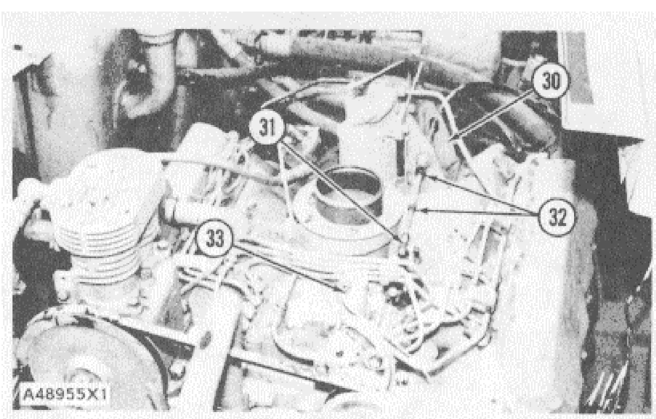
15. Loosen clamps (24), (27) and (28) and remove hose (26), tube assembly (25) and the hoses from the machine.



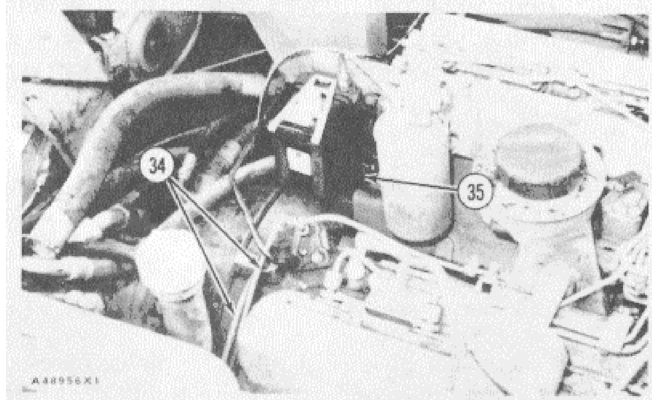
16. Disconnect *,,ire (33) from the fuel shut-off solenoid.

17. Disconnect rod end (3 1) from the governor control lever.

18. Remove rod end (31), the locknut, two grommets (32), the two locknuts and one lockwasher to remove the governor control cable from the back of bracket (30).

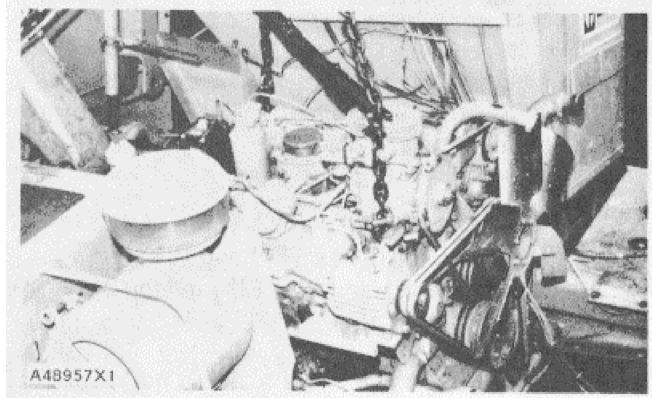


19. Disconnect fuel lines (34) from the junction block.

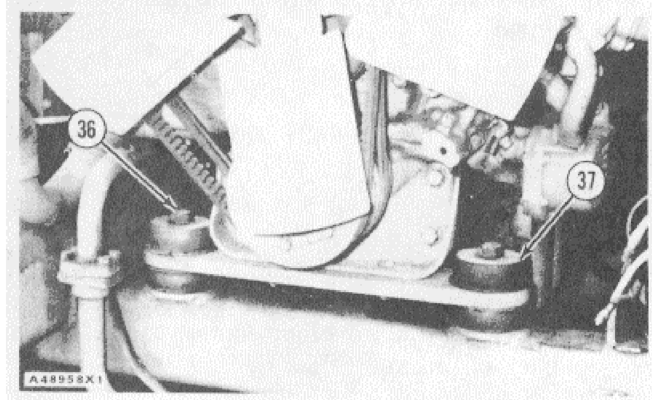


20. Disconnect drain hose (35) from the water separator.

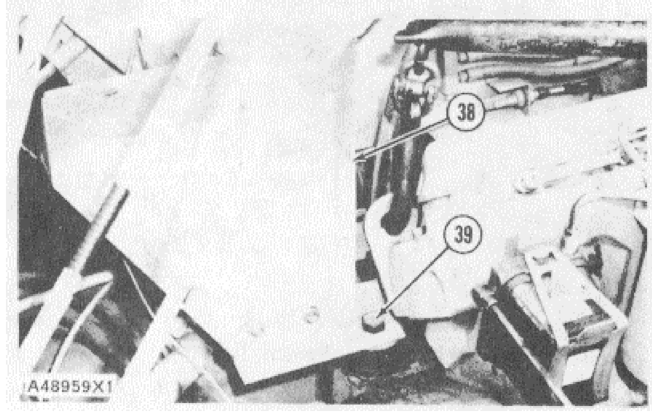
21. Fasten a hoist to the engine.



22. Remove bolts (36) and the upper half of mount assemblies (37) from the engine front support.



23. Remove bolts (39) from the two engine rear support brackets, brace assembly (38) and the upper halves of the mount assemblies.

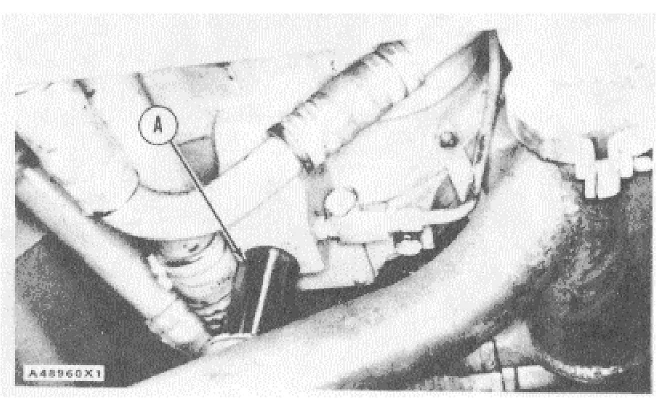


24. Put tooling (A) in position under the torque converter for support.

25. Remove the bolts, washers, two clips and strap that hold the torque converter housing to the flywheel housing.

26. Move the engine forward enough to remove the flywheel ring gear from the torque converter. Remove the engine. The weight of the engine is 1540 lb. (693 kg).

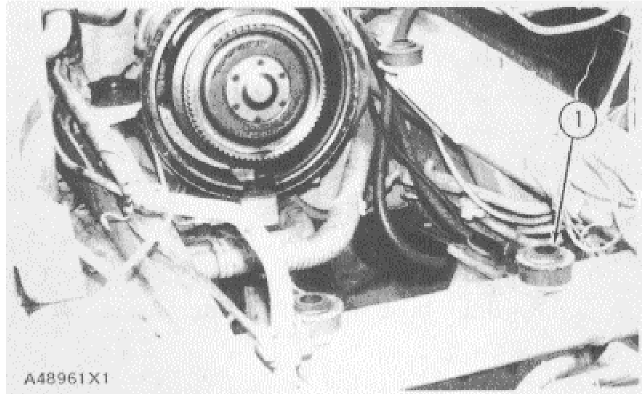
CAUTION: Do not cause damage to the oil pump suction bell assembly when the engine is removed.



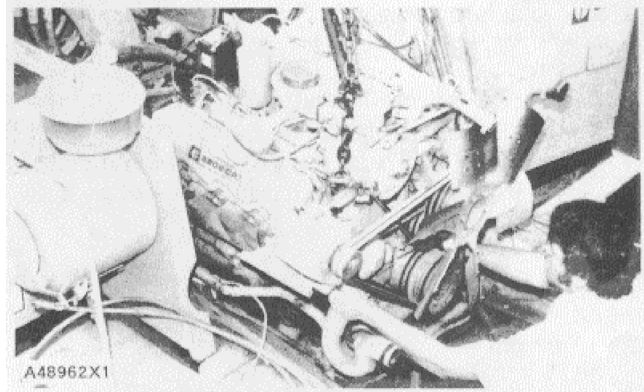
ENGINE

INSTALL ENGINE

	Tools Needed	A
8S7620	Base Assembly	1
8S7650	Cylinder	1
8S7615	Pin	1
5P3100	Pump Group	1



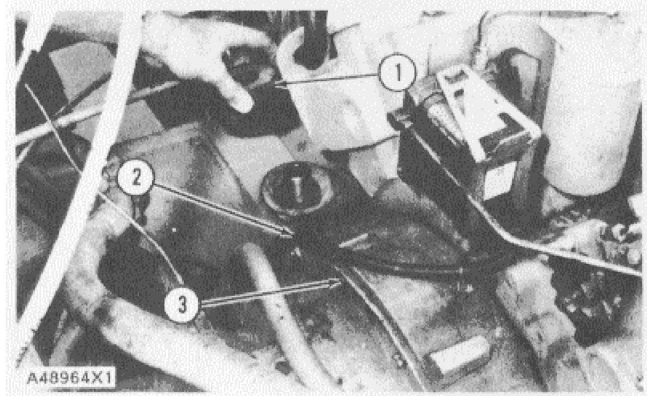
1. Put the lower halves of mount assemblies (1) in position on the tractor frame.



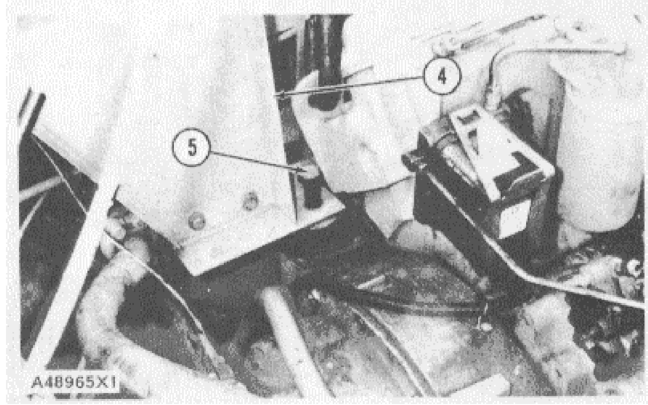
2. Put the gasket in position on the torque converter.

3. Fasten a hoist to the engine and put it in position on the tractor frame. Make sure the gear teeth of the rotating housing in the torque converter and the ring gear on the flywheel are correctly engaged before the weight of' the engine is lowered on the frame.

CAUTION: Do not cause damage to the oil suction bell assembly on the oil pump when the engine is installed.



4. Install the two drain hose clips (2), bolts (3) and the washers that hold the torque converter to the flywheel housing.



5. Install the sleeves and upper halves of mount assemblies (1) in the engine rear supports.

6. Put brace assembly (4) in position on the left rear engine mount and install bolts (5) and the nuts in both engine rear mounts.

ENGINE

7. Install the sleeve,,, upper halves of' the mount assemblies and tighten bolts (6).

8. Remove the hoist from the engine.

9. Connect fuel Iines (8) to the junction block. Connect drain 11)se (7) to the water separator.

10. Connect w ire (12) to the fuel shut-off solenoid.

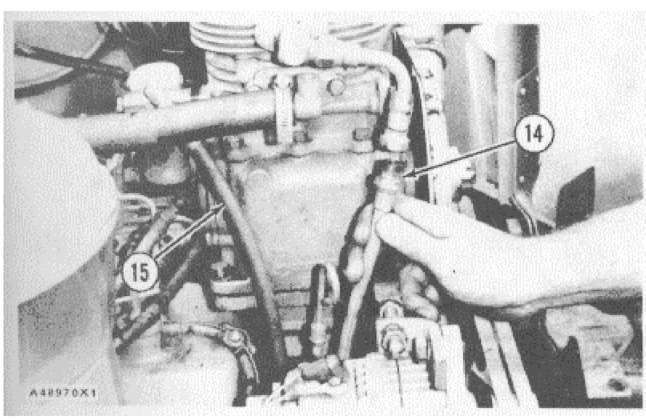
11. Pull the governor control cable through bracket (10) and install the lockwasher, two locknuts (9), the two grommets, the locknut and rod end (11) on the cable.

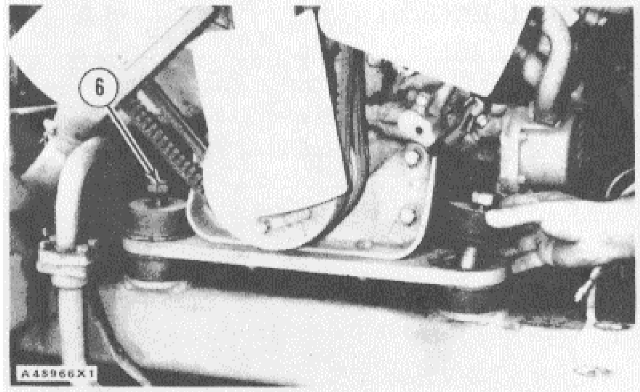
12. Connect rod end (11) to the governor control Iever.

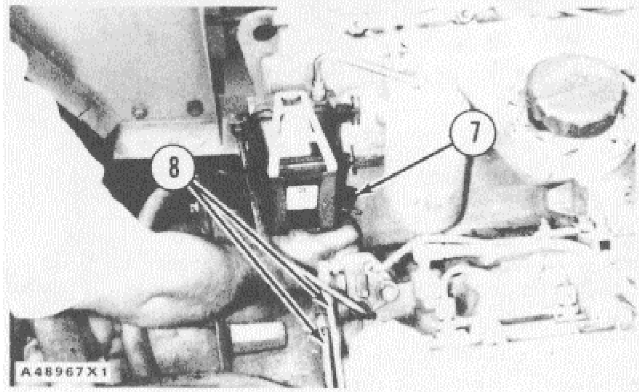
13. Connect the air indicator hose (13) to the air cleaner housing.

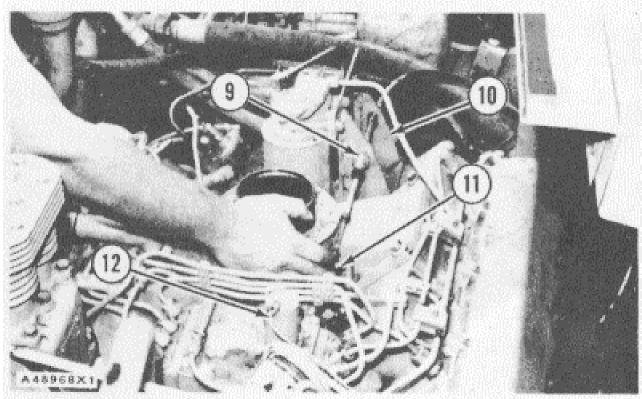
14. Put the air inlet tube assembly in position and tighten the clamps for the hoses.

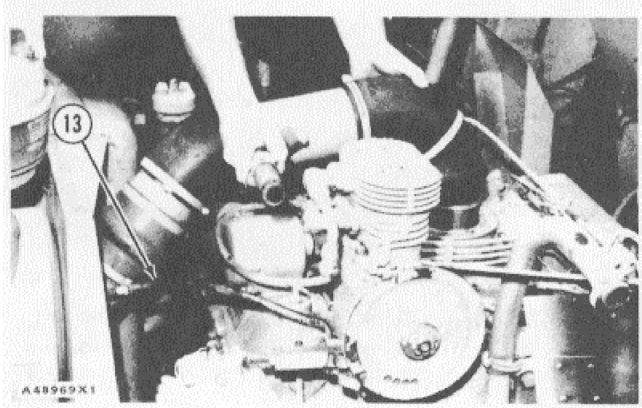
15. Connect hose assembly (15) to the air compressor governor and hose assembly (14) to the air compressor.



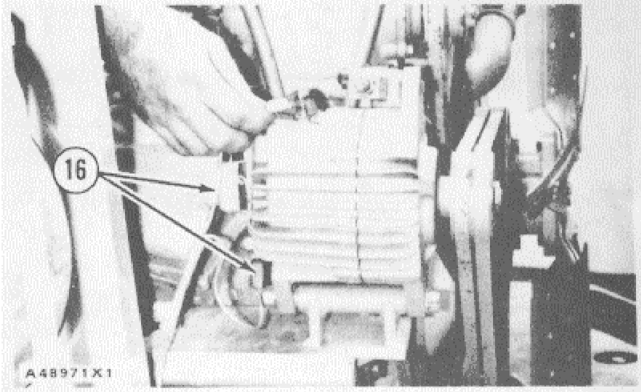




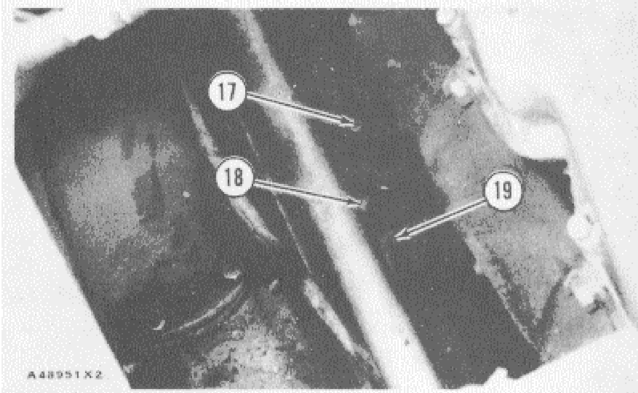




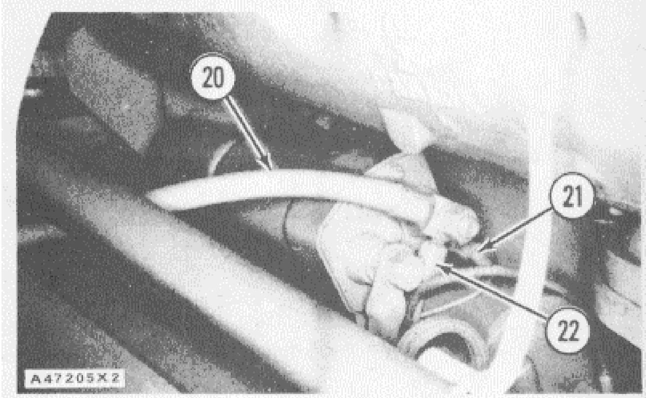
16. Connect wires (16) to their correct locations on the alternator.



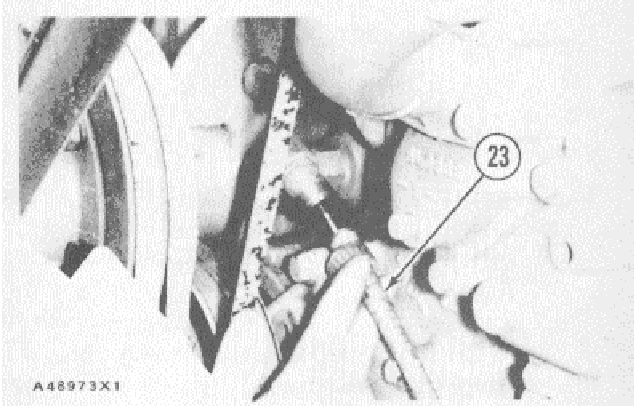
17. Connect the ground cable (17), alternator wire (1) and starting motor wire (19) to the tractor frame at the base of the hydraulic tank.



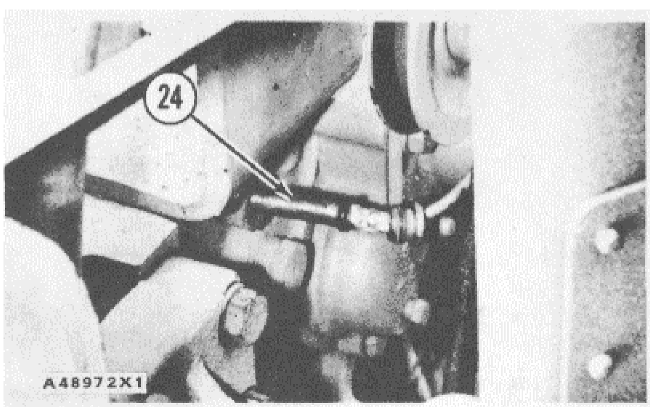
18. Connect wires (20), (21) and (22) to the starting motor.



19. Connect tachometer drive cable (23) to the tachometer drive.

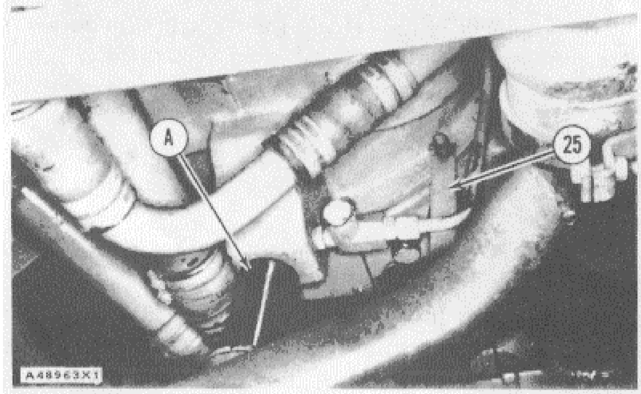


20. Install water temperature sending unit (24) in the timing gear cover.



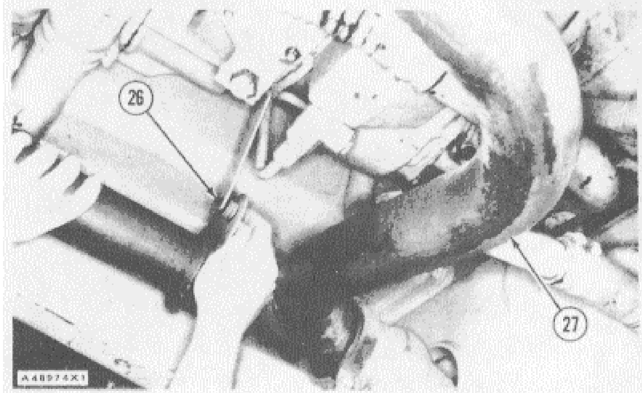
ENGINE

21. Install strap (25) on the torque converter housing.



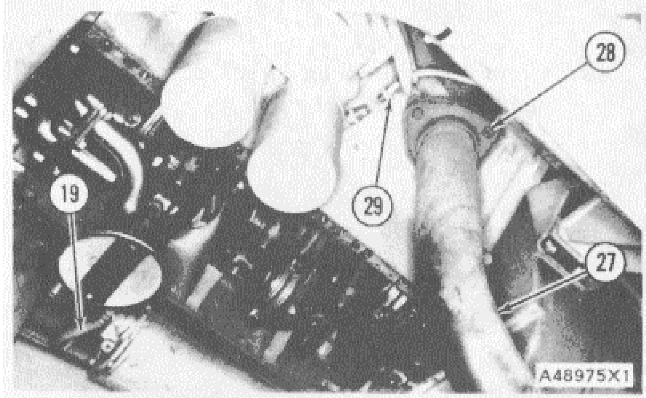
22. Remove tooling (A) from under- the torque converter.

23. Install bolt (26), the washers and nut to hold exhaust pipe assembly (27).



24. Connect wire (19) to the starting motor.

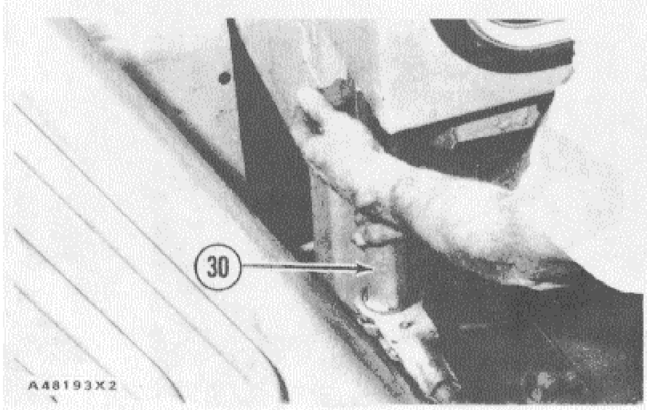
25. Put exhaust pipe assembly (27) in position and install the bolts and nuts. (28) to h0old it to the exhaust manifolds



26. Connect oil pressure line (29) to the oil filter base.

27. Install the oil level gauge in the engine.

28. Fill the torque converter with clean hydraulic oil.

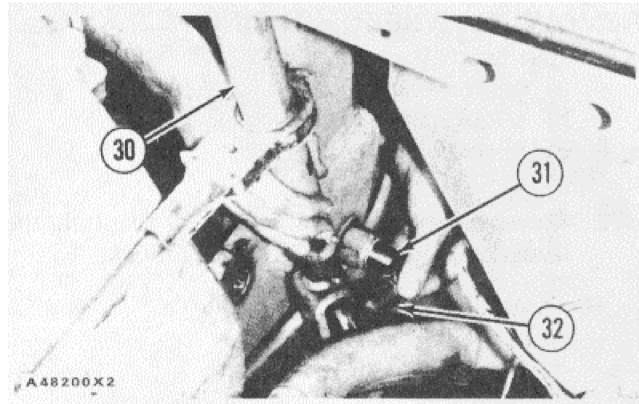


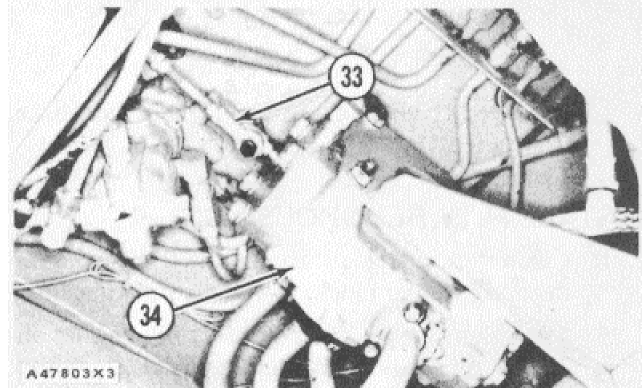
29. Lower the cab to its original position as follows:
    a) Lower the cab with jack assembly (30).
    b) Install the bolts an(d nuts that hold the left rear fender to the cab.
    c) Remove the pins that hold jack assembly (30) in position and remove the jack assembly from the tractor frame.

d) Install bolt (3 I1), the storage bracket and nut to hold the right rear corner of the cab.
e) Put jack assembly (30) in position and install pins (32) to hold it to the cab and storage bracket.
f) Connect rod end (33) for the steering linkage to steering control valve (34).

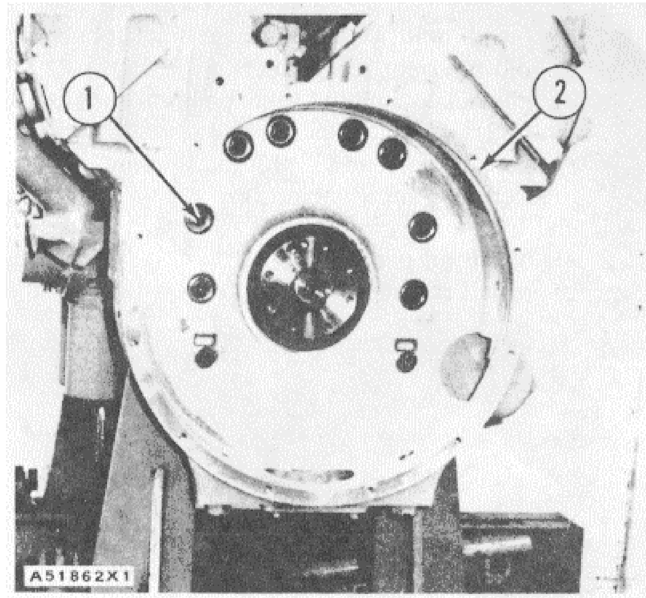
end by:

a) install oil pan
b) install radiator





FLYWHEEL HOUSING

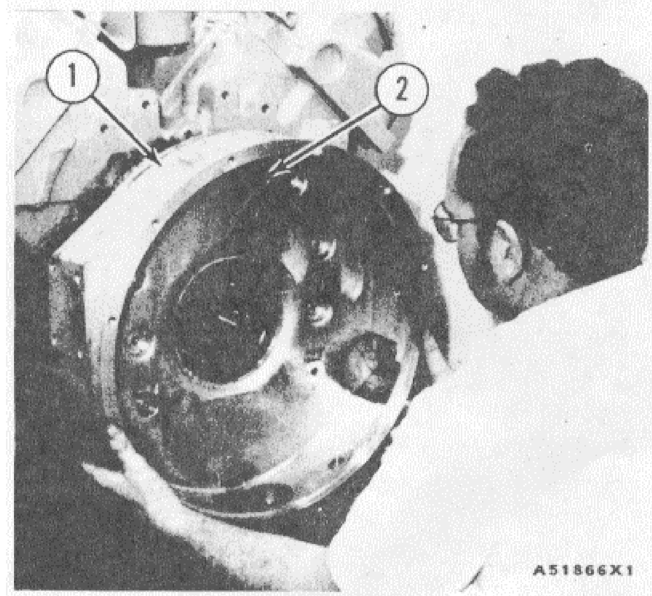


REMOVE FLYWHEEL HOUSING

start by:
a) remove starter
b) remove flywheel
c) remove oil pan

1. Remove bolts (1) and the washers that hold the flywheel housing to the cylinder block.

2. Remove flywheel housing (2) and the gasket from the cylinder block.



INSTALL FLYWHEEL HOUSING

1. Clean the contact surfaces of the flywheel housing and cylinder block. Install the flywheel housing gasket on the cylinder block.

2. Install a 3/8"-16 NC guide bolt (2) with a minimum length of 4 in. in the cylinder block.

3. Put clean engine oil on the lip of the crankshaft rear seal. Put flywheel housing (1) in position on the cylinder block and install the bolts and washers to hold it.

4. Cut the gasket so it is even with the bottom of the cylinder block and flywheel housing.

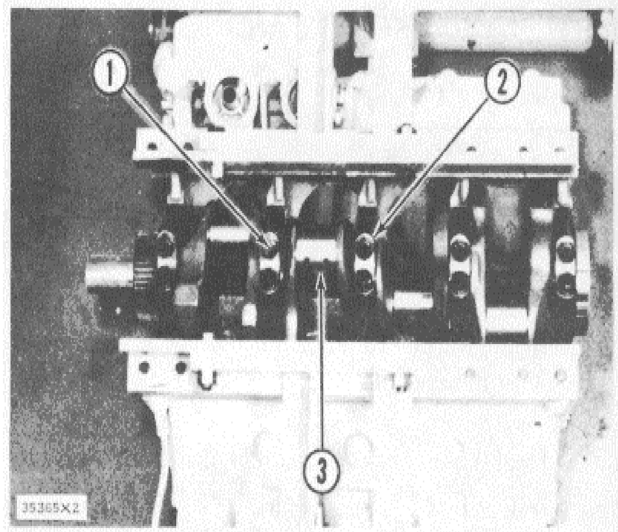
end by:
a) install starter
b) install flywheel
c) install oil pan

CRANKSHAFT AND GEAR

REMOVE CRANKSHAFT AND GEAR

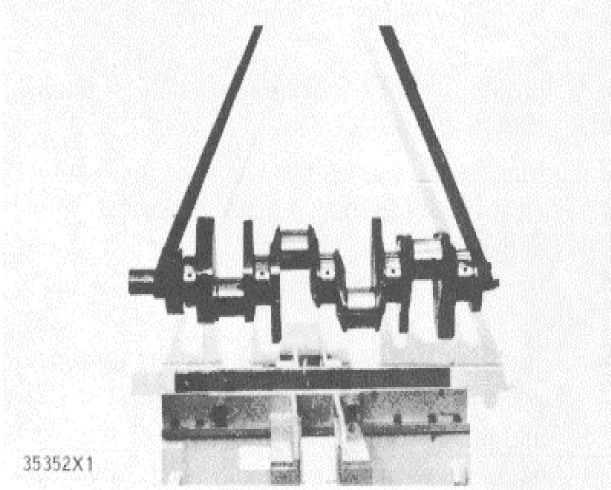
	Tools Needed	A	B
	OTC Model 1730-A Engine		
	Stand	1	
8B7551	Bearing Puller Attachment	1	
1 P820	Puller Group		1
8B7549	Leg 2		
8B7561	Step Plate		1
3H465	Plate		4
1 B4207	Nut		2
5P3100	Pump Group		1

start by:
a) remove flywheel housing
b) remove valve lifters
c) remove pistons
d) remove timing gear cover and oil pump



1. Fasten a hoist and put the engine in position on tool (A).

2. Turn the crankshaft until the timing mark on the crankshaft gear is in alignment with the timing mark on the camshaft gear.



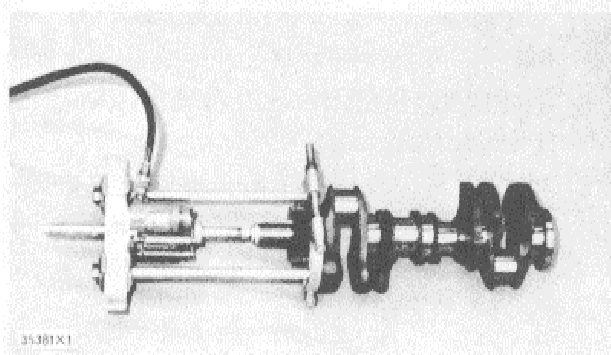
NOTE: For more detail about removal of main bearings see **REMOVE AND INSTALL CRANKSHAFT MAIN BEARINGS.**

3. Remove bolts (1) and main bearing caps (2). Remove the lower halves of the main bearings from the caps.

4. Install two of the bolts that hold the flywheel in place in the end of crankshaft.

5. Fasten a hoist and remove crankshaft (3) from the engine. The weight of the crankshaft is 120 lb.(54 kg).

CAUTION: Be careful not to cause damage to the crankshaft journals when the crankshaft is removed.



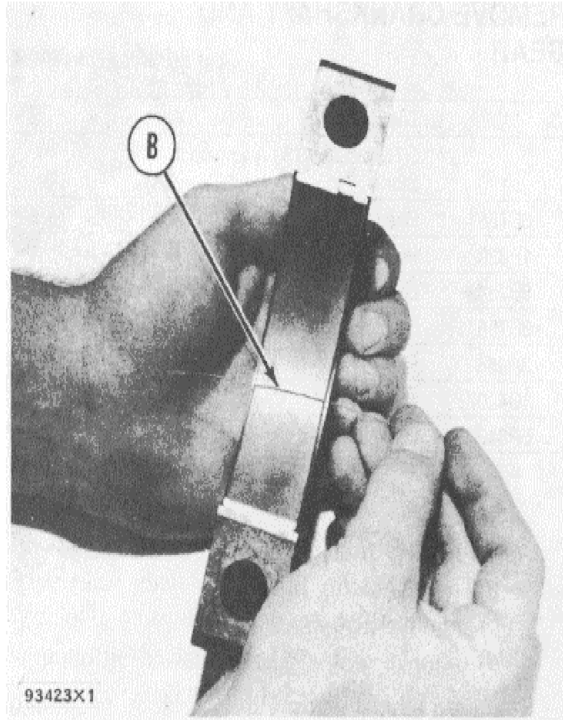
6. Remove the upper halves of the main bearings from the cylinder block.

7. Install tooling (B) and remove the gear from the crankshaft.

CRANKSHAFT AND GEAR

INSTALL CRANKSHAFT AND GEAR

	Tools Needed	A	B
8S2328	Dial Test Indicator Group	1	
5B1161	Wire		*



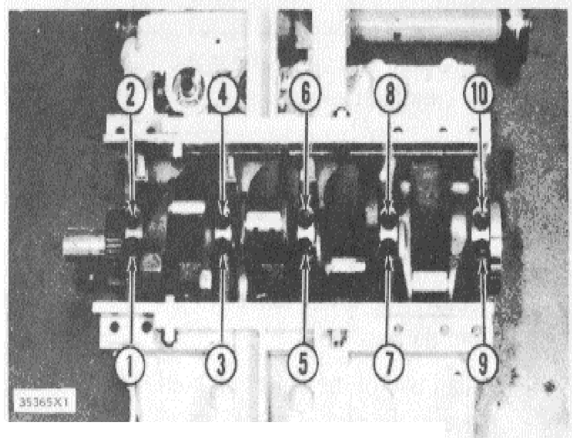
I. Install the key for the crankshaft gear so it is even with the end of the crankshaft.

2. Heat the crankshaft gear to a maximum temperature of 500°F (2600C).Install the gear on the crankshaft with the '"V" mark on the gear toward the pulley end of the crankshaft.

3. Install the thrust bearing for the No.4 main.

4. Make sure the upper main bearings are clean. Put clean oil on the upper main bearings and journals of the crankshaft. Install the upper main bearings (the bearings with oil hole) into the engine block.

5. Install two of the bolts that hold the flywheel in place in the end of the crankshaft. Fasten a hoist and put the crankshaft in position in the block. Make sure the timing mark on the crankshaft gear is in alignment with the timing mark on the cam-haft gear.

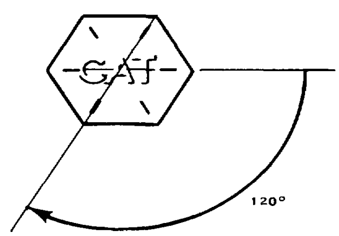


For more detail about installation of main bearings see REMOVE AND INSTALL CRANKSHAFTMAIN BEARINGS.CAUTION: When the bearing caps are installed{3.100} make sure the number on the side of the cap is next to and respective with the number on the engine block.

6. Check the bearing clearance with wire (B).Put the lower main bearings into the caps. Put the caps in position and install the bolts. Tighten the bolts in number sequence as follows:

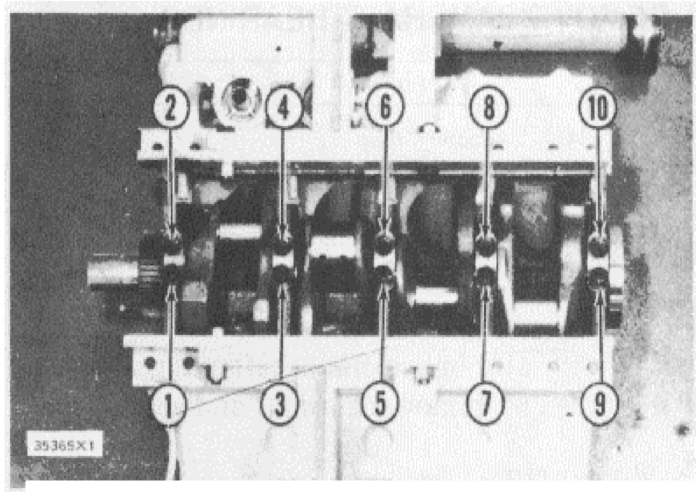
   a) Tighten bolts I through I 0 to a torque of 30 +3 lb. ft.(4 ± 4 N m).

   b) Put a mark on each bolt head and bearing cap. Tighten bolts 1 through 10 120° _± 5° more.

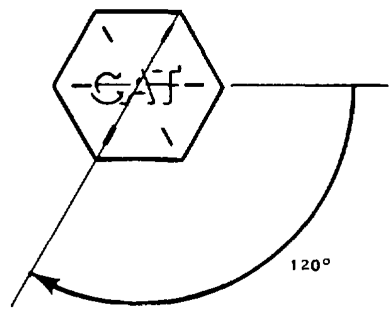


CRANKSHAFT AND GEAR

7. Remove the bearing caps and measure the thickness of the wire. The main bearing clearance must be .002 to .005 in.(0.05 to 0.13 mm).The maximum permissible clearance is .006 in.(0.15mm).



8. Put clean engine oil on the bolt threads{3.100} washer faces and lower halves of the main bearings. Put the bearing caps in position and install the bolts. Tighten the bolts in number sequence as follows:
   a) Tighten bolts 1 through 10 to a torque of 30 + 3 lb. ft.(40 ± N-m).
   b) Put a mark on each bolt head and bearing cap. Tighten bolts 1 through 10 120° ± 5° more.



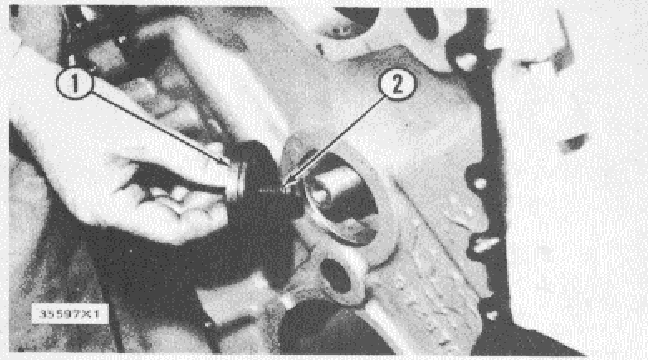
30912X1

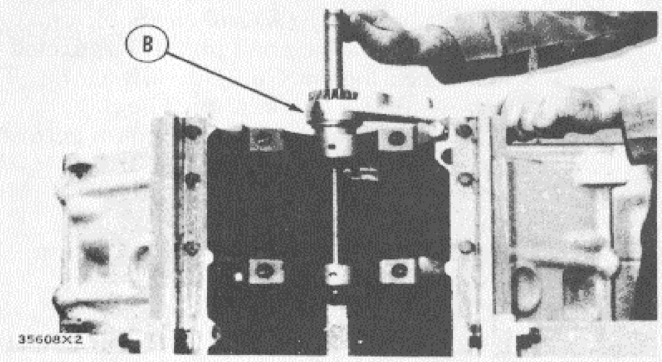
9. Install indicator group (A) and check the end play of the crankshaft. The end play is controlled by the thrust bearing on No.4 main bearing. The end play with new bearings must be .006 ± .003 in.(0.15 ± 0.08 mm).The maximum permissible end play with used bearings is .012 in.(0.30mm). end by:
   a) install timing gear cover and oil pump
   b) install pistons
   c) install valve lifters
   d) install flywheel housing

CAMSHAFT BEARINGS

REMOVE CAMSHAFT BEARINGS

Tools Needed	A	B
1P5545 Adapter Group	1	
BS2241Camshaft Bearing Installation &		
Removal Group		1
8H684Ratchet Box Wrench		1





start by:

a) remove crankshaft and gear
b) remove camshaft and gears

NOTE: The crankshaft does not have to be removed for removal and installation of the camshaft bearings{3.100} but must be removed to correctly clean the oil passages in the cylinder block.

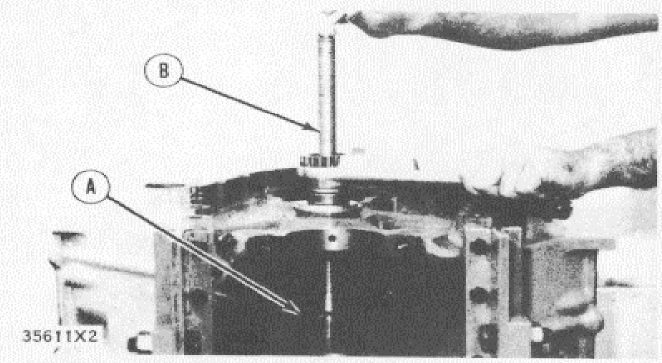
1. Install tooling (B) through the flywheel housing end of the cylinder block.

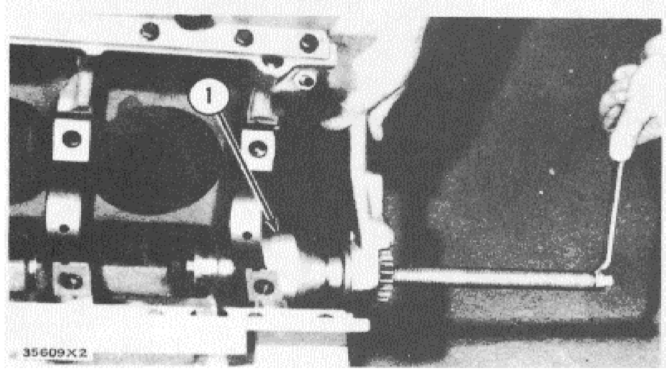
2. Install washer (I) and bolt (2) from tool group (A) in the end of the shaft of tooling (B).Remove the bearings from the cylinder block. Start with the front bearing.

3. Thoroughly clean the oil passages and surfaces where the camshaft and bearings fit.

INSTALL CAMSHAFT BEARINGS

Tools Needed	A	B
1P5545 Adapter Group	1	
BS2241Camshaft Bearing Installation &		
Removal Group		1
8H684Ratchet Box Wrench		1





1. Start with the rear camshaft bearing and install the bearings in the cylinder block with tooling (A) and (B).Make sure the oil holes in the bearing are in alignment with the oil holes in the cylinder block.

2. To install the front camshaft bearing{3.100} put tube (1) from tool group (B) in position shown with the tube over the boss on the front of the cylinder block and pull the bearing into place. Make sure the oil holes in the bearings are in alignment with the oil holes in the cylinder block. end by
   a) install camshaft and gears
   b) install crankshaft and gear

SECTION 2
DISASSEMBLY AND ASSEMBLY
POWER TRAIN

AXLES

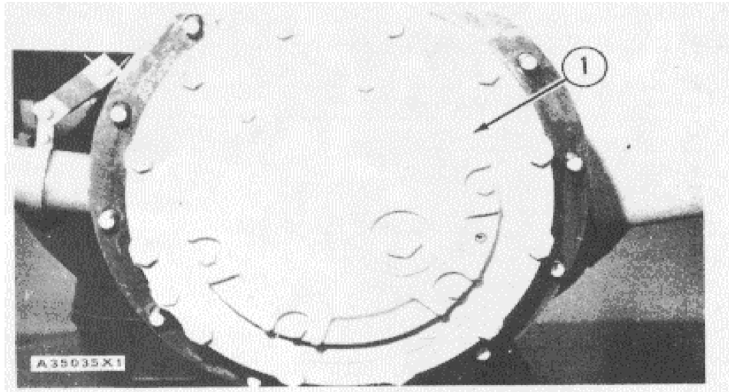
REMOVE AXLES

Tools Needed	A
2P8312Retaining Ring Pliers	1

NOTE: Rim and tire removed for better photo illustration.

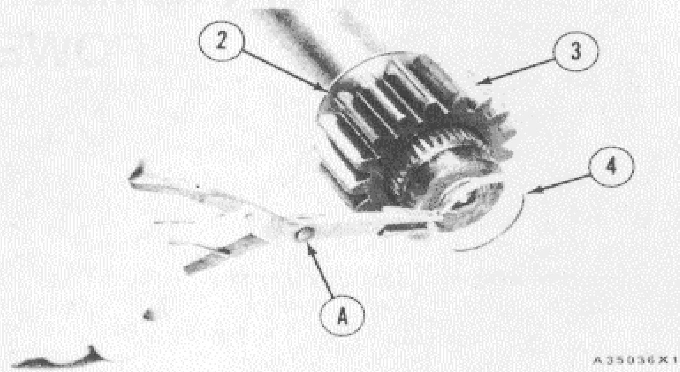
I. Drain the oil from the final drive. The final drive capacity is 1.5 U.S, .gal.(5.7 litre).

2. Remove cover (1).



3. Remove the axle from the axle housing. Weight of the axle is 45 lb.(20 kg).

4. Remove retaining ring (4) with tool (A).Remove gear (3) and washer (2) from the axle.



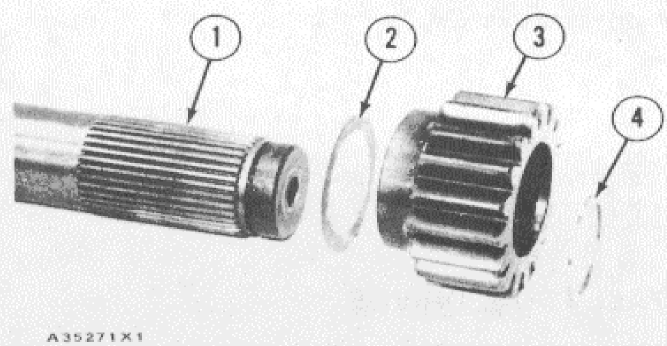
INSTALL AXLES

Tools Needed	A
2P8312Retaining Ring Pliers	1

1. Install washer (2) on axle (I) with the steel side of the washer toward gear (3).

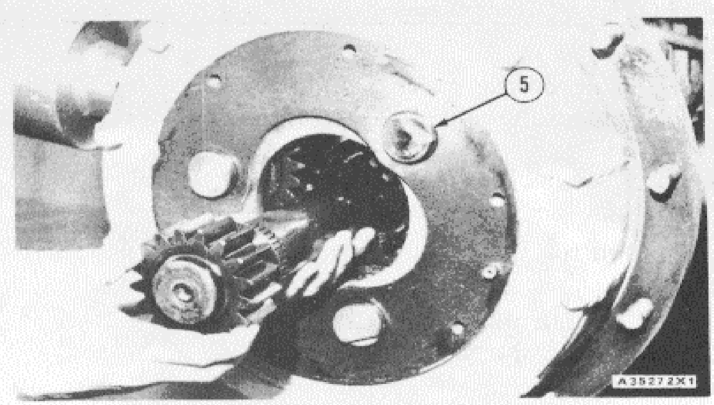
2. Install gear (3) on axle (1).

3. Install retaining ring (4) on the axle with tool (A).



4 .Install the axle in the axle housing.

NOTE: Make sure the notches in shafts (5) are toward the outside of the final drive carrier as shown.



5. Make a replacement of the seal in the cover if necessary.

6. Install the cover.

7. Fill the final drive compartment with oil to the correct level. See LUBRICATION AND MAINTENANCE GUIDE. Tighten the plug to a torque of 75 ± 5 Ib. ft.(100 + 7 N. m).

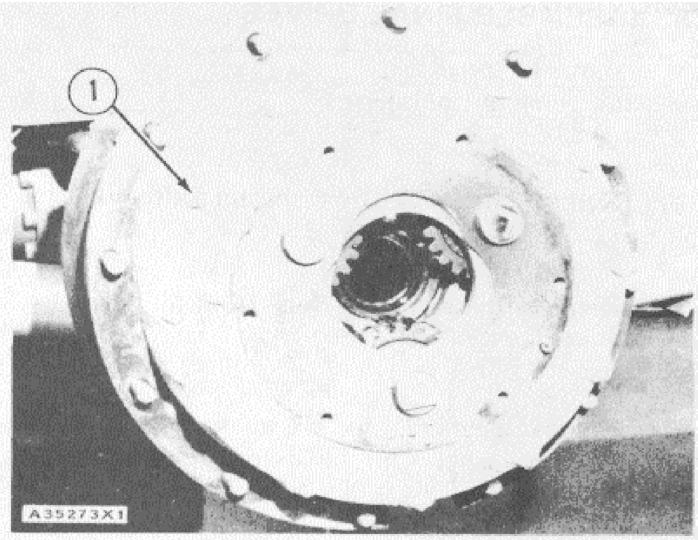
FINAL DRIVES

REMOVE FINAL DRIVES

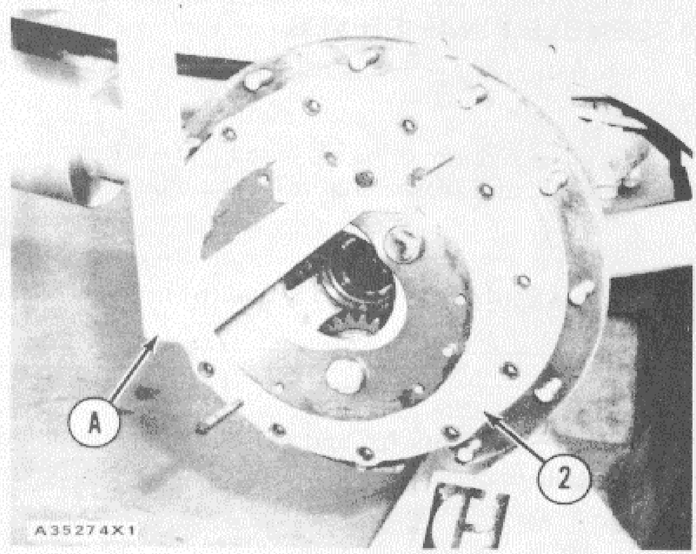
Tools Needed		A
FT121	Lifting Bracket	1

start b):
a) remove axles

NOTE: Rim and tire removed for better photo illustration.



I. Remove bolts (I) that hold the final drive carrier to the wheel assembly.



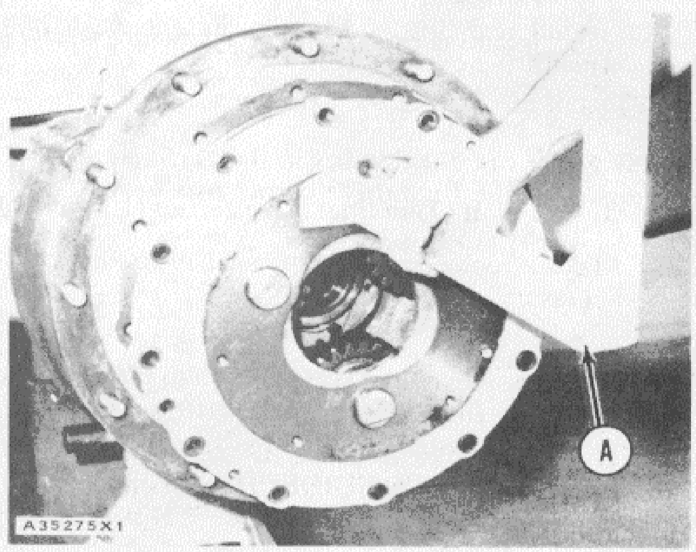
2. Use tool (A) and fasten a hoist to final drive.

3. Install two "/2'-13 NC forcing screws into final drive carrier (2).

4. Remove final drive. Weight of the final drive is 85 lb.(39 kg).

INSTALL FINAL DRIVES

Tools Needed	A
FT121Lifting Bracket	1



I. If necessary make a replacement of the O-ring seal in the wheel assembly.

2. Use tool (A) and fasten a hoist to final drive.

3 .Put the final drive in position on the machine.

4. Tighten the bolts to a torque of 195 ± 18 lb. ft. (265 ± 24 N. m).
end by:
a) install axles

FINAL DRIVES

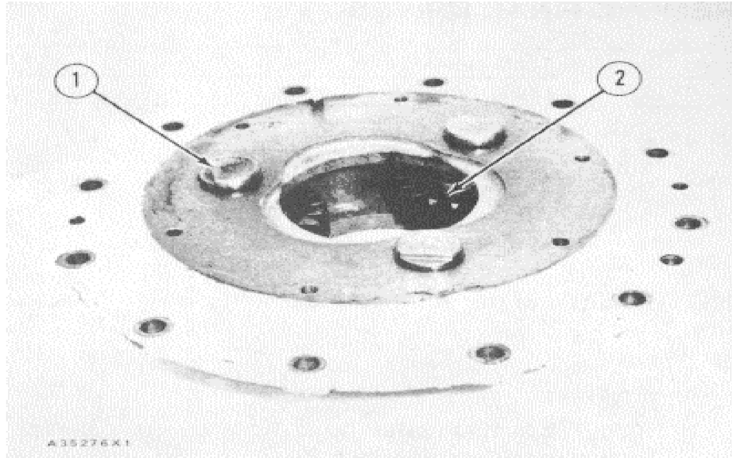
DISASSEMBLE FINAL DRIVES

start by:
a) remove final drives

I. Remove shafts (1) from the final drive carrier.

2. Remove the retaining rings from the shafts.

3. Remove gears (2) the six steel washers the six bronze washers and the six bearings from gears (2).



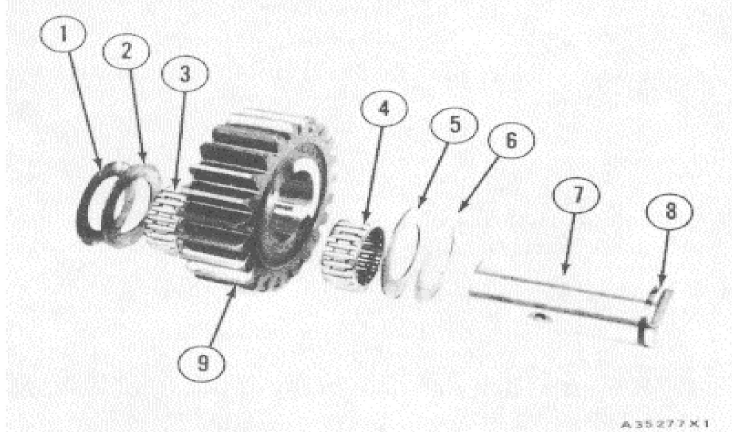
ASSEMBLE FINAL DRIVES

I. Install bearings (3) and (4) in gear (9).

2. Install ring (8) on shaft (7).

3. Hold washers (I) (2) (5) and (6) in position on gear (9).

NOTE: Steel washers (2) and (5) must be assembled next to gear (9).

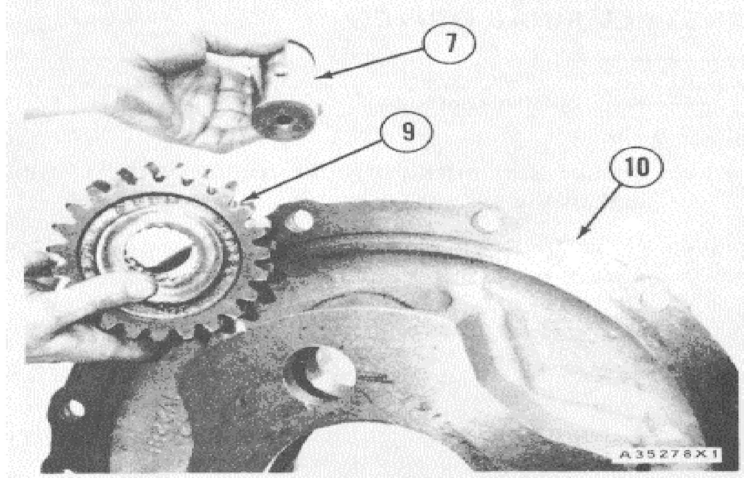


4 Install gear (9) the bearings and the washers in final drive carrier (10).

5. Install shaft (7) in final drive carrier (10) to hold gear (9) in position.

NOTE: Make sure the flat surface of shaft (7) is toward the outside of final drive carrier (10) so the cover assembly can be installed. Do Steps I through 5 for the other two gears in final drive carrier.

end by:
a) install final drives



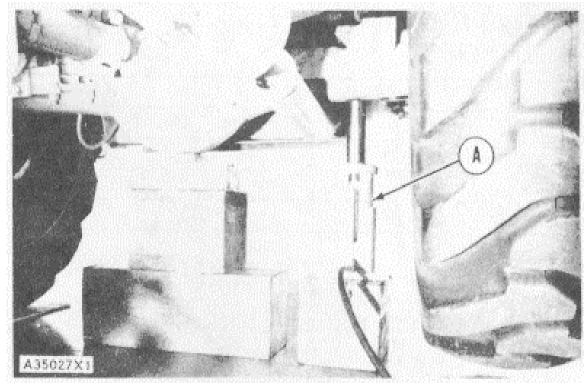
TRACTOR RIM AND TIRE

REMOVE TRACTOR RIM AND TIRE

	Tools Needed	A
8S7610	Base Assembly	1
8S7650	Cylinder	1
5P3100	Pump Group	1

I. Loser the scraper and put blocks in front and behind the wheels.

2. Put tooling (A) in position and lift the machine as shown.



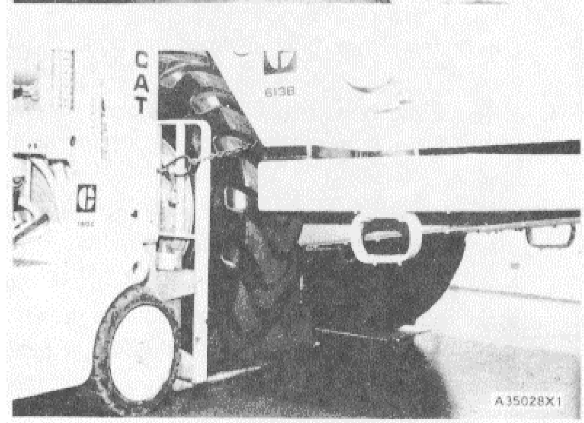
WARNING: Machine can fall off') of hydraulic jack. Put blocks under the differential housing for support.

3. Remove all but one of the nuts that hold the rim to the wheel assembly

4. Loosen the last nut approximately .125 in.(3.18

WARNING: The tire can fall off of the lift truck. Make sure lake sure the tire is fastened to the lift truck.

5. Fasten the tire to a lift truck with a chain as shown

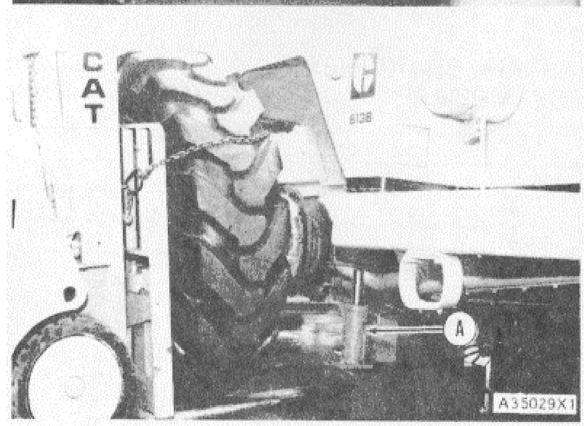


6. Remove the last nut that holds the tire in position. Remove the rim and tire.' eight of the rim and tire Is 925 lb.(421 kg).

INSTALL TRACTOR RIM AND TIRE

	Tools Needed	A
8S7610	Base Assembly	1
8S7650	Cylinder	1
5P3100	Pump Group	1

1. Fasten the tire to a lift truck),with a chain as shown.



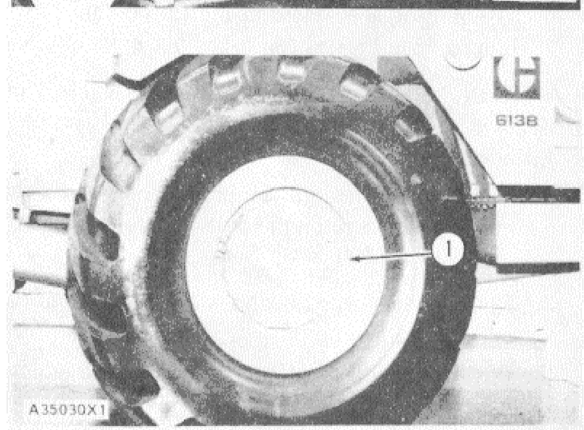
WARNING: Make sure tire is fastened to the lift truck.

2. Put the rim and tire in position on the machine.

3. Install four nuts that hold the rim to the wheel assembly.

4. Remove the chain and lift truck.

5. Install the remainder of nuts (I) that hold the rim and tire to the "wheel assembly .Tighten the nuts to a torque of 375 ± 25Ib .ft.(510 ± 35 N m).



6. Remove the support blocks from under the differential housing.

7. Lower the machine to the ground. Remove tooling (A) from under the machine.

BRAKE HEAD ASSEMBLES

REMOVE BRAKE HEAD ASSEMBLIES

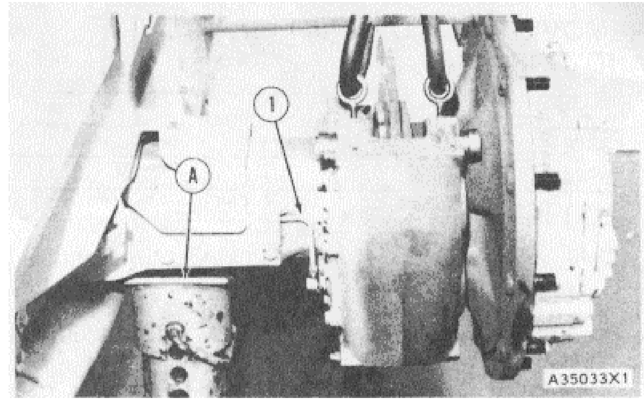
Tools Needed		A
8S7640	Stand	I
8S7611	Tube	1
8S7615	Pin	1
8S8048	Saddle	1

start by:
a) remove tractor rim and tire

1. Remove the hydraulic jack used to lift the machine to remove the tire. Install tooling (A) for
2. Disconnect brake line (1) from the brake head assembly .
3. Remove the bolts that hold the anchor pins in position. Pull the anchor pins out of the head assembly .75 in.(19.05 mm).

NOTE: If necessary push the brake linings from the wheel disc to remove the brake head assembly.

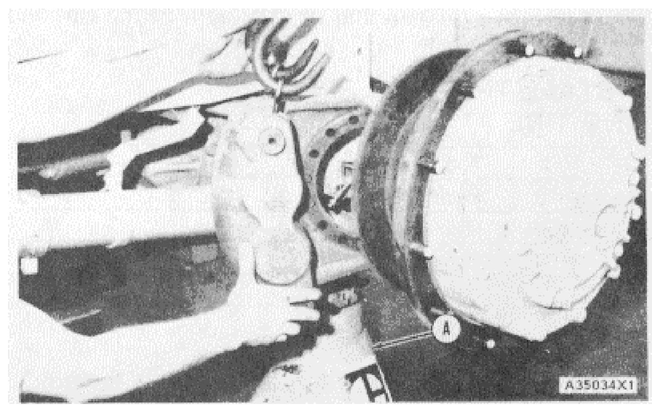
4.. Install two 3/8"-16 NC forged eyebolts in the brake head assembly and fasten a hoist as shown.
5. Remove the eight bolts that hold the brake head assembly to the axle housing.



NOTE: The center two bolts can not be removed com pletely because of the clearance between the brake head assembly and the brake line guard. Remove these bolts with the brake head assembly.

6. Remove the brake head assembly. Weight of the brake head assembly is 90 lb.(41 kg).

CAUTION: The two anchor pins and brake linings are free to fall out of the brake head assembly and must be held in position.



INSTALL BRAKE HEAD ASSEMBLIES

Tools Needed		A
8S7640	Stand	I
8S7611	Tube	1
8S7615	Pin	1
8S8048	Saddle	1

1. Fasten a hoist to the brake head assembly with two 3/8"-16 NC forged eyebolts.
2. Put two of the bolts that hold' the brake head assembly to the axle housing in the center two holes of the brake head assembly bracket

CAUTION: Make sure the two anchor pins and friction pads are held in position hen the brake head assembly is installed.

3. Put the brake head assembly in position on the machine and tighten the bolts to a torque of 225 + 25Ib .ft.(300 + 35 N. m).
4. Remove the forged eyebolts and hoist from the brake head assembly.
5. Push the anchor pins into the brake head assembly. Make sure there is .010 in.(0.25 mm) or more distance between the anchor pins and wheel disc. Install the bolts to hold the anchor pins.
6. Connect the brake line to the brake head assembly.
7. Remove (bleed) the air from the hydraulic brake system. See AIR REMOVAL FROM BRAKES in TESTING AND ADJUSTING.
8. Remove tooling (A).Put into position the hy draulic jack used to lift the machine for tire installation.

end by:
a) install tractor rim and tire

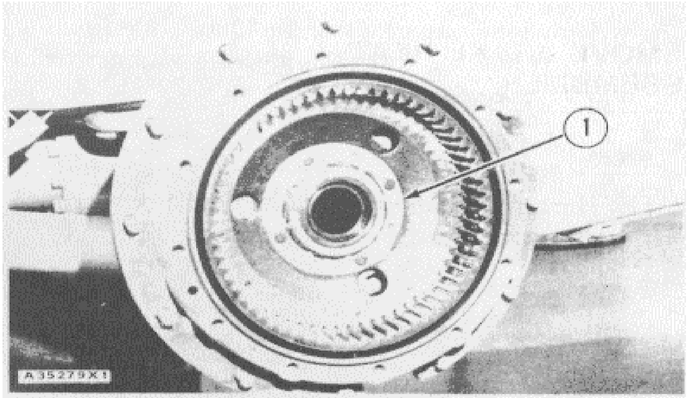
TRACTOR WHEEL ASSEMBLIES, BEARINGS AND SEALS

REMOVE TRACTOR WHEEL ASSEMBLIES, BEARINGS AND SEALS

	Tools Needed	A	B
5P2978	Spanner Wrench	1	
FT797	Lifting Bracket		1

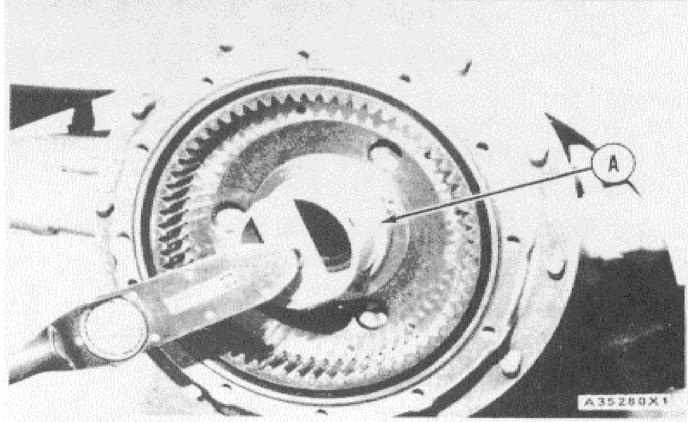
start by:
- a) remove tractor rim and tire
- b) remove brake head assemblies
- c) remove final drives

1. Remove the lockwlre and lock (I).

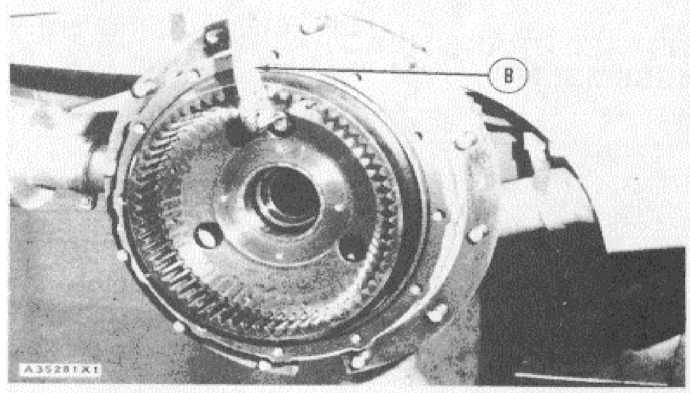


2. Fasten a hoist to the %assembly.

3. Use tool (A) and remove the nut that holds the wheel assembly on the spindle

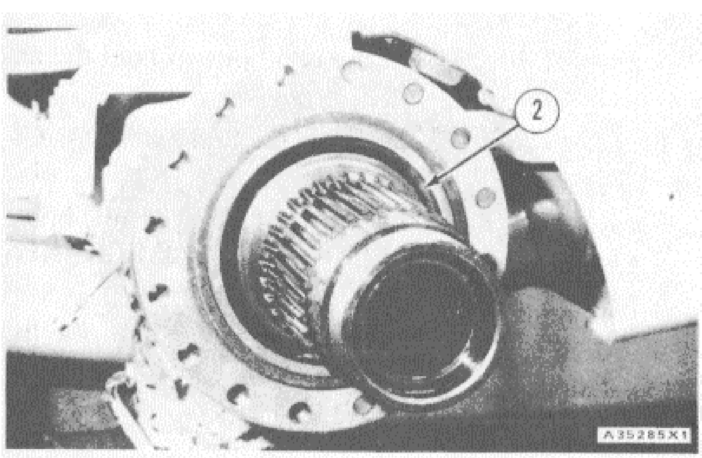


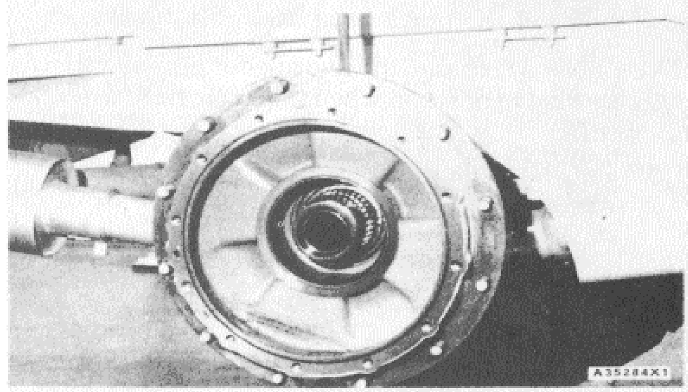
4. Use tool (B) and a hoist to remove the final drive ring gear and hub assembly. Weight of the final drive ring gear and hub assembly is 70 lb.(32 kg).



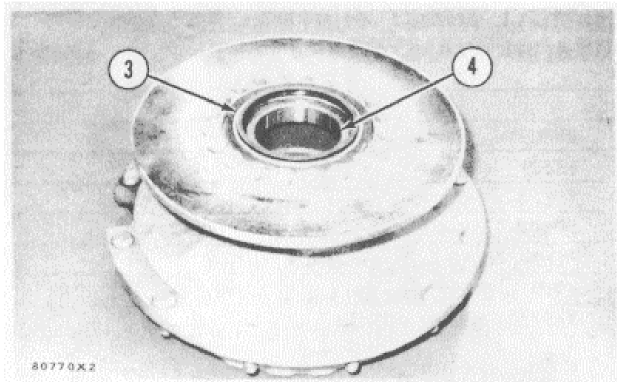
5. Remove the wheel assembly. Weight of the wheel assembly is 180 lb.(82 kg).

6. Remove the inner half of the Duo-Cone floating seal (2) from the spindle. Remove the rubber toric sealing ring from the metal floating ring.





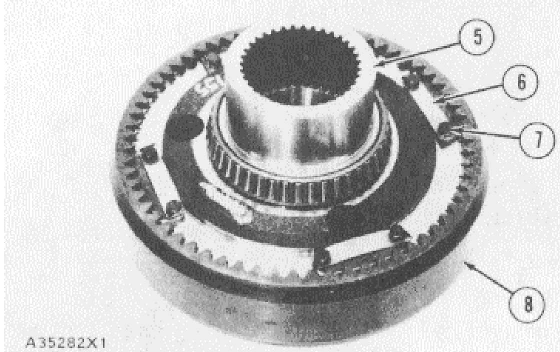
TRACTOR WHEEL ASSEMBLIES, BEARINGS AND SEALS



7. Remove the outer half of the Duo-Cone floating seal (3) and the toric sealing ring retainer from the wheel assembly.

NOTE: The toric sealing ring retainer must be removed evenly or damage to the retainer will result.

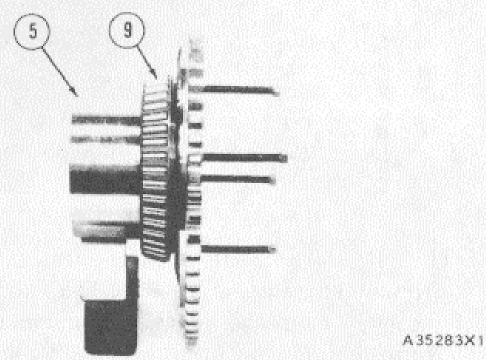
8. Remove the rubber toric sealing ring from the metal floating ring.



9. Remove O-ring seal from the toric sealing ring retainer.

10. Remove the inner bearing cone (4) from the wheel assembly).

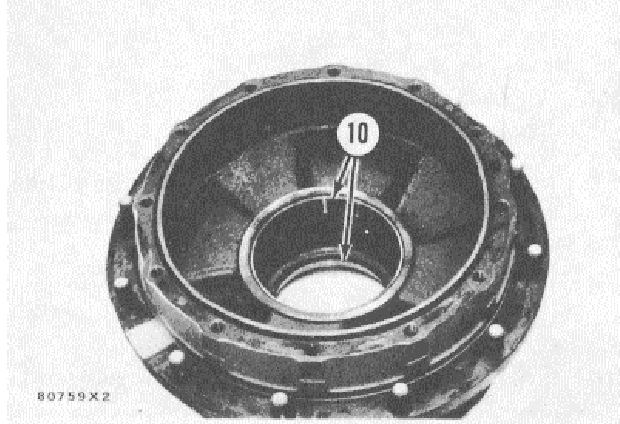
11. Remove bolts (7), locks, (6) and the four plates that hold hub assembly (5) and ring gear (8) together.



12. Remove hub assembly (5) from ring gear (8).

13. Remove the bushing from hub assembly (5).

14. Install four 3/8"-16 NC forcing screws in hub assembly (5).Tighten the forcing screws until the' make contact with bearing cone (9).Tighten the forcing screws evenly to remove the bearing cone from the hub assembly.



15. Remove the inner and outer bearing cups (10) from the , wheel assembly.

TRACTOR WHEEL ASSEMBLIES, BEARINGS AND SEALS

INSTALL WHEEL ASSEMBLIES, BEARINGS AND SEALS

	Tools Needed	A	B	C	D	E
2S8027	Seal Installer	1				
1P531	Handle		1			
1P524	Drive Plate		1			
1P514	Drive Plate		1			
FT524	Lifting Bracket			1		
FT797	Lifting Bracket				1	
5P2978	Spanner Wrench					1

1. Lower the temperature of the inner and outer bearing cups for the wheel assembly.

2. Install outer bearing cup (I) in the wheel assembly.

3. Install the inner bearing cup in the wheel assembly .

4. Install the inner bearing cone in the wheel assembly.

5. Install the O-ring seal on the toric sealing ring retainer.

6. Install toric sealing ring retainer in the wheel assembly.

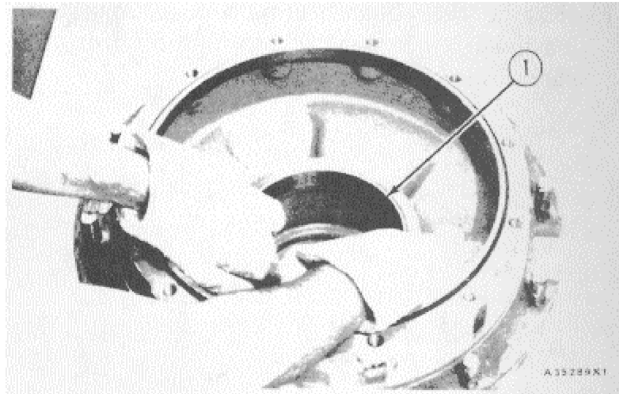
NOTE: The rubber seals and all surfaces that make contact with the seals must be clean and dry. After installation of the seals, put oil on the contact surfaces of the metal seals.

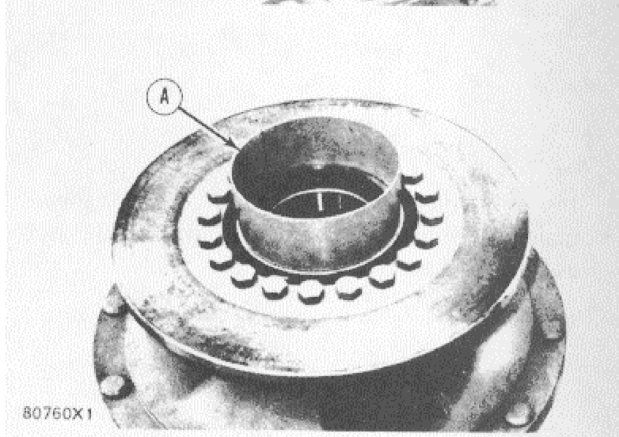
7. Install the two rubber toric sealing rings on the two metal floating seals.

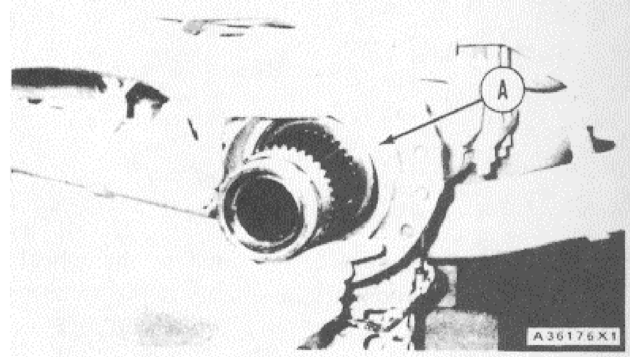
8. Install the outer half of the Duo-Cone floating seal in the wheel assembly with tool (A).

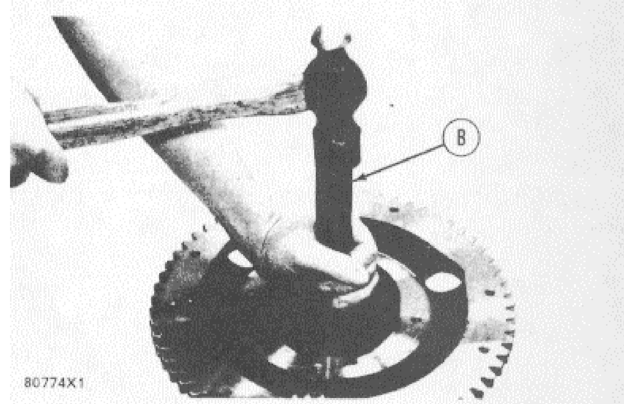
9. Install the inner half of the Duo-Cone floating seal on the spindle with tool (A).

10. Install the bushing in the hub assembly with tooling (B).



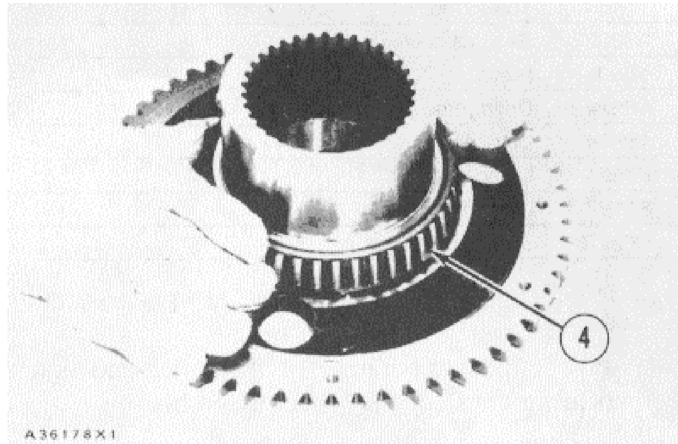




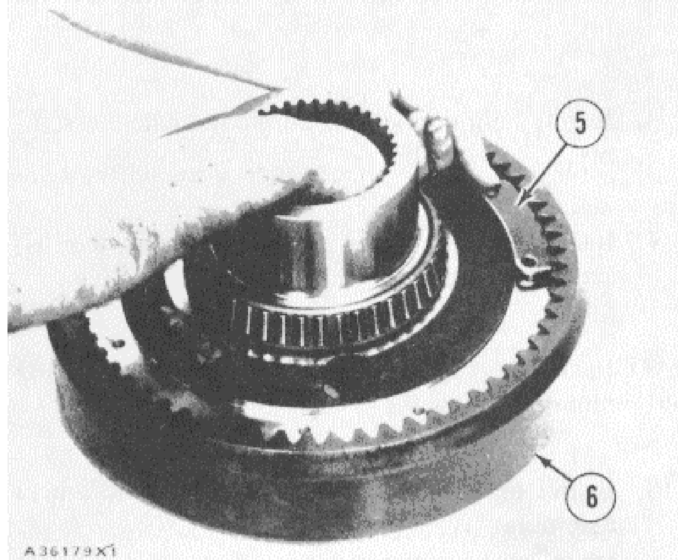


TRACTOR WHEEL ASSEMBLIES, BEARINGS AND SEALS

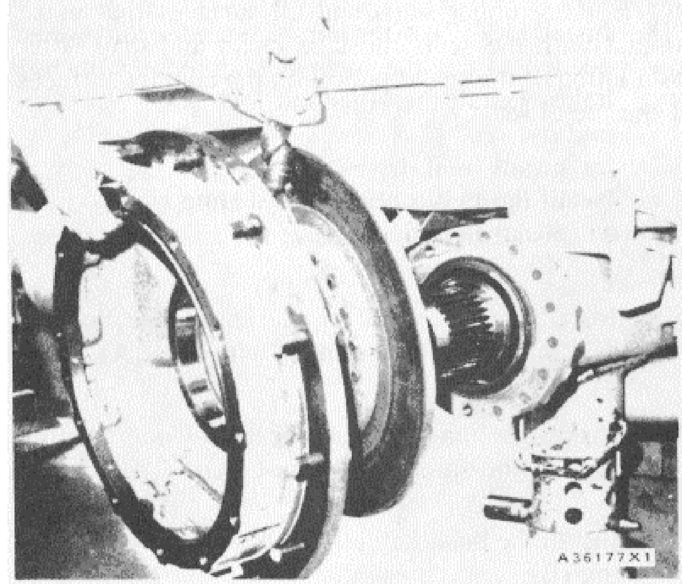
11. Heat the u-heel outer bearing cone (4) in oil to a maximum temperature of 275°F (135 C).Install the bearing on the hub assembly.



12. Install the hub assembly in ring gear (6). Install plates (5).the locks and bolts to hold the hub assembly position.

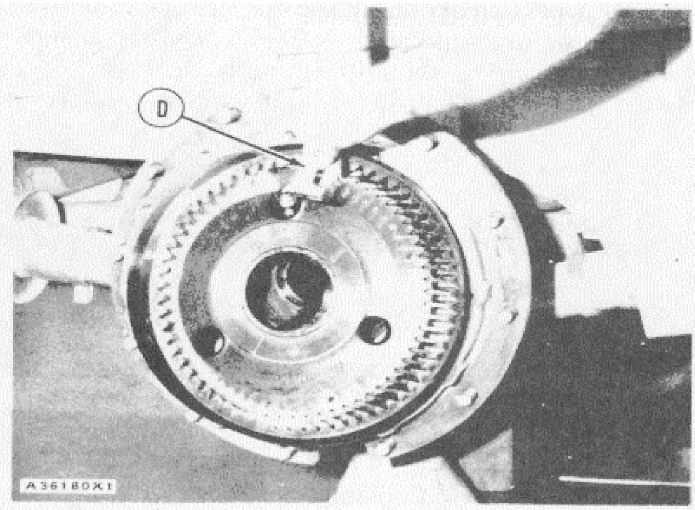


13. Use tool (C) and fasten a hoist to the wheel assemble .Put the , heel assembly in position on the machine.



TRACTOR WHEEL ASSEMBLIES, BEARINGS AND SEALS

14.Use tool (D) and fasten a hoist to the hub assembly and gear. Put the hub assembly and gear in position on the machine.

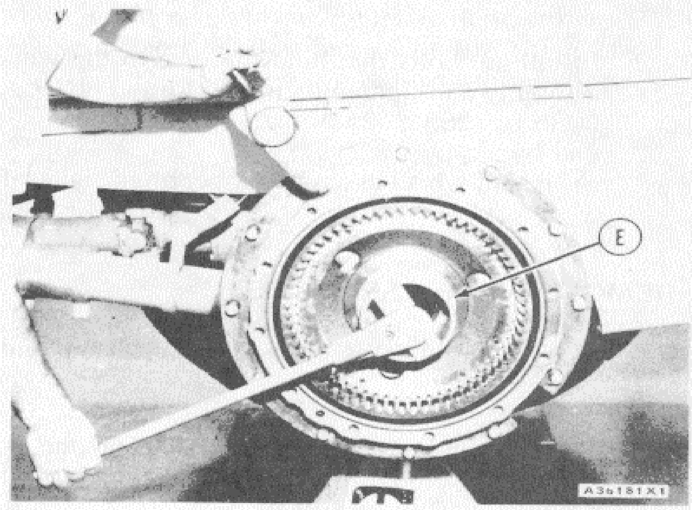


15.Install the nut on the spindle.

16. Tighten the nut with tool (E) while the wheel is turned with a 8 in.(203 mm) long lb.in.(N m) 9S7354 torque wrench. The torque must be 75 ± 25 lb.in.(8.50 ± 2.83 N-m).For other lb.in. torque wrenches, the correct torque indication can be found with this formula:

$$C = \frac{A \times T}{A + B}$$

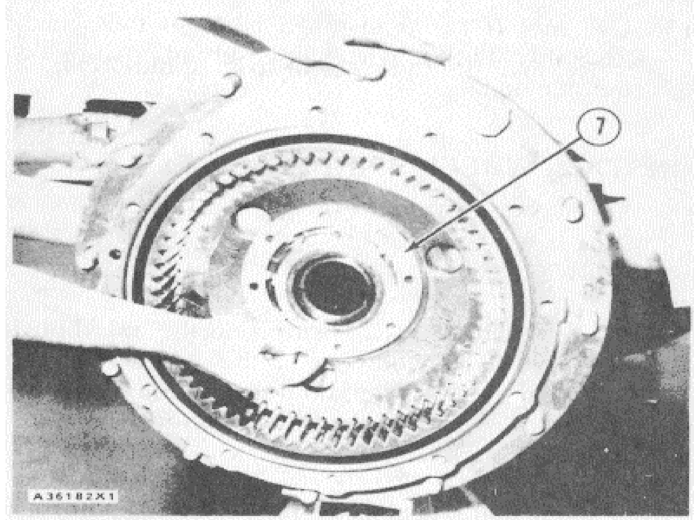
"C" is the torque wrench reading.
"A" is the length of the torque wrench.
"B" is the distance from the center of the wheel to the wheel stud.
"T" is torque on bearings IT = 160 $^{+}$ 50 lb.in.(18.1 ± 5.7 N m)].



NOTE: The torque wrench must be installed on wheel nut so it is in line with the center of the wheel as shown.

17. Turn wheel slowly at a constant speed for one or two turns to check torque reading after adjustment has been made.

18 .Install lock (7) on the nut. Tighten the nut more if needed to get the lock in alignment with bolt holes. Install the bolts and lock wire.
end by:
a) install final drives
b) install brake head assemblies
c) install tractor rims and tires



WHEEL BRAKE DISCS, WHEEL SPINDLES

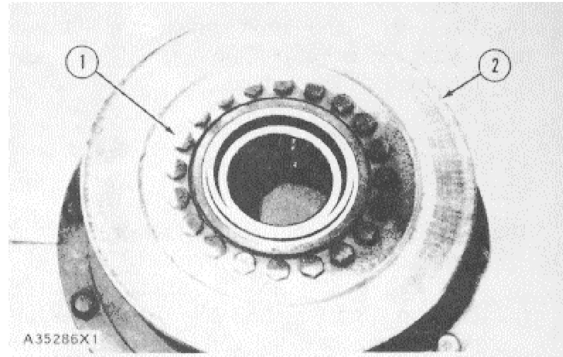
REMOVE WHEEL BRAKE DISCS

start by:

a) remove wheel assemblies, bearings and seals

1. Remove bolts (I).

2. Remove disc (2).



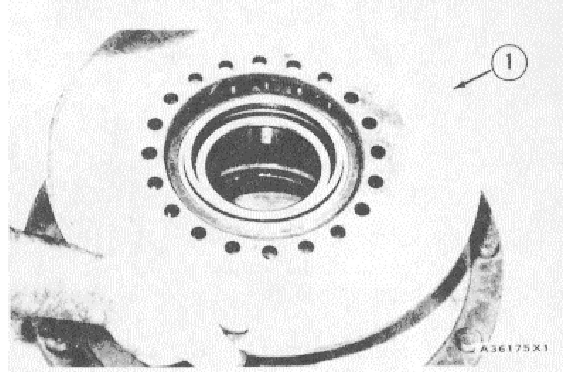
INSTALL WHEEL BRAKE DISCS

1. Put disc (I) in position on the wheel assembly.

2. Install the bolts that hold the disc to the wheel assembly and tighten them to a torque of 195 ± 20 lb.ft.(265 ± 25 N m).

end by:

a) install wheel assemblies, bearings and seals



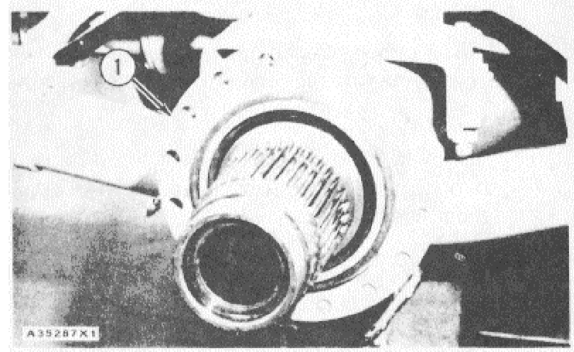
REMOVE WHEEL SPINDLES

start by:

a) remove wheel assemblies, bearings and seals

1. Remove the bolts that hold spindle (I) to the axle housing. Remove spindle (I).Weight of the spindle is 40 lb.(18 kg).

2. Remove the O-ring seal from spindle (I).



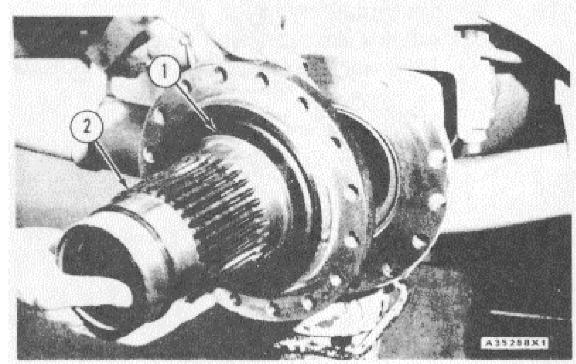
INSTALL WHEEL SPINDLES

1. Put the O-ring seal on spindle (2).

2. Put spindle (2) in position on the axle housing with the oil hole (1) in the vertical position. Install the bolts that hold the spindle on the axle housing. Tighten the bolts to a torque of 225 ± 25 Ib.ft.(300 ± 35 N-m).

end by:

a) install wheel assemblies, bearings and seals

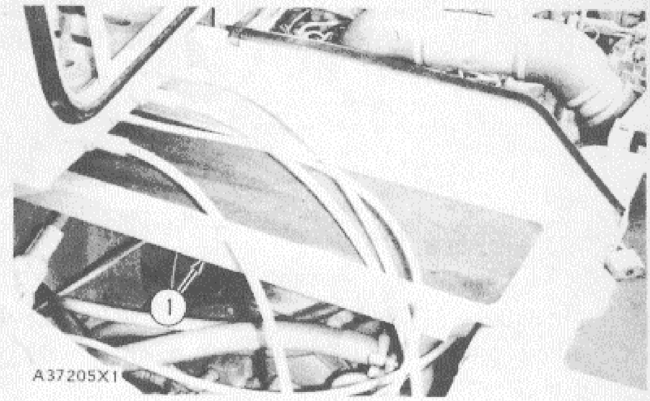


TORQUE CONVERTER

REMOVE TORQUE CONVERTER

start by:
a) remove elevator hydraulic pump*
b) remove steering and scraper hydraulic pump*

1. Remove panel assembly (1).

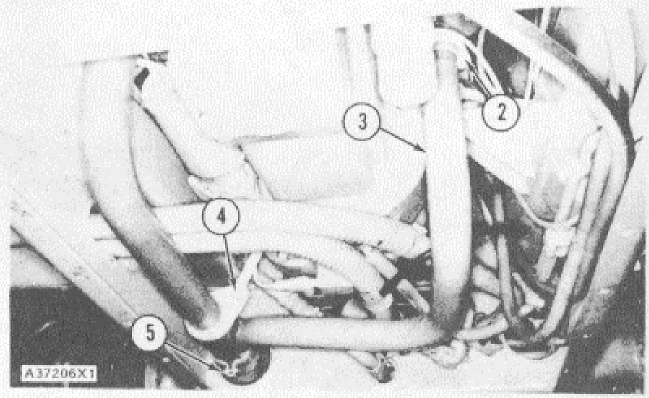


2. Remove six bolts (2) from the two exhaust pipe assembly) flanges.

3. Loosen bolt (5) in the clamp.

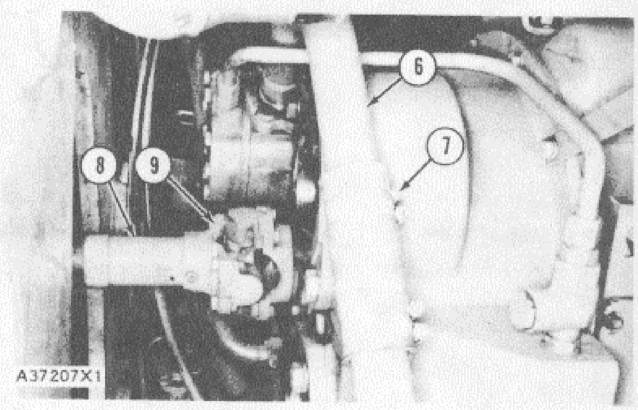
4. Remove bolt (4) and remove exhaust pipe assembly (3).

5. Remove bolts (9) and disconnect upper drive shaft (8) from the torque converter.

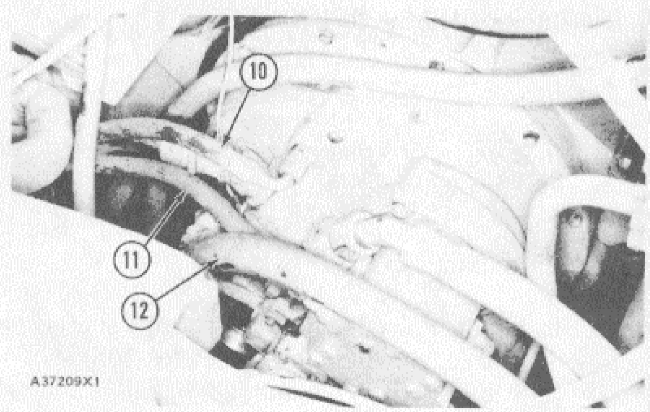


6. Loosen clamps (7) and disconnect tube assembly (6) from the tube.

7. Disconnect hose assemblies (10) and (12) from the torque converter.



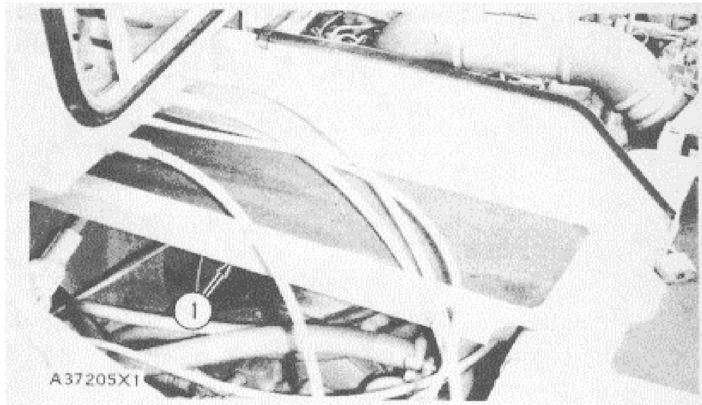
8. Disconnect hose assemble (1 I) from the transmission pump.



*This operation is in the VEHICLE SYSTEMS DISASSEMBLY AND ASSEMBLY.

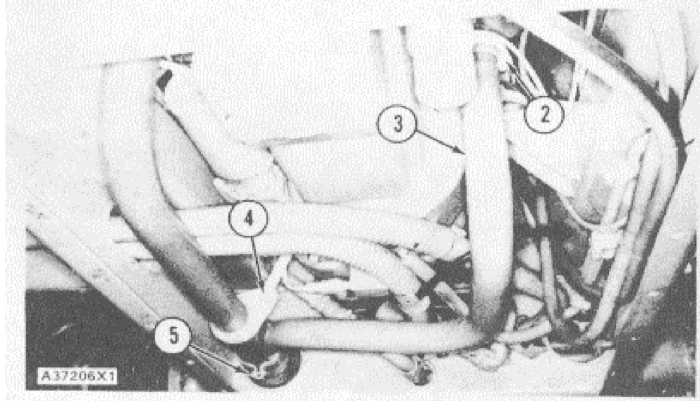
TORQUE CONVERTER

9. Disconnect hose assemblies (13) and (14) and remove the temperature sending unit (15) from the torque converter.



10. Install a 5/8”- 11 NC forged eyebolt in the top of the torque converter and fasten a hoist.

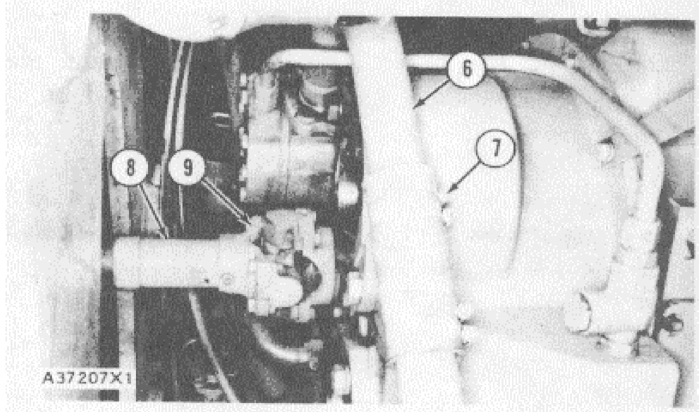
11. Remove bolts (16) and lower the torque converter to the floor. Weight of the torque converter is 250 lb.(113 kg).



INSTALL TORQUE CONVERTER

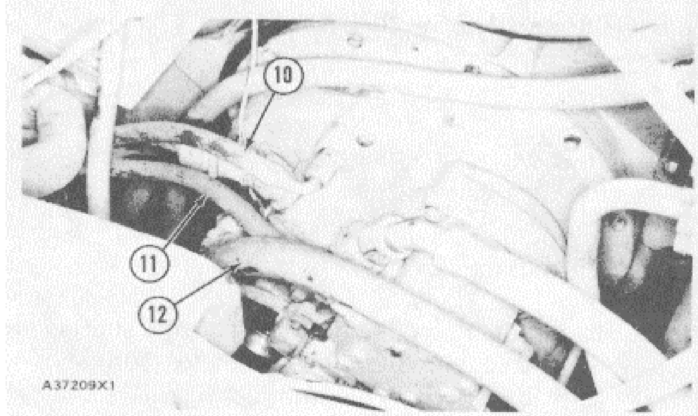
1. Put the torque converter in position under the machine.

2. Install a 5/8"- 1 NC forged eye bolt in the top of the torque converter and fasten a hoist.



3. Install the gasket and lift the torque converter into position on the machine.

4. Install the bolts that hold the torque converter to the flywheel housing.

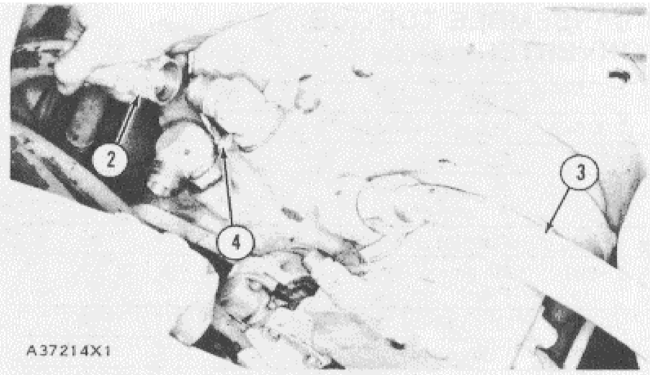


5. Install the bolts that hold upper drive shaft (I) to the torque converter and tighten to a torque of 45 $\pm$ 5 lb.ft.(60 $\pm$ 7 N m).

TORQUE CONVERTER

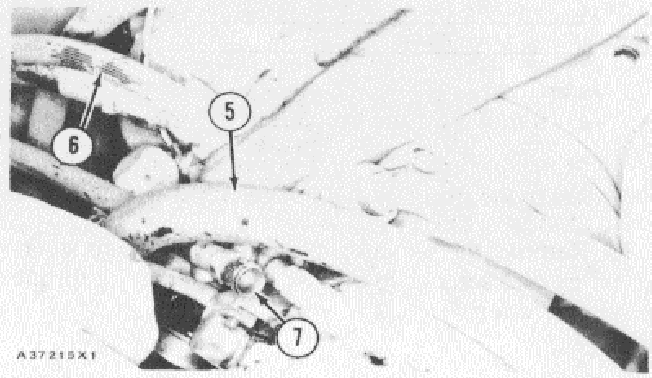
6. Connect hose assemblies (2) and (3) and install temperature sending unit (4) to the torque converter.

7. Connect hose assemblies (5), (6) and (7) to the torque converter.



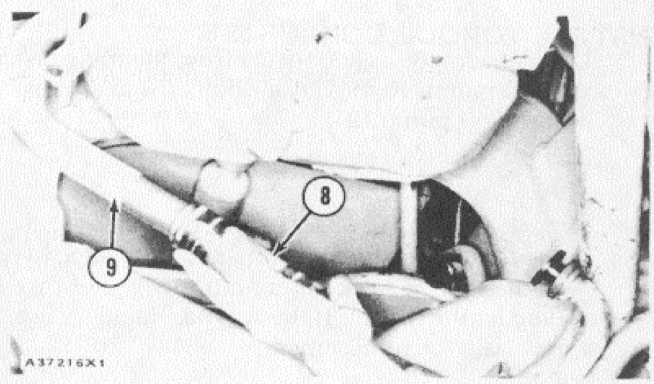
8. Install the hood panel assembly.

9. Connect tube assembly (9) to the transmission oil pump supply with hose (8) and--tighten the clamps.

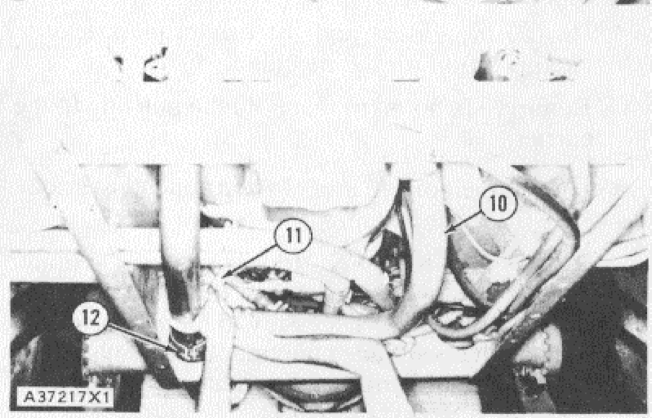


10. Put exhaust pipe assembly (10) in position and install the bolt, washer and nut through strip (11) to hold pipe assembly (10) in position.

11. Install the bolts that hold pipe assembly (10) to the exhaust manifolds.



12. Tighten bolt (12) in the clamp.
    end by:
    a) install steering and scraper hydraulic pump*
    b) install elevator hydraulic pump*

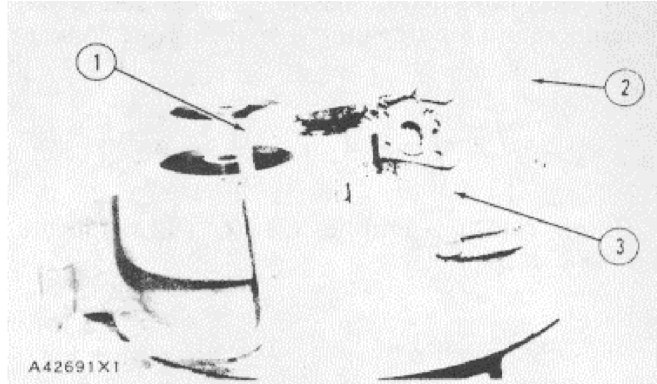


*This operation is in the VEHICLE SYSTEMS DISASSEMBLY AND ASSEMBLY.

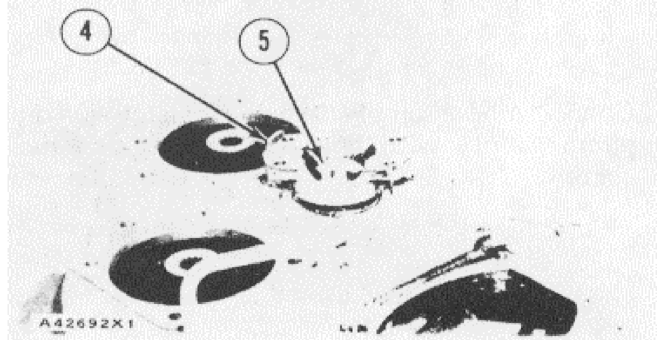
TORQUE CONVERTER

DISASSEMBLE TORQUE CONVERTER

	Tools Needed	A	B	C	D	E
8B7548	Puller Assembly	1				
T774	Spacer	1				
8H663	Bearing Puller					
	Attachment	1				
8H684	Ratchet Box Wrench	1				
2P8312	Retaining Ring					
	Pliers		1			
1 P462	Drive Plate			1		
9S289	Compressor				1	
1 P532	Handle					1
1P504	Dnve Plate					1
1 P507	Drive Plate					1

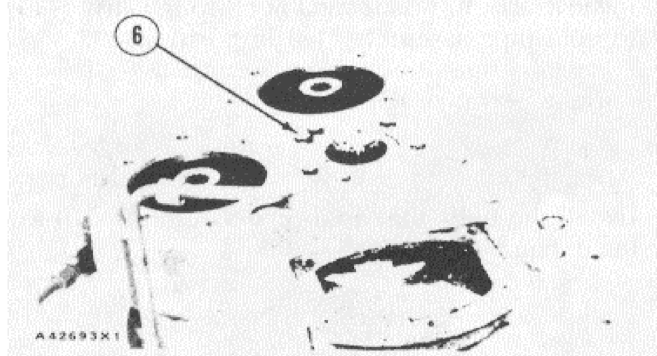


start by:
a) remove torque converter



1. Remove the elevator hydraulic pump and steering and scraper hydraulic pump from the torque converter.

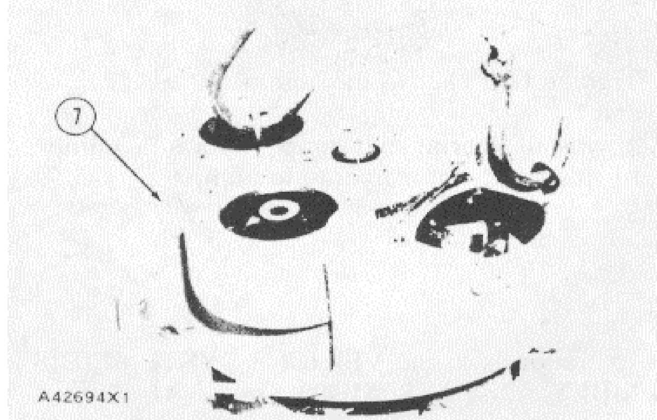
2. Disconnect tube assembly (I) from the transmission oil pump. Remove four bolts (3) and transmission oil pump (2).



3. Remove two bolts (5), the retainer and flange (4) from the shaft. Check the condition of the O-ring seal under the flange If the seal has damage, use a new part for replacement.

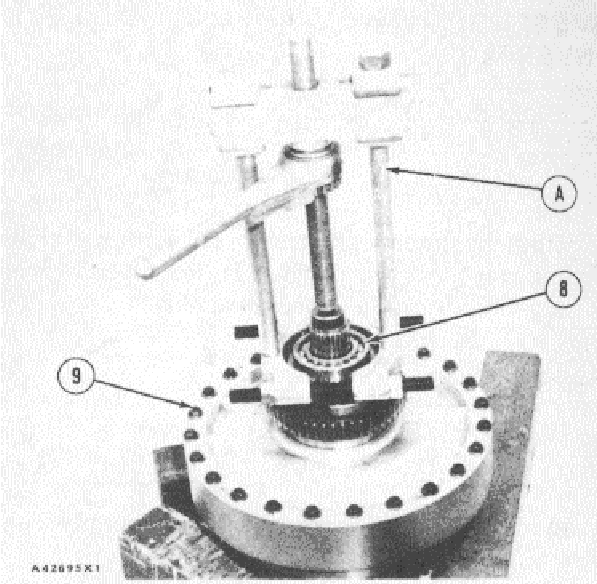
4. Remove six bolts (6) that hold the housing to the carrier.

5. Install two 3/8"-16 NC forged eyebolts in housing (7) as shown. Fasten a hoist to the housing and remove it. It is necessary to hit the end of the shaft with a soft faced hammer until the housing is free of the bearing on the shaft. Weight of the housing is 96 lb.(43.5 kg).



TORQUE CONVERTER

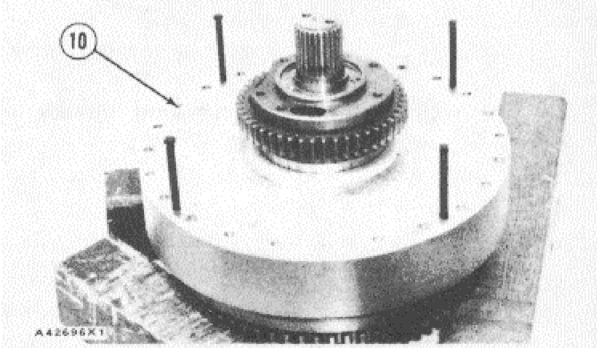
6. Remove bearing (8) from the shaft with tooling (A).



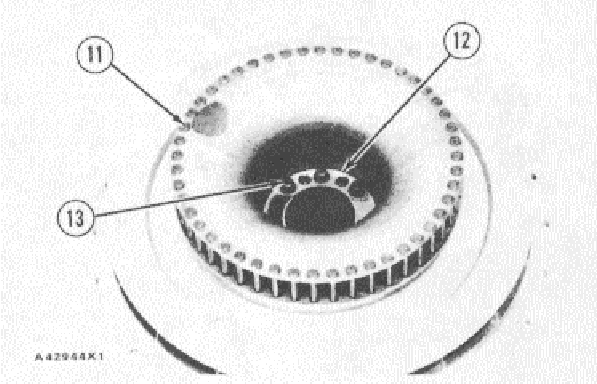
CAUTION: Bearing (8) will have damage when it is removed. Use a new part for replacement.

7. Remove twenty-four bolts (9) and washers that hold the impeller wheel to the rotating housing.

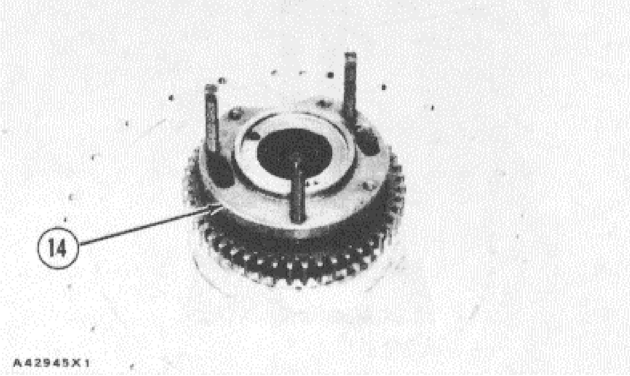
8. Install four 3/8"-16 NC forcing screws in the impeller wheel as shown. Tighten the screws evenly until the impeller wheel (10) is loose and can be removed from the rotating housing.



9. Turn the impeller wheel over. Remove six bolts (13) and two plates (12). Remove guide wheel assembly (stator) (11).

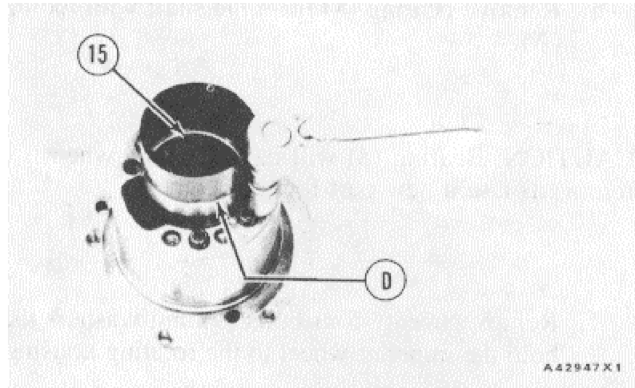


10. Turn the impeller wheel over. Install three 3/8"-16 NC forcing screws in carrier (14). Tighten the screws evenly until the carrier is loose. Remove the carrier.

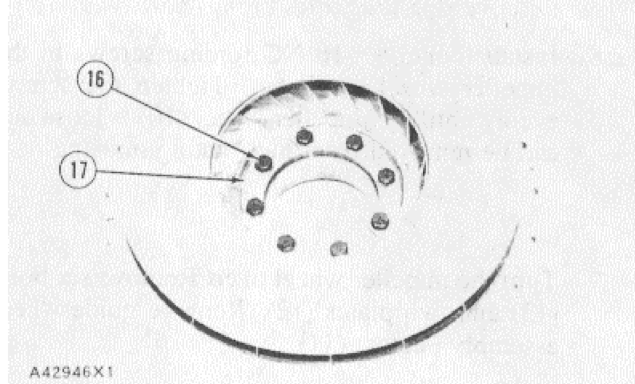


TORQUE CONVERTER

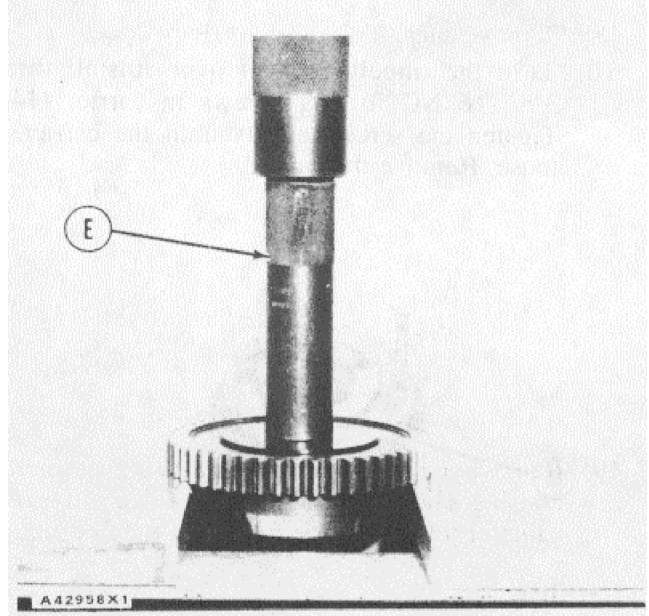
11. Remove sleeve (15) from carrier (14) with tooling (D).



12. Turn the impeller wheel over. Remove eight bolts (16) and two plates (17). Remove the gear assembly from the wheel assembly.

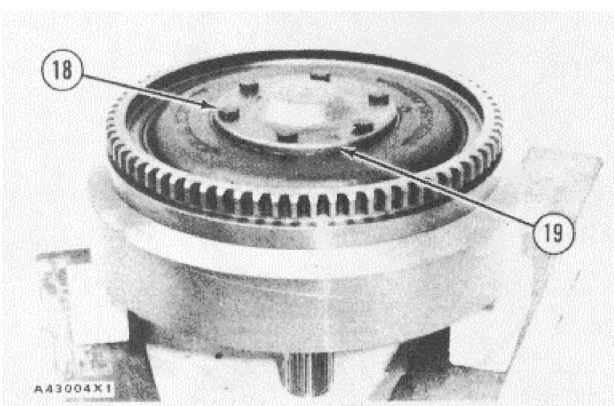


13. Remove the bearing from the gear assembly with tooling (E) and an arbor press.

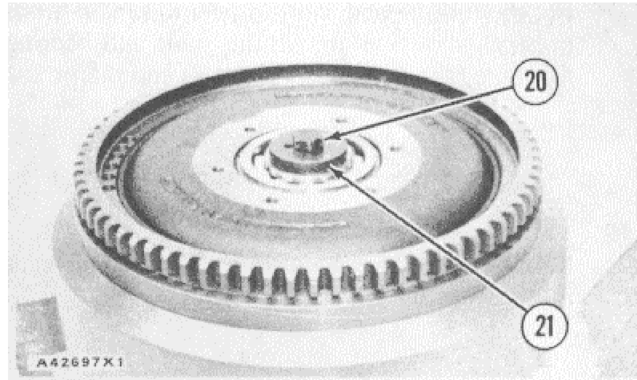


14. Put the rotating housing on wood blocks as shown.

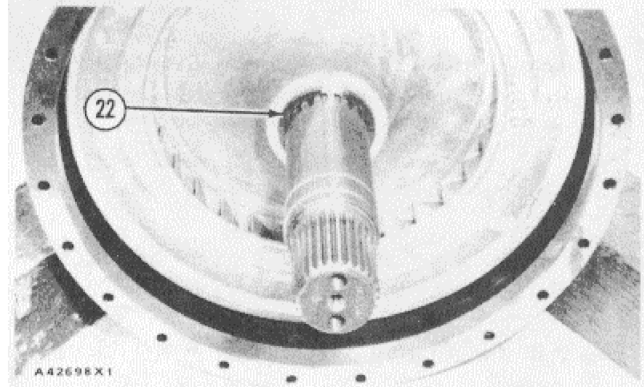
15. Remove bolts (18) and retainer (19).



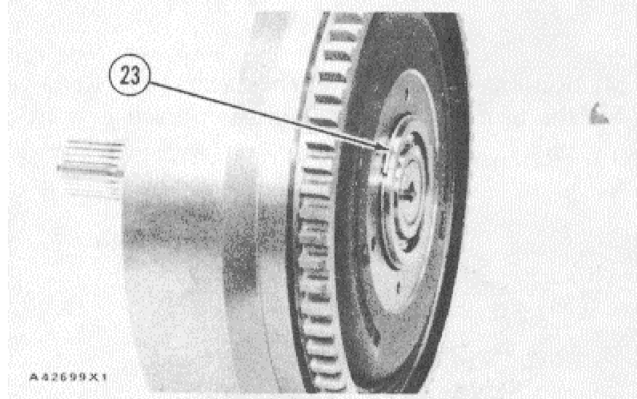
16. Remove bolt (20) and retainer (21) from the end of the shaft.



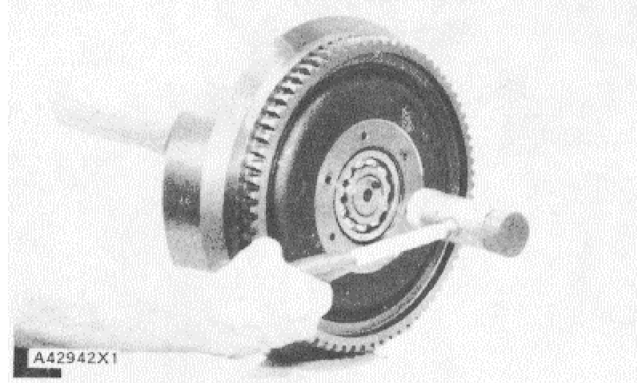
17. Remove ring (22) from the shaft with tool (B).



18. Remove ring (23) with tool (B).

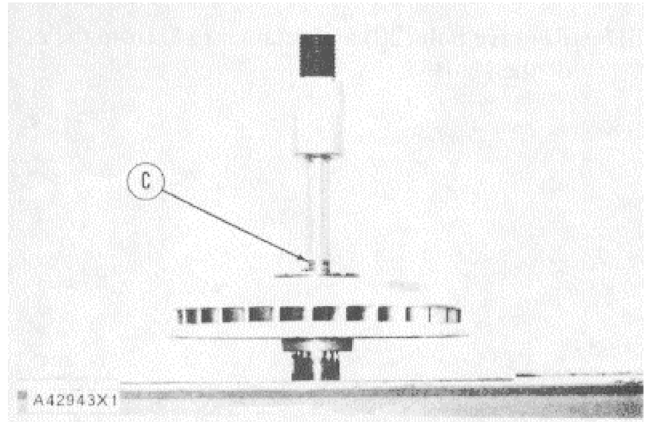


19. Remove the shaft and turbine as a unit from the housing. Hit the end of the shaft with a soft faced hammer to remove the unit from the housing.



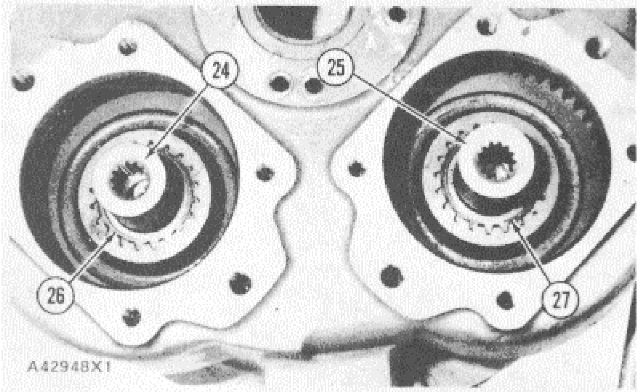
TORQUE CONVERTER

20. Put the turbine and shaft in position in an arbor press as shown. Remove the shaft and bearing from the turbine with tooling (C) and the press.

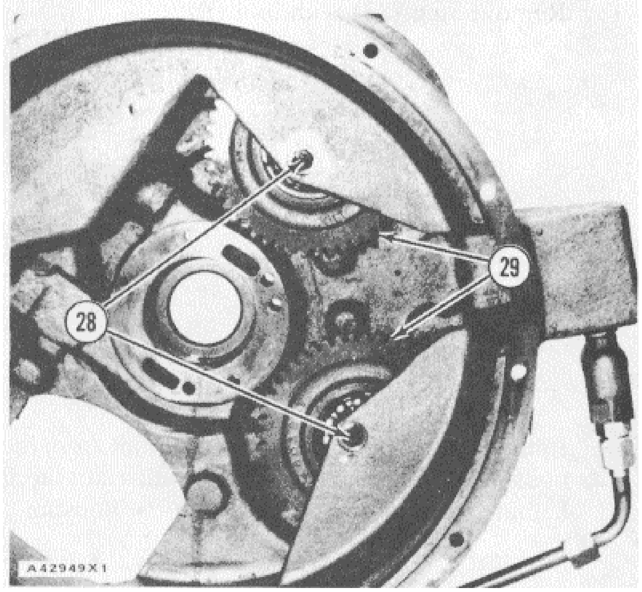


2. Remove ring (26) and adapter (24) from the gear in the converter housing.

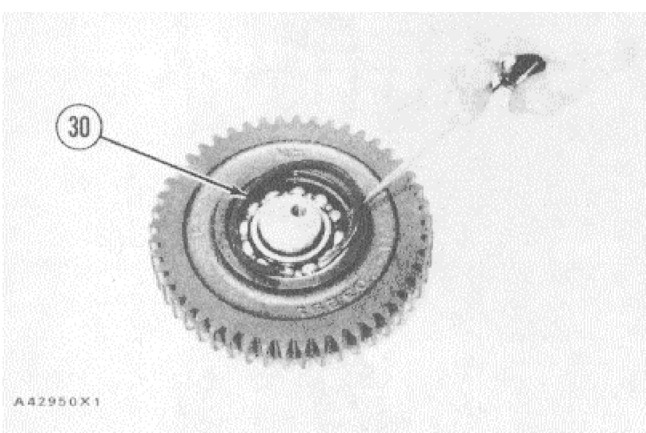
22. Remove ring (27) and adapter (25) from the gear.



23. Turn the converter housing on its side. Remove two bolts (28) and two gears (29) from the housing.

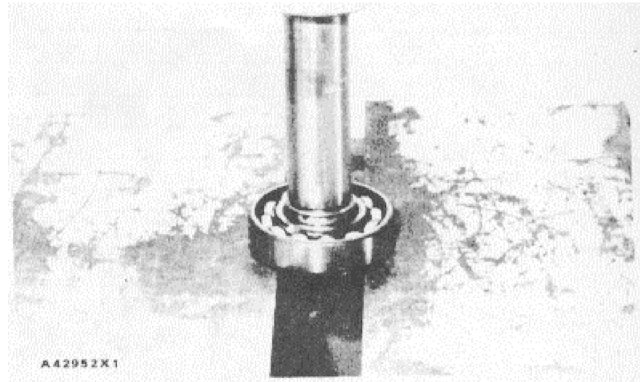


24. Remove rings (30) from two gears (29). Remove the bearings and retainers from each gear as a unit.

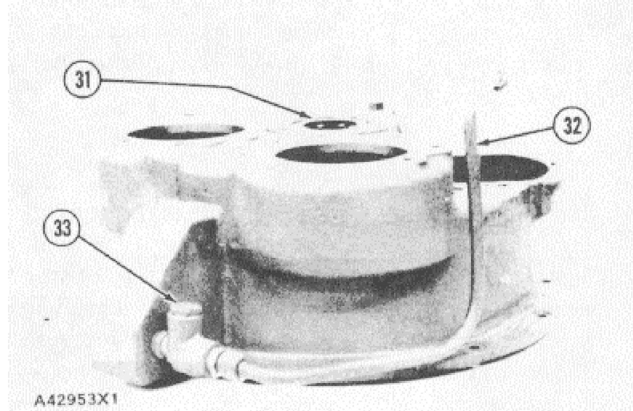


TORQUE CONVERTER

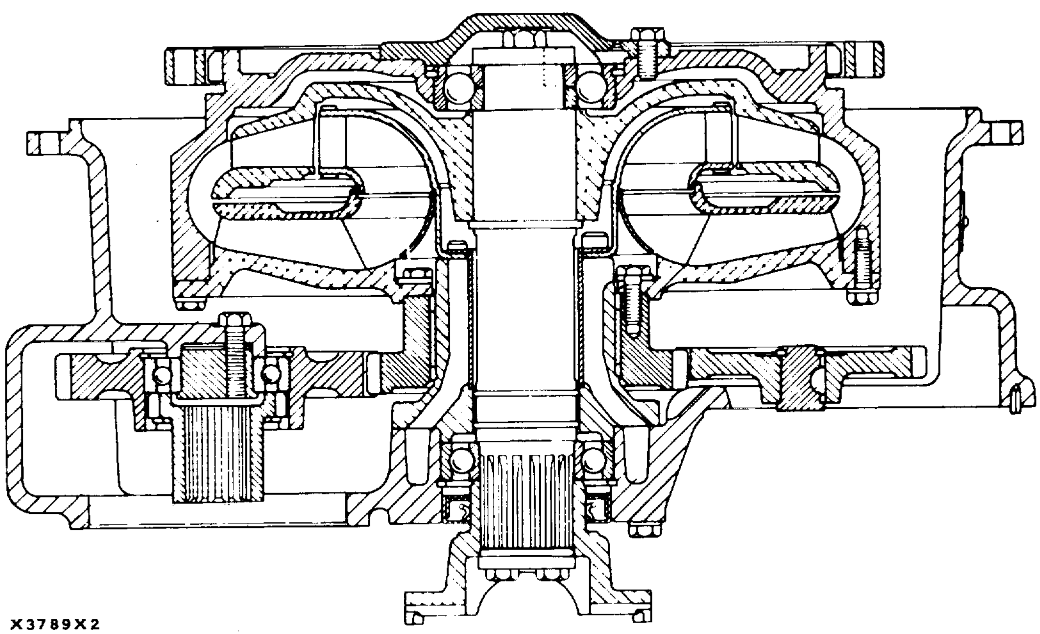
25. Remove the retainers from each bearing pith an arbor press.



26. Remove tube assembly (32). Remove strainer assembly (33).



27. Remove lip type seal (31) from the converter housing.

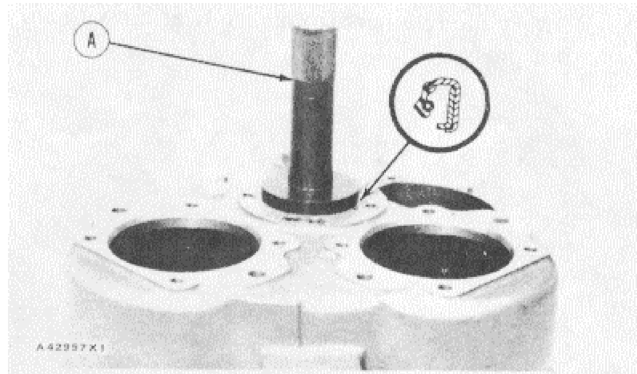


ASSEMBLE TORQUE CONVERTER

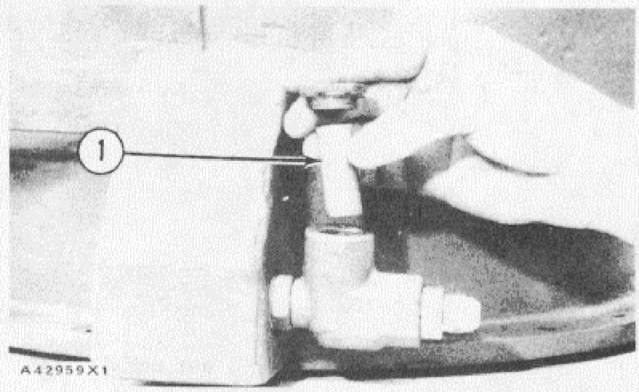
	Tools Needed	A	B	C	D
1P532	Handle	1	1		
1P505	Drive Plate	1			
1P482	Drive Plate	1			
1P507	Drive Plate		1		
1P524	Drive Plate		1		
9S289	Compressor			1	
2P8312	Retaining Ring Pliers				1

CAUTION: Before the torque converter is assembled, see Torque Converter Clearance Checks. These clearances must be correct for the torque converter to operate with efficiency.

1. Install the ring in the groove that is in the converter housing which is under the lip type seal. Install the lip type seal in the converter housing with tooling (A). Install the seal until it is even with the outside surface of the housing and with the lip of the seal toward the inside of the housing.

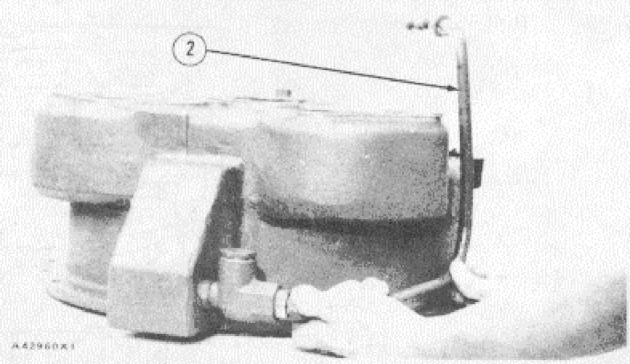


2. Make sure strainer assembly (1) is clean and free of dirt and foreign material.

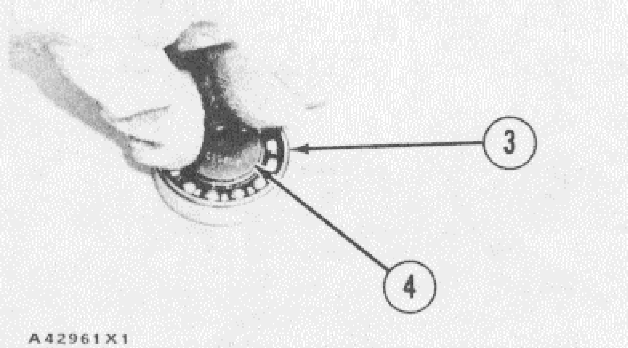


3. Install strainer assembly (1).

4. Install tube assembly (2).

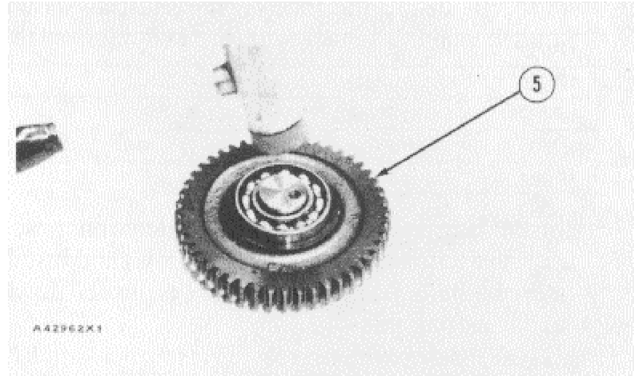


5. Heat two bearings (3) to a maximum temperature of 275°F (1350C). Put the bearings in position over the two retainers (4) as shown.

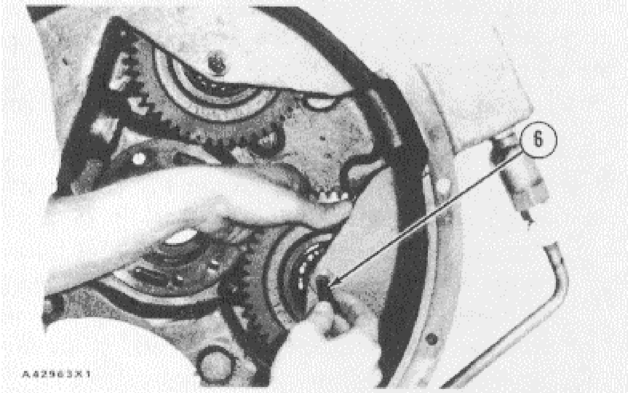


TORQUE CONVERTER

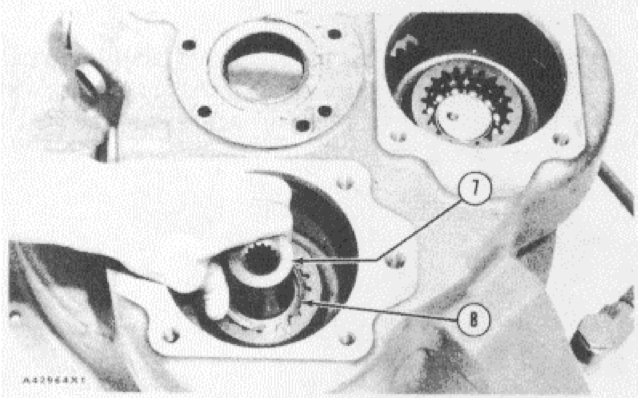
6. Install the bearings and retainers in two gears (5). Make sure the threaded hole in the retainer is toward the bottom of gears when they are installed.



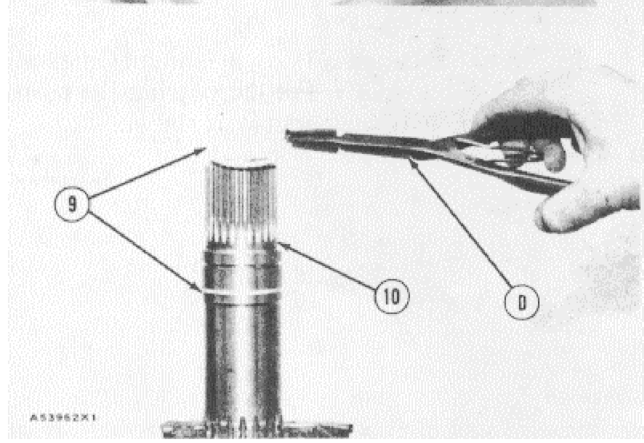
7. Put two gears (5) in position in the converter housing as shown. Install bolts (6) that hold them. Tighten the bolts to a torque of 36 + 2 Ib. ft. (46 + 3 N-m).



8. Install adapters (7) in both gears. Install rings (8) that hold the adapters in position.



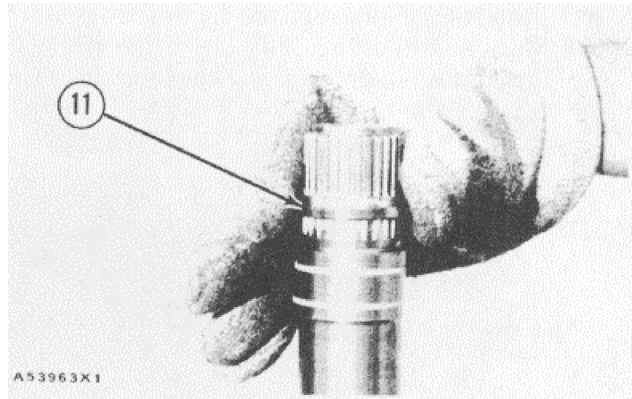
9. Put shaft (10) in a vise as shown. Do not damage the splines on the shaft.



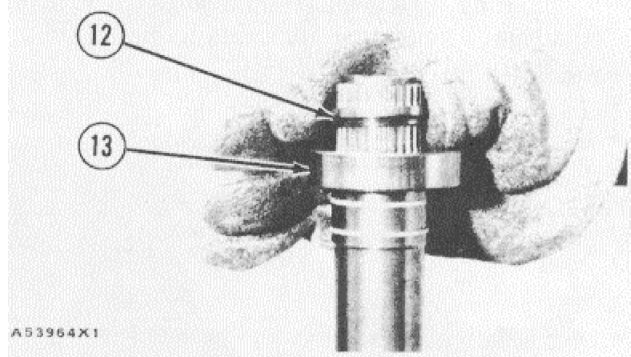
10. Install ring (9) with tool (D).

TORQUE CONVERTER

11. Heat inner race (11) to a temperature of 275°F (135°C). Install the race on the shaft as shown until it makes contact with the shoulder on the shaft.

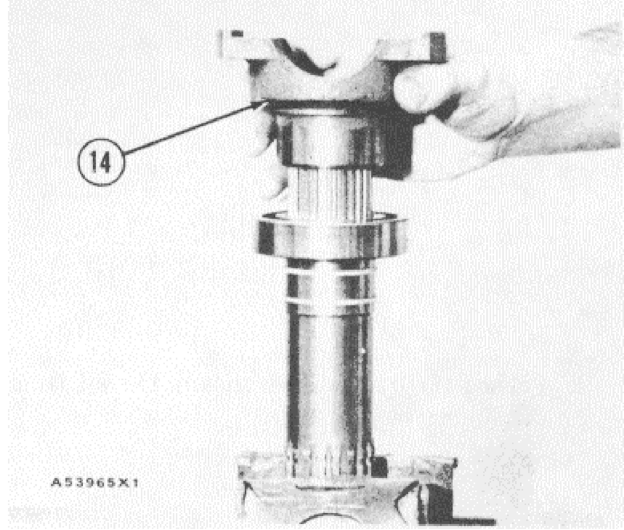


12. Install bearing (13) on the shaft. Heat inner race (12) to a temperature of 275F (1 135°C) and install it on the shaft. sure the race is pushed down as far as possible.

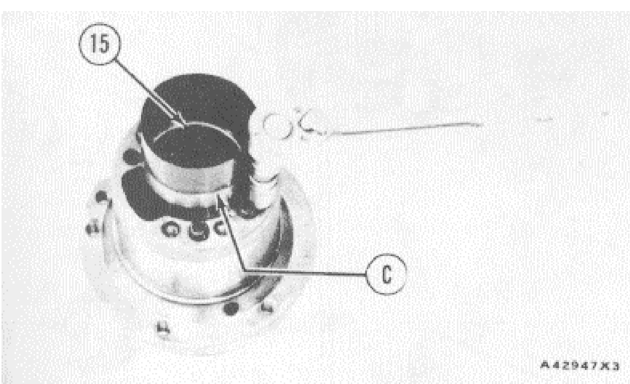


13. Temporarily install yoke (14) with two bolts and washers.

14. Turn the shaft around in the vise.

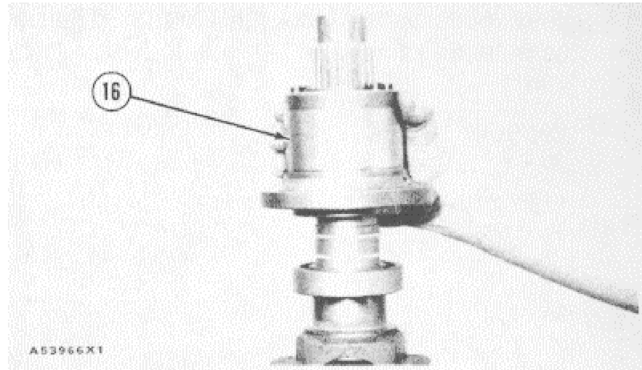


15. Use tooling (C) to install sleeve (15) in the carrier. Install the sleeve until it makes contact with the counterbore in the carrier. Make sure the tab on sleeve (15) fits in the groove of the carrier.

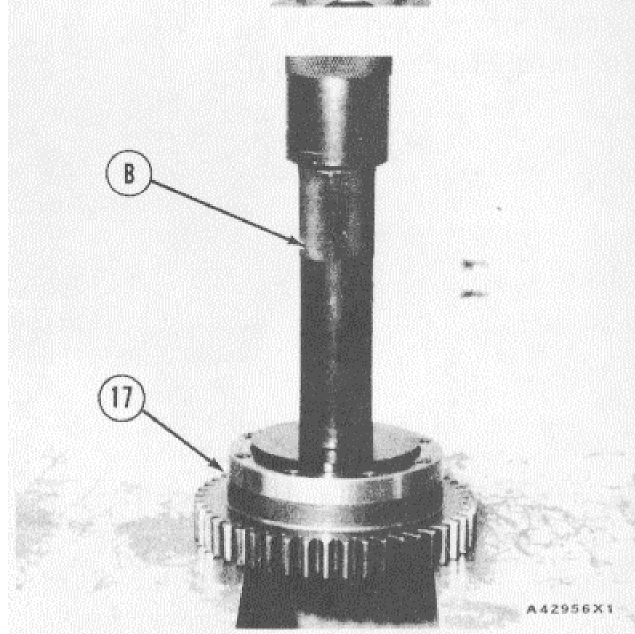


TORQUE CONVERTER

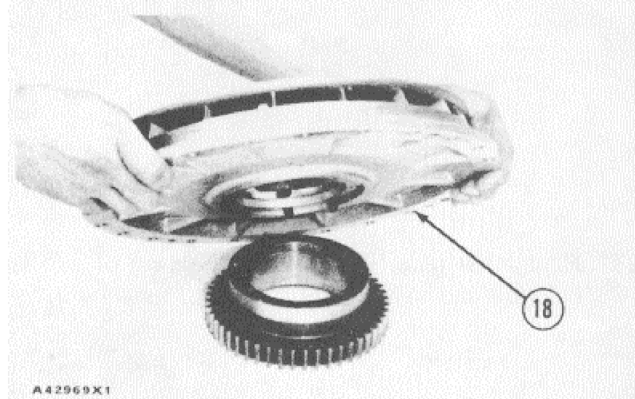
16. Put clean oil on the ring on the shaft. Install carrier (16) on the shaft as shown.



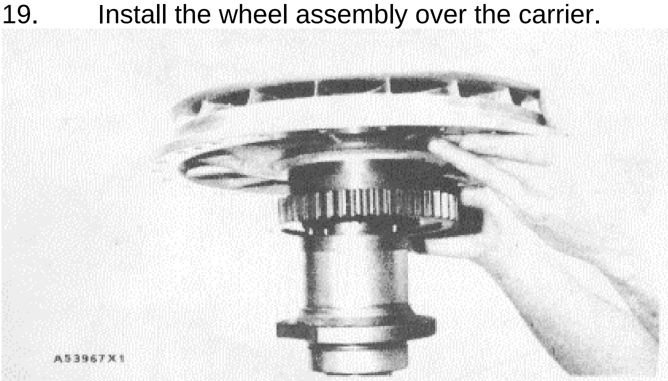
17. Install the bearing in gear (17) with tool (B) and an arbor press. Install the bearing until it is .32 in. (8.13 mm) below the machined surface (with threaded holes) of the gear.



18. Put wheel assembly (18) in position over gear (17). Install the bolts and plates that hold the unit together. Tighten the bolts to a torque of 20 ± 1 lb. ft. (25 ± 1 N. m).

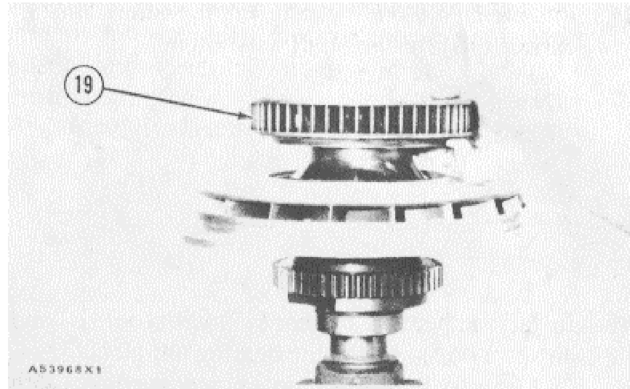


19. Install the wheel assembly over the carrier.

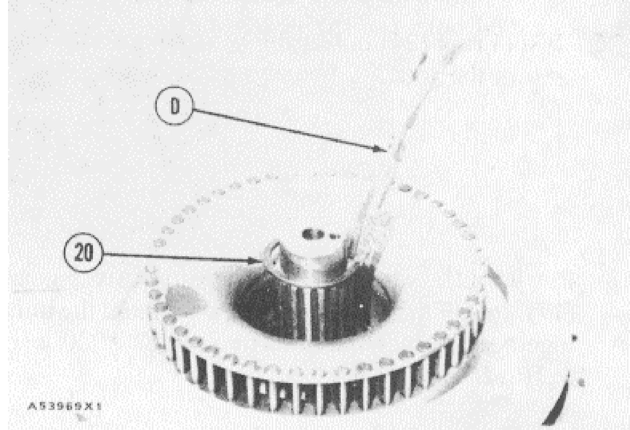


TORQUE CONVERTER

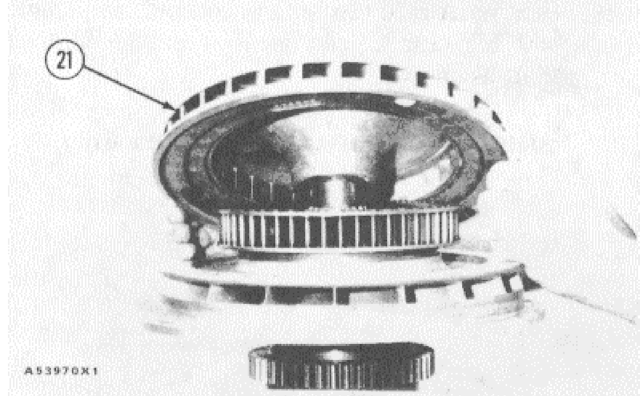
20. Put stator (19) in position in the turbine. Install the six bolts and two locks that hold it. Tighten the bolts to a torque of 20 ± 1 lb. ft. (25 ± 1 N-m).



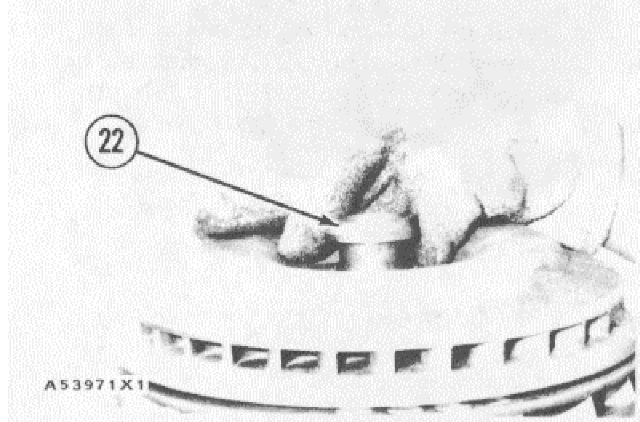
21. Install ring (20) with tool (D).



22. Put turbine (21) in position on the shaft as shown.

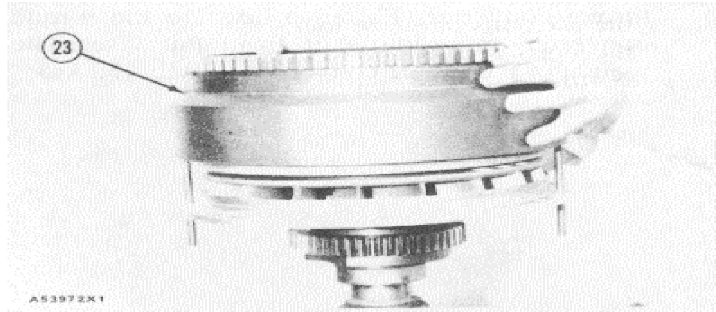


23. Heat inner race (22) to a temperature of 275°F (135°C) and install it on the shaft as shown.

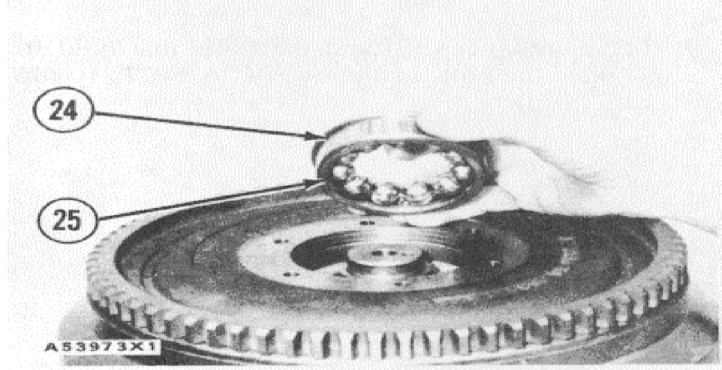


TORQUE CONVERTER

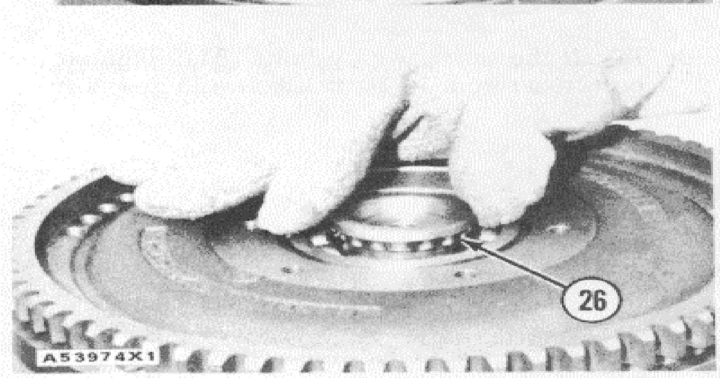
24. Install two 5/16"-18 NC guide pins 6 in. (15.2 cm) long in the rotating housing. Put rotating housing (23) in position over the turbine. Install five of the twenty-four bolts to hold the housing in position. Tighten the five bolts to a torque of 20 $^{+}$ I lb.ft. (25 + I N.m).



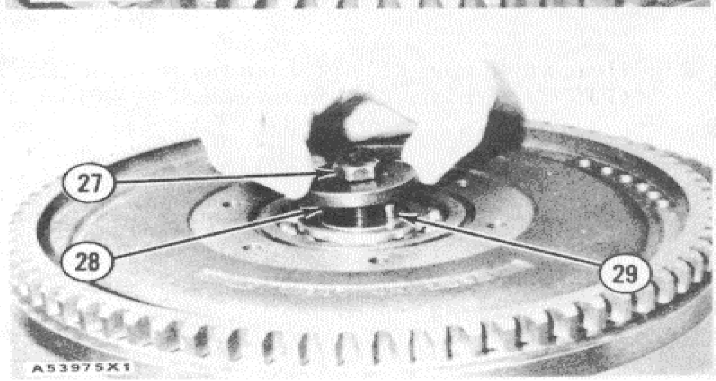
25. Install ring (24) in bearing (25). Install the bearing in the rotating housing as shown.



26. Heat inner race (26) to a maximum temperature of 275'F (I 35°C) and install it on the end of the shaft as shown.

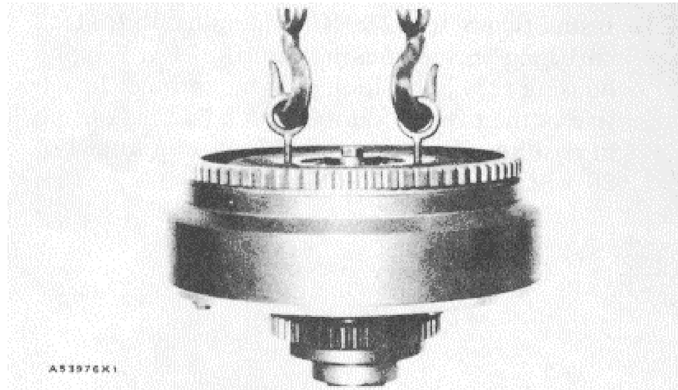


27. Install pin (29) in the end of the shaft. Install retainer (28) and bolt (27). Tighten the bolt to a torque of 81 + 4 lb.ft. (11 I + 5 N.m).

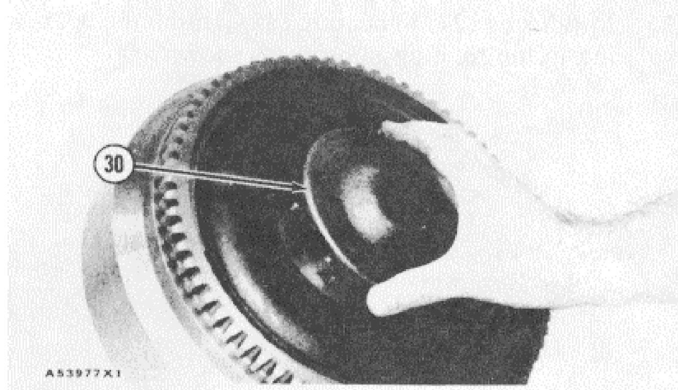


TORQUE CONVERTER

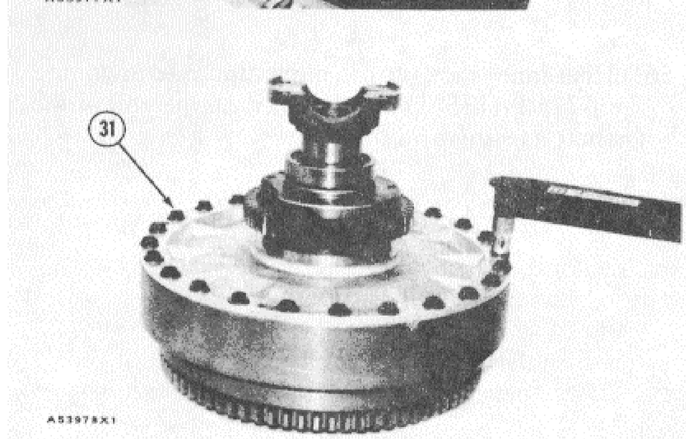
28. Install two 3/8"-16 NC forged eyebolts in the torque converter. Fasten a hoist to the torque converter and remove it from the vise. The weight of the torque converter is 70 lb. (32 kg).



29. Install retainer (30) and the bolts that hold it. Tighten the bolts to a torque of 36 - 2 Ib.ft. (46 _ 3 N.m).



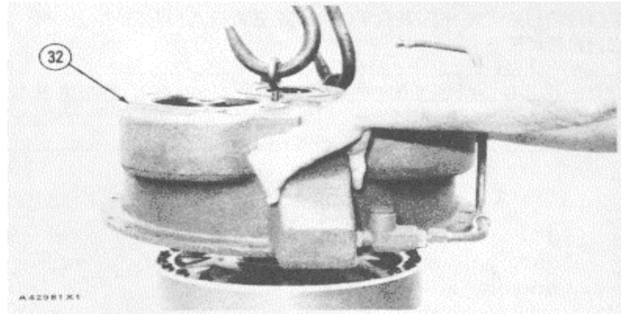
30. Install the other twenty) bolts (31). Tighten the bolts to a torque of 20 + I lb.ft. (25 - I N.m).



31. Remove the yoke from the shaft.

TORQUE CONVERTER

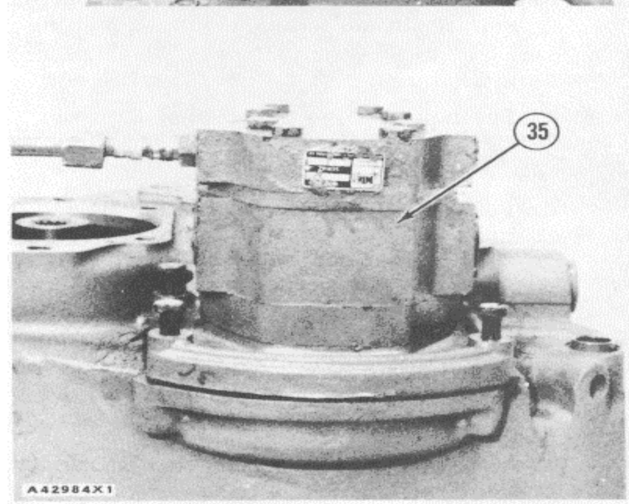
32. Fasten a hoist to converter housing (32) and put it in position over the rotating housing.



33. Install six bolts (34) that hold the converter housing in position. Tighten the bolts to a torque of 36 + 2 lb.ft. (46 + 3 N.m).

34. Install flange (33), the O-ring seal, the retainer and bolts that hold the flange in position. Tighten the bolts that hold the flange to a torque of 36 - 2 lb.ft. (46 + 3 N.m).

35. Install transmission oil pump (35). Install the four bolts that hold it. Connect the tube assembly to the transmission oil pump.



36. Install the steering and scraper hydraulic pump and the elevator hydraulic pump. end by:
    a) install torque converter

TORQUE CONVERTER CLEARANCE CHECKS

	Tools Needed	A	B
5B9079	Nut	4	
8S2328	Dial Test Indicator Group		1

1. There must be a minimum radial (running) clearance between the inside diameter of the rotating housing and turbine.

2. Check the clearance between the inside diameter of the rotating housing and the turbine as follows:

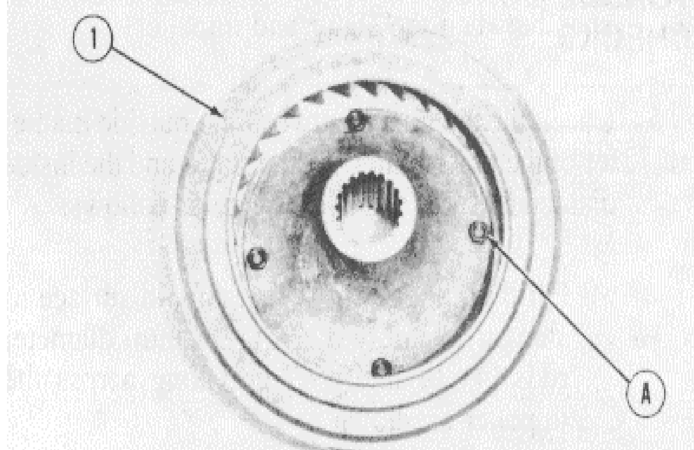
   a) Install tooling (A) in four positions in the rotating housing as shown.

   b) Put the rotating housing on a smooth fiat surface. Install turbine (I) in the housing.

   c) Put tooling (B) in the position shown.

   d) Push turbine (I) toward tooling (B) until it makes contact with the inside diameter of the rotating housing. Adjust the dial indicator until it is on zero. Slide the turbine 180° away from tooling (B) until it makes contact with the other side of the rotating housing. Make a record of the dimension measured.

   e) Make this check at several locations around the housing. Make a record of each of the dimensions measured. The largest dimension measured is used for the clearance between the two parts. The total clearance measured across the diameters must be .020 to .040 in. (0.51 to 1.02 mm) With a maximum permissible clearance of .045 in. (1.14 mm). The radial (running) clearance is half of the dimensions measured.



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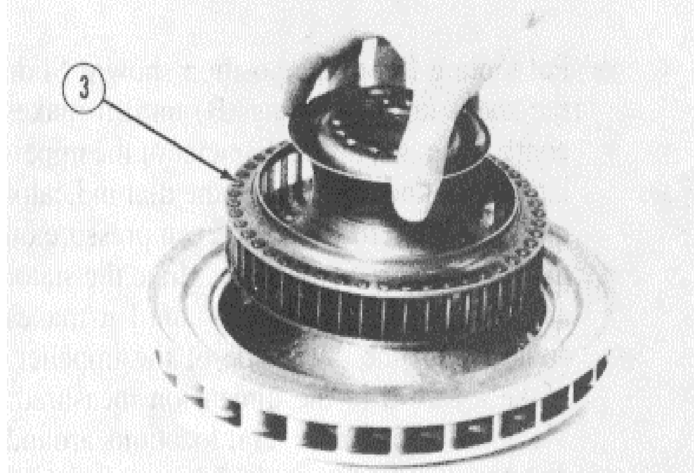

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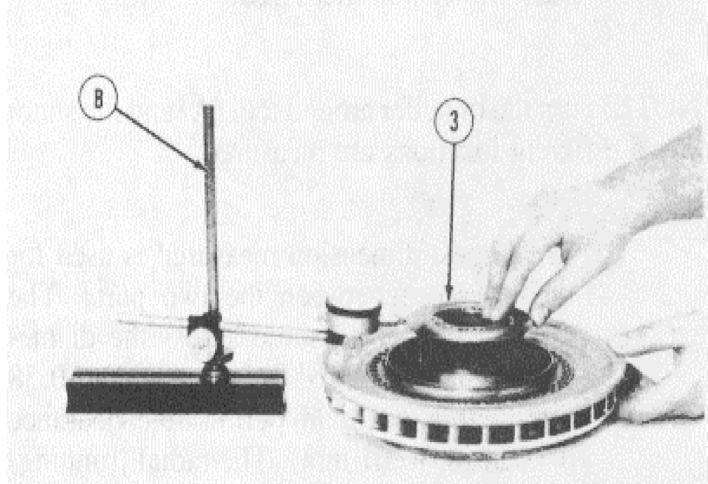
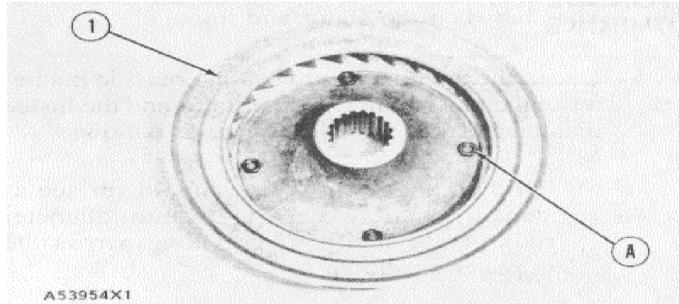


A53956X1

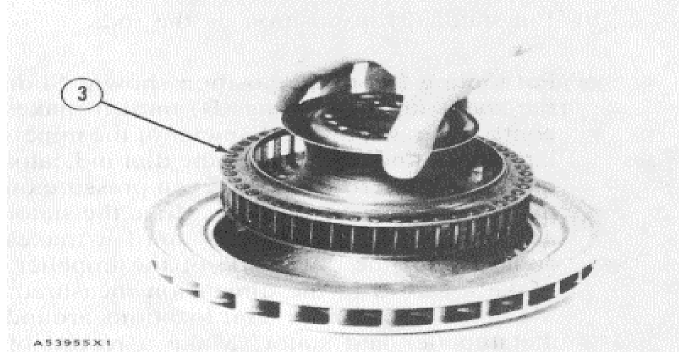
TORQUE CONVERTER CLEARANCE CHECKS

3. There must be a minimum radial (running) clearance between the turbine and stator. Check the clearance between the turbine and stator as follows:

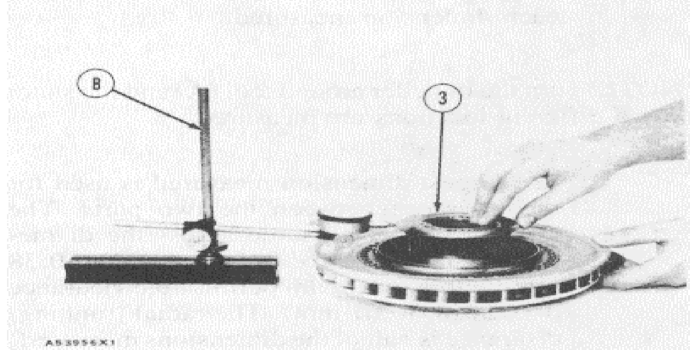
a) Put turbine (I) on a smooth flat surface. Install tooling (A) at four positions around the turbine as shown.



b) Put stator (3) in position in the turbine. Make sure the welded fins in the stator are not in contact with tooling (A).



c) Put tooling (B) against the stator as shown. Move the stator toward tooling (B) until it makes contact with the inside diameter in the turbine. Adjust the dial indicator until it is on zero. Slide stator (3) 180° away from tooling (B) until it makes contact with the other side of the turbine. Make a record of the dimension measured.



d) Make this check at several locations around the turbine. Make a record of each dimension measured. The largest dimension measured is used for the clearance between the two parts. The total clearance measured across the diameters must be .012 to .018 in. (0.30 to 0.46 mm) with a maximum permissible clearance of .030 in. (0.76 mm). The radial (running) clearance is half of the dimensions measured.

TORQUE CONVERTER CLEARANCE CHECKS

4. There must be a minimum radial (running) clearance between the stator and impeller.

5. Check the clearance between the outside diameter of the inner flange for the stator and the inside diameter of the impeller flange as follows:

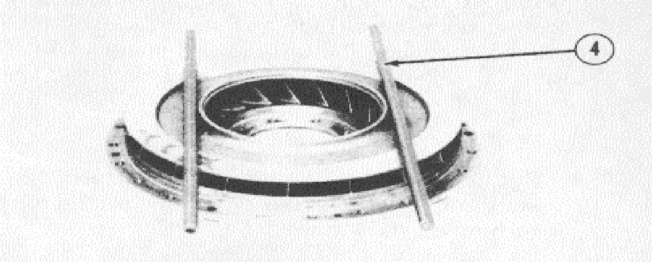
   a) Put the impeller on a flat smooth surface as shown. Install two ½/2" (12.7 mm) diameter rods (4) 18 in. (45.7 cm) long across the impeller as shown.

   b) Put stator (3) in position on the rods.

   c) Put tooling (B) in the position shown. Slide the stator toward tooling (B) until it makes contact with the inside diameter of the impeller and tooling (B). Adjust the dial indicator until it is on zero. Keep an even pressure on the stator when it is moved. Move the stator away from tooling (B) 180° until it makes contact with the other side of the impeller. Make a record of the dimension measured. Make this check at several locations around the impeller and stator. Make a record of each dimension measured.

NOTE: Turn the impeller around tool (A) and the stator when different locations are measured.

   d) The largest dimension measured is used for the clearance between the two parts. The total clearance measured across the diameters must be .009 to .015 in. (0.23 to 0.38 mm) with a maximum permissible clearance of .024 in. (0.61 mm). The radial (running) clearance is half of the dimensions measured.



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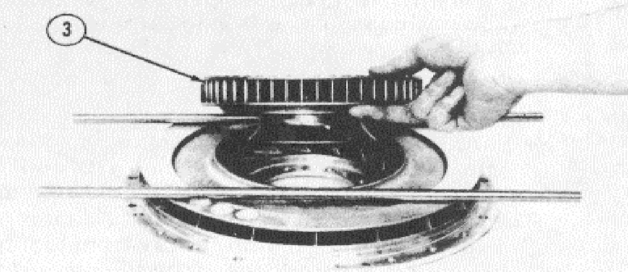

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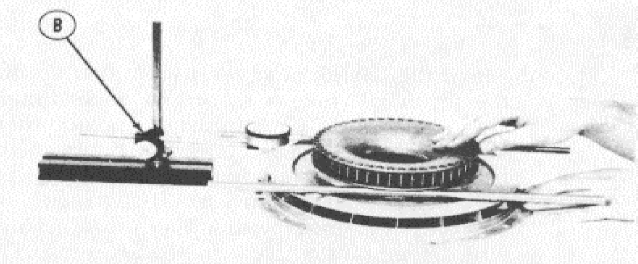

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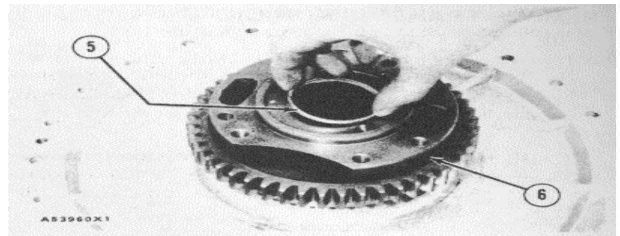
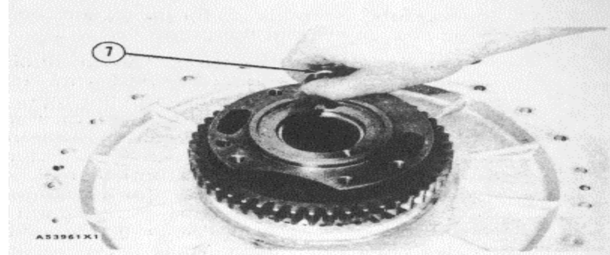
TORQUE CONVERTER CLEARANCE CHECKS

6. Check the ring gap in the carrier as follows;
   a) Install seal ring (5) in carrier (6).





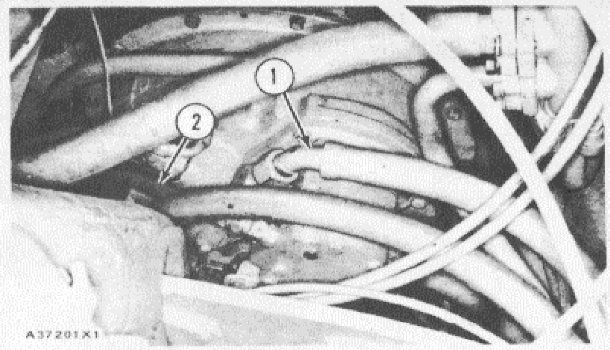
   b) Check the seal ring with a feeler gauge (7). The ring gap must be .005 to .O I S in. (0. 13 to 0.38 mm).

TRANSMISSION OIL PUMP

REMOVE TRANSMISSION OIL PUMP

1. Disconnect hose assembly (I) for the transmission oil filter from the pump.

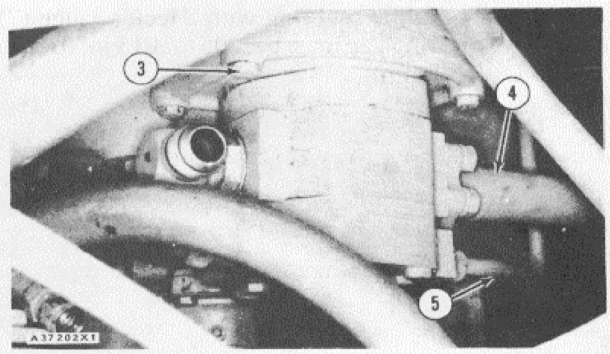
2. Disconnect hose assembly (2) for the transmission oil return from the pump.



3. Disconnect tube assembly (5) for the torque converter oil scavenge from the pump.

4. Disconnect tube assembly (4) for the transmission oil supply from the pump.

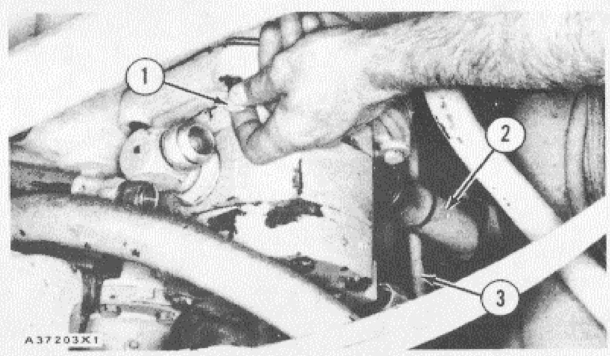
5. Remove bolts (3) and remove the pump from the torque converter.



INSTALL TRANSMISSION OIL PUMP

1. Put a new gasket on the pump and put the pump in position in the torque converter housing.

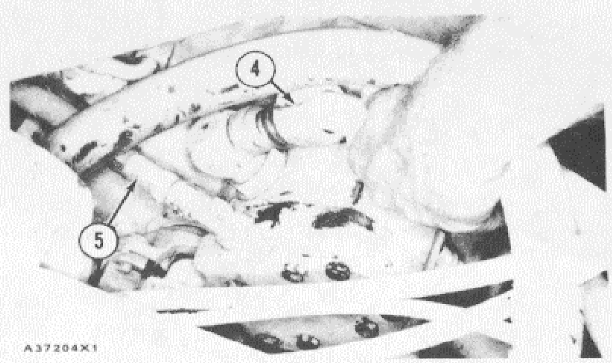
2. Install bolts (1) and tighten to a torque of 36 $^{+}$ 2 lb.ft. (46 ± 3 N.m).



3. Connect tube assemblies (2) and (3) to the pump.

4. Connect hose assemblies (4) and (5) to the pump.

5. Fill the transmission with transmission oil to the correct level.



TRANSMISSION OIL PUMP

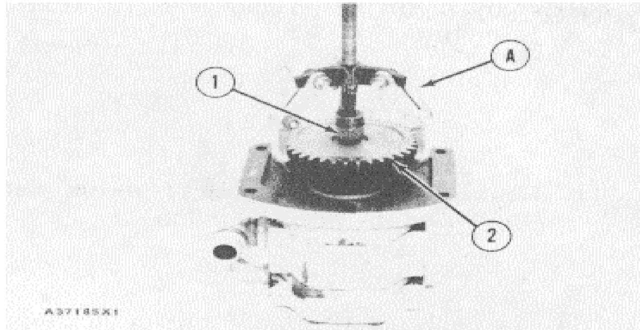
DISASSEMBLE TRANSMISSION OIL PUMP

	Tools Needed	A
1P2321	Puller Assembly1	
1 P463	Drive Plate	1

start by:

a) remove transmission oil pump

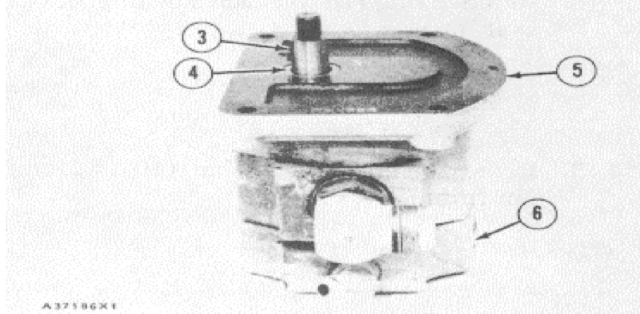
1. Loosen nut (I) and pull gear (2) loose with tool (A).
2. Remove tooling (A), nut (I) and gear (2).



3. Loosen the eight bolts on the back of plate (6).

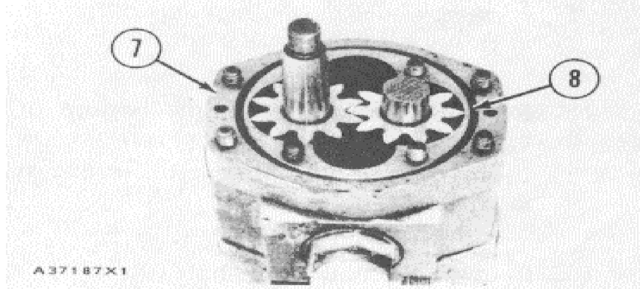
4. Remove key (3) from the shaft.

5. Remove plate assembly (5) from the pump.



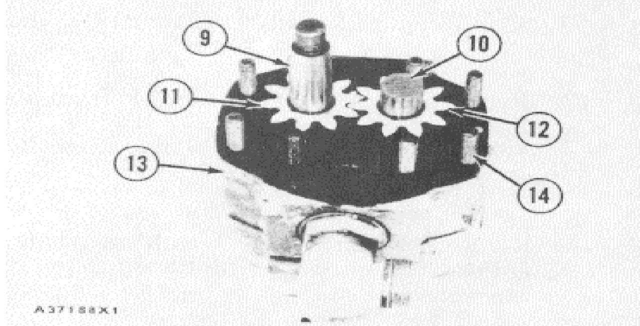
6. Remove seal (4) from plate assembly (5).

7. Remove case (7) and remove O-ring seals (8) from each side of the case.



8. Remove bolts (14) from the pump.

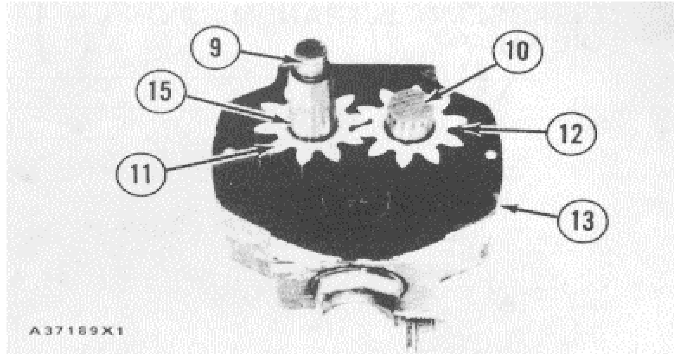
9. Remove spacer assembly (13), shaft (9), gear (11), shaft (10) and gear (12) as a unit.



TRANSMISSION OIL PUMP

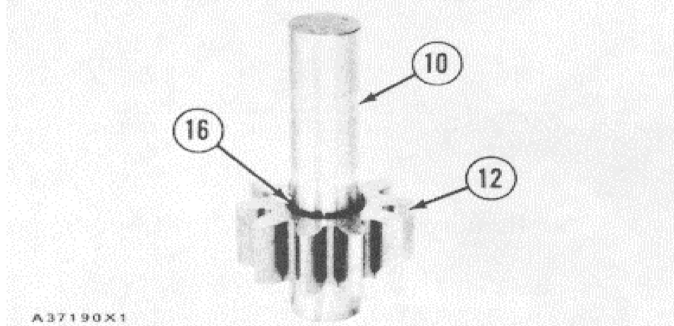
10. Remove shaft (10) and gear (12) from spacer assembly (13).

11. Remove ring (15) and gear (I I) from shaft (9).



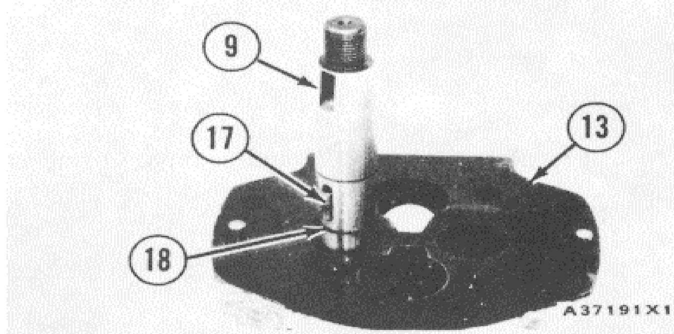
12. Remove ring (16) on each side of gear (12) from haft (10).

13. Remove gear (12) from shaft (10) and remove the in from shaft (10).



14. Remove pin (17) and ring (18) from shaft (9).

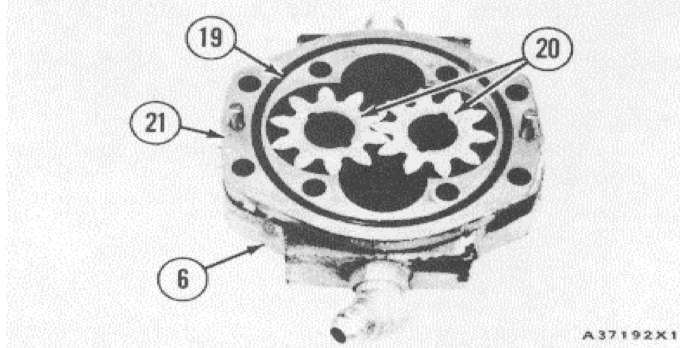
15. Remove shaft (9) from the bottom of spacer assembly (13).



16. Remove the ball from shaft (9).

17. Remove gears (20) and case (21) from plate (6).

18. Remove O-ring seals (19) from each side of case (21).

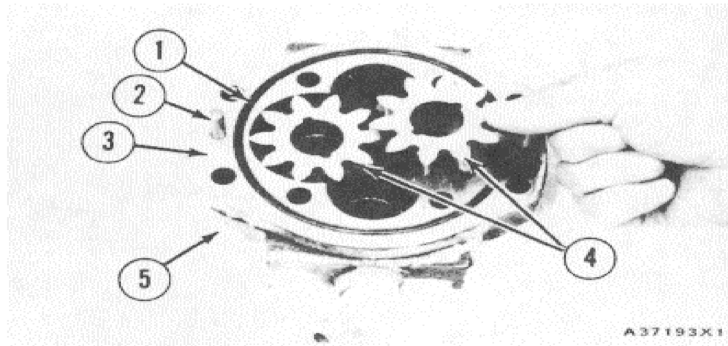


TRANSMISSION OIL PUMP

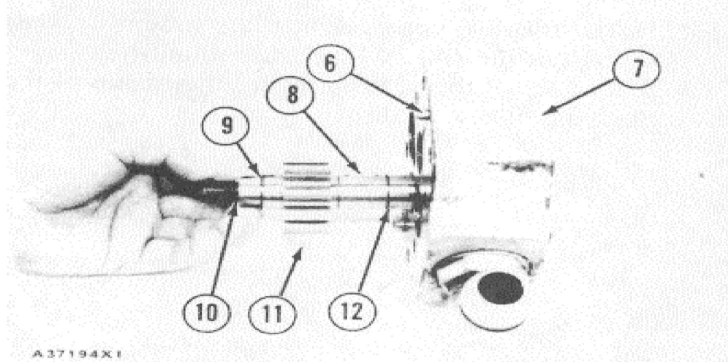
ASSEMBLE TRANSMISSION OIL PUMP

	Tools Needed	A
1P531	Handle	1
1P461	Drive Plate	1
1P472	Drive Plate	1

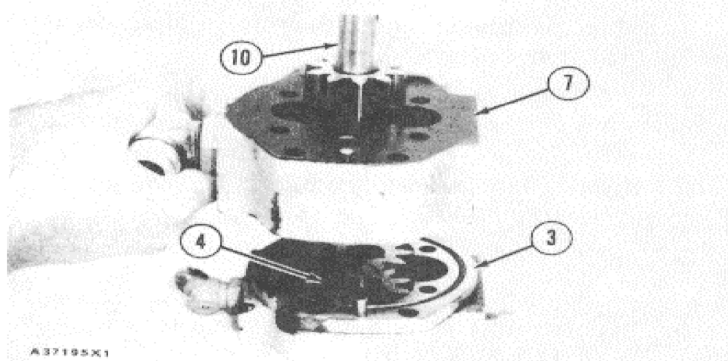
1. Make a replacement of pins (2) in plate (5) if necessary.
2. Install o-ring seals (1) on each side of case (3).
3. Put case (3) and gears (4) in position on plate (5).



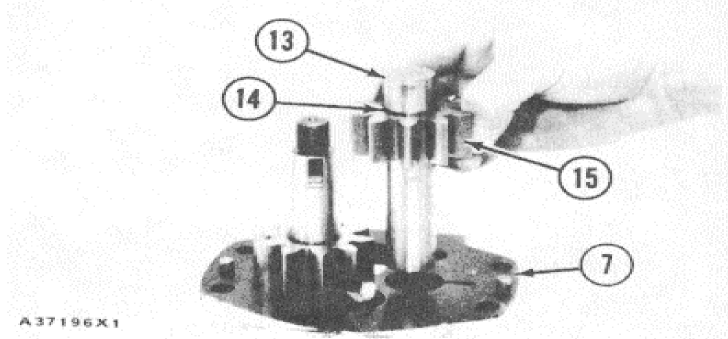
4. Make a replacement of pins (6) in spacer assembly (7) if necessary.
5. Install ring (12), pin (8), gear (11) and ring (9) on shaft (10).



6. Install shaft (10) in spacer assembly (7) and install the ball that holds the shaft in position.
7. Install spacer assembly (7) on case (3) and turn shaft (10) until the ball fits into the groove (slot) in gear (4).



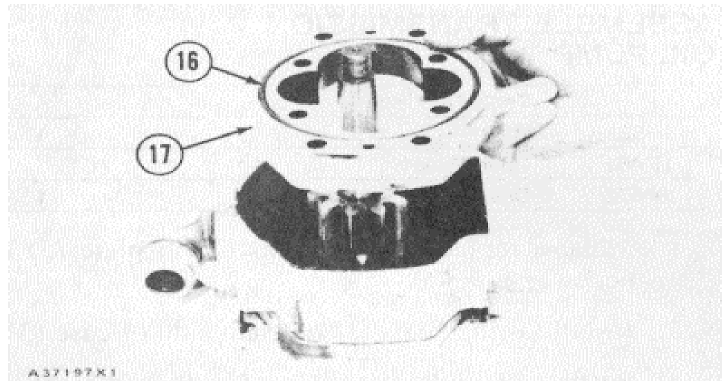
8. Install the pin in shaft (13) that holds gear (15).
9. Install gear (15) on shaft (13) and install the two rings (14) on each side of the gear.



10. Install shaft (13) in spacer assembly (7).

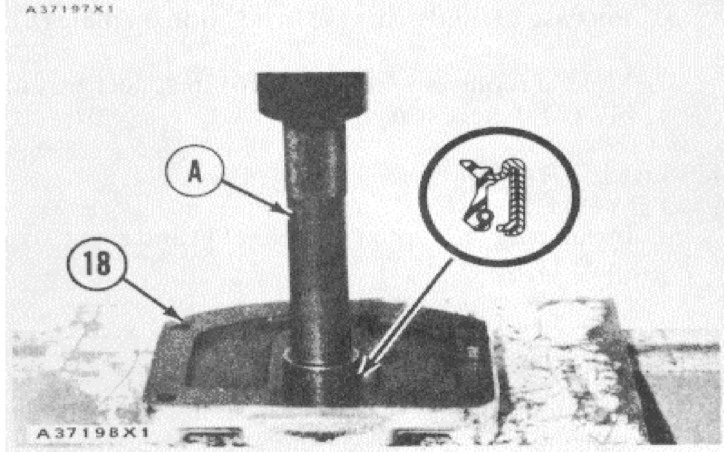
TRANSMISSION OIL PUMP

11. Install O-ring seals (16) on each side of case (17).

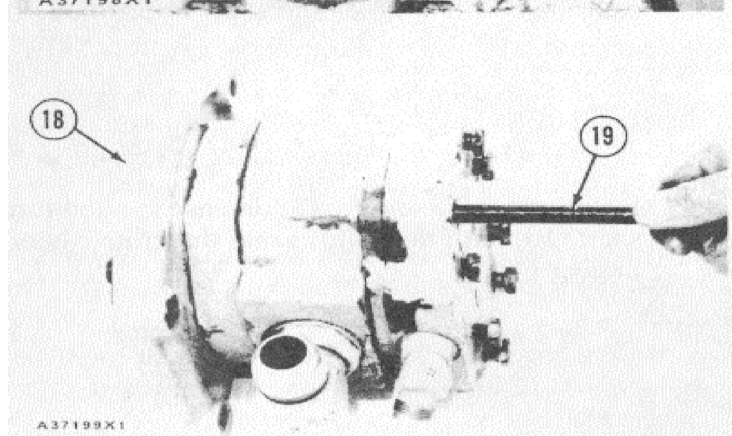


I2. Install case (17) on the spacer assembly.

13. Install the lip type seal in plate assembly (18) with tooling (A). Make sure that the spring loaded lip of the seal is toward the inside of the plate assembly as shown.



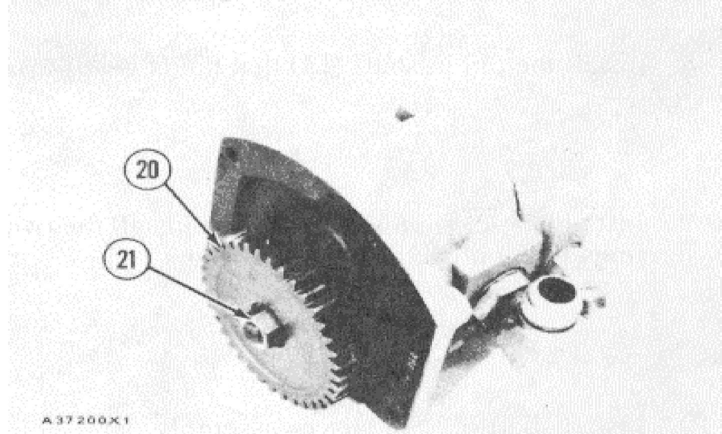
14. Make a replacement of the pins in plate assembly (18) if necessary.



15. Install plate assembly (18).

16. Install bolts (19) and tighten to a torque of 36 ± 2 lb. ft. (46 ± 3 N•m).

17. Install the key in the shaft.



18. Install gear (20) and tighten nut (21) end by:

a) install transmission oil pump

TRANSMISSION OIL FILTER AND BYPASS VALVE

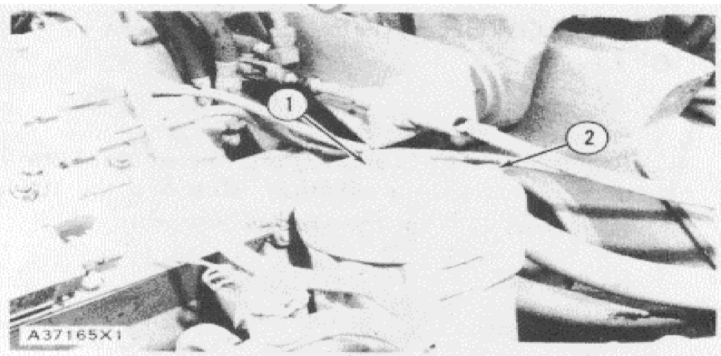
REMOVE TRANSMISSION OIL FILTER AND BYPASS VALVE

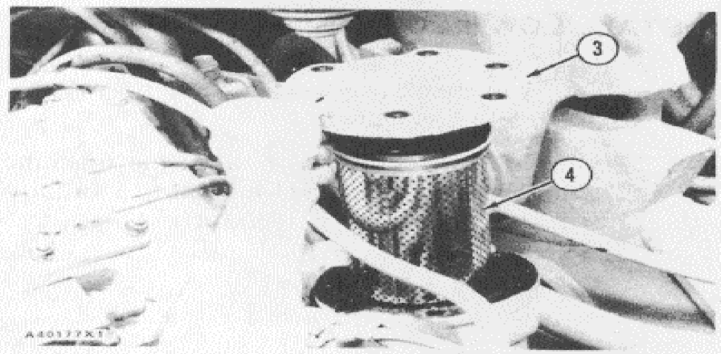
1. Remove plug (1), the spring and bypass valve spool.

2. Remove bolts (2).

3. Remove cover assembly (3) and element assembly) (4) from the filter housing.

4. Remove nut (5), the retainer and element assembly) (4) from cover assemble) (3). Remove the O-ring seals from the cover assembly and element assembly.





INSTALL TRANSMISSION OIL FILTER AND BYPASS VALVE

1. Put the O-ring seal in position on cover assembly (1).

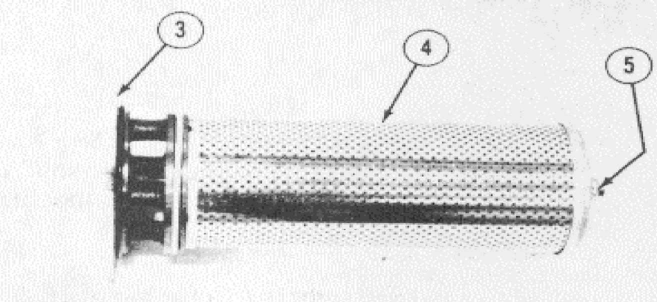
2. Make sure stud (5) is tightened to a torque of 40 ± 5 lb. ft. (55 ± 7 N•m).

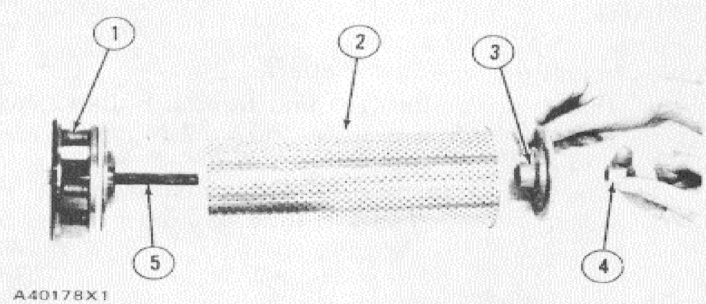
3. Install the O-ring seal on retainer (3).

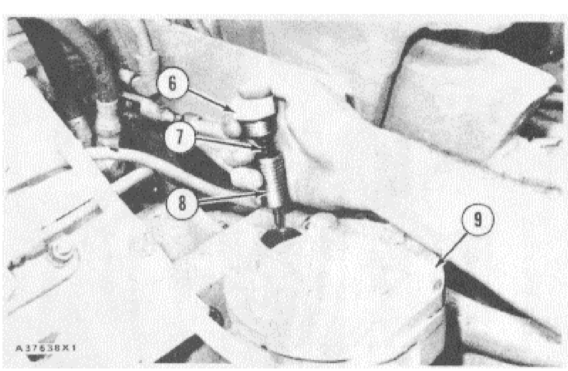
4. Install element assembly (2), retainer (3) and nut (4) on the cover assembly. Tighten the nut to a torque of 10 ± 2 lb. ft. (14 ± 3 N•m).

5. Install the cover assembly and element assembly in the housing and tighten-bolts (9).

6. Install valve spool (8), spring (7), the O-ring seal and plug (6). Tighten the plug to a torque of 35 5 lb. ft. (45 ±7 N•m).



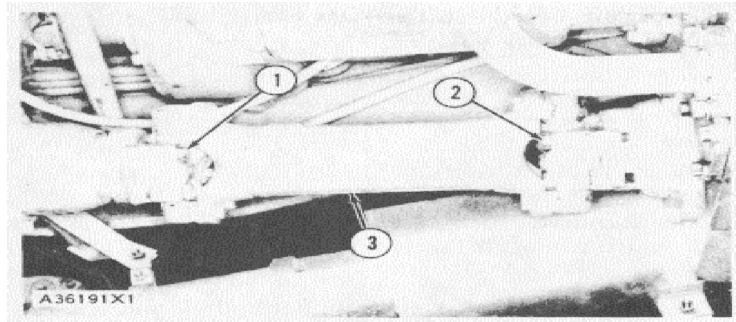




DRIVE SHAFTS

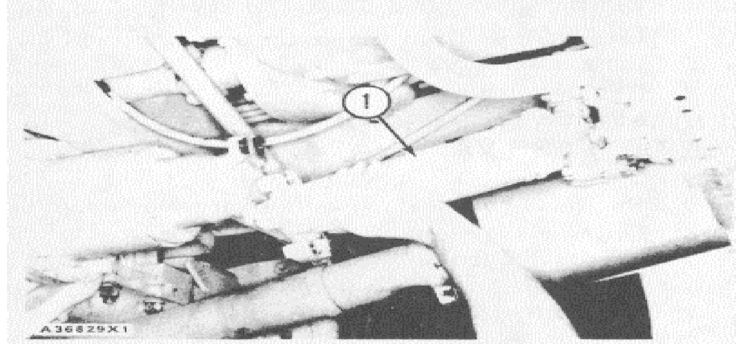
REMOVE LOWER DRIVE SHAFT

1. Remove bolts (I) and (2) and the nuts that hold drive shaft (3) in position. Remove the drive shaft.



INSTALL LOWER DRIVE SHAFT

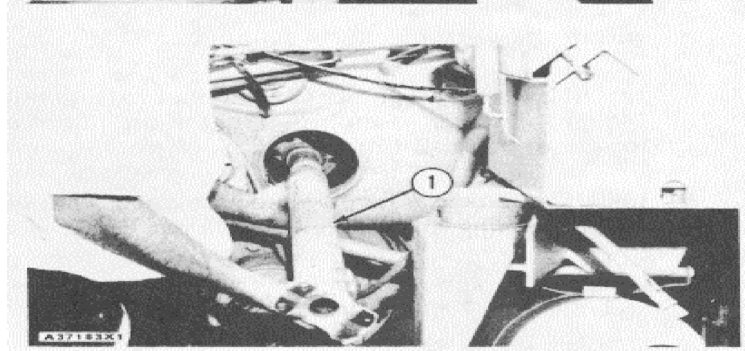
1. Put drive shaft (1) in position on the machine. Tighten the eight bolts and four nuts to a torque of 120 ± 10 lb. ft. (160 ± 14 N•m).



REMOVE UPPER DRIVE SHAFT

start by:
a) remove transmission and transfer gears

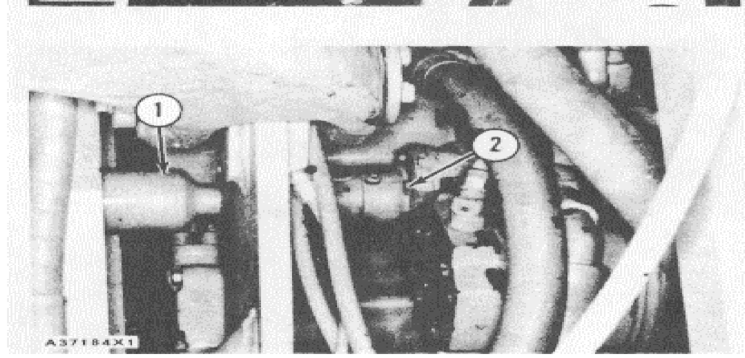
1. Remove the four bolts that connect drive shaft (1) to the torque converter and remove the drive shaft.



INSTALL UPPER DRIVE SHAFT

1. Install drive shaft (1) and tighten bolts (2) to a torque of 45 ± 5 lb. ft. (60 ± 7 N•m).

end by:
a) install transmission and transfer gears



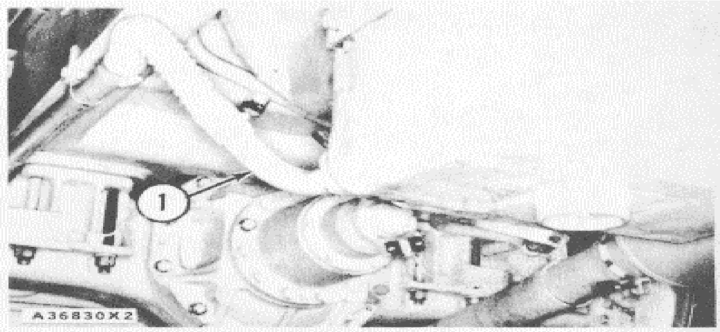
TRANSMISSION AND TRANSFER GEARS

REMOVE TRANSMISSION AND TRANSFER GEARS

start by:
a) remove lower drive shaft

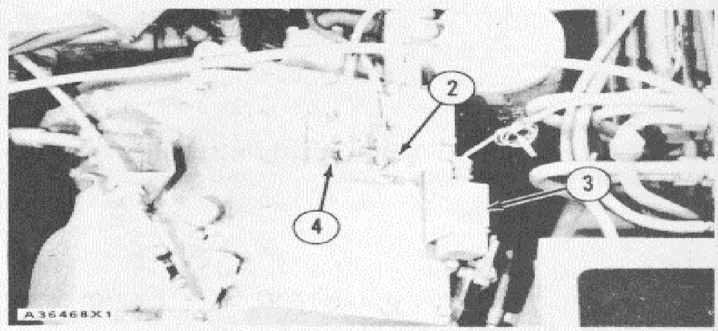
1. Turn the tractor $^{90^\circ}$ to the scraper.

2. Drain the oil from the transmission and transfer gears.
3. Disconnect pump supply line (I) from the transmission.



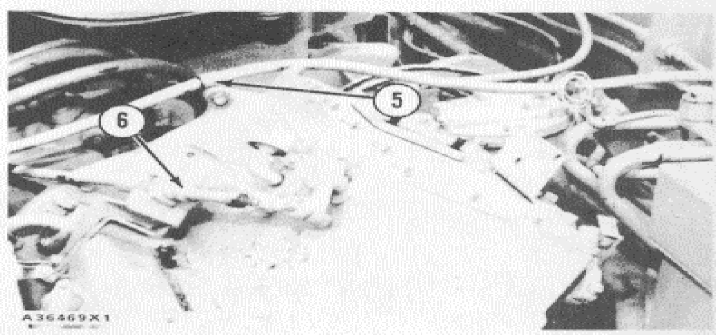
4. Remove back-up alarm switch (3) from the transmission and move it to the side.

5. Remove two nuts (4) and remove grease line bracket (2) from the transmission.



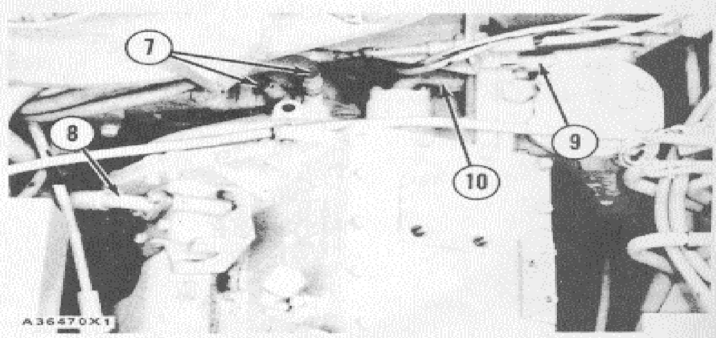
6. Remove the bolt and nut from battery wire clip (5).

7. Disconnect speed selector control cable (6) and the directional control cable from the levers and brackets on the transmission.



8. Disconnect oil cooler hose (8) and lubrication lines (7) from transmission.

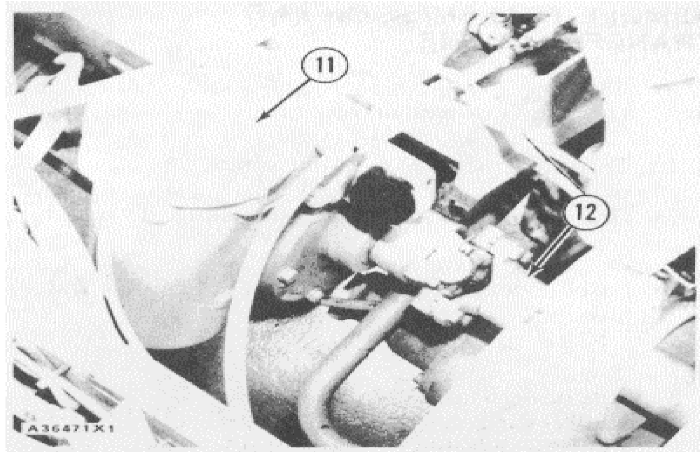
9. Disconnect supply lines (9) and (10) from transmission.



TRANSMISSION AND TRANFER GEARS

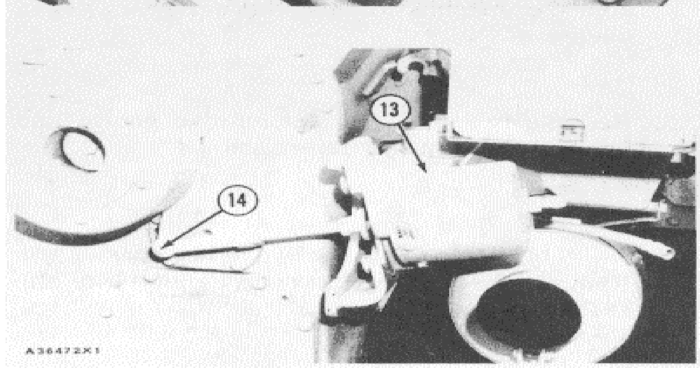
10. Remove transmission oil filter base (II).

11. Disconnect drive shaft (I 2) from the input transfer gears.



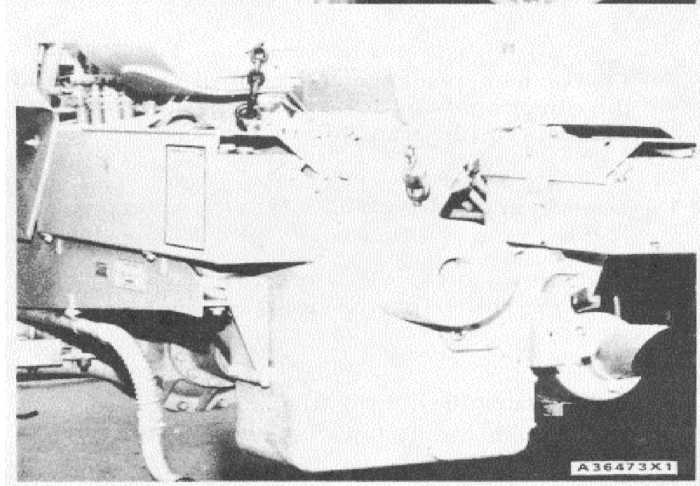
12. Disconnect the air line from brake chamber assembly (13).

13. Release the parking brake with shop air pressure of 70 psi (4.9 kg/cm²) or (480 kPa). Remove the cotter pin and pin (14).



14. Remove brake chamber assembly (13) from the bracket.

15. Install two 5/8"-11 NC forged eyebolts in the transfer gear cases. Fasten a hoist to the transmission and transfer gears. Remove the six bolts that hold the transmission and transfer gears to the tractor. Remove the transmission and transfer gears. Weight of the transmission and transfer gears is 1250 lb. (563 kg).

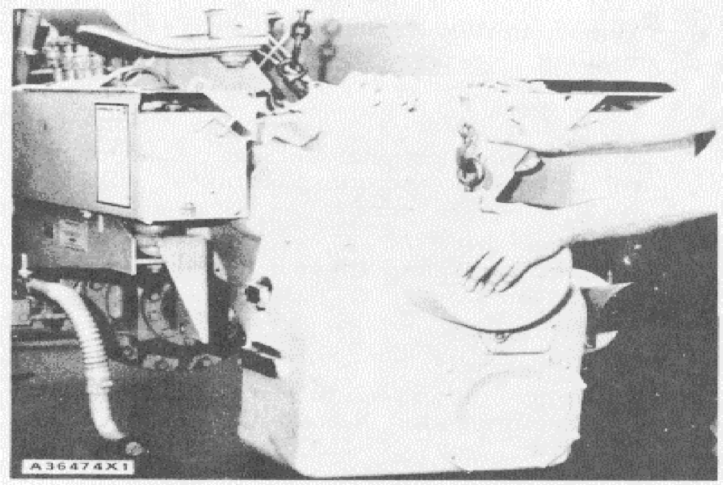


TRANSMISSION AND TRANSFER GEARS

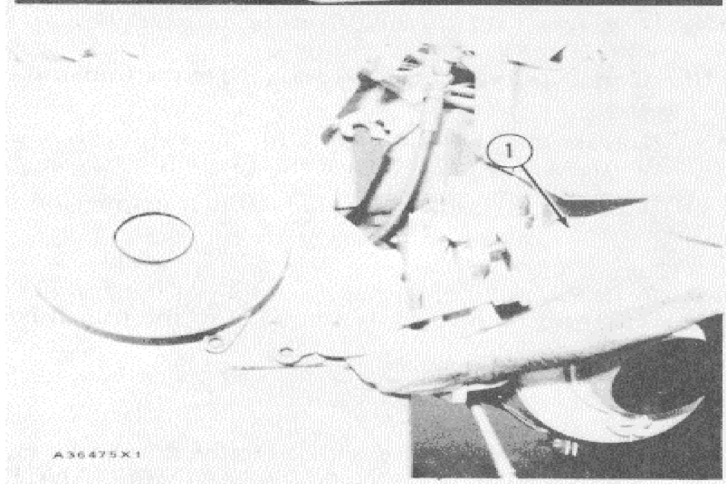
INSTALL TRANSMISSION AND TRANSFER GEARS

1. Fasten a hoist to the transmission and transfer gears.

2. Put the transmission and transfer gears in position on the tractor and tighten the six bolts that hold the transmission and transfer gears to the tractor.

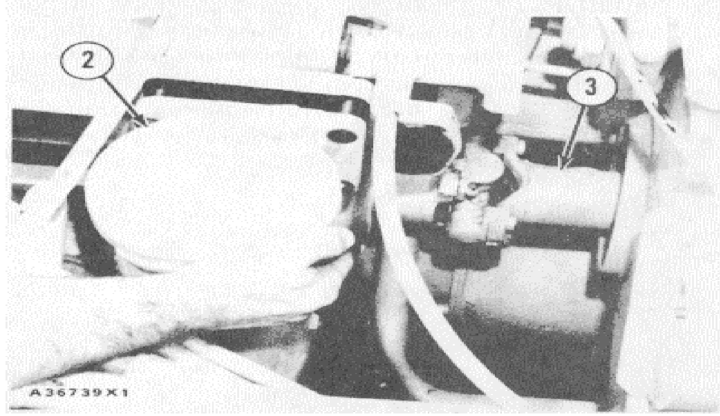


3. Install brake chamber assembly (1). Activate the brake chamber assembly with shop air pressure at 70 psi. (4.9 kg/cm²) or (480 kPa). Connect the rod end to the parking brake lever with the pin and cotter pin.



4. Connect upper drive shaft (3) to the input transfer gears.

5. Install transmission oil filter base (2).

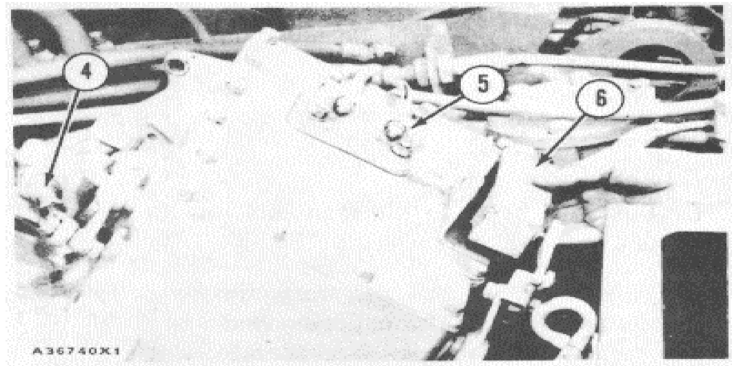


TRANSMISSION AND TRANSFER GEARS

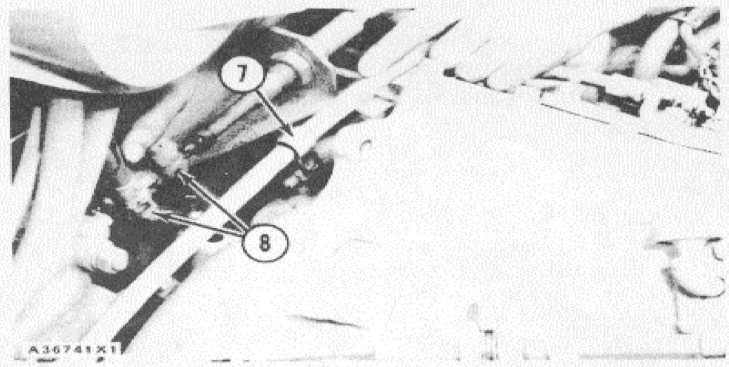
6. Connect lubrication line bracket (5) to the transmission.

7. Connect the directional and speed selector control cable (4) to the transmission.

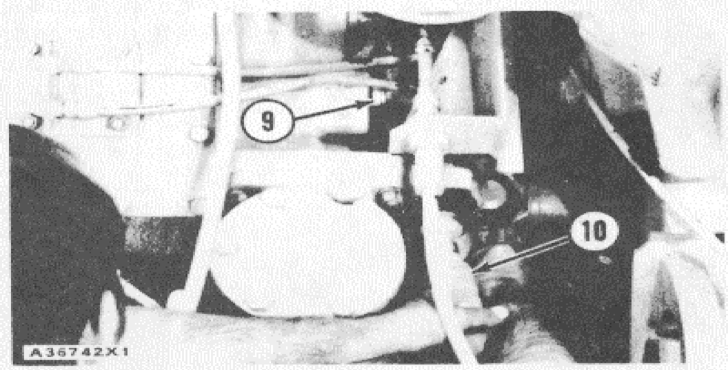
8. Install back-up alarm (6) switch on the bracket on the transmission.



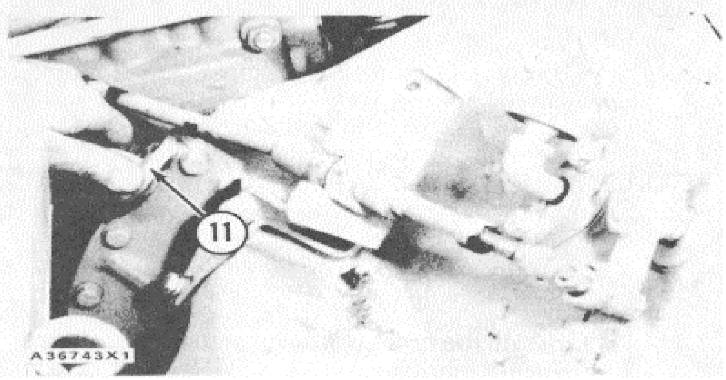
9. Install the bolt and nut in battery cable clip (7). Connect lubrication lines (8) to the input-transfer gear case.



10. Connect supply lines (9) and (10) to the transmission.

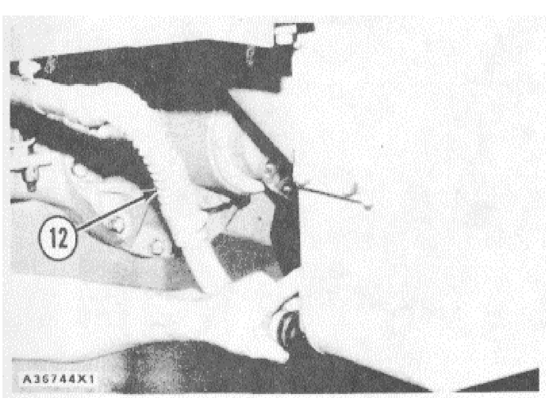


11. Connect oil cooler line (11) to the transmission.



12. Connect pump supply line (12) to the transmission.

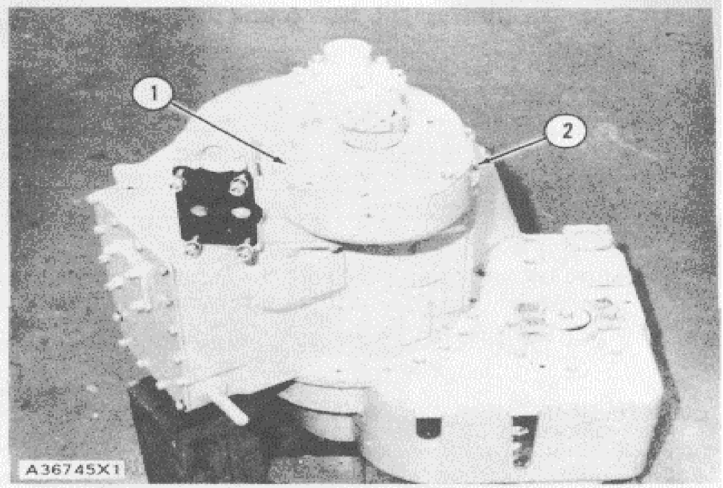
13. Fill the transmission with oil to the correct level. See LUBRICATION AND MAINTENANCE GUIDE.
    end by:
    a) install lower drive shaft



INPUT TRANSFER GEARS AND TRANSMISSION

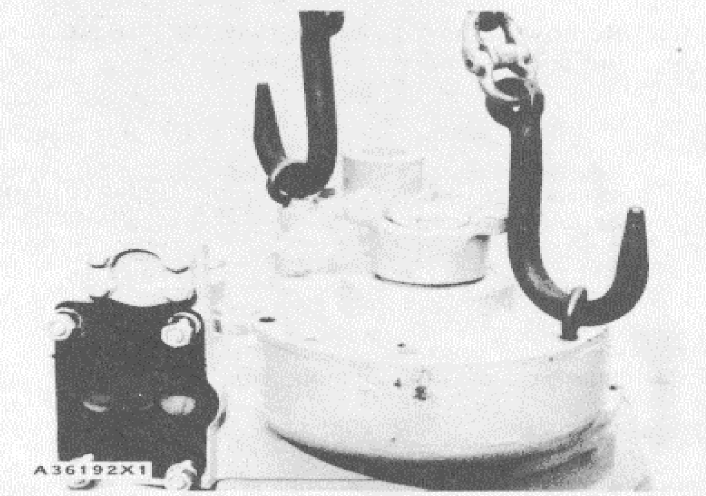
SEPARATION OF INPUT TRANSFER GEARS FROM TRANSMISSION

start by:
a) remove transmission and transfer gears
b) remove parking brake



1. Fasten a hoist to the transmission and transfer gears. Put the transmission and transfer gears on wood blocks as shown. Weight of the transmission and transfer gears is 1250 lb. (563 kg).

2. Remove bolt (I) and bolts (2).



3. Install two 3/8"-16 NC forged eyebolts in the input transfer gear housing.

4. Fasten a hoist and remove the input transfer gears. Weight of the input transfer gears and housing is 140 lb. (63 kg).

CONNECTION OF INPUT TRANSFER GEARS TO TRANSMISSION

1. Fasten a hoist to the input transfer gear housing.

2. Put the input transfer gears in position on the transmission and tighten the bolts.

CAUTION: Do not damage the seal ring on the end of the transmission shaft when the transfer gears are installed.

end by:
a) install the transmission and transfer gears
b) install parking brake

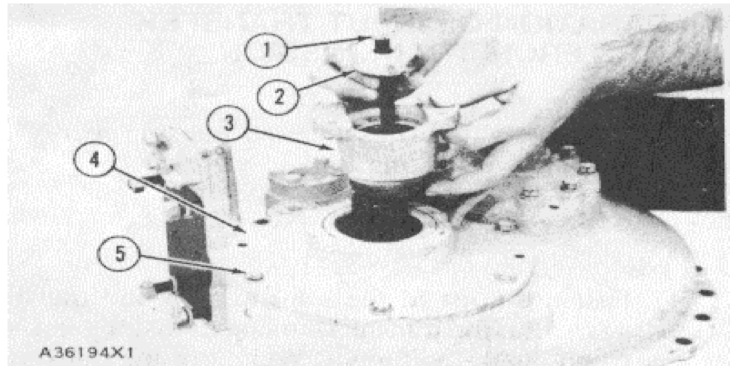
INPUT TRANSFER GEARS

DISASSEMBLE INPUT TRANSFER GEARS

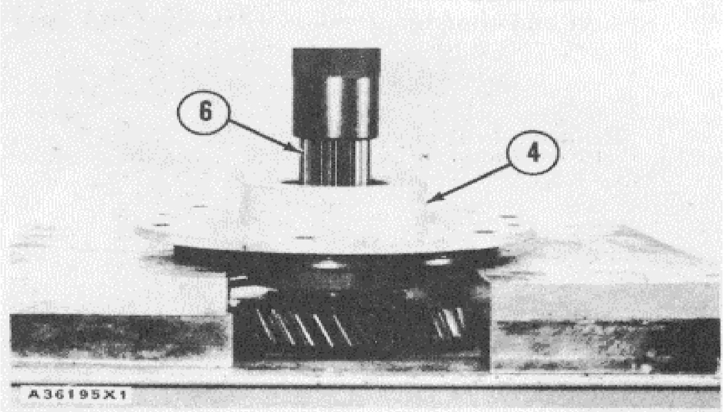
	Tools Needed	A	B
8B7548	Puller Assembly	1	
8B7554	Bearing Cup Puller Attachment	1	
8H684	Ratchet Box Wrench	1	
5P2970	Spanner Wrench		1

start by:
a) separation of input transfer gears from transmission

1. Remove bolt (1), washer (2) and flange (3).

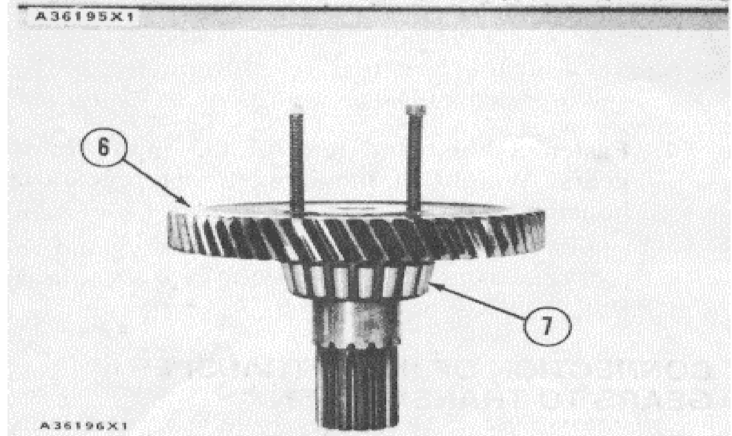


2. Remove bolts (5) and use two 3/8'- 16 NC forcing screws and remove cage (4).



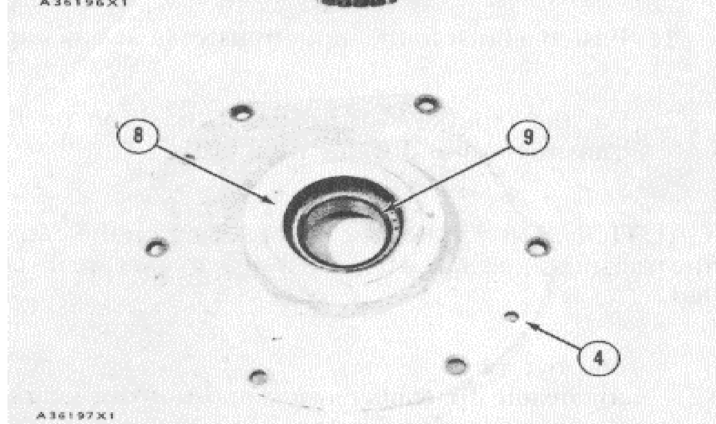
3. Use a press and remove the input gear (6) from cage (4) as shown.

4. Remove the spacer from gear (6).

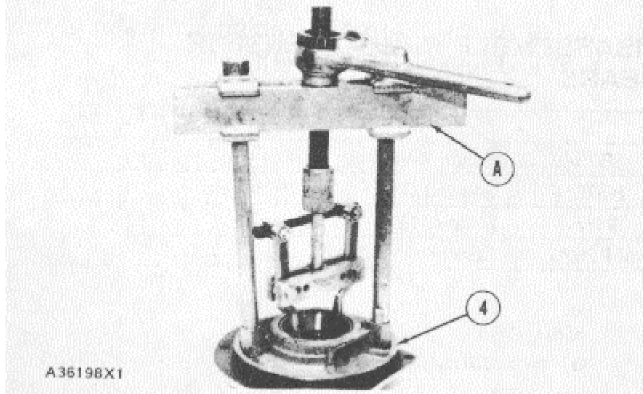


5. Install two 3/8"-16 NC forcing screws and remove bearing cone (7) from gear (6).

6. Remove seal (8) and bearing cone (9) from cage (4).



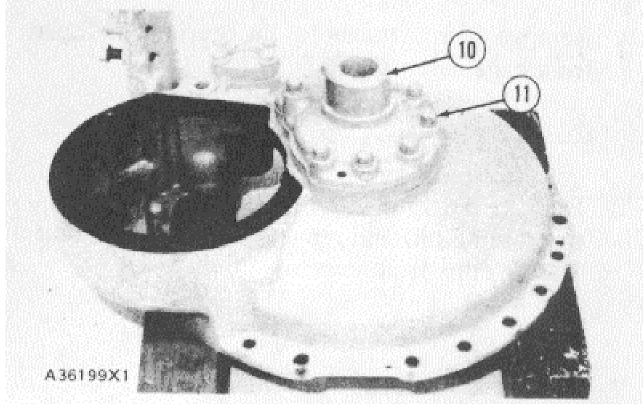
INPUT TRANSFER GEARS



7. Use tooling (A) and remove the inner and outer bearing cups from cage (4).

8. Remove the ring that holds the bearing cups apart from cage (4).

9. Remove the O-ring seal from cage (4).

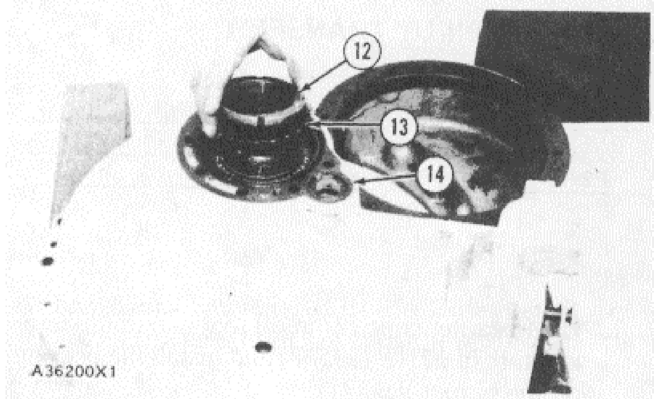


10. Remove bolts (I I).Install two 3/8"'-16 NC forcing screws and remove manifold (10).

11. Remove the small O-ring seal from cage assembly (14).

12. Use tool (B) and remove nut (12) and lock (13).

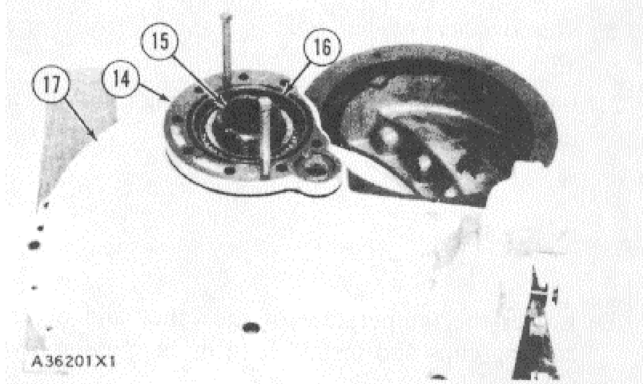
CAUTION: When the cage assembly and bearing cone are removed, gear (15) is free to fall from case assembly. Use a wooden block to hold gear in position to prevent damage.



13. Install two 3/8"-16 NC forcing screws and remove cage assembly (14) and the bearing cone as a unit from case assembly (17).

14. Remove the O-ring seals from case assembly (17).

15. Remove O-ring seal (16) from cage assembly (14).

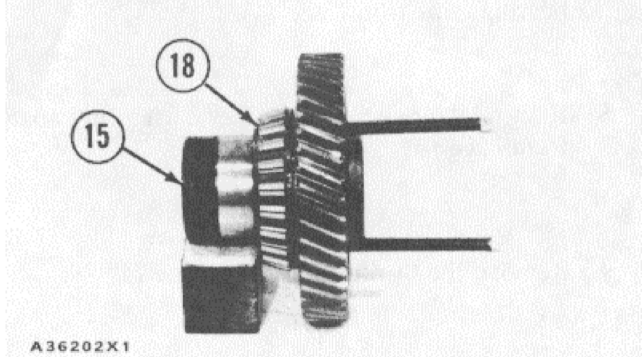


16. Remove gear (15) from case assembly (17).

17. Remove the spacer from gear (15).

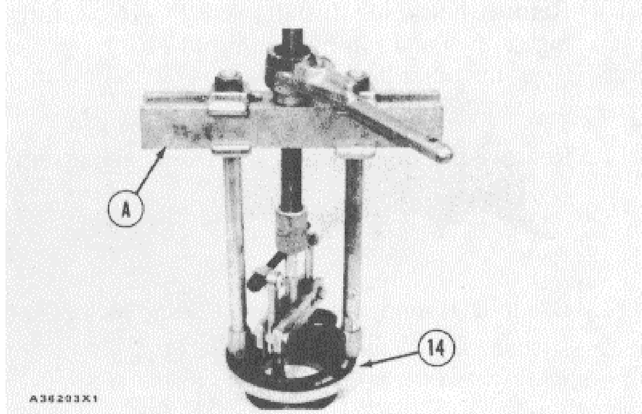
INPUT TRANSFER GEARS

18. Install two 3/8"-16 NC forcing screws in gear (15) and remove bearing (18).



19. Remove the ring that holds the bearing cups apart from cage assembly (14).

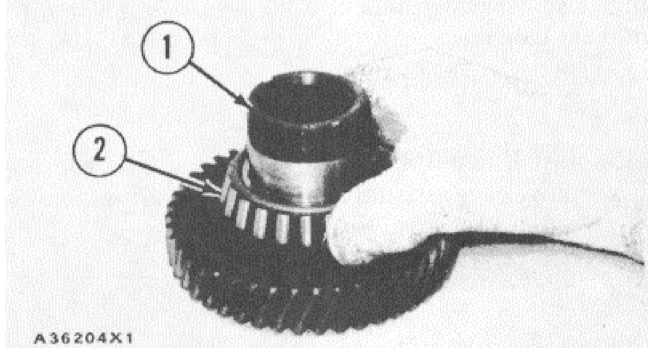
20. Use tooling (A) and remove the inner and outer bearing cups from cage assembly (14).



ASSEMBLE INPUT TRANSFER GEARS

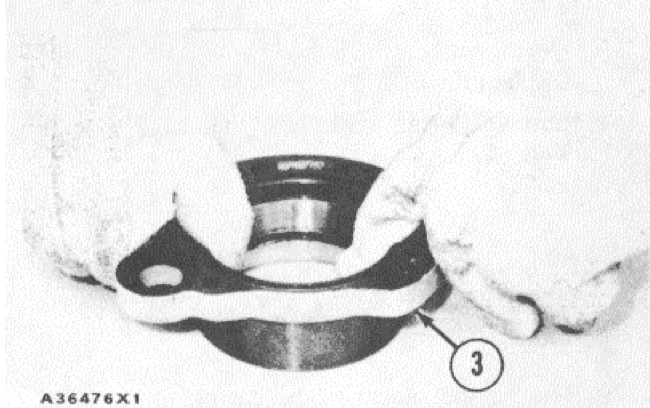
	Tools Needed	A
5P2970	Spanner Wrench	1

1. Heat bearing cone (2) in oil to a maximum temperature of 275°F (135°C) and install the bearing on the output gear (1).



2. Install the ring that holds the bearing cups apart in cage assembly (3).

3. Lower the temperature of the inner and outer bearing cups and install them in cage assembly A36476 (3).



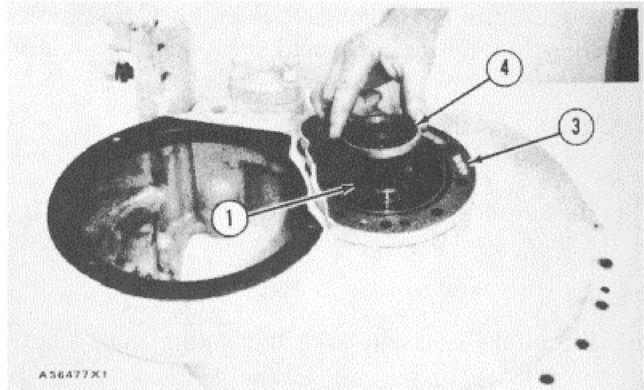
INPUT TRANSFER GEARS

4. Install the O-ring seals in the case assembly and cage assembly (3).

5. Install cage assembly (3) in the case assembly.

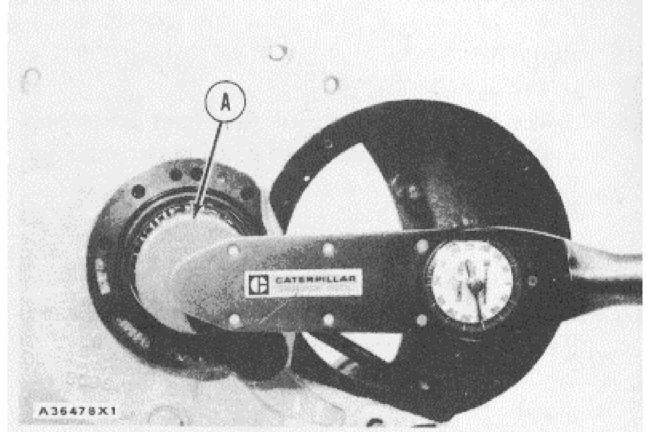
6. Put gear (1) in position in the case assembly. Use a wood block to hold the gear in position.

7. Install spacer (4) on gear (1).

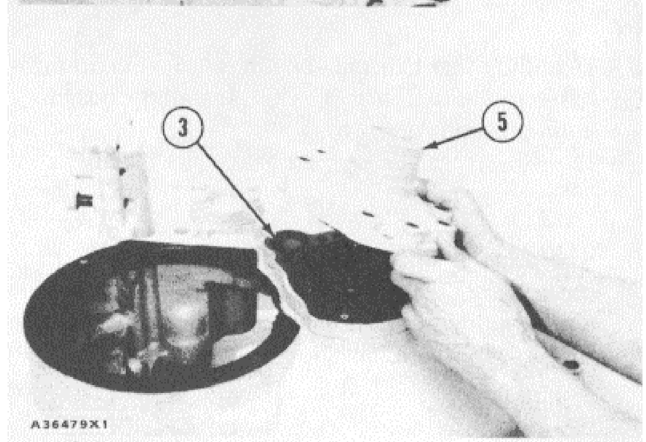


8. Heat the outer bearing cone in oil to a maximum temperature of 275°F (I 35°C). Install the bearing cone on gear (1).

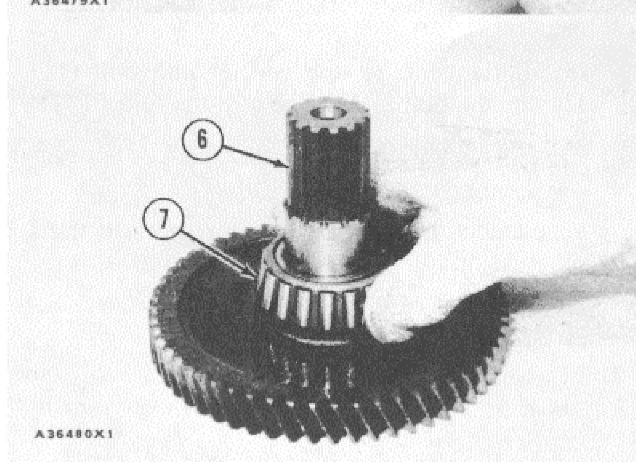
9. Install the lock and nut on gear (1). Use tool (A) and tighten the nut to a torque of 150 + 10 lb.ft. (205 + 14 N.m). Bend the lock on the nut.



10. Install manifold (5) on cage assembly (3).



11. Heat inner bearing cone (7) in oil to a maximum temperature of 275°F (135°C). Install inner bearing cone (7) on input gear (6).



INPUT TRANSFER GEARS

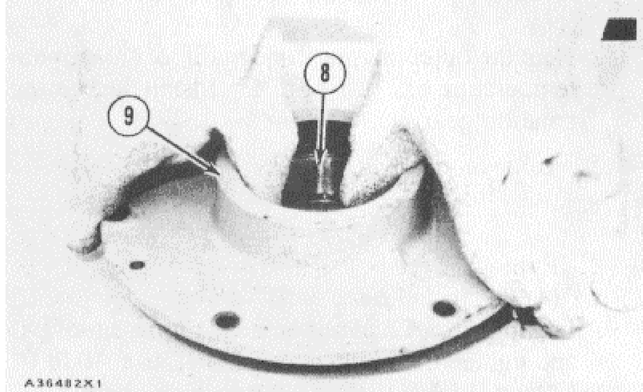
12. Install gear (6) in the case assembly. Make sure the teeth of gear (6) and the output gear are engaged.

13. Install the spacer on gear (6).

14. Install the ring that holds the bearing cups apart in cage (9).

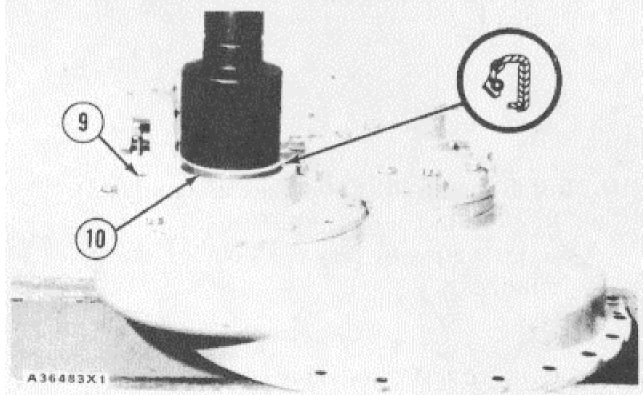
15. Lower the temperature of the inner and outer bearing cups (8). Install the bearing cups in cage (9).

16. Install the O-ring seal on cage (9) and install cage (9) in the case assembly.



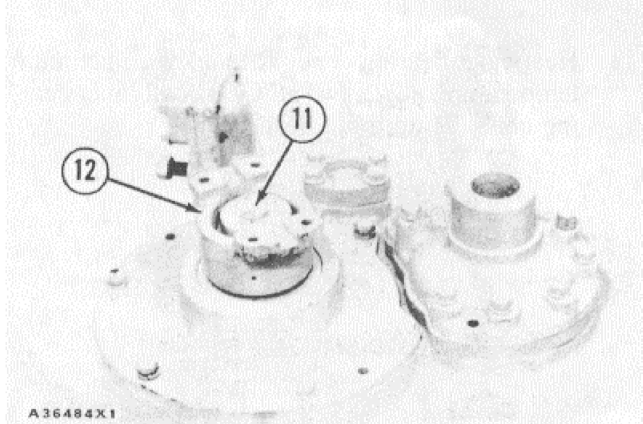
17. Heat the outer bearing cone in oil to a maximum temperature of 275°F (I 35°C). Install the bearing cone on input gear (6).

18. Use a press and a 2 3/4" x 3/4' drive socket to install seal (10) in the case assembly with the seal case even with the case assembly and the seal lip toward the inside as shown.



19. Install flange (12), the washer and bolt (I 1). Tighten the bolt to a torque of 80 -5 lb.ft. (I 10 + 7 N.m).
end by:

a) connection of input transfer gears to transmission



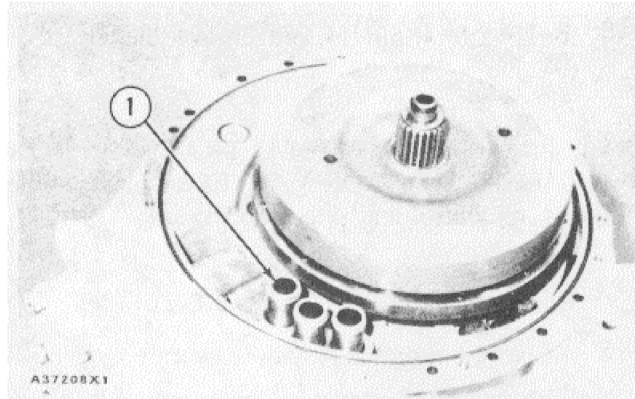
TRANSMISSION

DISASSEMBLE TRANSMISSION

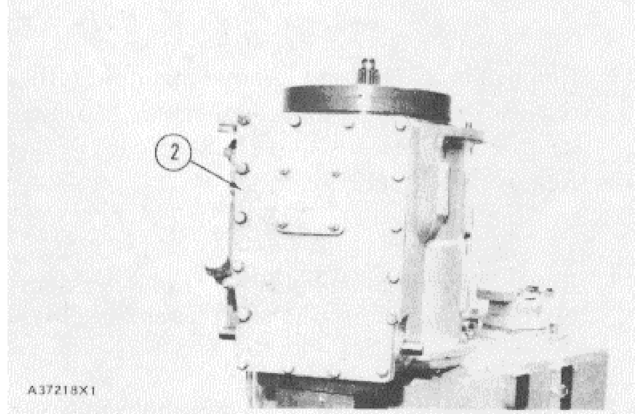
	Tools Needed	A	B	C
8B7548	Puller Assembly	1		
8H684	Ratchet Box Wrench	1		
8H663	Bearing Puller Attachment	1		
1P488	Drive Plate	1		
FT833	Clamp		2	
1P525	Drive Plate			1

start by:
a) separation of input transfer gears from transmission

1. Remove sleeves (1) from the manifold.

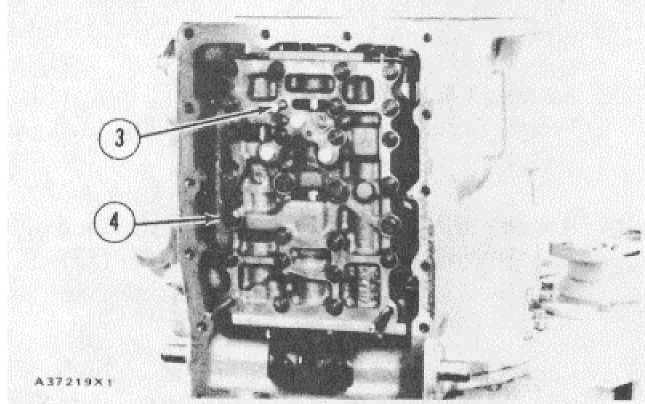


2. Remove cover (2).

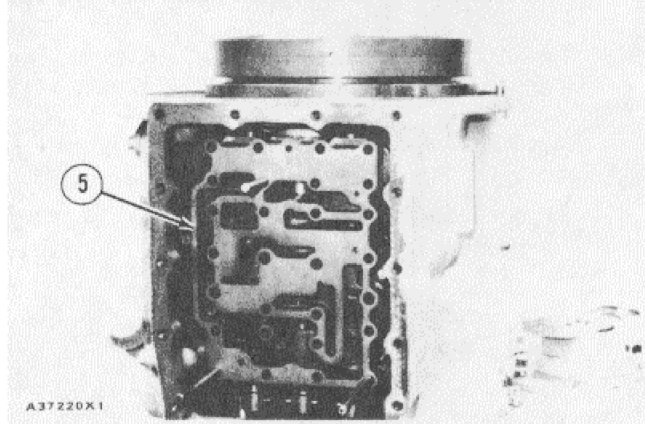


3. Remove three bolts from pressure control valve (4) and install three 5/16"-18 NC guide pins (3) approximatel) 7 in. (17.8 cm) long as shown.

4. Remove the bolts and remove pressure control valve (4).

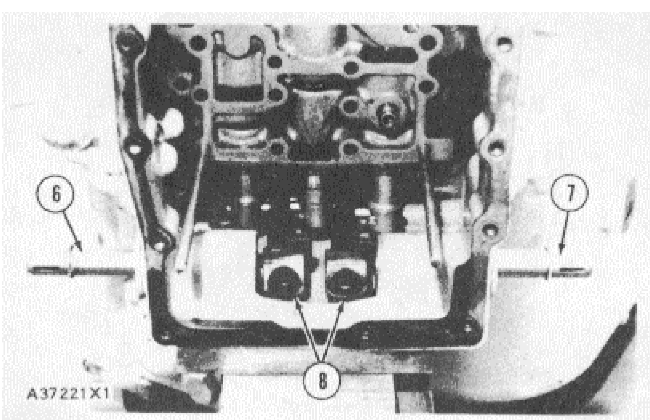


5. Remove plate (5).



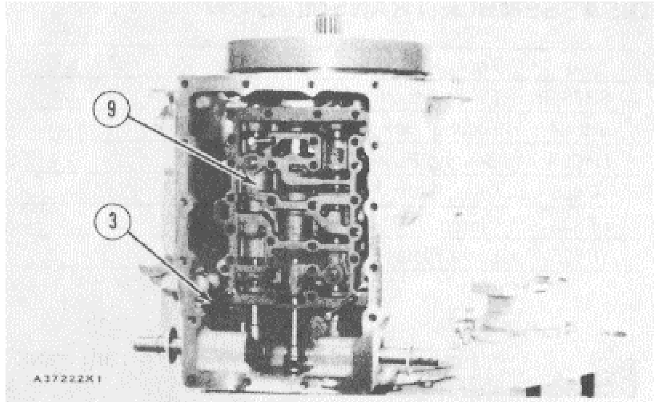
6. Remove the bolts from lever assemblies (8) and slide shafts (6) and (7) out of the lever assemblies.

7. Remove lever assemblies (8).



8. Remove guide pins (3) and remove selector valve (9).

NOTE: See DISASSEMLE TRANSMISSION HYDRALULIC CONTROL VALVES to disassemble the pressure control and selector valves.

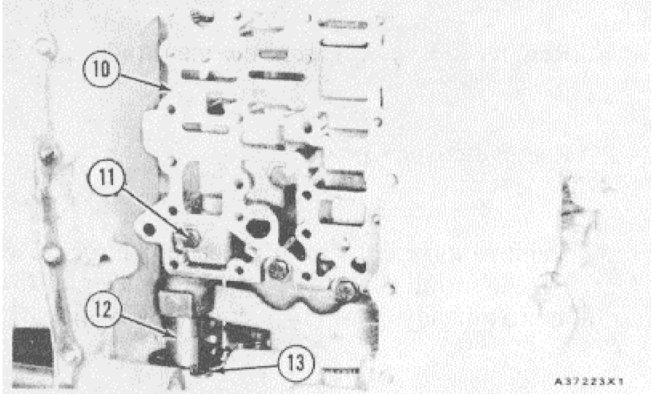


9. Remove ring (13) from sleeve (12).

10. Push sleeve (12) down and out of manifold (10).

11. Remove bolts (11) and remove manifold (10).

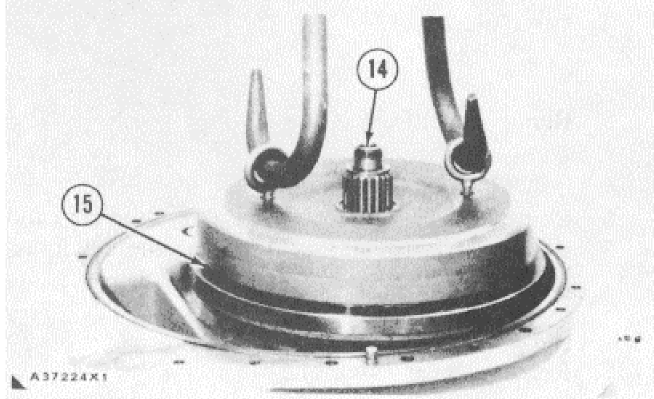
12. Remove sleeve (12).



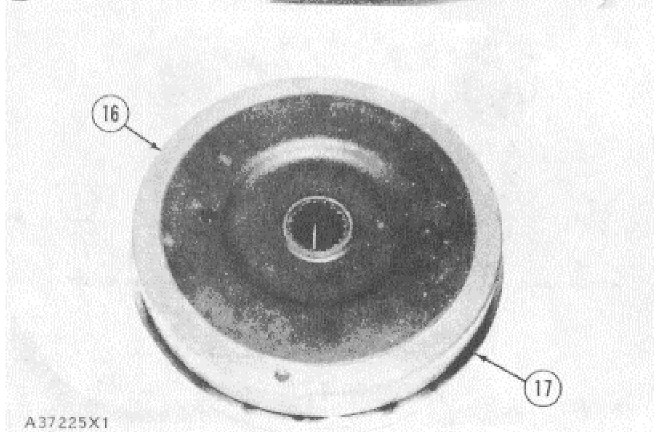
13. Remove the ring that holds No. 1 clutch assembly (15) in position from shaft assembly (14).

14. Install two 3/8"-16 NC forged eyebolts in No. 1 clutch assembly (15).

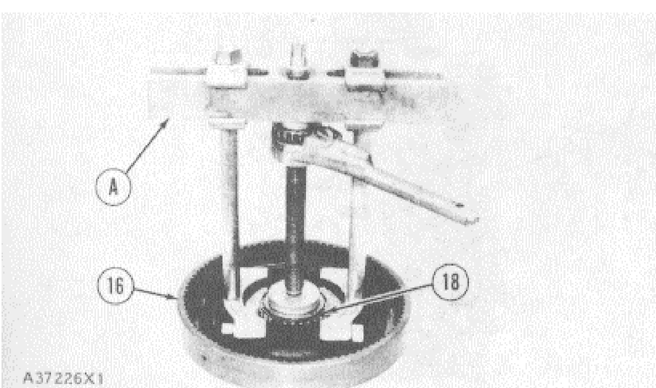
15. Fasten a hoist and remove clutch assembl) (15). Weight of the clutch assembly is 60 lb. (27 kg).



16. Remove the eyebolts from the clutch assemby and remove coupling (16) from piston (17).

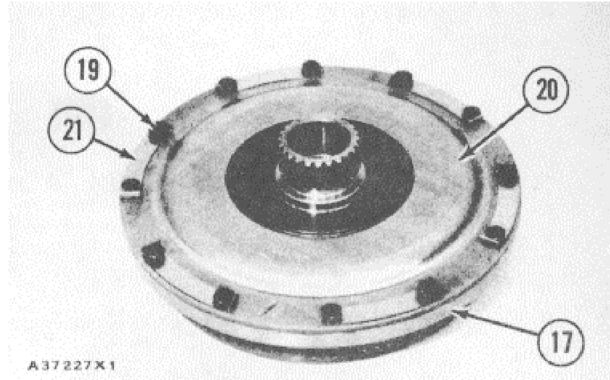


17. Remove bearing race and roller assembly (18) from the inside of coupling (16), with tooling (A).



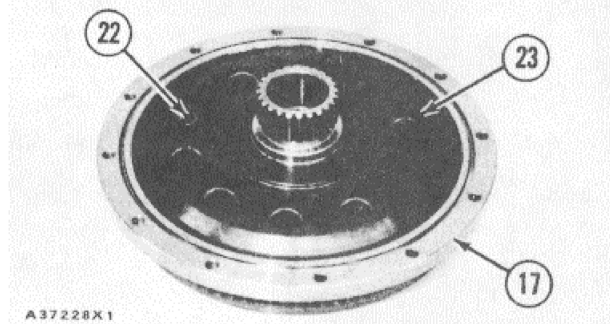
TRANSMISSION

18. Remove bolts (19), locks (21) and piston (20) from piston (17).



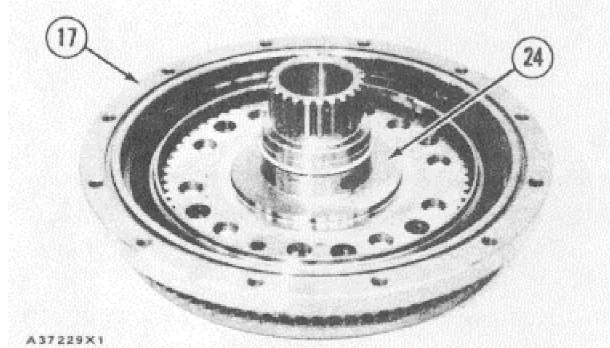
19. Remove springs (22) and manifold (23) from piston (17).

20. Remove the seal rings from manifold (23).



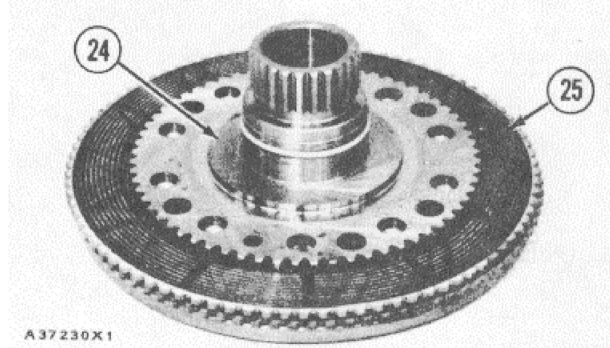
21. Remove piston (17) from hub (24).

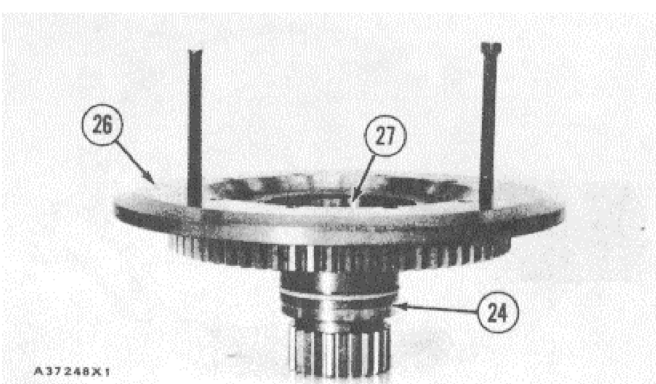
22. Remove disc assemblies (25) and the plate from hub (24).



23. Remove plate (26) from hub (24) with two 3/8"-16 NC forcing screws.

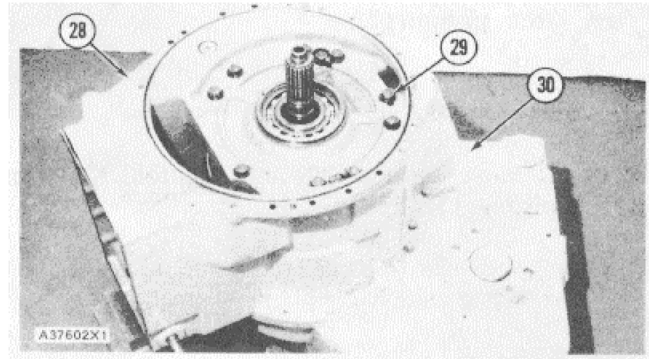
24. Remove bearing race (27) from hub (24).



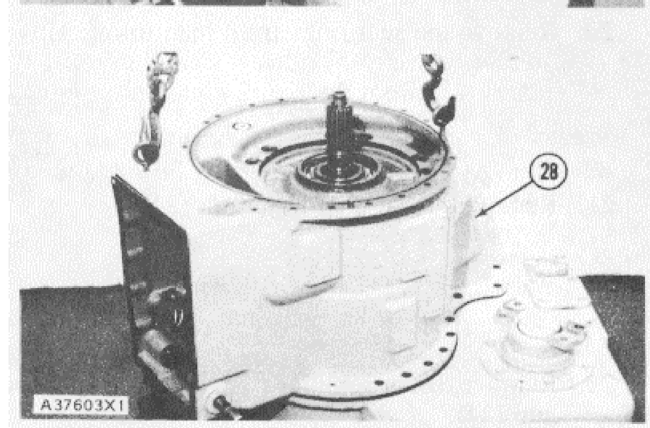


TRANSMISSION

25. Remove bolts (29) and (30) that hold case (28) in position.

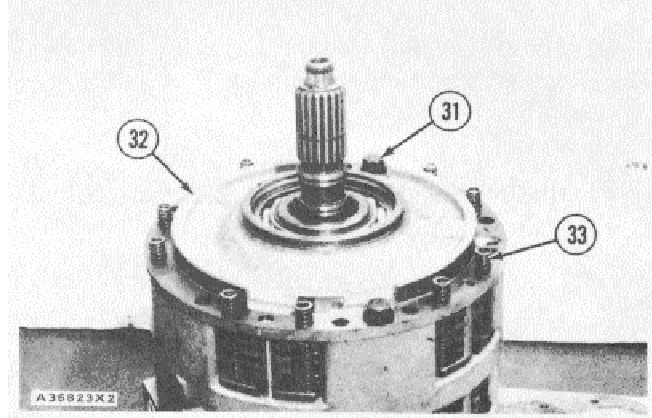


26. Install two 3/8"'-16 NC forged eyebolts in case (28). Fasten a hoist to case (28) and remove the case. Weight of the case is 135 lb. (61 kg).



27. Remove springs (33) and bolts (31).

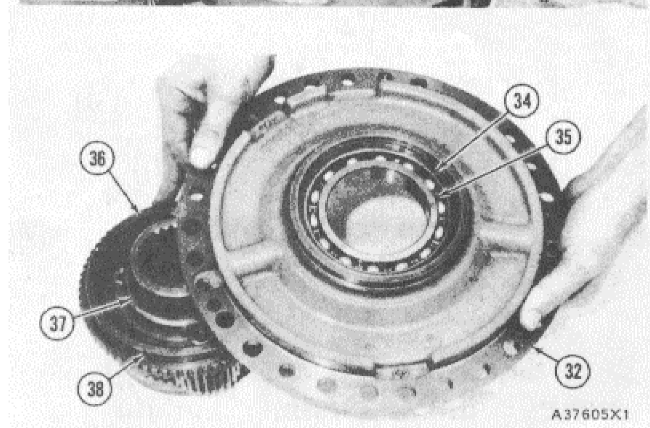
28. Remove plate (32) and the carrier assembl) as a unit.



29. Remove the ring that holds carrier assembl) (36) and plate (32) together.

30. Remove plate (32) from the carrier assembly.

31. Remove ring (34) and bearing (35) from plate (32).



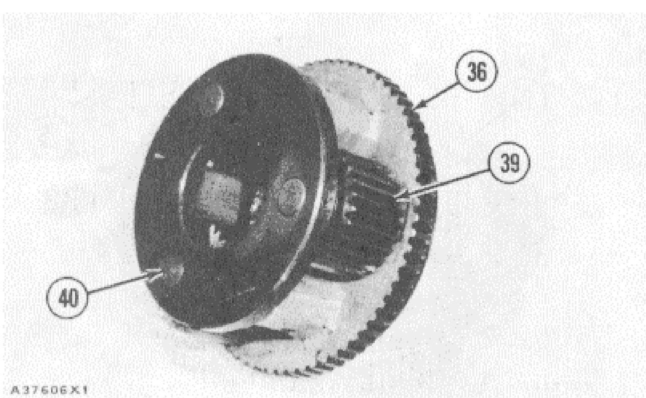
32. Remove the seal ring from sleeve (37).

33. Remove seal ring (38) from carrier assembly (36).

34. Push the pins into shafts (40) with a punch and hammer.

35. Remove shafts (40), gears (39) and the washers from carrier assembly (36). There is a washer on each side of the gears. Remove the bearings from the gears. Remove the pins from the shafts.

36. Remove the dowel and sleeve (37) from carrier assembly (36) if a replacement is necessary.



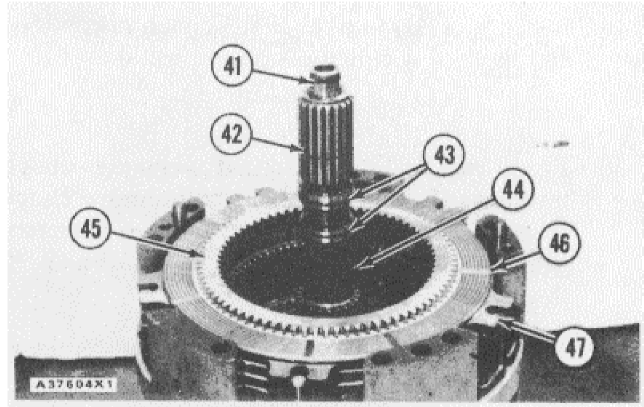
TRANSMISSION

37. Remove shaft assembly (42).

38. Remove pin (44) and seal rings (43) from the shaft assembly.

39. Remove the seal ring from coupling (41).

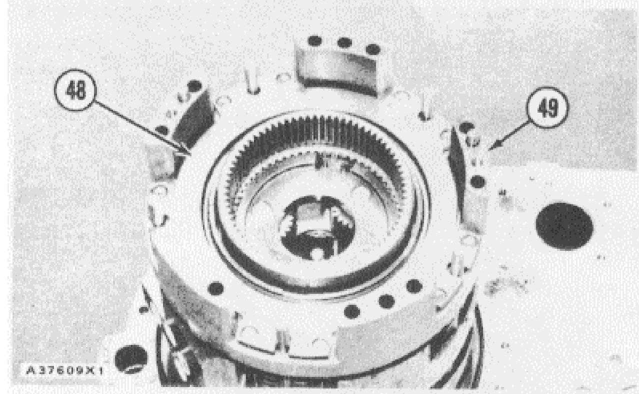
40. Remove the ring that holds coupling (41) in position and remove coupling (41) from shaft assembly (42).



41. Remove gear (45), disc assemblies (46) and plates (47) from the No. 2 clutch housing.

42. Remove No. 2 clutch housing (49) and remove piston (48) from the housing.

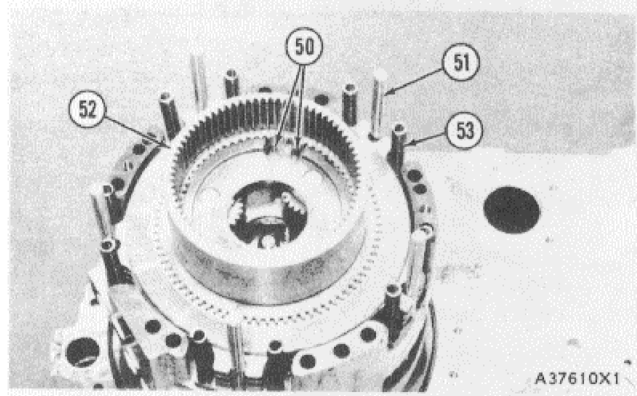
43. Remove the seal rings from piston (48).



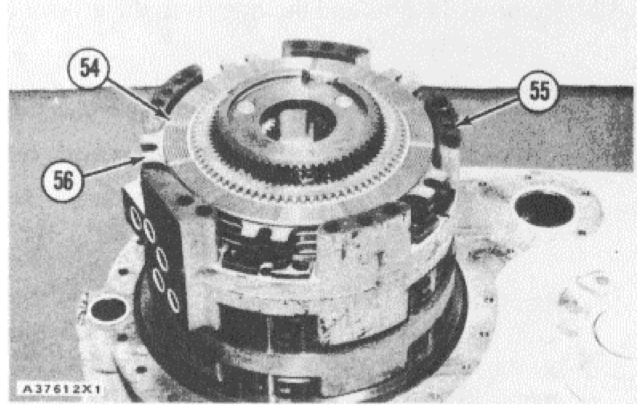
44. Remove pins (5 1) and springs (53) from the No. 3 and 4 clutch housing.

45. Push pins (50) into the carrier assembly with a punch and hammer.

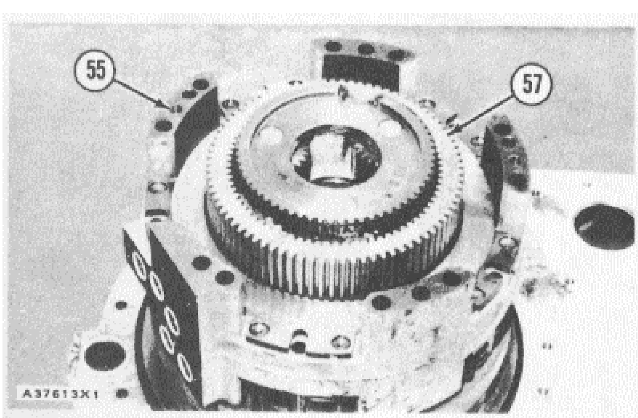
46. Pull the ends of the ring that hold gear (52) in position, together and remove gear (52).



47. Remove disc assemblies (54) and plates (56) from No. 3 and 4 clutch housing (55).



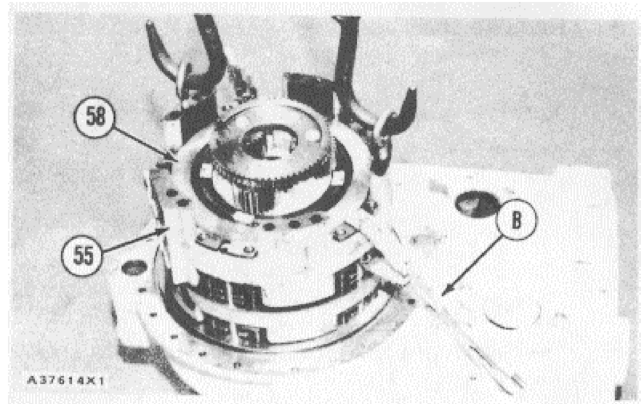
48. Remove gear (57) from clutch housing (55).



TRANSMISSION

49. Install tool (B) to hold No. 3 clutch piston (58) and the No. 4 clutch piston in position.

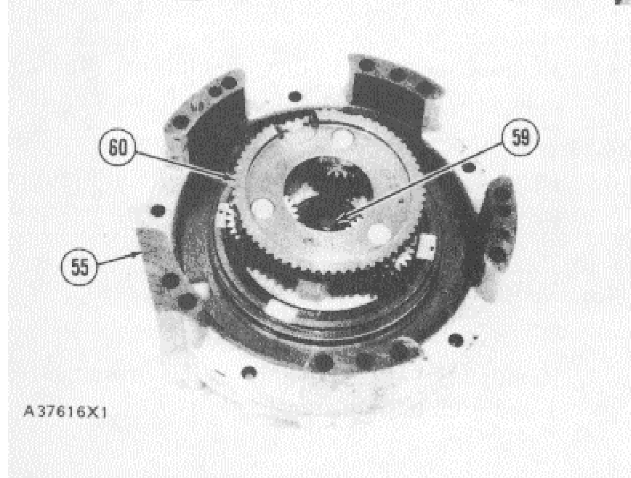
50. Install two 1/2"-13 NC forged eyebolts in clutch housing (55). Fasten a hoist and remove clutch housing (55) the pistons and the two planetary gear assemblies as a unit. Weight of the unit is 90 lb. (41 kg).



51. Remove tool (B) and remove the pistons from clutch housing (55).

52. Remove the seal rings from the pistons.

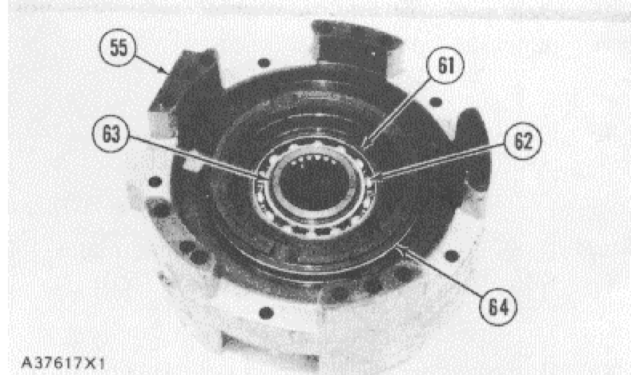
53. Remove bolt (59), the plate and the No. 3 carrier from clutch housing (55).



54. Turn clutch housing (55) over. Remove ring (63) that holds carrier (60) in position and remove No. 2 carrier (60) from the clutch housing.

55. Remove ring (61) and bearing (62) from clutch housing (55).

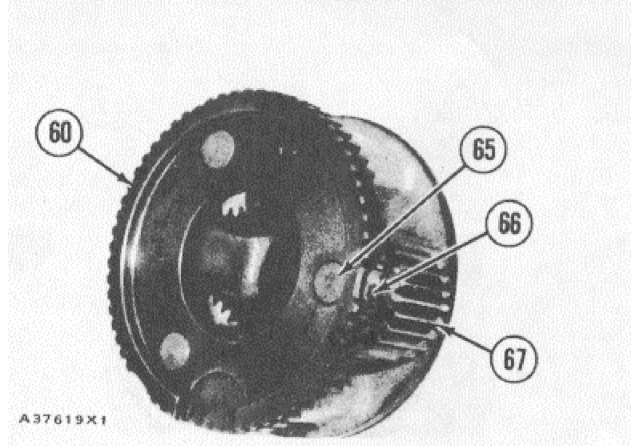
56. Remove seal rings (64) from each side of the clutch housing.



57. Remove the pins and the ring from the groove in No. 2 carrier (60).

58. Push pins (66) into shafts (65) with a punch and hammer.

59. Remove shafts (65), gears (67) and the washers from carrier (60). There is a washer on each side of the gears. Remove the bearings from the gears. Remove the pins from the shafts.

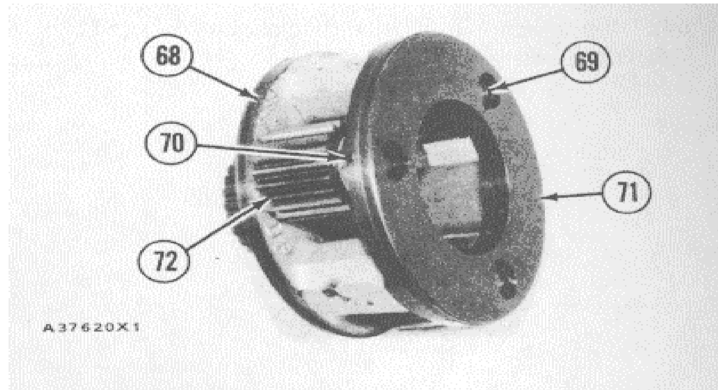


TRANSMISSION

60. Remove seal ring (68) from No. 3 carrier (71).

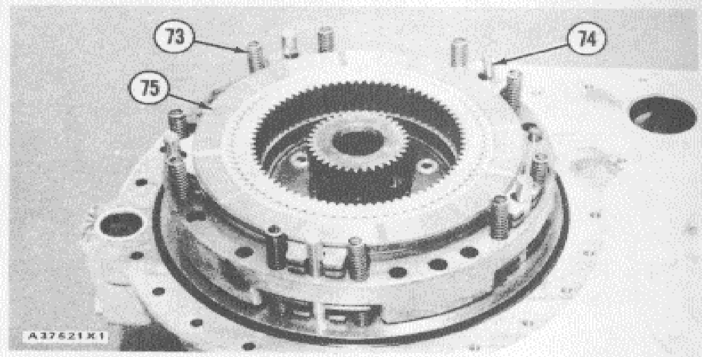
61. Push pins (70) into shafts (69) with a punch and hammer.

62. Remove shafts (69), gears (72) and the washers from carrier (71). There is a washer on each side of the gears. Remove the bearings from the gears. Remove the pins from the shafts.



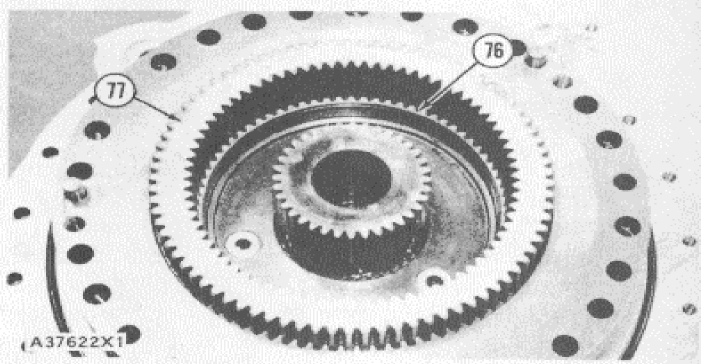
63. Remove springs (73) and pins (74).

64. Remove No. 4 disc assemblies (75) and the plates.



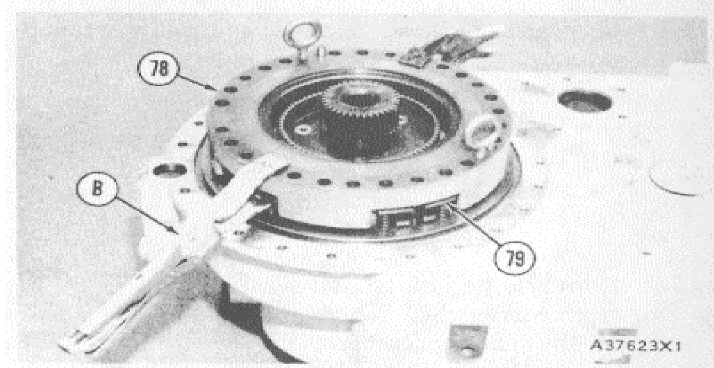
65. Remove ring (76) and remove gear (77).

66. Install tool (B) to hold No. 5 piston (79) in No. 5 clutch housing (78).

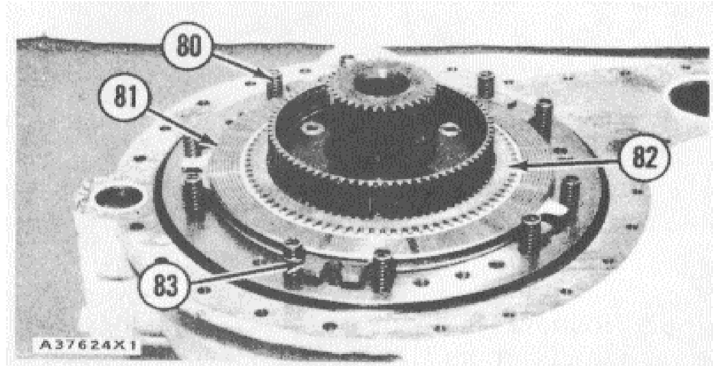


67. Install two 7/16"-14 NC forged eyebolts in clutch housing (78). Remove the clutch housing and piston (79) by hand.

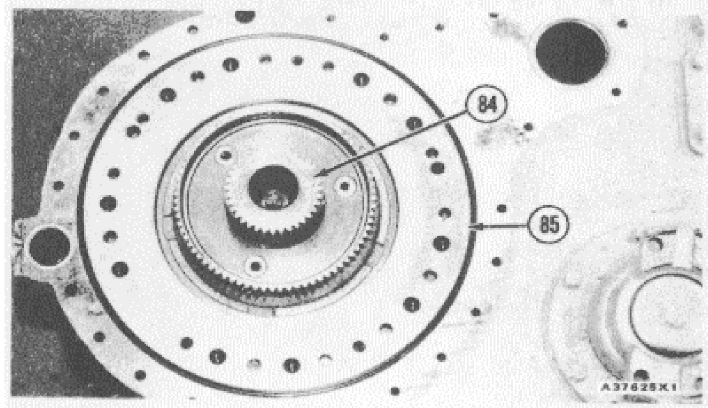
68. Remove tool (B) and piston (79) from the clutch housing. Remove the seal rings from the piston and clutch housing.



69. Remove springs (80), disc assemblies (81), plate (83) and gear (82).

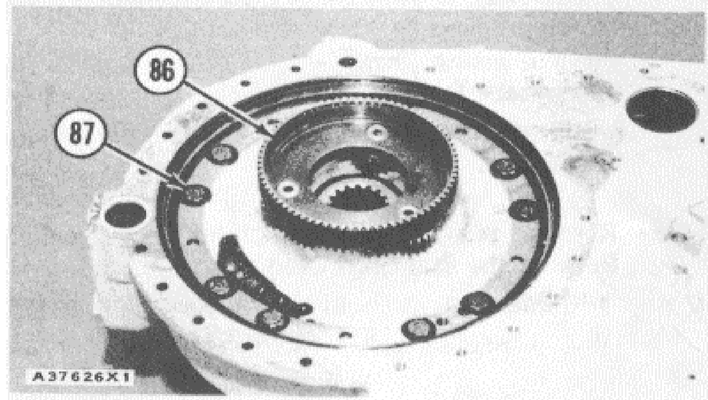


70. Remove plate (85).



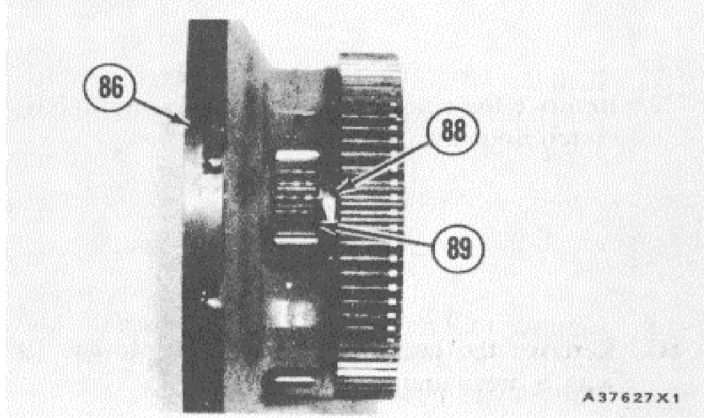
71. Remove the bolt and washer and remove gear (84).

72. Remove bolts (87) and the washer and remove carrier (86).



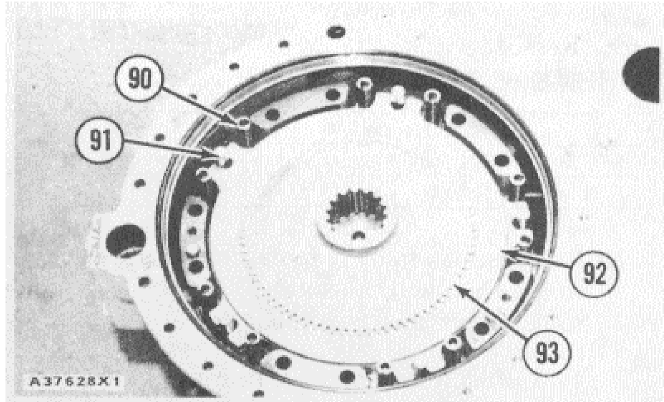
73. Push pins (88) into the shafts with a punch and hammer.

74. Remove the shafts, the washers and gears (89) from carrier (86). There is a washer on each side of the gears. Remove the bearings from the gears. Remove the pins from the shafts.

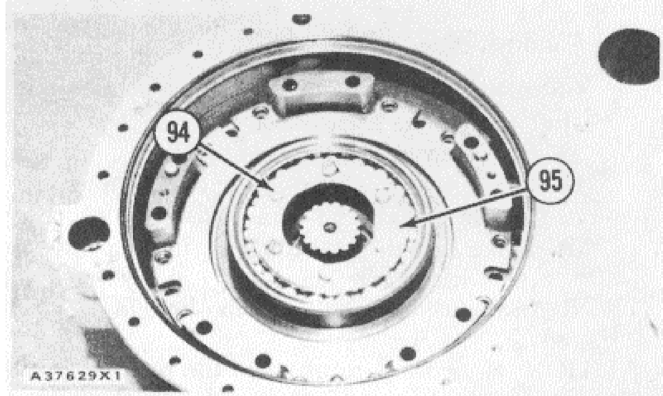


TRANSMISSION

75. Remove springs (90), pins (91), gear (93), disc assemblies (92) and the plates.

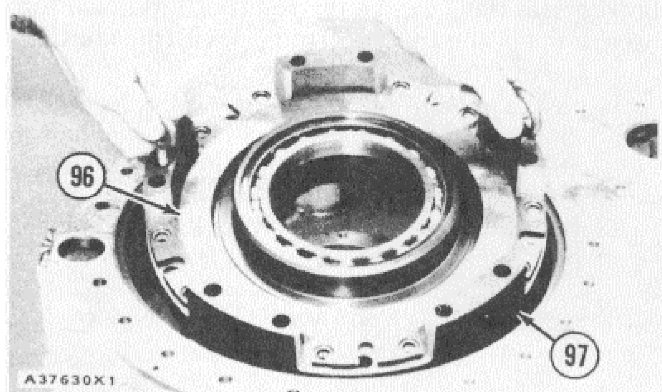


76. Remove bolts (94), the locks and retainer (95).



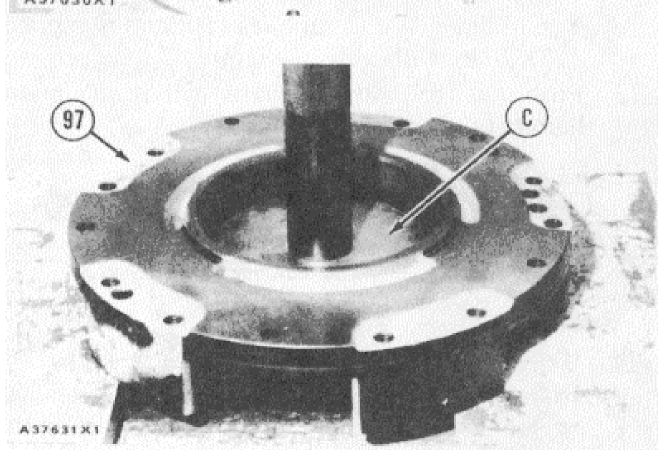
77. Install two 3/8"-16 NC forged eyebolts in No. 6 clutch housing (97) and remove the clutch housing and piston (96).

78. Remove piston-(96) from clutch housing (97). Remove the seal rings from the piston and clutch housing.



79. Remove the ring that holds the bearing in No. 6 clutch housing (97).

80. Remove the bearing from clutch housing (97) with a press and tool (C).



ASSEMBLE TRANSMISSION

	Tools Needed	A	B
FT833	Clamp	2	
FT834	Nozzle		1

1. If necessary, make a replacement of dowels (3) in No. 6 clutch housing (2) so they extend the same height as the original dowels.

2. Lower the temperature of bearing (4) and install it in No. 6 clutch housing (2).

3. Install ring (1) to hold bearing in position.

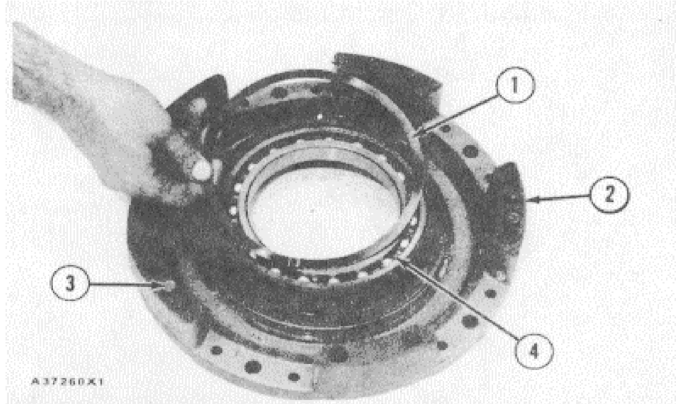
4. Install the pistons and seal rings in all of the clutch housings as follows:
    a) Put clean oil on the seal rings.
    b) Install seal rings (6) in the clutch housings.
    c) Install seal rings (7) in pistons (5).
    d) Make sure the seal rings are in the centers of their respective grooves. Lightly push the pistons into position in the housings.

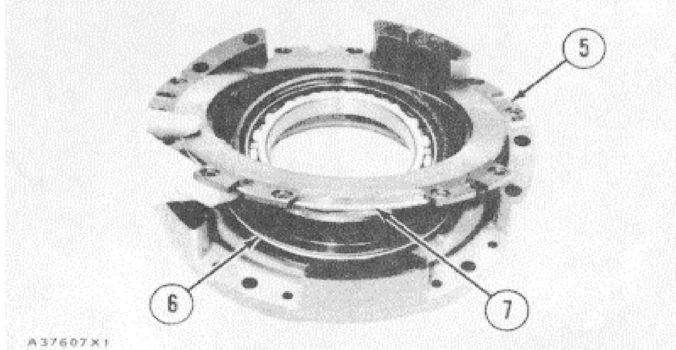
CAUTION: Be extra careful when the pistons are installed in the housings. Seal rings with damage or broken seal rings can be the result of too much force used or the pistons not in alignment with the housings.

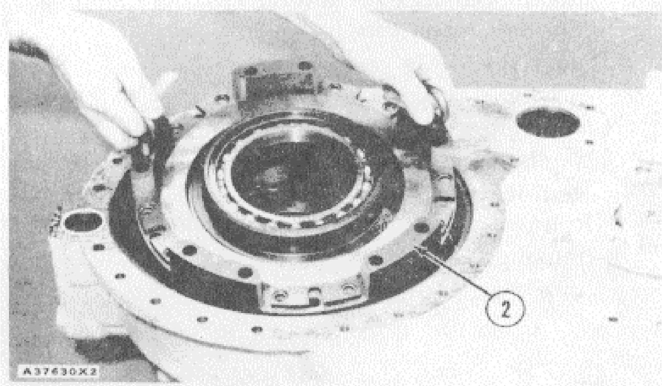
5. Install two 3/8''- 16 NC forged eyebolts in No. 6 clutch housing (2) and install the clutch housing and piston in the output transfer gear case.

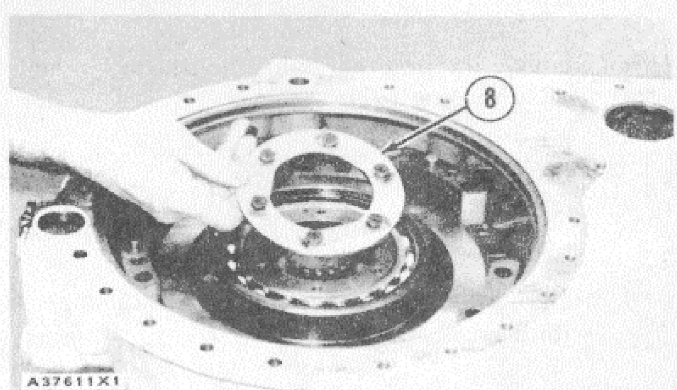
6. Install retainer (8), the three locks and tighten the bolts.

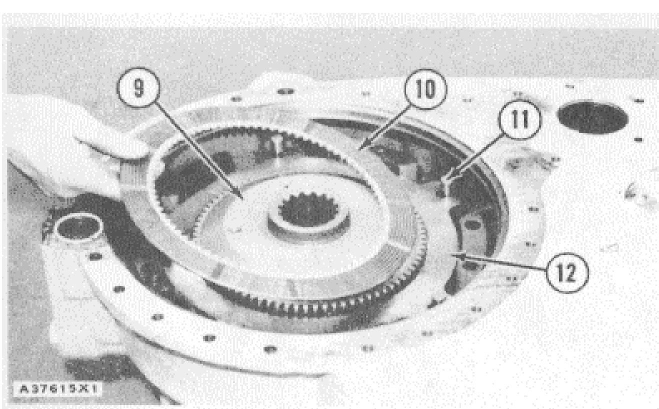
7. Install gear (9) and pins (II) in No. 6 clutch housing.
8. Install three disc assemblies (10) and two plates (12). Start with a disc assembly.





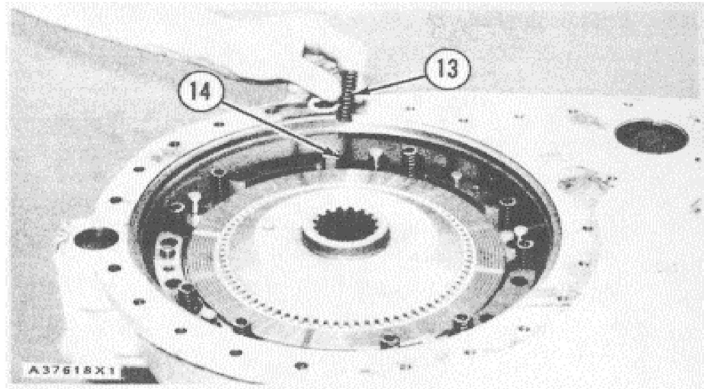




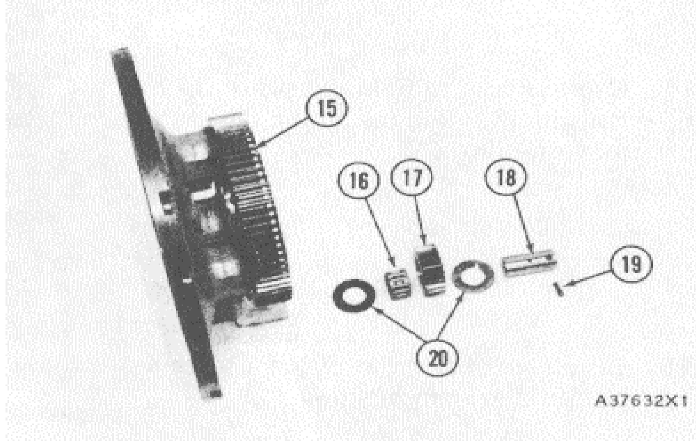


TRANSMISSION

9. Install pins (14) and springs (13) in the No. 6 clutch housing assembly.

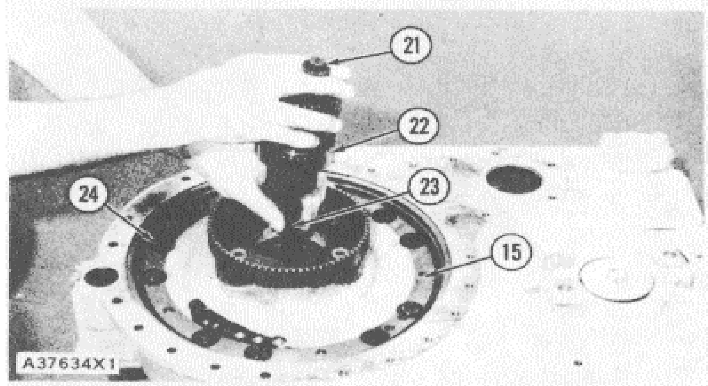


10. Assemble No. 6 planetary carrier (15) as follows:
    a) Install bearing (16) in each gear (17).
    b) Put gears (17) in position in carrier (15) with washers (20) on each side of the gears.
    c) Install shafts (I 8) in carrier (15) to hold gears (17) and the washers. Make sure the holes in the shafts are in alignment with the holes in the carrier.
    d) Install pins (19) even with the surface of carrier (15) to hold shafts (18) in position.

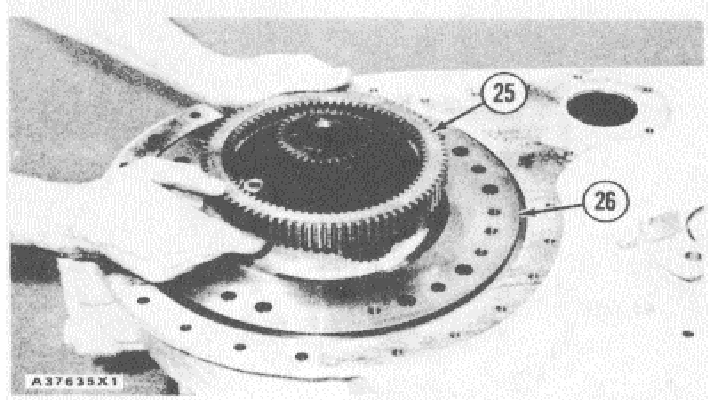


11. Put No. 6 planet carrier (15) in position on the clutch housing. Make sure the springs and pins are in position and install the washers and bolts (24). Tighten the bolts to a torque of 85 ± 5 lb.ft. (115 ± 7 N m).

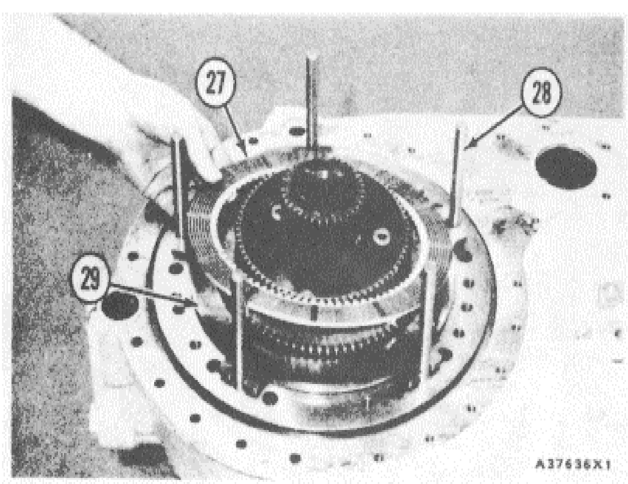
12. Install sleeve (23), sun gear (22), the washer and bolt (21). Tighten the bolt to a torque of 34 ± 2 lb.ft. (45 ± 3 N m).



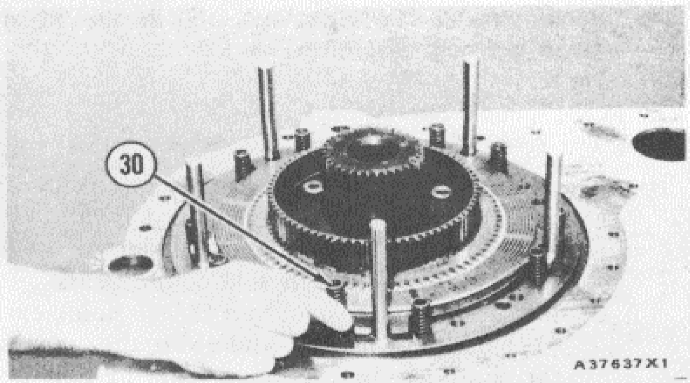
13. Install plate (26) and No. 5 clutch ring gear (25).



14. Install long pins (28), the two disc assemblies (27) and plate (29). There must be a disc assembly on each side of plate (29).

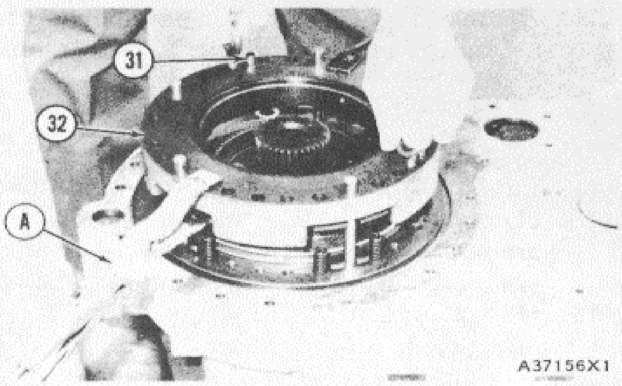


15. Install springs (30).

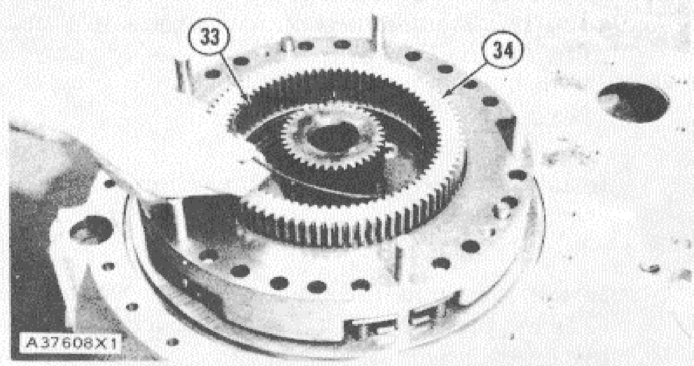


16. If necessary, make a replacement of dowels (31) on each side of No. 5 clutch housing (32) so they extend the same height as the original dowels.

17. Use tool (A) to hold the piston in No. 5 clutch housing (32) and install the clutch housing. Remove tooling (A).

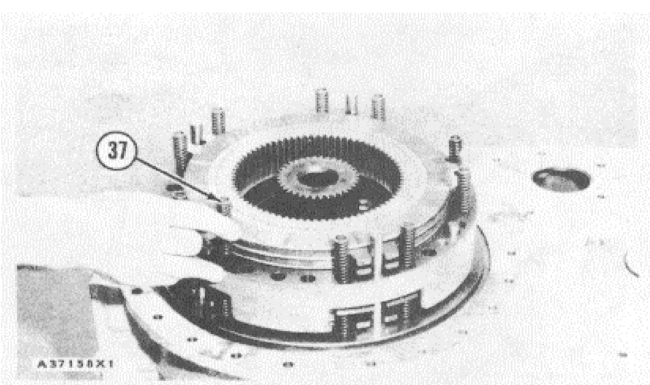


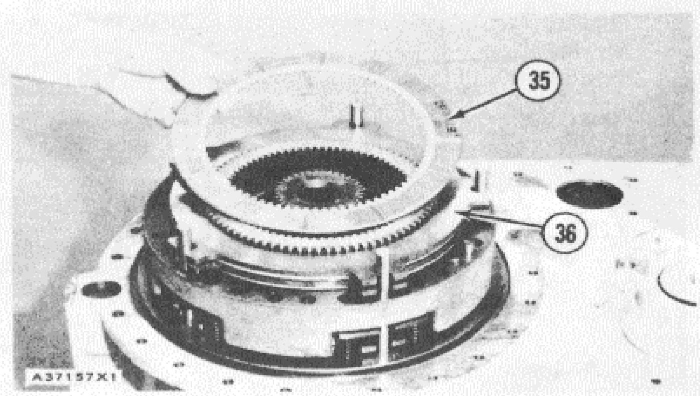
18. Install No. 4 clutch ring gear (34) and ring (33) to hold the gear in position.



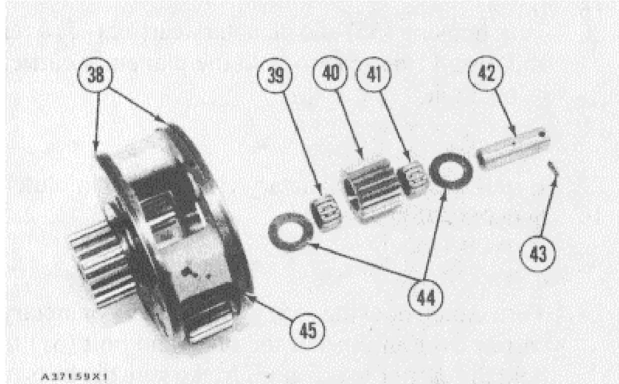
19. Install the three disc assemblies (35) and two plates (36)for the No. 4 clutch. Start with a disc assembly.

20. Install springs (37).

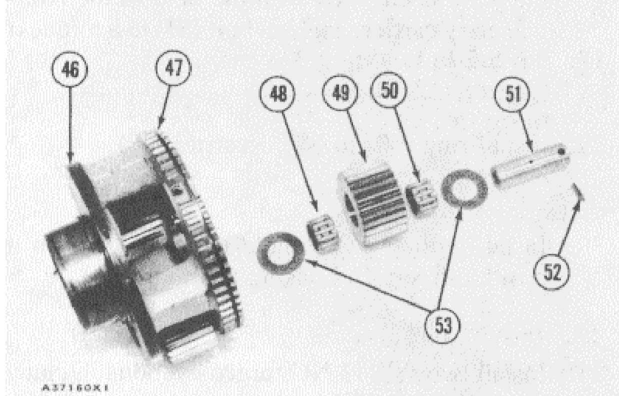




21. Assemble No. 4 planetary carrier as follows:
    a) Install seal rings (38) on carrier (45).
    b) Install bearings (39) and (41) in each gear (40).
    c) Put gears (40) in position in carrier (45) with washers (44) on each side of the gears.
    d) Install each shaft (42) in carrier (45) to hold gears (40) and washers (44) in position. Make sure the holes in the shafts are in alignment with the holes in the carrier.
    e) Install pins (43) even with the surface of carrier (45) to hold shafts (42) in position.

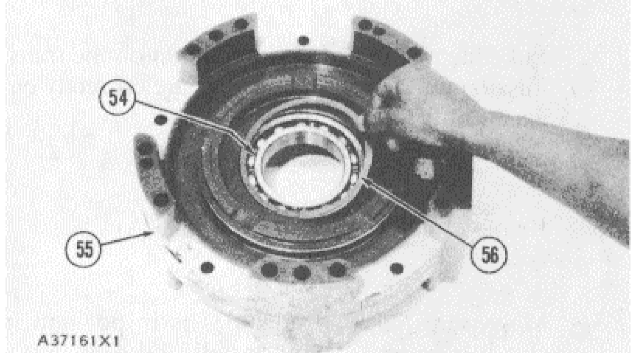


22. Assemble No. 3 planetary carrier as follows:
    a) Install seal ring (46) on carrier (47).
    b) Install bearings (48) and (50) in each gear (49).
    c) Put gears (49) in position in carrier (47) with washers (53) on each side of the gears.
    d) Install each shaft (51) in carrier (47) to hold gears (49) and washers (53) in position. Make sure the holes in the shafts are in alignment with the holes in the carrier.
    e) Install pins (52) even with the surface of carrier (47) to hold shafts (51) in position.

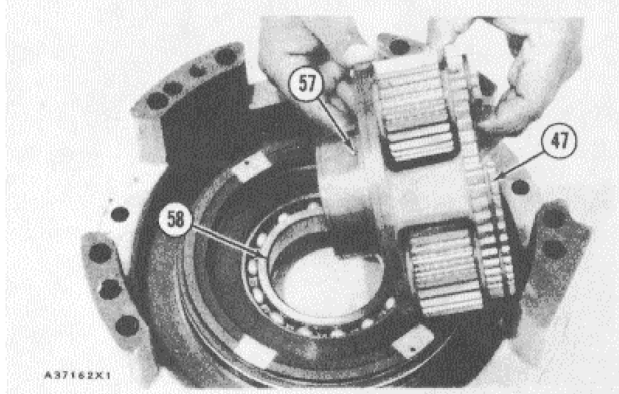


23. Lower the temperature of bearing (54). Install the bearing in No. 3 and 4 clutch housing (55) with the notch of the bearing down toward the No. 3 clutch side of housing (55).

24. Install ring (56) to hold bearing (54) in position.



25. Install No. 3 planetary carrier (47) in the No. 3 and 4 clutch housing. Make sure dowel (57) in the carrier is in alignment with notch (58) in the bearing.



TRANSMISSION

26. Turn housing (55) and planetary carrier (47) over and install ring (59) to hold the planetary carrier in position.

27. Install the No. 4 planetary carrier (45) in clutch housing (55).

28. Turn clutch housing (55) and the No. 4 planetary carrier over and install the plate and bolt (61) to hold the carrier in position. Make sure the boss in the plate is engaged with the hole in the No. 4 planetary carrier. Tighten bolt (61) to a torque of 34 ± 2 Ib.ft. (45 ± 3 N m).

29. Install ring (60) in No. 3 carrier (47).

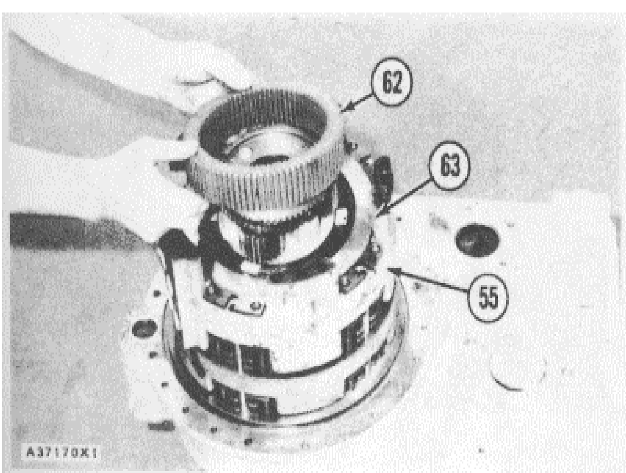
30. Install tooling (A) to hold the No. 4 piston in position in clutch housing (55).

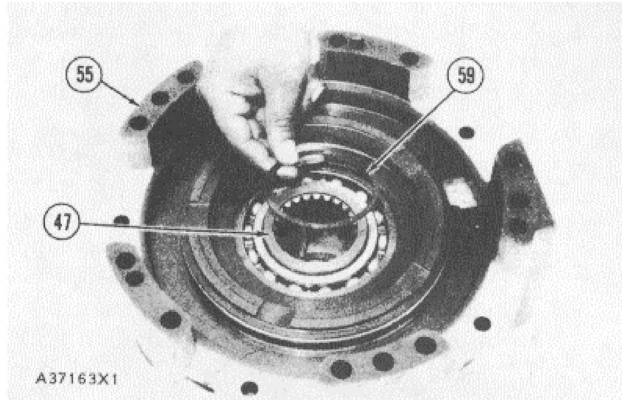
31. Install two ’2"-13 NC forged eyebolts in clutch housing (55) and fasten a hoist to it.

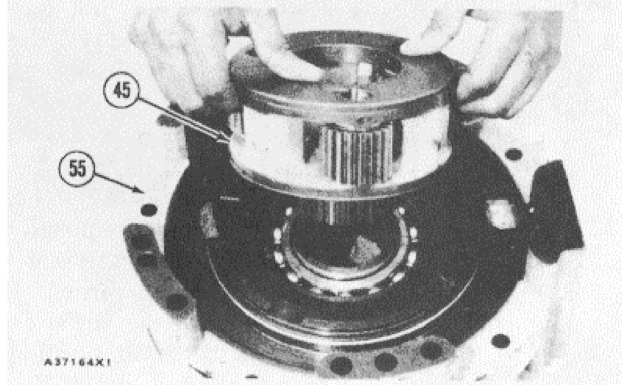
32. Put clutch housing (55) in position on the transmission. Make sure the springs are correctly engaged in the No. 4 piston.

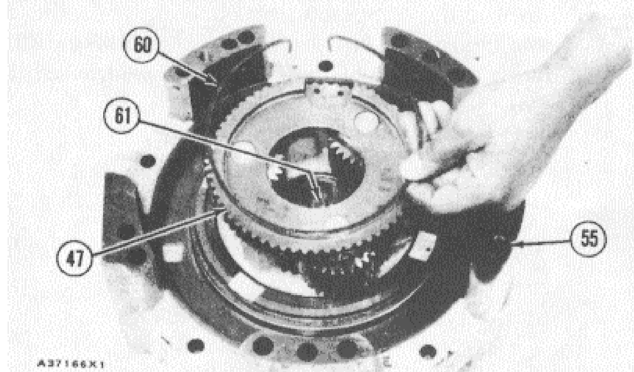
33. Remove the eyebolts and tooling (A).

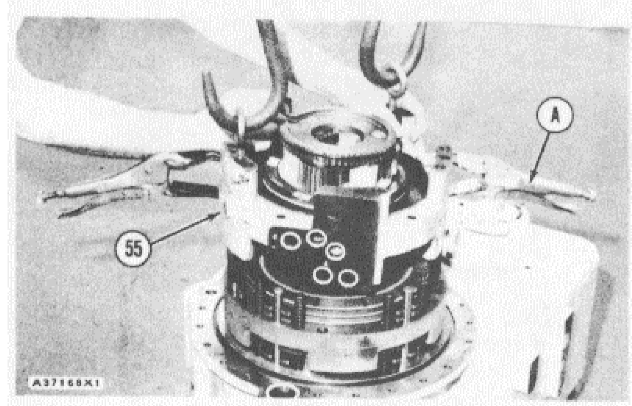
34. Make sure No. 3 piston (63) is in position in clutch housing (55) and install ring gear (62).



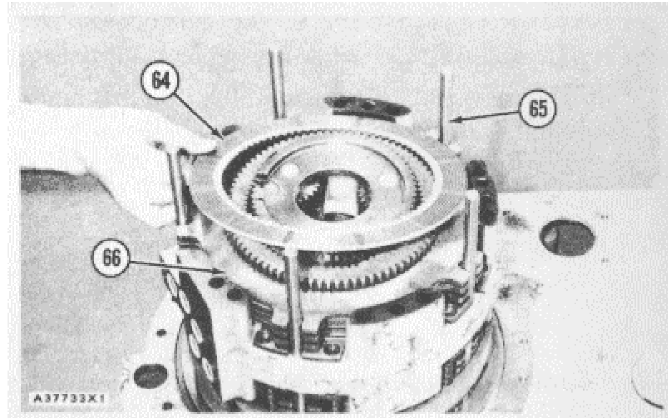




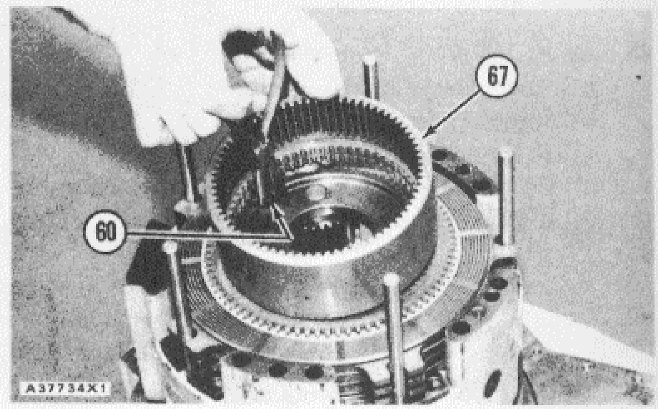




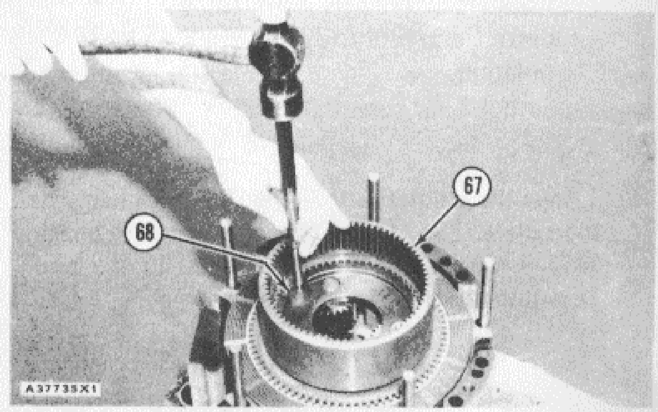
35. Install pins (65), the four disc assemblies (64) and three plates (66). Start with a disc assembly.



36. Put ring (60) under compression to install gear (67).



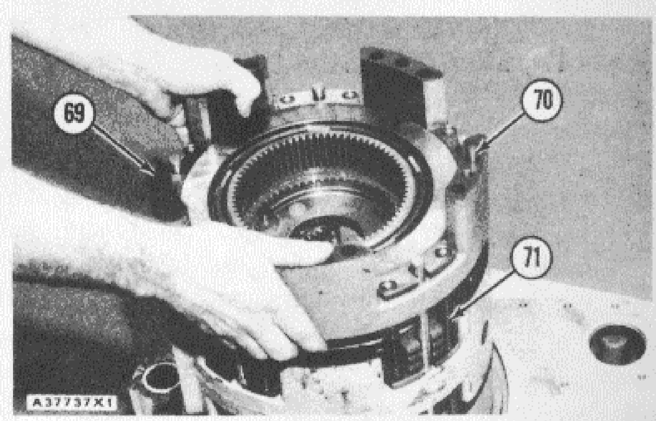
37. Use a hammer and punch and install pins (68) to hold the ends of the ring apart inside gear (67).



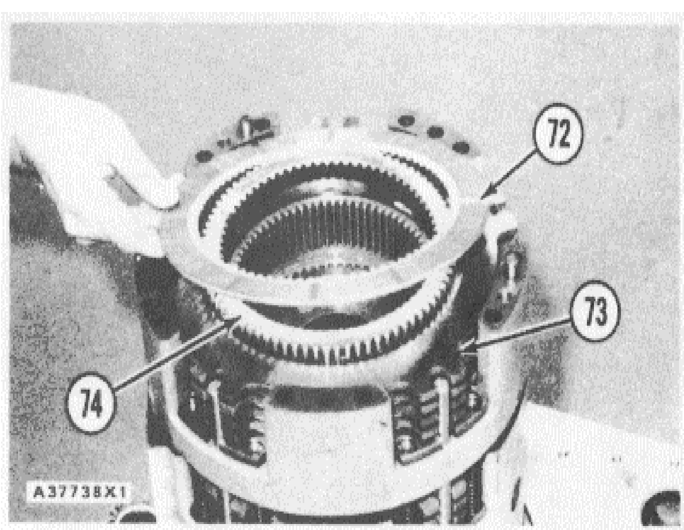
38. Install springs (71).

39. If necessary, make a replacement of dowels (70) in No. 2 clutch housing (69) so they extend to the same height as the original dowels.

40. Install No. 2 clutch housing (69) and piston. Make sure springs (71) engage in the holes in the No. 2 clutch housing.



41. Install ring gear (74), the five disc assemblies (72) and four plates (73). Start with a disc assembly.

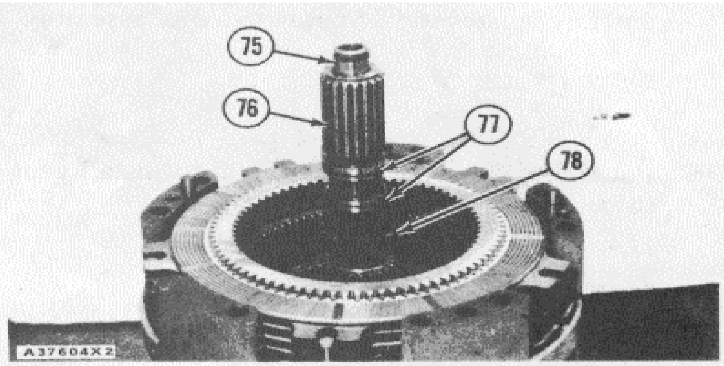


TRANSMISSION

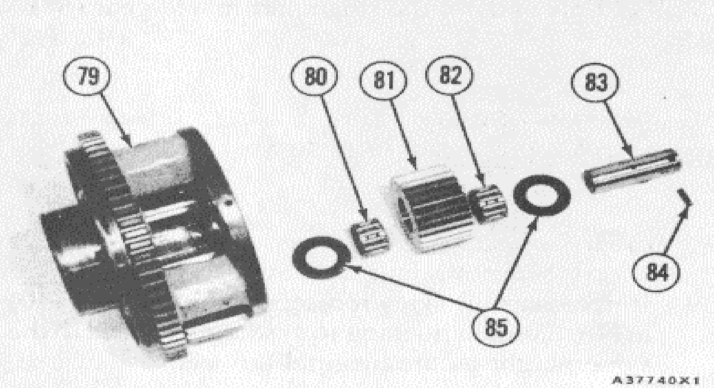
42. Install pin (78), seal rings (77) and coupling (75) in shaft assembly (76). Install the ring that holds coupling (75) in shaft assembly (76).

43. Install the seal ring on coupling (75).

44.Install shaft assembly (76).

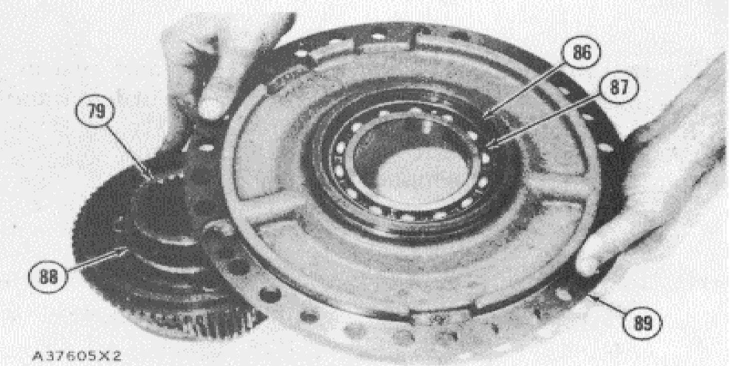


45. Assemble No. 2 planetary carrier as follows:
    a) Install the seal ring on carrier assembly (79).
    b) Install bearings (80) and (82) in each gear (81).
    c) Put gears (8 1) in position in carrier assembly (79) with washers (85) on each side of the gears.
    d) Install shaft (83) in carrier assembly (79) to hold gears (81) and washers (85) in position. Make sure the holes in the shafts are in alignment with the holes in the carrier assembly .
    e) Install pins (84) even with the surface of carrier assembly (79) to hold shafts (83) in position.



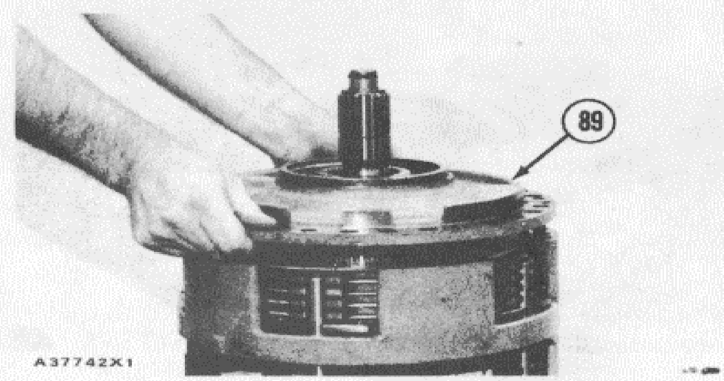
46. Lower the temperature of bearing (87) and install it in plate (89). Make sure the notch in bearing (87) is down when it is installed in the plate. Install ring (86) to hold the bearing.

47. Heat sleeve (88) in oil to a maximum temperature of 275°F (I 35°C) and install it on carrier assembly (79).Install the dowel in carrier assembly (79) above sleeve (88). Install the seal ring on sleeve (88).



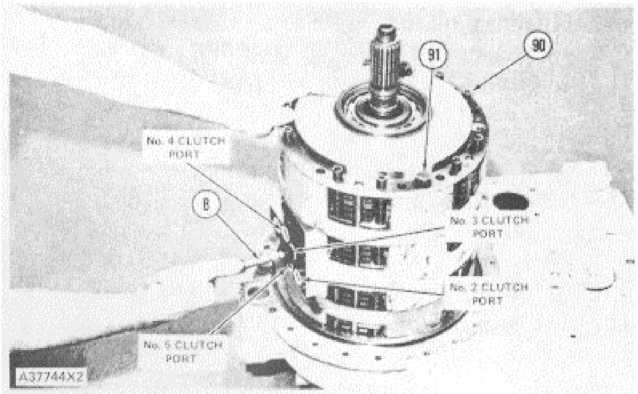
48. Put plate (89) on carrier assembly (79). Make sure the notch in bearing (87) engages with the dowel in carrier assembly (79). Install the ring that holds plate (89) and carrier assembly (79) together.

49. Install plate (89) on the No. 2 clutch housing.



TRANSMISSION

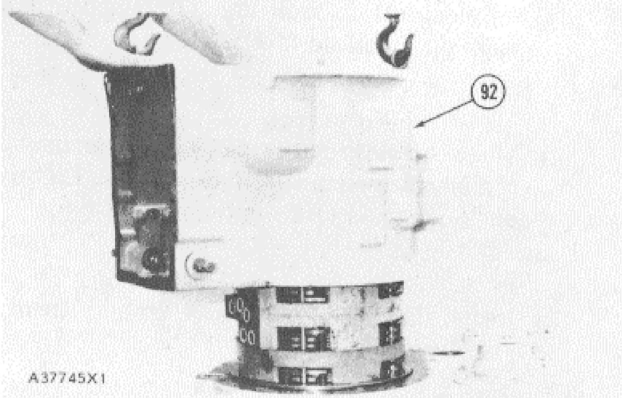
50. Install springs (90), the washers and bolts (91).Make sure all springs are engaged correctly and tighten bolts (91) to a torque of 85 + 5 lb. ft. (1 15 m 7 N. m).



51. Check to make sure the pistons are free in their clutch housings as follows:
    a) Put air (free of water) under a pressure of 100 to 150 psi (7.0 to 10.5 kg/cm2) or (690 to 1030 kPa) into the five oil passages with tool (B).

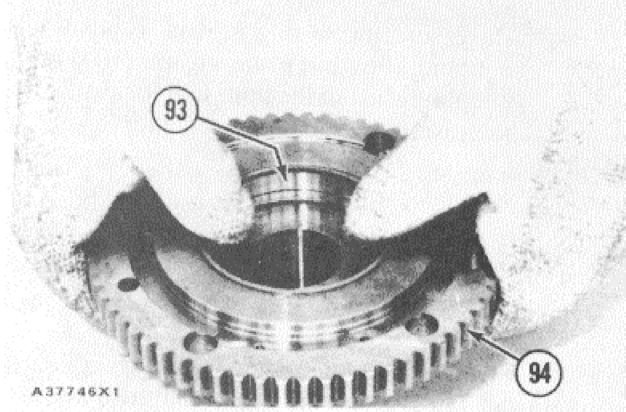
    b) There must be .12 to .25 in. (3.0 to 6.4 mm) of travel for each piston.

    c) If the pistons do not move the distance in Step 51 b put a small amount of oil in the five passages. Follow procedure in Step 51 a. If the pistons still do not move, the transmission must be disassembled and the pistons checked.



52. Install two 3/8"-16 NC forged eyebolts in case (92). Fasten a hoist to case (92). Make sure the O-ring seals are in position on the output transfer gear case and install case (92).

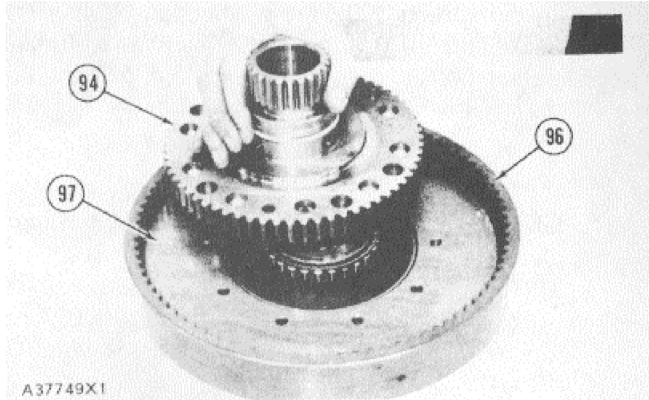
53. Install the nine long bolts and washers that hold case (92) in position and tighten them to a torque of 85 + 5 Ib. ft. (115 + 7 N. m).



54. Assemble the No. I clutch as follows:
    a) Lower the temperature of bearing cup (93) and install it in hub (94).

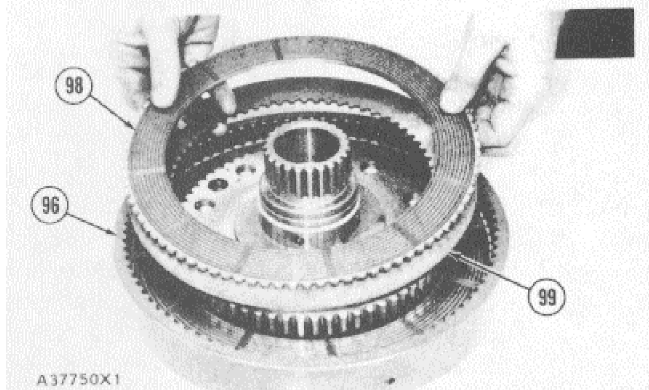
    b) Heat race and roller assembly (95) in oil to a maximum temperature of 275°F (I 35°C) and install it on coupling (96).

c) Install plate (97) in coupling (96).



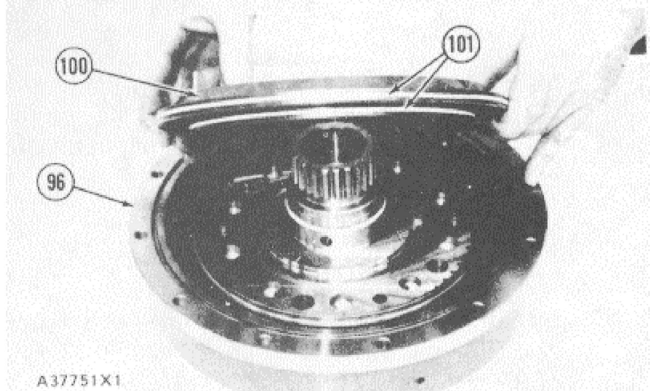
d) Install hub (94) in coupling (96).

e) Install the trio disc assemblies (98) and plate (99) in coupling (96) as shown.



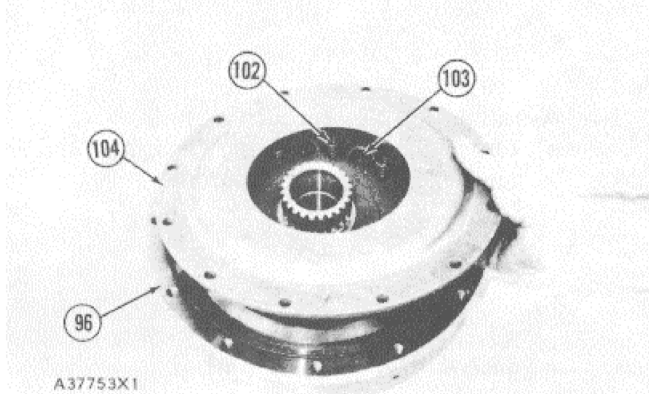
f) Put clean oil on seal rings (101) and install them on manifold (100).

g) Make sure the seal rings (101) are in the centers of their respective grooves. Lightly push manifold (100) into coupling (96).



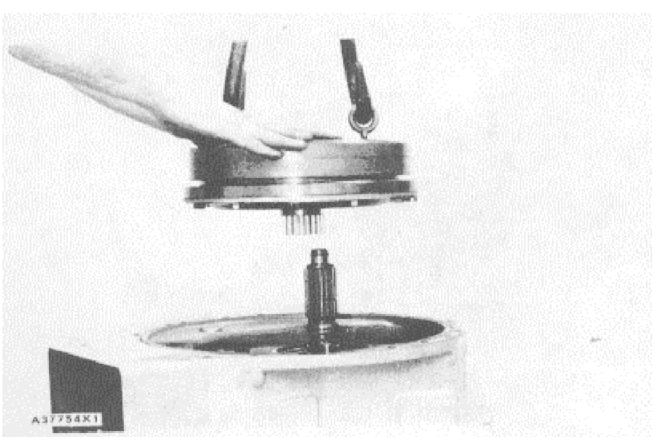
h) Install the washers, bolts (103) and springs (102).

i) Make sure the O-ring seal is in position in coupling (96) and install piston (104) on the coupling. Install the bolts and locks that hold the piston and coupling together.



55. Install two 3/8"-16 NC forged eyebolts in the No. 1 clutch and fasten a hoist to it.

56. Install the No. I clutch in the transmission as shown.



TRANSMISSION

57. Install ring (105) to hold the No. 1 clutch in position.

58. Install the O-ring seals on sleeve (106).

59. Install sleeve (106) and ring (107) so the sleeve is pushed all the way into the output transfer gear case for installation of the valve manifold.

60. Make sure the five O-ring seals (108) are in position on the transmission.

61. Install manifold (109) and tighten the four bolts (110) to a torque of 35 + 3 lb. ft. (45 + 4 N. m).

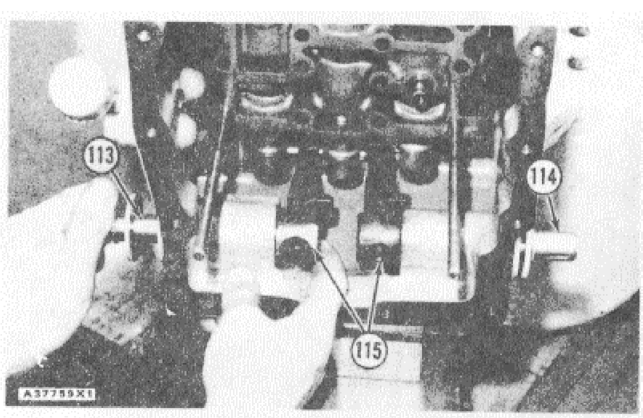
62. Push sleeve (106) up into manifold (109) and install ring (107) to hold the sleeve in position.

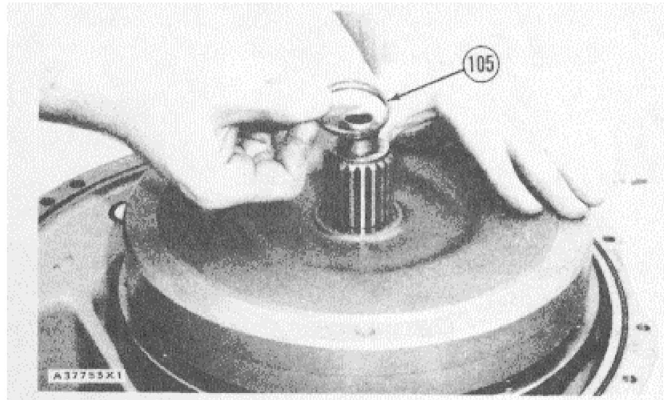
NOTE: See ASSEMBLE TRANSMISSION HYDRAULIC CONTROL VALVES to assemble the selector and pressure control valves.

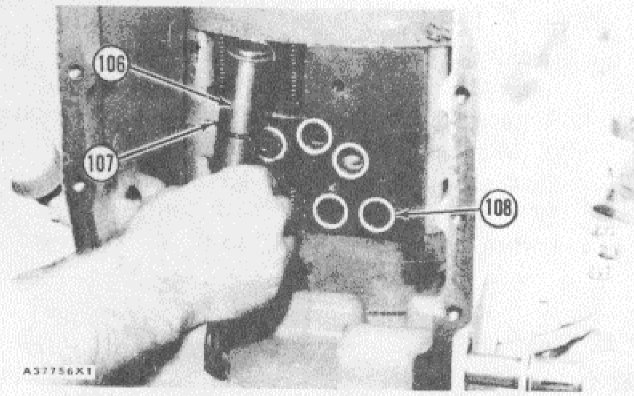
CAUTION: When selector valve (11) is installed the valve spools must be held in position because they are free to fall out and be damaged.

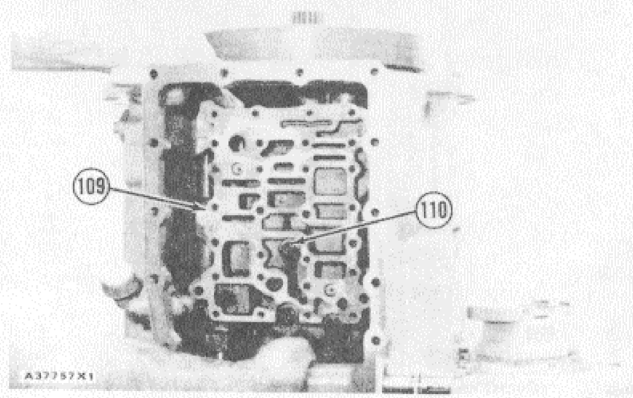
63. Put selector valve (111) in position and install three 5/16"-18 NC guide bolts (112) approximately 7 in. (17.8 cm) long to hold the valve.

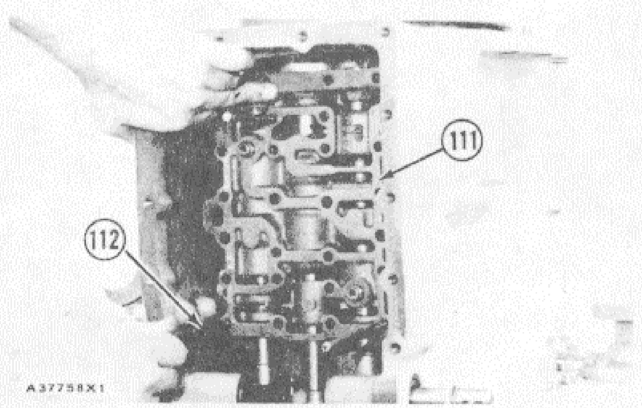
64. Put levers (115) in position. Make sure that the levers are engaged with the valve spools and push shafts (113) and (1 14) into levers (115). Install the bolts that hold the levers to the shafts and tighten them to a torque of 35 + 3 lb. ft. (45 + 4 N. m).



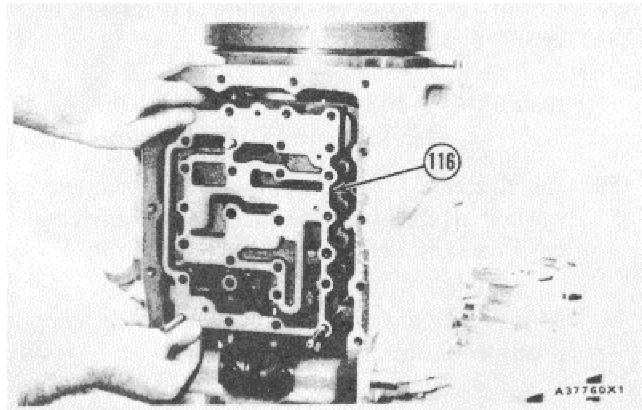




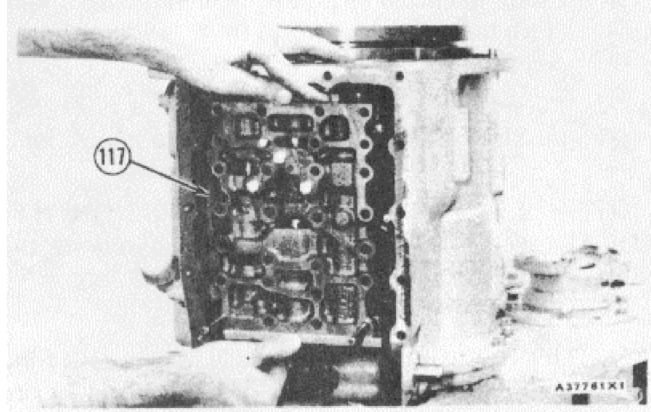




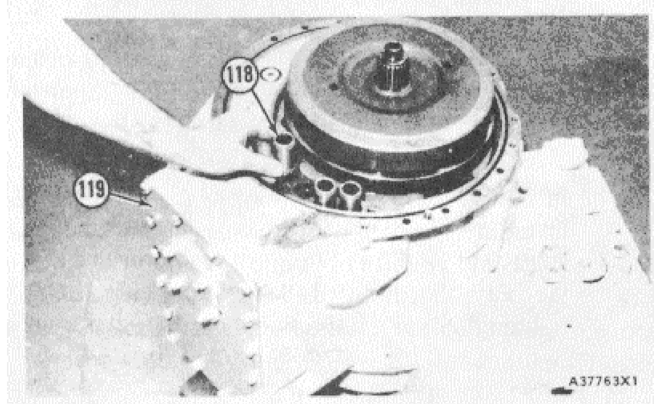
65. Install plate (1 16).



66. Install pressure control valve (117) and install four of the bolts that hold the valves in position. Remove the guide bolts and install the remainder of the bolts that hold the valve together. Tighten the twelve point 5/16"- -18 NC bolts to a torque of 22 ± 3 lb. ft. (28 ± 4 N. m) and the 3/8"-16 NC bolts to a torque of 35 ± 3 lb. ft. (45 ± 4 N. m).



67. Install the gasket and cover (119) on the transmission case.



68. Install the O-ring seals on sleeves (118) and install the sleeves in the transmission.
end by:
a) connection of input transfer gears to transmission

DISASSEMBLE TRANSMISSION HYDRAULIC CONTROL VALVES

start by:

a) remove transmission hydraulic control valves (See DISASSEMBLE TRANSMISSION)

1. Disassemble the pressure control valve as follows:

a) Remove the smallest cover from body assembly (1).

b) Remove slug (3) and converter inlet ratio valve spool assembly (2).

c) Remove stop (4) and the modulating relief valve spool assembly from body assembly (1).

d) Remove slug (3), pin (8), stop (7), spring (6) and plunger (5) from converter inlet ratio valve spool assembly (2).

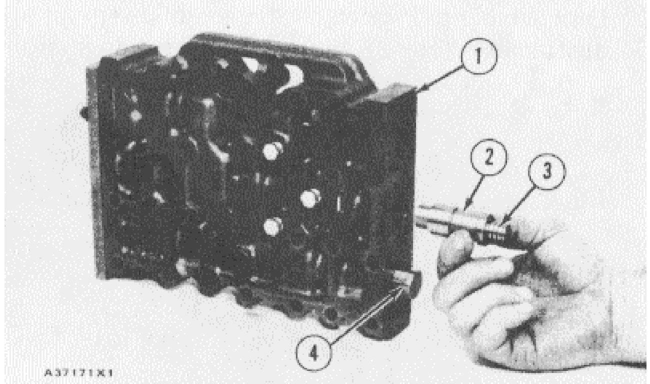
e) Remove slug (9), ring (10), retainer (11), spring (l 2), plunger (13), ring (16) and spacers (15) from modulating relief valve spool assembly (14).

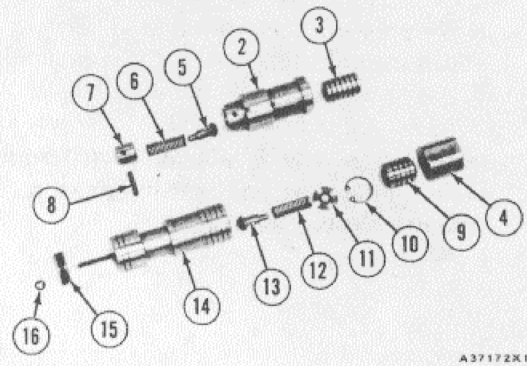
NOTE: Spacers (15) are used for the adjustment of the pressure control valve. Keep these spacers together for installation.

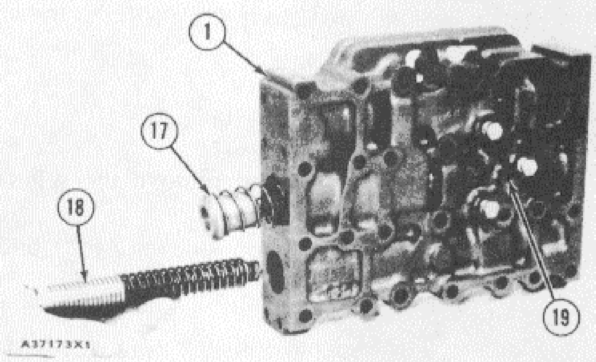
f) Remove the larger cover from body assembly (1).

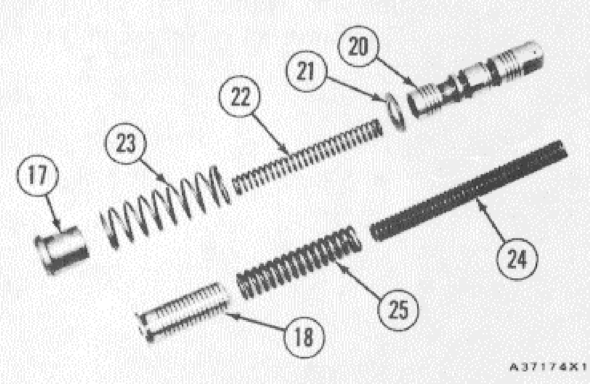
g) Remove load piston (18), spring (25), spring (24), stop (17), spring (23), spring (22), washer (21) and differential and safety valve spool (20) from body assembly (1).

h) Remove dowel (19) and the stop from the body assembly.







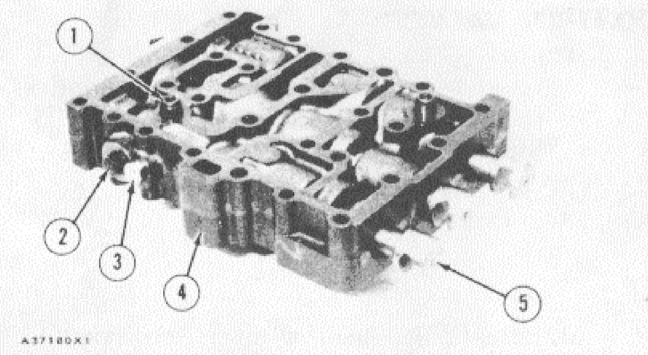


TRANSMISSION HYDRAULIC CONTROL VALVE

2. Disassemble the selector valve as follows:
   a) Remove bolt (2), the two washers and stop (3) from valve body (4).

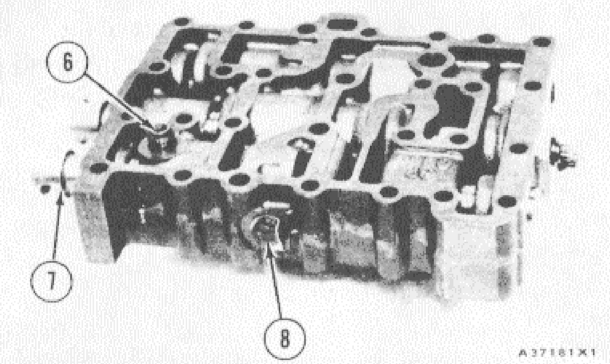
   b) Remove two detent assemblies (1) from each side of valve body) (4).

   c) Remove speed selector valve spool (5).



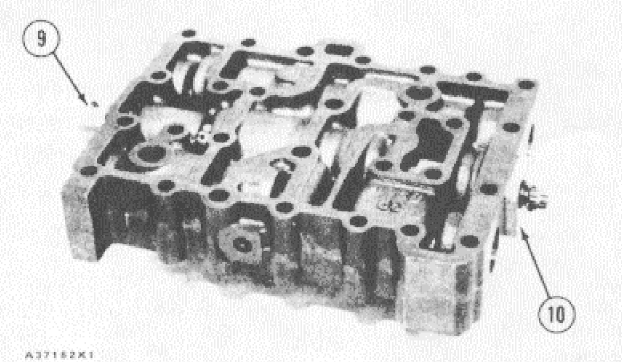
   d) Remove screw (8) and the lock.

   e) Remove two detent assemblies (6) from each side of the valve c body and remove directional selector valve spool (7).

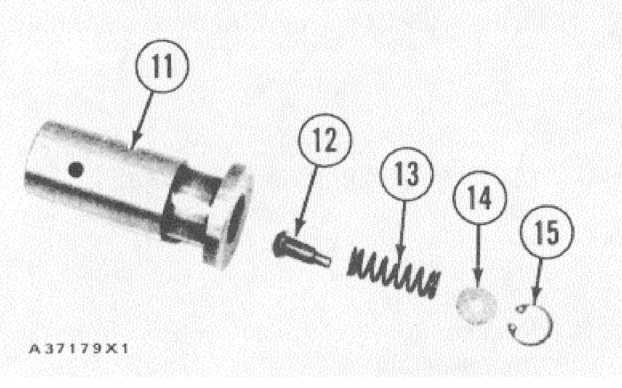


   f) Remove the speed selector valve assembly (9).

   g) Remove cover (10) and remove the relief valve assembly.



   h) Remove ring, (15), washer(14). spring (13), plunger(12) from relief' salve assembly (11).



ASSEMBLE TRANSMISSION HYDRAULIC CONTROL VALVES

1. Assemble the selector valve as follows:

a) Make sure all of the parts of the selector control valve are clean and free of dirt. Put clean SAE 30 oil on the parts of the selector valve.

b) Install the plunger, spring, washer and ring in relief valve assembly (2).

c) Install relief valve assembly (2) in the valve body. Install the cover and tighten the bolts to a torque of 22 + 3 lb. ft. (30 + 4 N. m).

d) Install speed selector valve spool assembly (1) in the valve body.

e) Install directional valve spool (3).

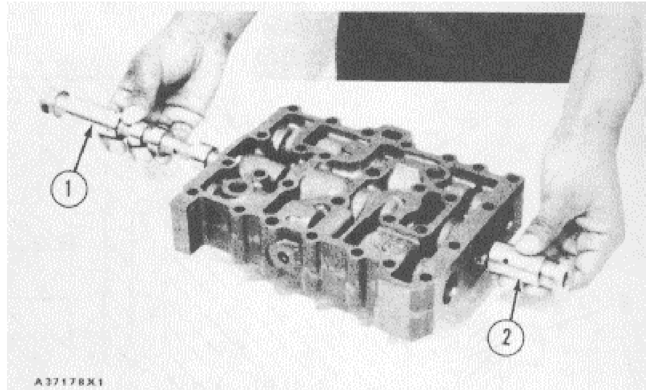
f) Make a replacement of the O-ring seals on detent assemblies (5) if necessary. Install the detent assemblies (4).

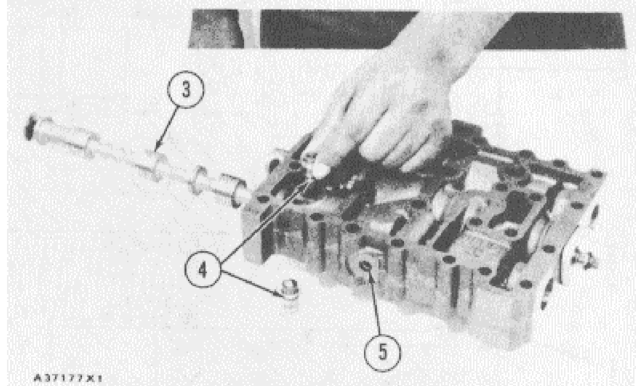
g) Install the setscrew and lock in hole (5).

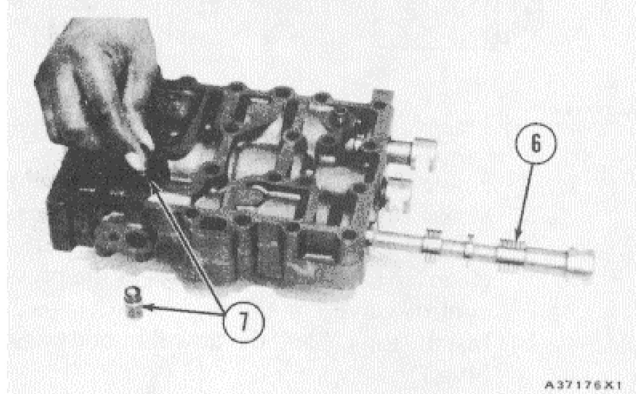
h) Install speed selector valve spool (6).

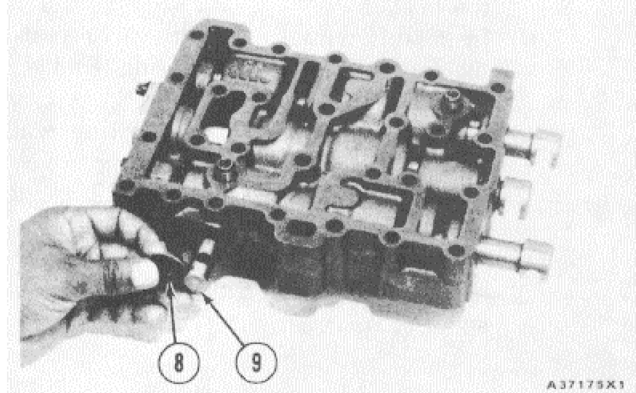
j) Make a replacement of the O-ring seals on detent assemblies (7) if necessary and install the detent assemblies.

k) Install stop (9), the two washers and bolt (8).

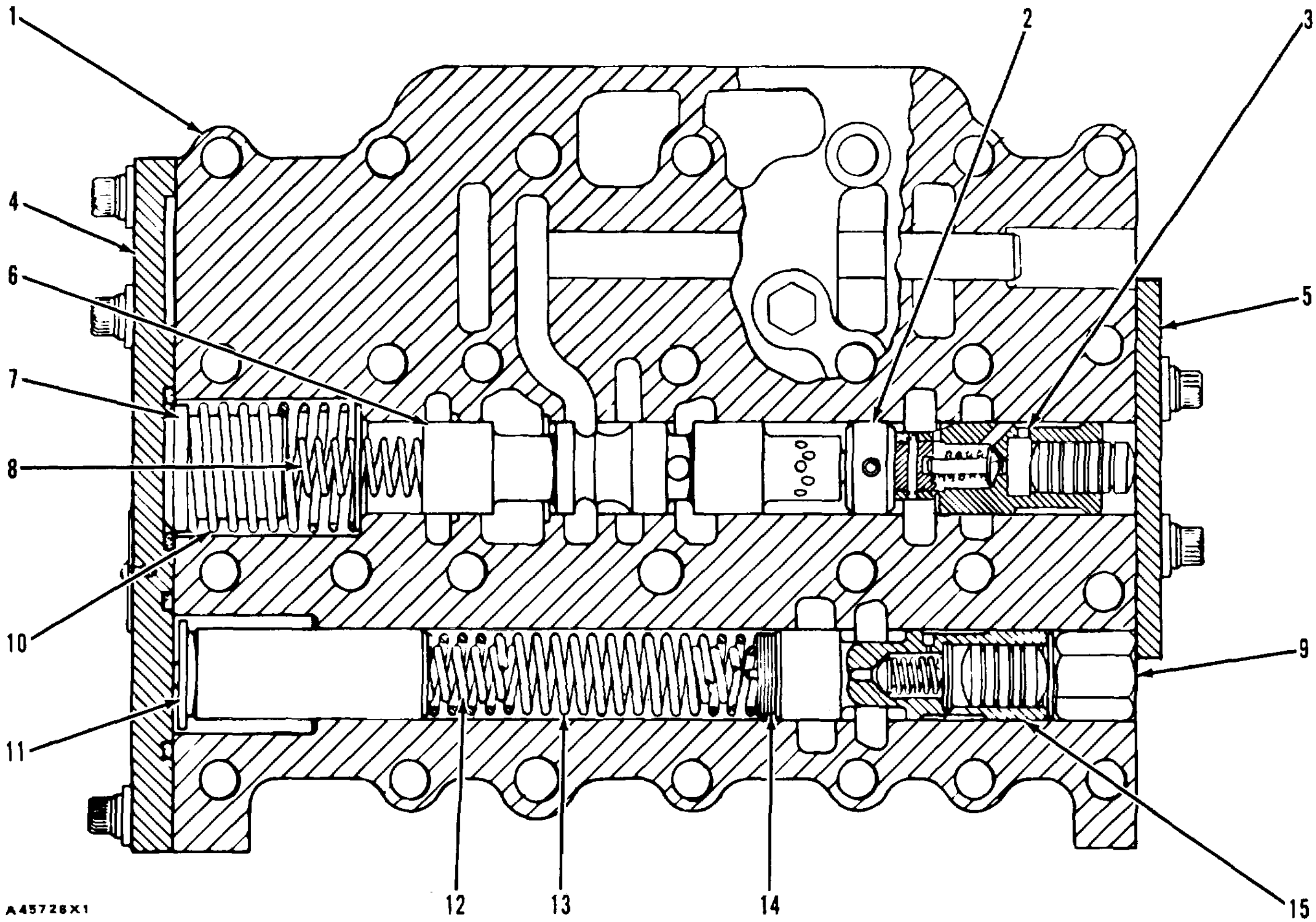








TRANSMISSION HYDRAULIC CONTROL VALVES



2. Assemble the pressure control valve as follows:
   a) Make sure all of the parts of the pressure control valve are clean and free of dirt. Put clean SAE 30 oil on the parts of the pressure control valve.
   b) Install stop (2) and the dowel in body assembly (1).
   c) Install spring (13), spring (12) and load piston (11).
   d) Install differential and safety valve spool (6), the washer, spring (10), spring (8) and stop (7).
   e) Make a replacement of the O-ring seals in cover (4) if necessary. Install the cover and tighten the bolts to a torque of 22 - 3 lb. ft. (28 + 4 N. m).
   f) Install spacers (14) and the ring that holds the spacers in position on modulating relief valve spool (15).
   g) Install the plunger, spring, retainer, ring and slug in modulating relief valve spool (15).
   h) Install modulating relief valve (15) and stop (9).
   j) Install the plunger, spring, stop, pin and slug in converter inlet ratio valve spool (3).
   k) Install converter inlet ratio valve spool (3).
   l) Install cover (5) and tighten the bolts to a torque of 22 + 3 lb. ft. (28 t 4 N. m).

3. Make adjustments to the transmission hydraulic controls after the transmission is installed in the machine. See POWER SHIFT TRANSMISSION TESTING AND ADJUSTING.

   end by:
   a) install transmission hydraulic control valves (See ASSEMBLE TRANSMISSION)

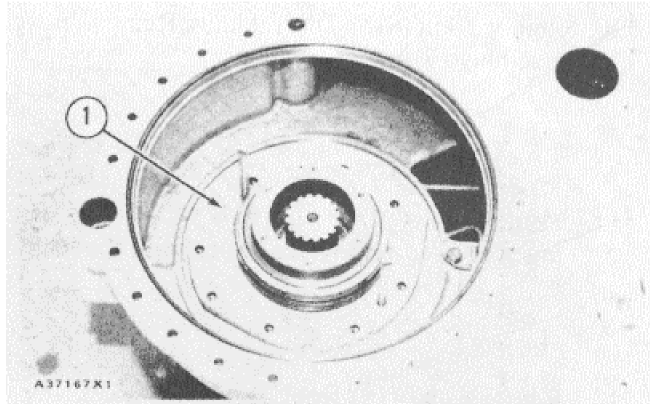
OUTPUT TRANSFER GEARS

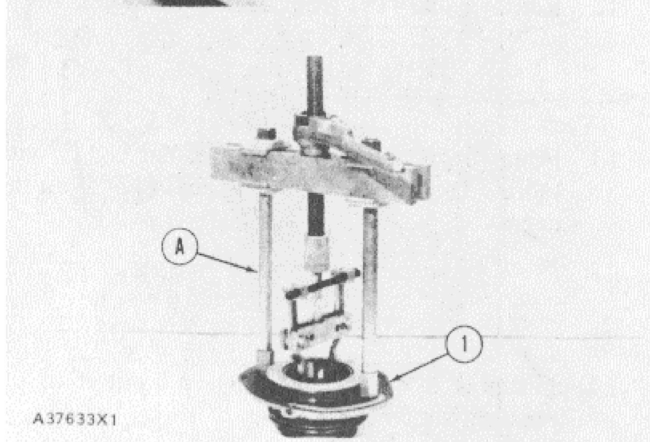
DISASSEMBLE OUTPUT TRANSFER GEARS

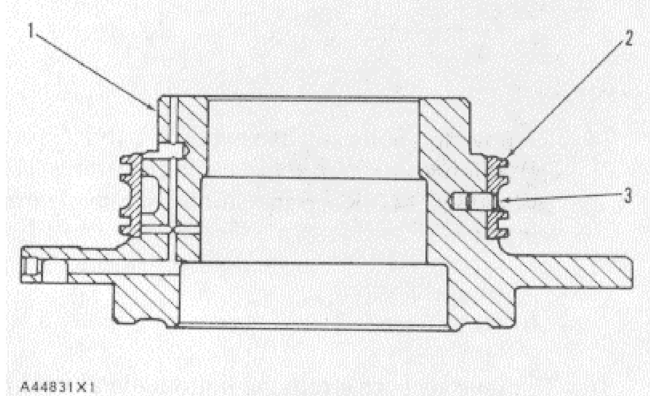
	Tools Needed	A	B	C
8B7548	Puller Assembly	1	1	
8B7554	Bearing Cup Puller			
	Attachment	1		
8H684	Ratchet Box Wrench	1	1	
8H663	Bearing Puller Attachment		1	
1P2322	Puller Assembly			1

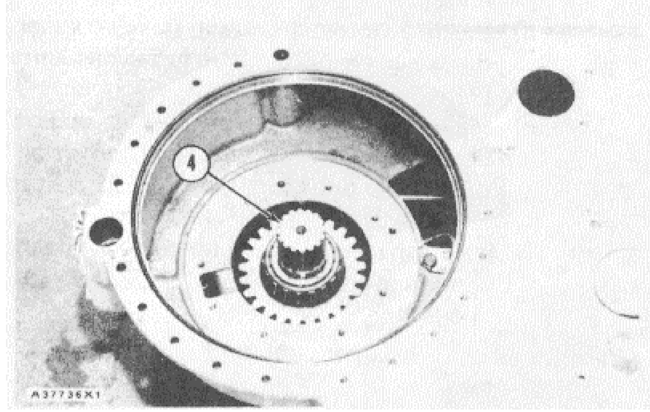
start by:
a) disassemble transmission

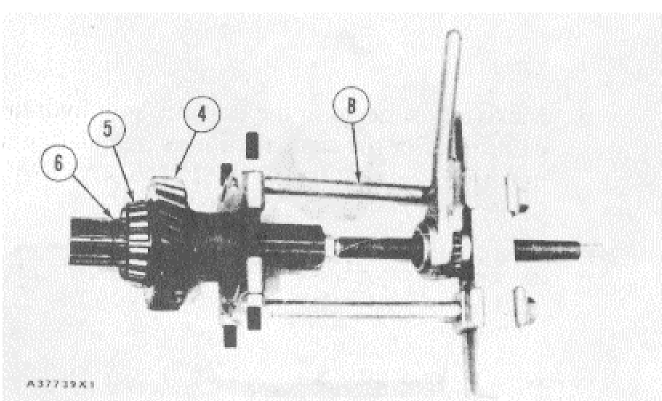
1. Remove the bolts and locks from cage assembly (1).
2. Use two 3/8"- 16 NC forcing screws and remove cage assembly (1).
3. Remove the bearing cup from cage assembly (1) with tooling (A).
4. Remove the seal rings from carrier (2).
5. Remove spring pin (3) from cage assembly (1).
6. Remove carrier (2) from cage assembly (1). The carrier will have damage after removal. Use a new part for replacement.
7. Remove gear (4) from the transfer gear case.
8. Remove ring (6) from gear (4).
9. Remove bearing cones (5) from gear (4) with tooling (B).





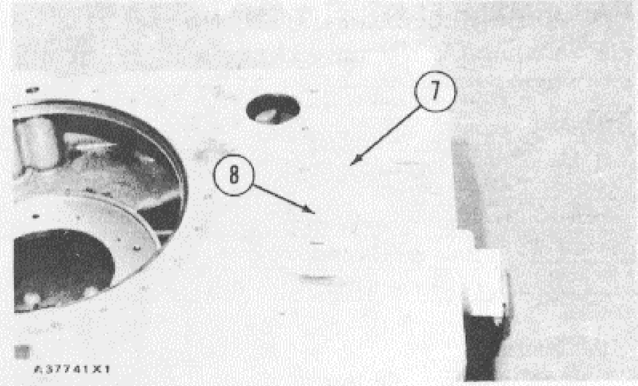






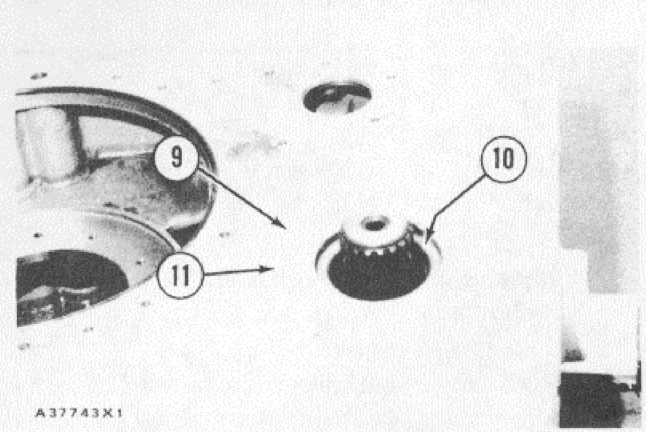
OUTPUT TRANSFER GEARS

10. Remove Dolt (X) and the retainer. Remove range assembly (7).



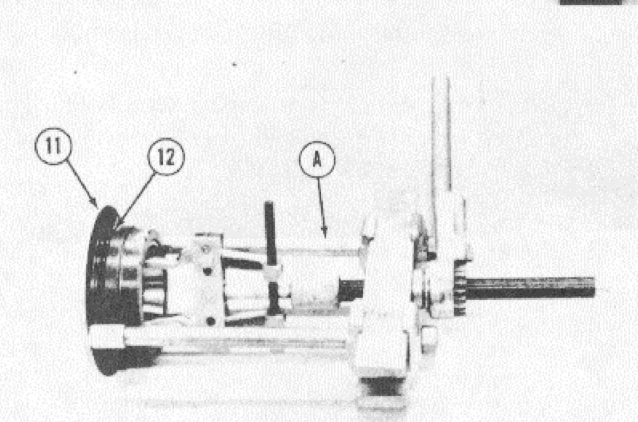
11. Remove bolts (9) and use two 3/8"-16 NC forcing screws to remove cage (11) and the shim.

12. Remove seal (10) from cage (11).

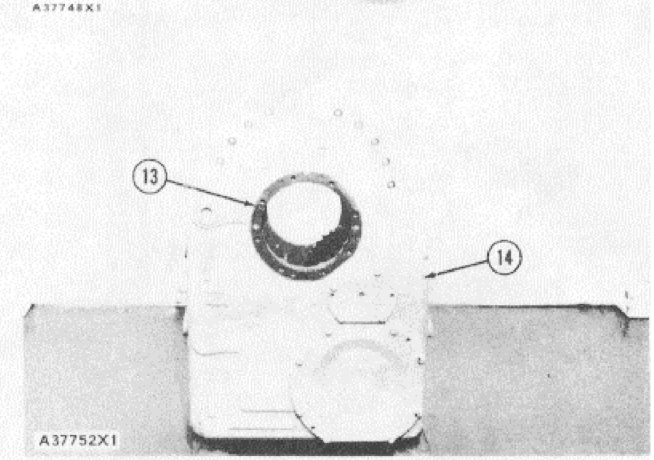


13. Remove the bearing cup from cage (11) with tooling (A). Remove O-ring seal (12) from the cage.

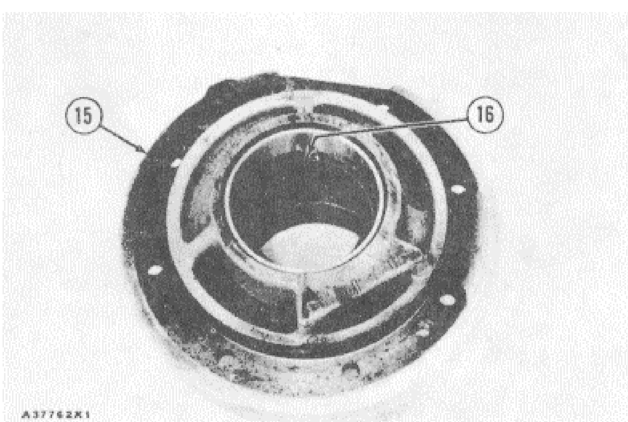
14. Fasten a hoist to case (14) and put it in the position shown.



15. Remove the bolts and use two 3/8"-16 NC forcing screws to remove the cage and shims (13) from case (14). Keep the shims together for assembly.



16. Remove seal (16) from the bottom of cage (15).



OUTPUT TRANSFER GEARS

17. Remove the bearing cup from cage (15) with tooling (A). Remove O-ring seal (17) from the cage.

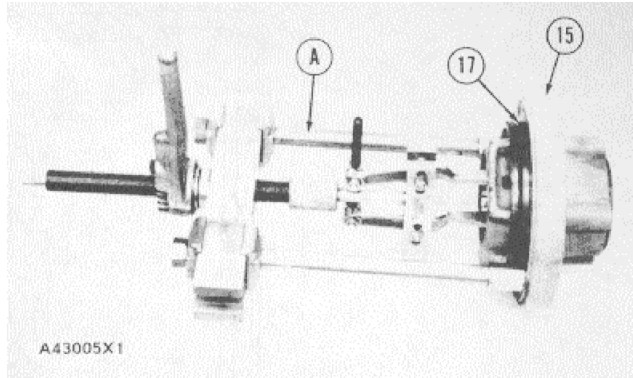
18. Remove the bolts from cage (18). Use two 3/8"-16 NC forcing screws and remove the cage from case (14).

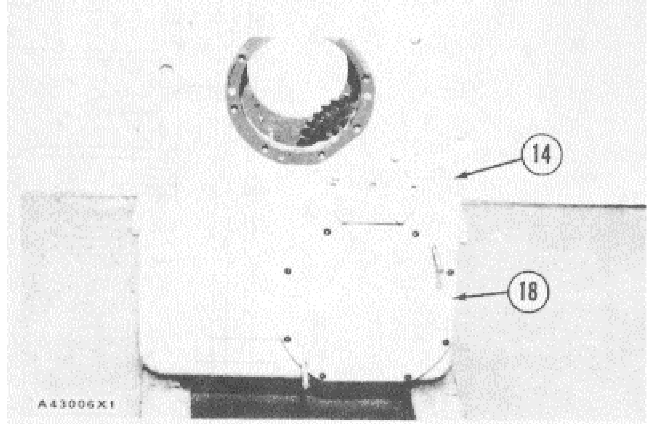
19. Remove the bearing cup from cage (18) with tooling (A). Remove O-ring seal (19) from the cage.

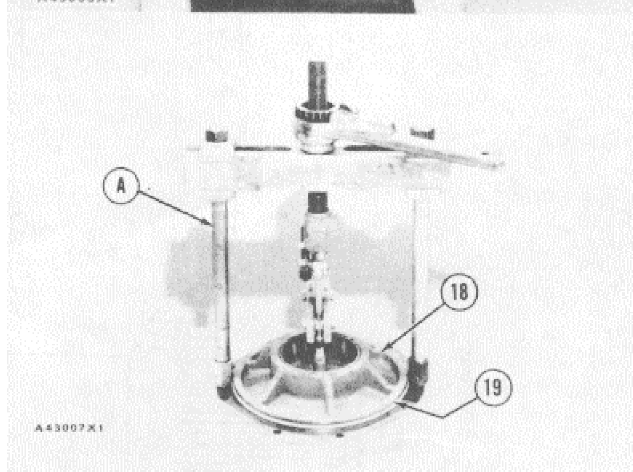
20. Remove gear (20) and the shaft assembly from the case.

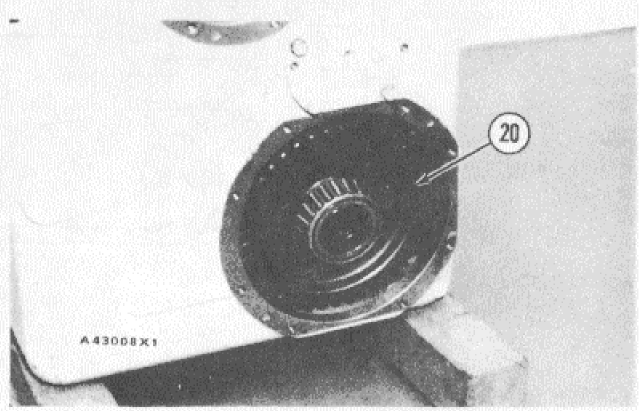
21. Use tooling (B) and remove the bearing cone from shaft assembly (21).

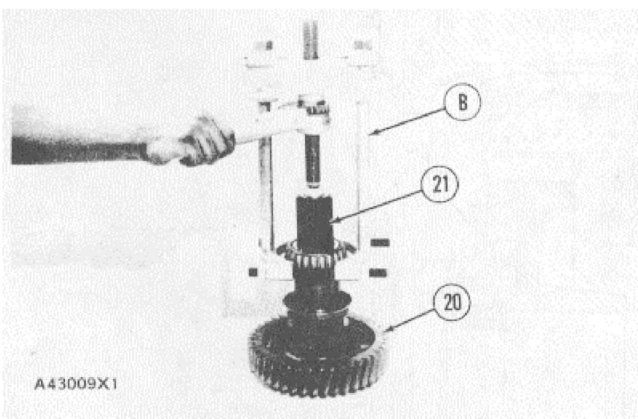
22. Remove gear (20) and the bearing cone from shaft assembly (21) with tool (C).

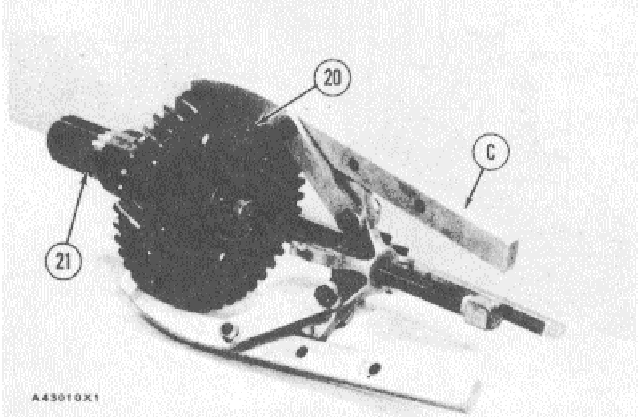




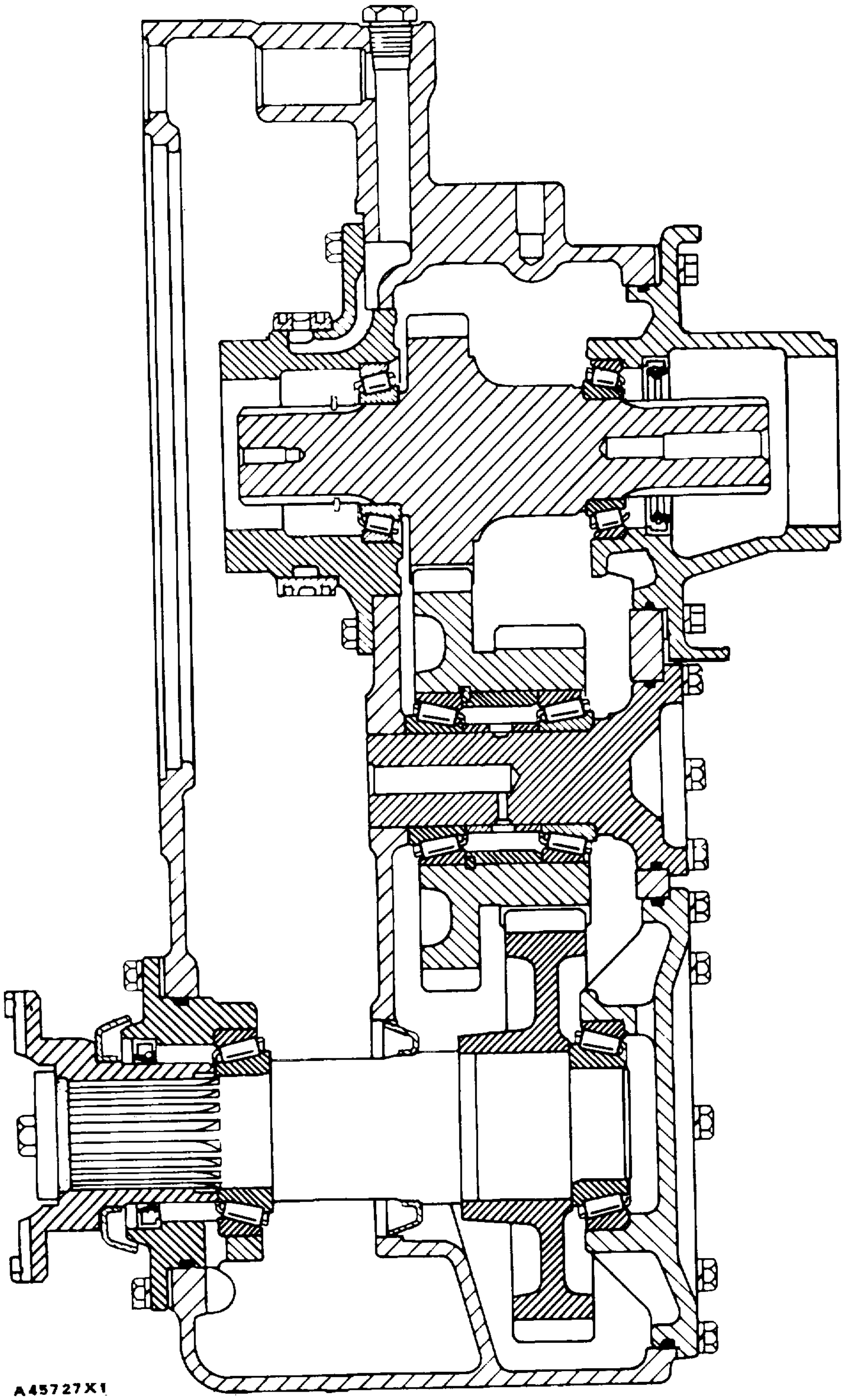








OUTPUT TRANSFER GEARS



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OUTPUT TRANSFER GEARS

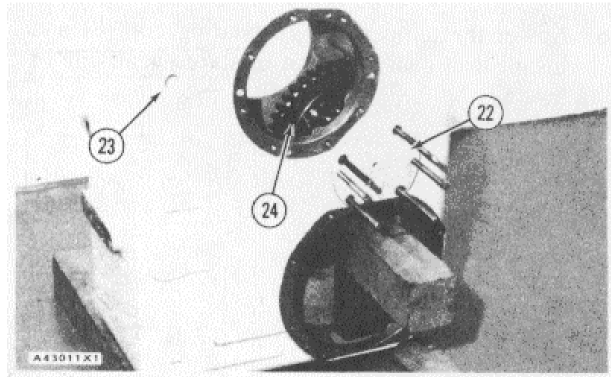
23. Remove plug (23), the seal and valve group from the case assembly. Remove the poppet, spring and plug from the valve body.

24. Put blocks under gear (24) for support.

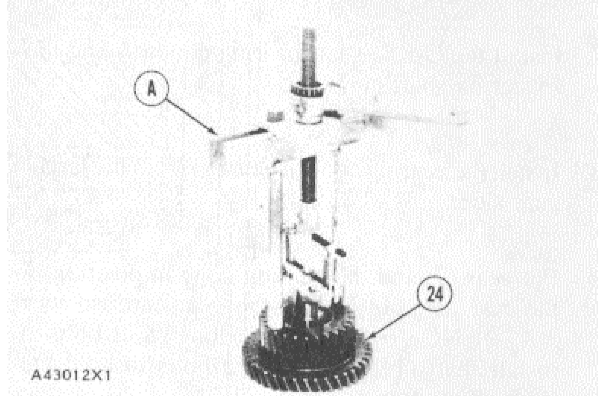
25. Remove the bolts from shaft (22) and install four 3/8"-16 NC x 6 in. (15.2 cm) long guide bolts as shown.

26. Remove shaft (22). Remove the bearing cone from the shaft.

27. Remove gear (24) from the case. Remove the bearing cone and spacer from the gear.



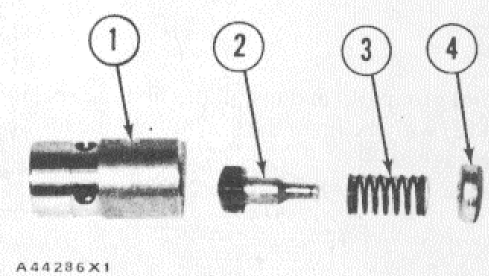
28. Use tooling (A) and remove the bearing cups and spacer from gear (24). Remove the snap ring from gear (24) if necessary.



ASSEMBLE OUTPUT TRANSFER GEARS

	Tools Needed	A	B
1P520	Driver Group	1	
8S2328	Dial Test Indicator Group		1

1. Install poppet (2), spring (3) and plug (4) in valve body (1).



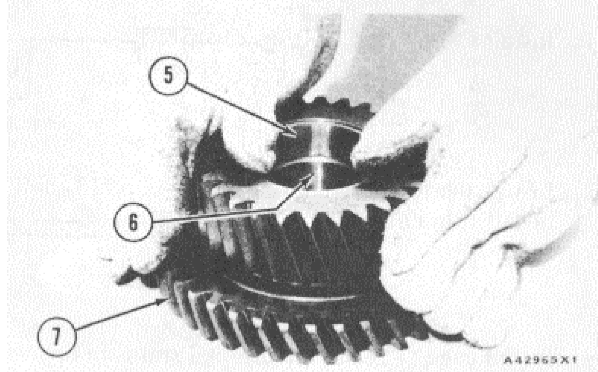
NOTE: Install plug (4) to a depth of .25 in. (6.35 mm) from the end face of valve body (I).

2. Install valve body (I) and the plug in the output transfer gear case.

3. Make a replacement of the ring in gear (7) if necessary .

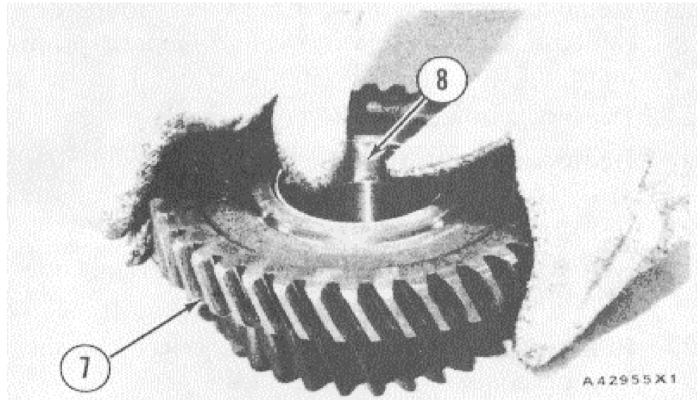
4. Install spacer (6) in gear (7) from the small gear side of gear (7).

5. Lower the temperature of bearing cup (5) and install it in the small gear side of gear (7).



OUTPUT TRANSFER GEARS

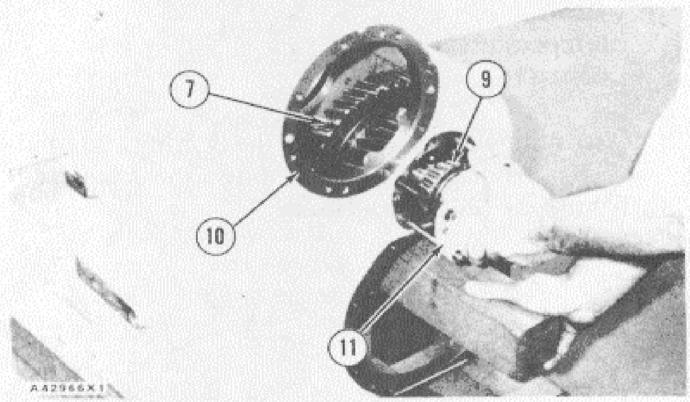
6. Lower the temperature of bearing cup (8) and install it in gear (7) from the large gear side of gear (7).



7. Install the O-ring seal, bearing cone (9) and the spacer on shaft (I l).

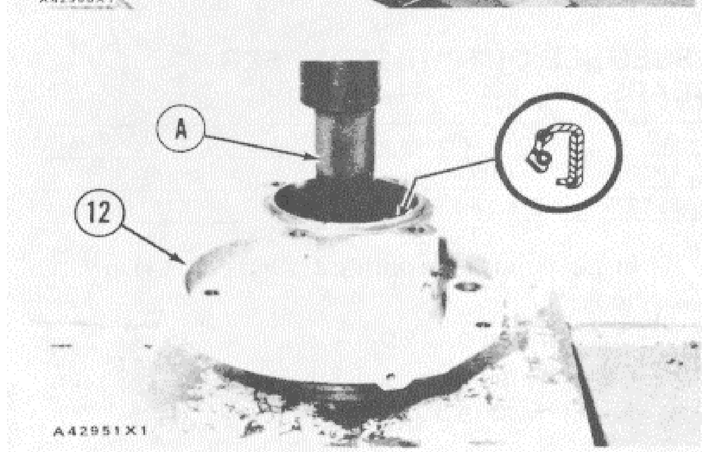
8. Install the bearing cone in gear (7) from the larger gear side.

9. Put gear (7) and the bearing cone in position in the case assembly. Hold the gear and use four 3/8'- 16 NC x 6 in. (15.2 cm) long guide bolts to install shaft (11). Tighten the bolts to hold the shaft in position.



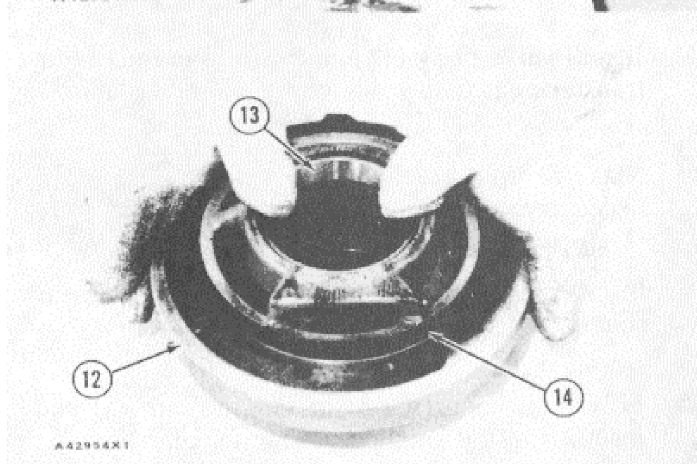
10. Use tool group (A) and install the lip type seal in cage (12) with the lip of the seal toward the inside of the cage.

11. Install O-ring seal (14) on cage (12).



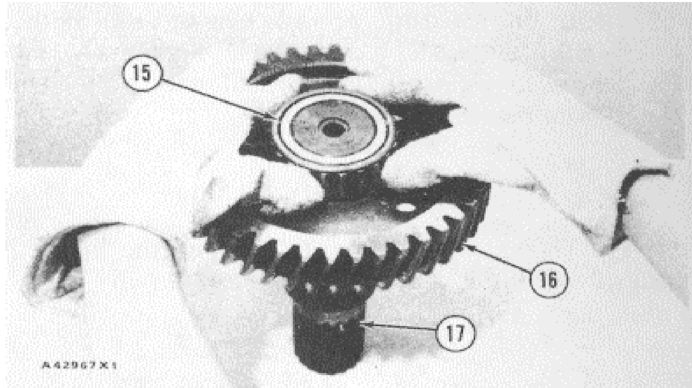
12. Lower the temperature of bearing cup (13) and install it in cage (12).

13. Install cage (12) and the original shims in opening (10) on the output transfer gears case.



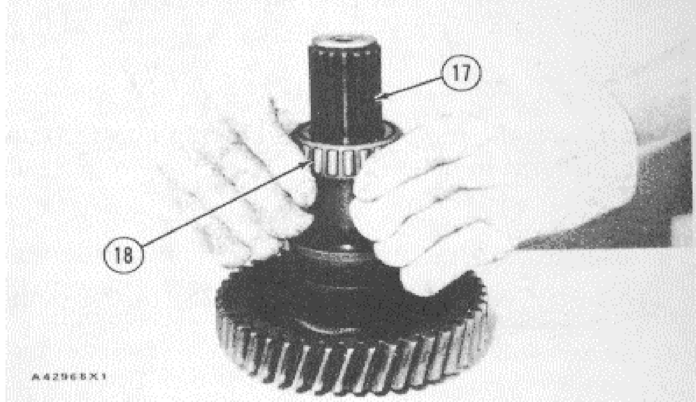
OUTPUT TRANSFER GEARS

14. Install gear (16) on output shaft (17).

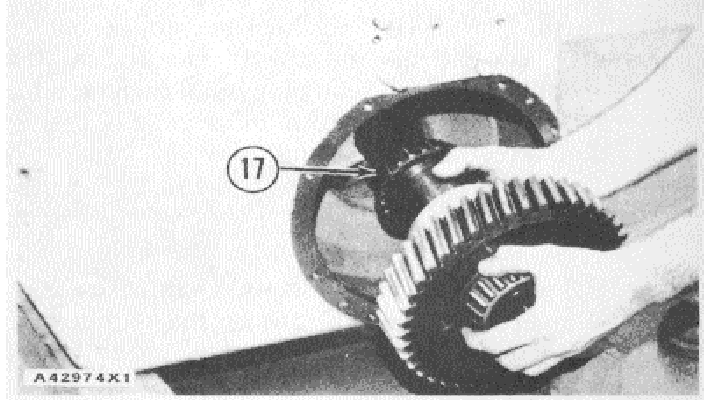


15. Heat bearing cone (15) in oil to a maximum temperature of 275°F (135°C). Install bearing cone (15) on shaft (17).

16. Heat bearing cone (18) in oil to a maximum temperature of 275°F (135°C). Install bearing cone (18) on shaft (17).



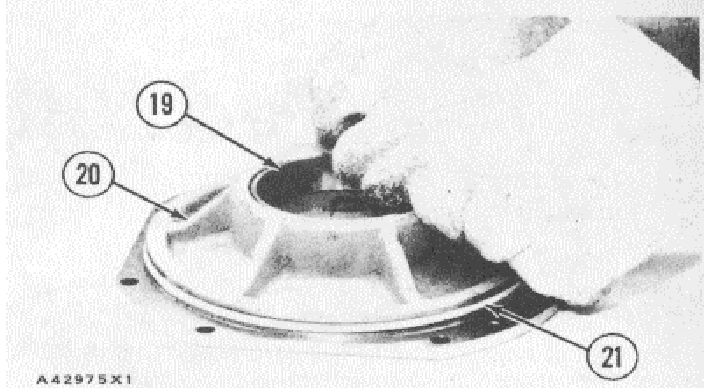
17. Install output shaft (17) in the output transfer gear case.



18. Install O-ring seal (21) on the output shaft rear bearing cage (20).

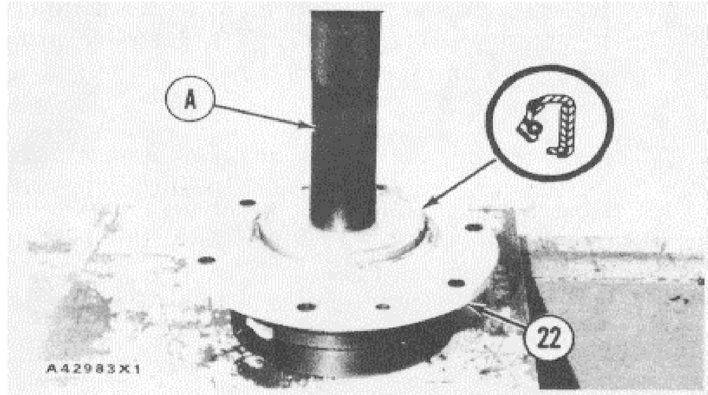
19. Lower the temperature of bearing cup (19) and install it in cage (20).

20. Install cage (20) on the output transfer gears case.



OUTPUT TRANSFER GEARS

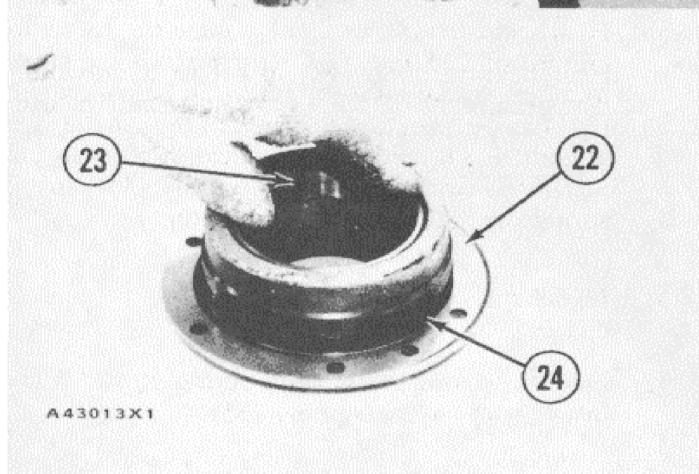
21. Put 7M7260 Liquid Gasket in the seal bore of cage (22) and let it dry. Use tool group (A) and a press to install the lip type seal in the output shaft front bearing cage (22).



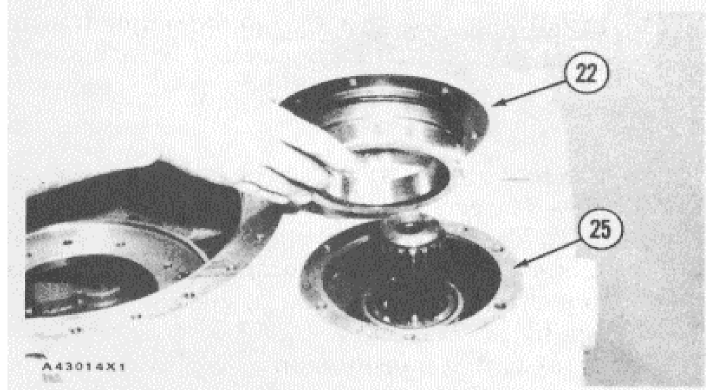
NOTE: The seal must be installed with the lip of the seal toward the inside of the cage as shown.

22. Install O-ring seal (24) on cage (22).

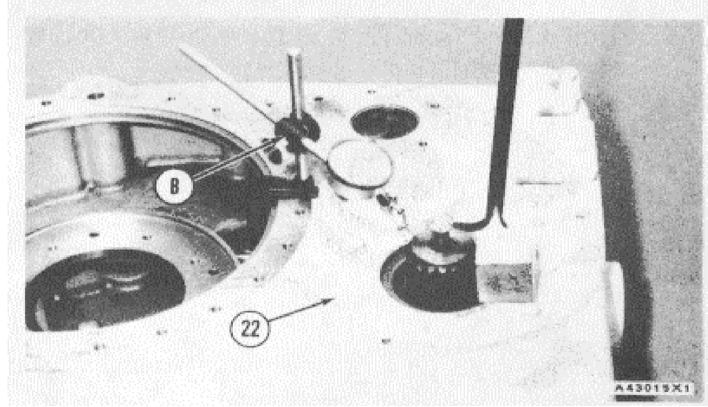
23. Lower the temperature of bearing cup (23) and install it in cage (22).



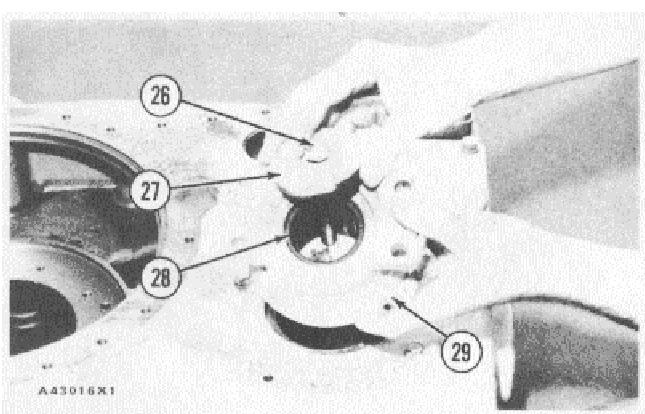
24. Install cage (22) and shims (25) in the output transfer gears case.



25. Use tool group (B) and check the output shaft end play. The end play must be .003 to .005 in. (0.08 to 0. 13 mm). If the end play is not correct, add or subtract shims (25) from under cage (22) to get the correct amount of end play.



26. Install yoke assembly (29), O-ring seal (28), retainer (27) and bolt (26) on the output shaft. Tighten bolt (26) to a torque of 80 ± 5 lb.ft. (110 ± 7 7 N m).



OUTPUT TRANSFER GEARS

27. Heat bearing cone (31) in oil to a maximum temperature of 275°F (135°C). Install bearing cone (31) on input gear (30).

28. Heat bearing cone (32) in oil to a maximum temperature of 275°F (135°C). Install bearing cone (32) on input gear (30).

29. Install ring (33) on input gear (30). Install input gear (30) in the transfer gears case.

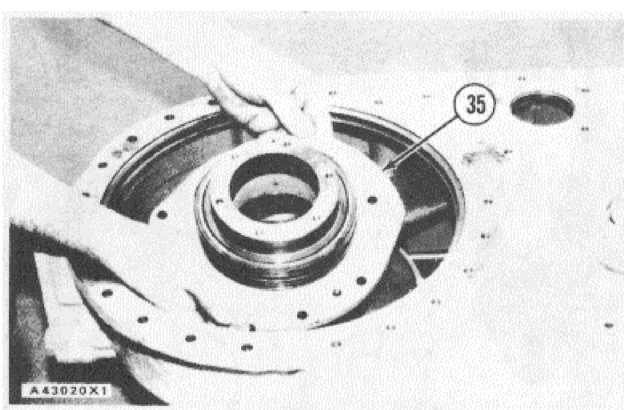
30. Heat seal carrier (34) in oil to a maximum temperature of 275°F (135°C) for no more than 10 minutes. Make sure the part number on carrier (34) can be seen and the hole in the carrier is in alignment with the hole in the cage assembly and install the carrier on cage assembly (35). Install spring pin (36) in the cage assembly.

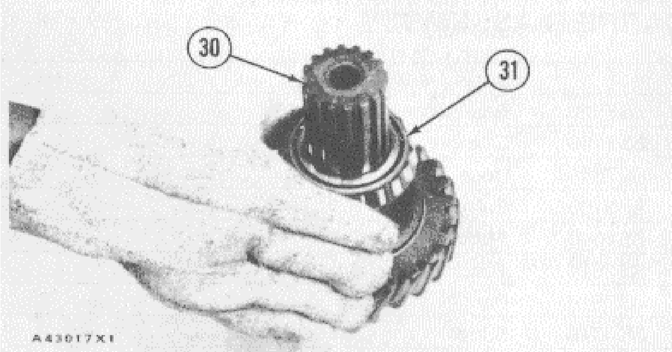
31. Install the seal rings on carrier (34).

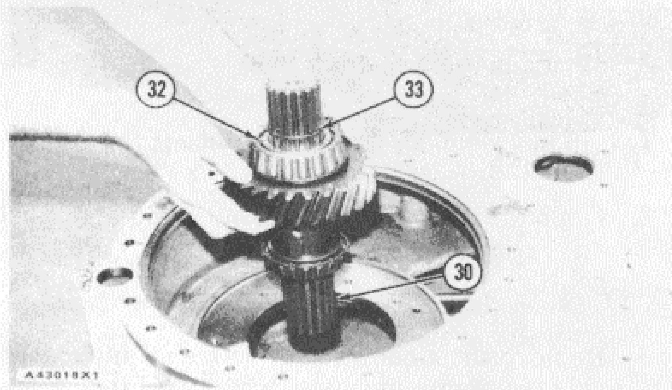
32. Lower the temperature of bearing cup (37) and install it in cage assembly (35).

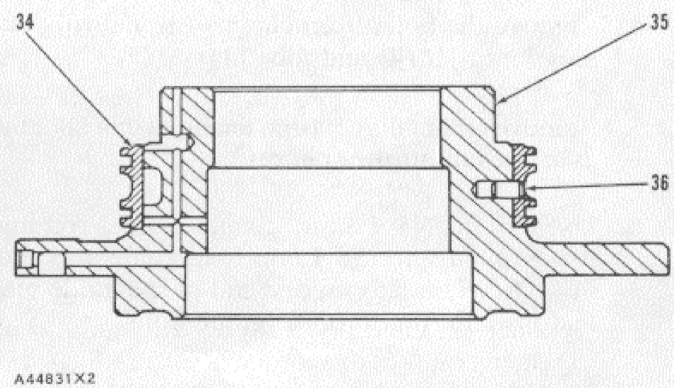
33. Install cage assembly (35) in the output transfer gears case. Install the locks and bolts that hold the cage assembly in position.

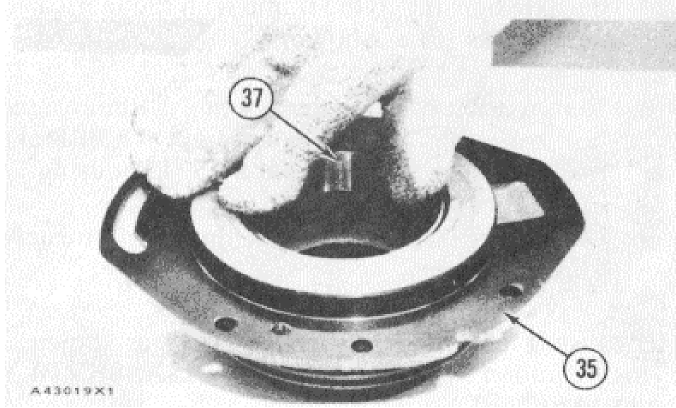
34. Use tool group (B) and check the input gear end play. The end play must be .003 to .005 in. (0.08 to 0. 13 mm). If the end play is not correct, add or subtract shims from under the rear bearing cage to get the correct amount of end play.
    end by:
    a) assemble transmission











REMOVE DIFFERENTIAL AND CARRIER ASSEMBLY

	Tools Needed	A	B
8S7620	Base Assembly	2	
BS7650	Cylinder	2	
8S7645	Hose Group	1	
5P3100	Pump Group	1	
8S7640	Stand		2
8S7611	Tube		2
8S7615	Pin		2
8S8048	Saddle		2

start by:
a) remove crankcase guard*
b) remove lower drive shaft

1. Put blocks under the scraper wheels for safety.

2. Drain the oil from the differential and both final drive compartments. The total capacity is 8 U.S. gal. (30.3 litre).

3. Remove the final drive covers and move each axle out approximately 12 in. (30 cm).

4. Remove the bolts from clamps (3) and (5). Remove muffler (4) and tube (1).

5. Remove eight nuts (2) from the bolts that hold the axle housing to the frame.

6. Use .75 in. (19.1 mm) diameter steel rod and make four 15 in. (38.1 cm) long guide pins. Put 3/4"-16 NF threads on one end of the guide pins and install a nut to make guide bolts.

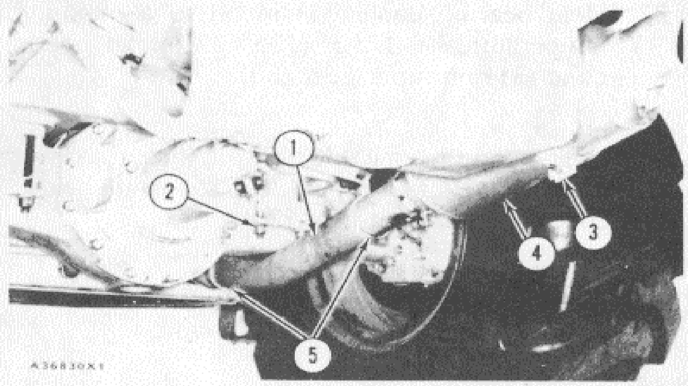
7. Make a replacement of four of the bolts that hold the axle housing to the frame with the fabricated guide bolts (6) as shown.

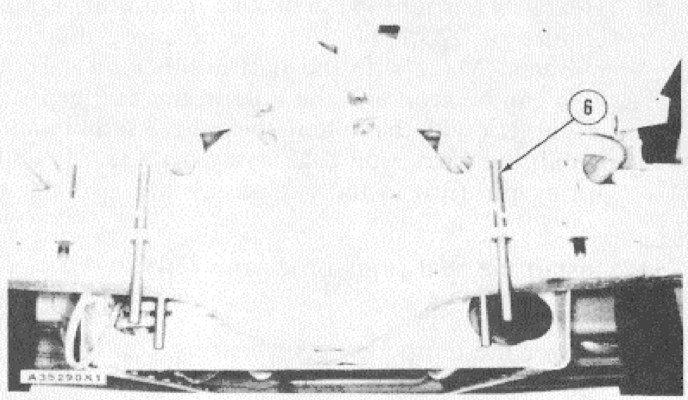
8. Remove bolt (7) from the assembly. Remove the bolt from the clip that holds right wheel brake line (8) to the frame above the axle housing.

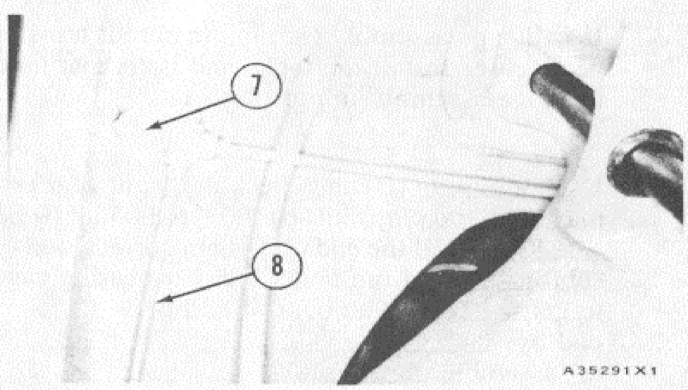
9. Use tooling (A) to lift the machine approximately 4 in. (10.2 cm).

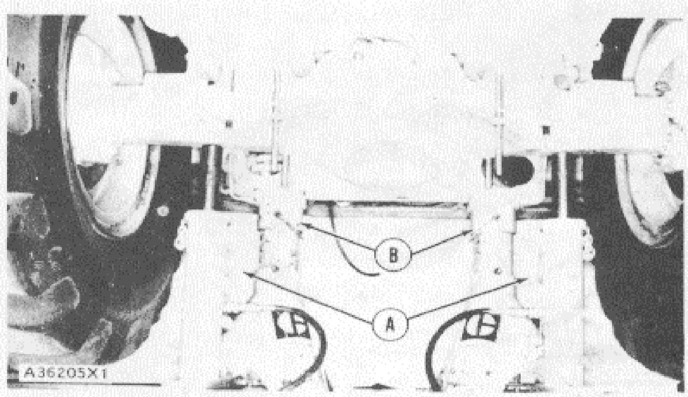
10. Install tooling (B) under the frame as shown.

*This operation is in the ENGINE DISASSEMBLY AND ASSEMBLY.



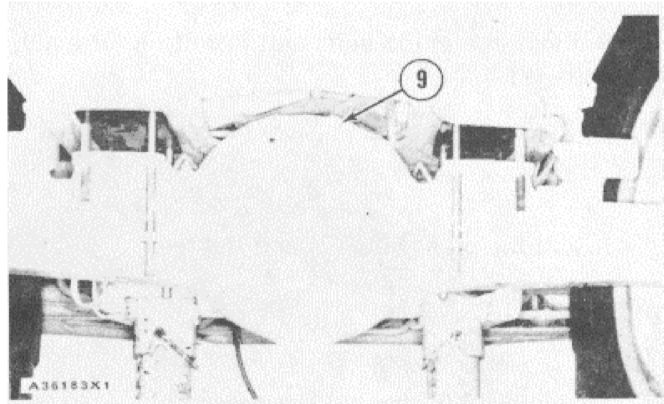




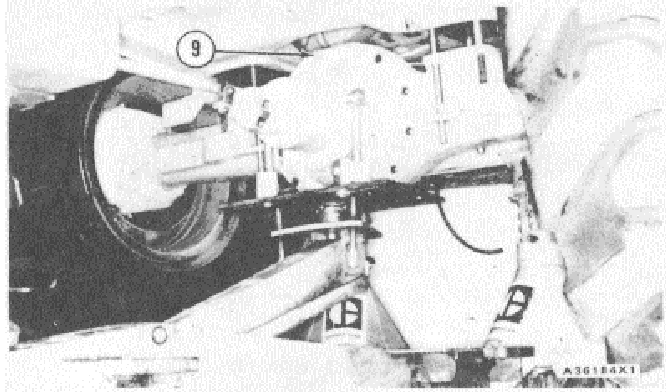


DIFFERENTIAL AND CARRIER ASSEMBLY

1. Lower the axle housing and wheels to the floor. Remove tooling (A).

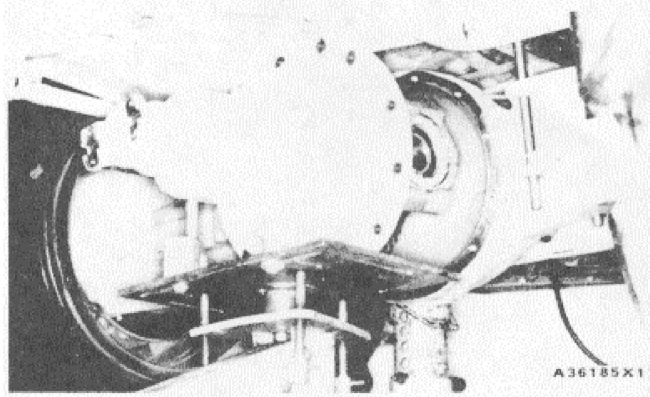


12. Remove all but the top two bolts (9) that hold the differential in the axle housing.



13. Put a transmission jack in position under the differential. Fasten the differential t(o the transmission jack.

14. Remove two bolts (9) and remove the differential. Weight of the differential is 450 lb. (203 kg).



INSTALL DIFFERENTIAL AND CARRIER ASSEMBLY

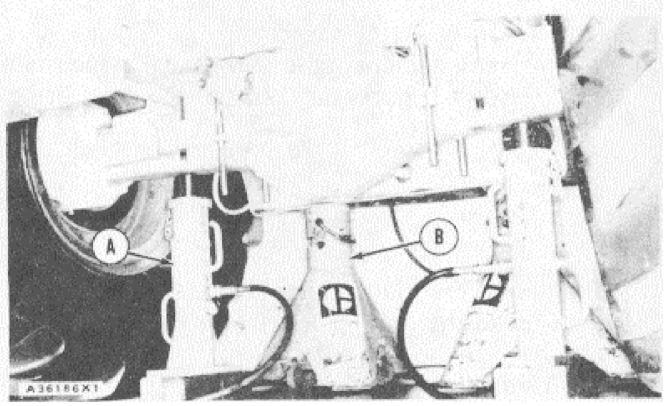
	Tools Needed	A	B
8S7620	Base Assembly	2	
857650	Cylinder	2	
8S7645	Hose Group	1	
5P3100	Pump Group	1	
8S7640	Stand		2
8S7611	Tube		2
8S7615	Pin		2
8S8048	Saddle		2

1. Fasten the differential to a transmission jack.

2. Install the differential in the axle housing with the transmission jack. Tighten the bolts to a torque of 195 $\pm$ 18 lb.ft. (265 $\pm$ 24 N.m).

3. Install tooling (A) under the axle housing. Lift the machine and remove tooling (B) from under the frame.

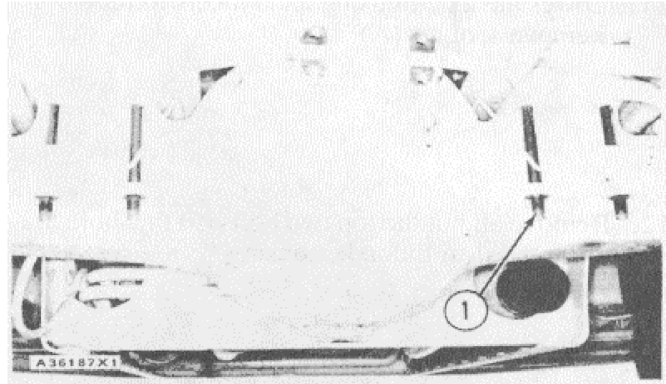
4. Lower the machine to the floor and remove tool- ing (A).



DIFFERENTIAL AND CARRIER ASSEMBLY

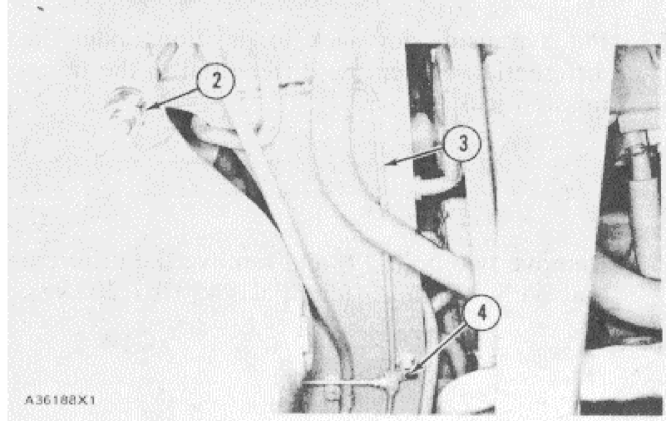
5. Remove the guide bolts and install the original bolts (I).

6. Install the eight nuts (2) and tighten.



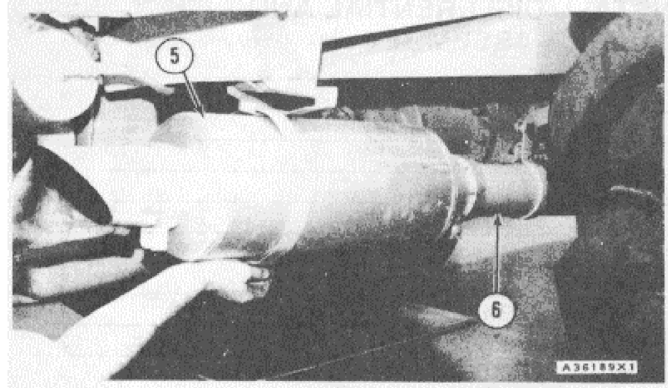
7. Install the bolts that hold tee assembly (4) to the frame.

8. Install the bolt in the clip that holds the right wheel brake line (3) to the frame.



9. Install muffler (5) and tube (6).

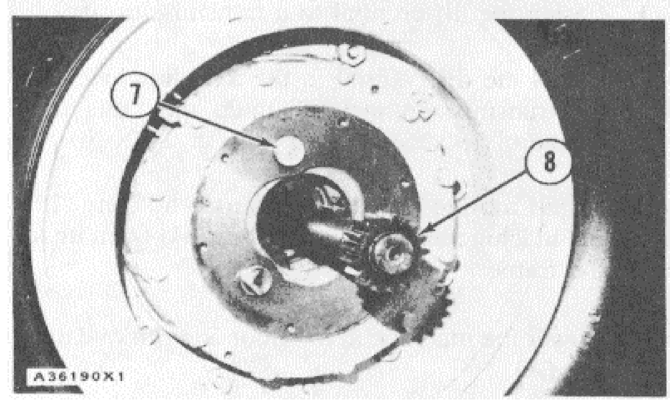
10. Install axles (8).



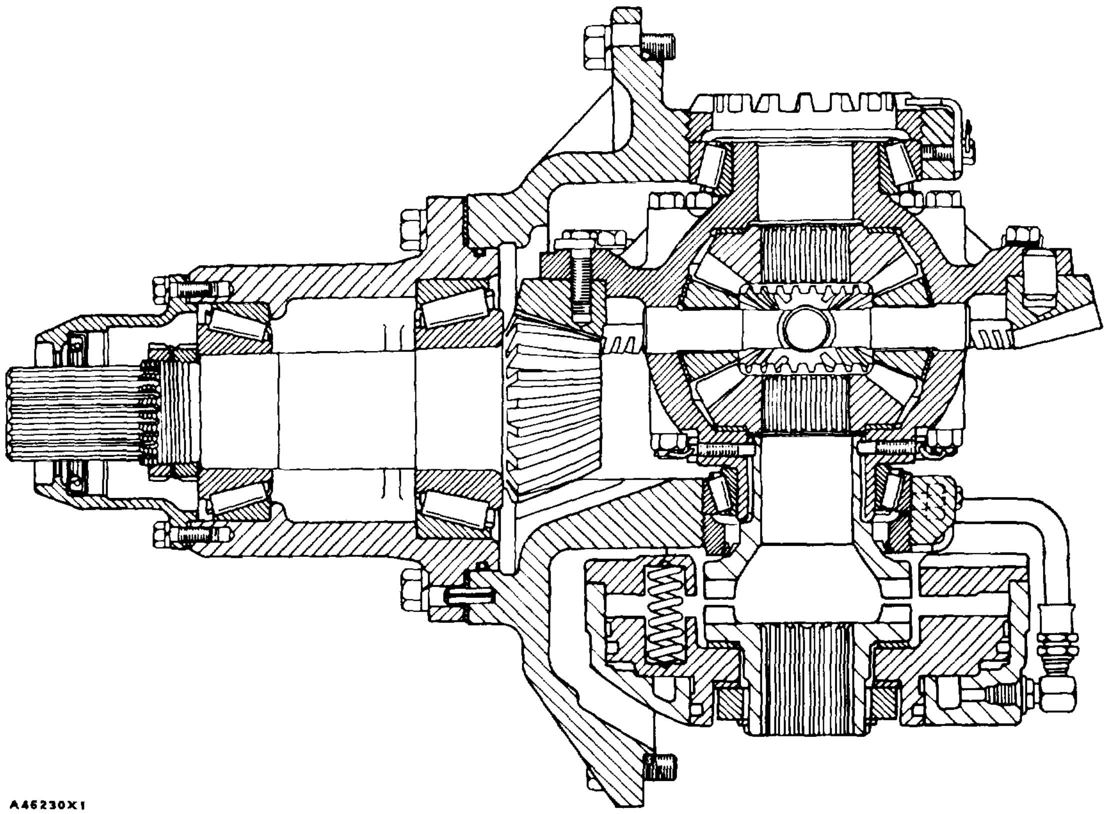
11. Make sure the flat surfaces on shafts (7) are in the position shown.

12. Make a replacement of the O-ring seal in the final drive covers if necessary. Install the final drive covers.

13. Fill the differential and final drive compartments with oil to the correct level.
end by:
a) install lower drive shaft
b) install crankcase guard



DIFFERENTIAL AND CARRIER ASSEMBLY

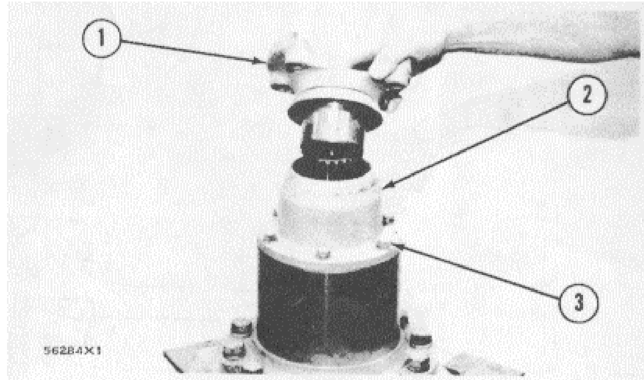


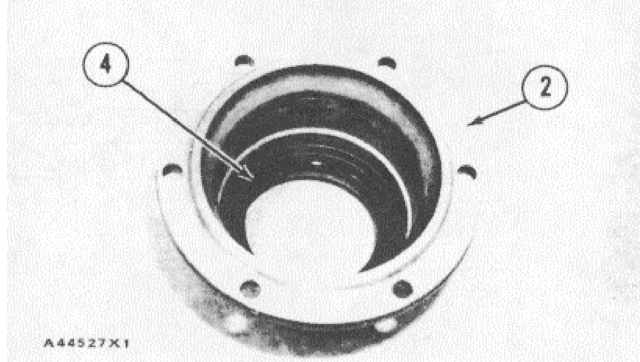
LOCK TYPE DIFFERENTIAL

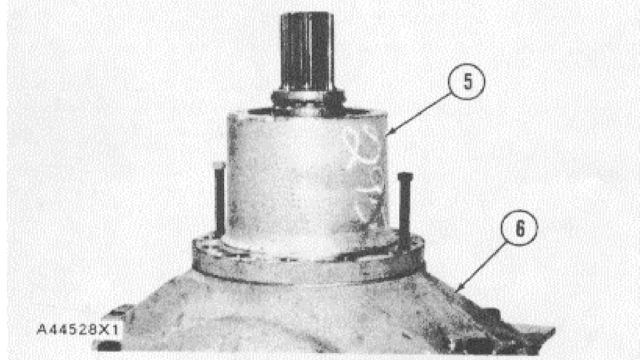
DIFFERENTIAL AND CARRIER ASSEMBLY (LOCK TYPE)

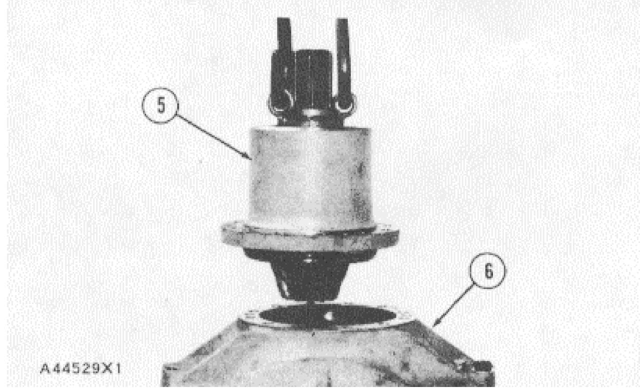
DISASSEMBLE DIFFERENTIAL AND CARRIER ASSEMBLY (LOCK TYPE)

	Tools Needed	A	B	C	D	E	F
1P2420	Transmission Repair Stand	1					
FT957	Differential Repair Positioner Group	1					
1P820	Hydraulic Puller Group		1				1
8B7557	Adapter		2				
8B7549	Leg		2				
184207	Nut		2				2
8B7560	Step Plate		1				
3H465	Plate		4				4
5P3100	Pump Group		1	1			1
5F7343	Bearing Puller Attachment			1			
1H3107	Puller Assembly			1			
1H3108	Leg			2			
7F9540	Hydraulic Puller			1			
1P2853	Spanner Wrench				1		
1P524	Drive Plate					1	
8B7551	Bearing Puller Attachment						1
1P493	Drive Plate						1
5F7369	Leg						2







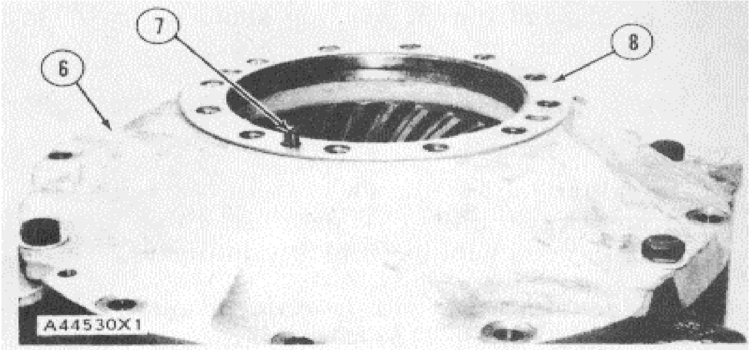


a) remove differential and carrier assembly start by:

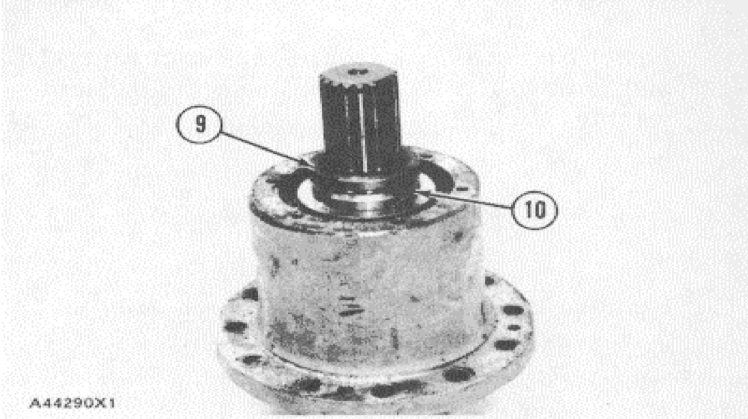
1. Put the differential and carrier assembly on stand (A) with the bevel gear down.
2. Remove yoke (I).
3. Remove bolts (3), seal retainer (2) and the gasket.
4. Remove seal (4) from retainer (2).
5. Remove the bolts that hold housing (5) to carrier assembly (6).
6. Install two 1/2 "-13 NC forcing screws and loosen housing (5) from carrier assembly (6).
7. Remove the forcing screws and install two 3/8”- 16 NC forged eyebolts in the top of housing (5). Fasten a hoist to the housing and remove it and the pinion as a unit. Weight of the unit is 85 lb. (39 kg).

DIFFERENTIAL AND CARRIER ASSEMBLY (LOCK TYPE)

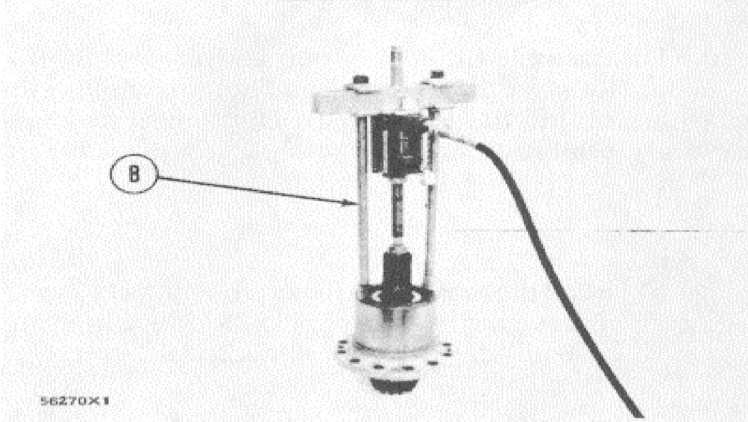
8. Remove spring pin (7) and shims (8) from carrier assembly (6). Put identification on the shims for assembly purposes.



9. Bend the tab of the lock from nut (9). Use tool (D) and remove nut (9), the lock and nut (10) from the pinion shaft.

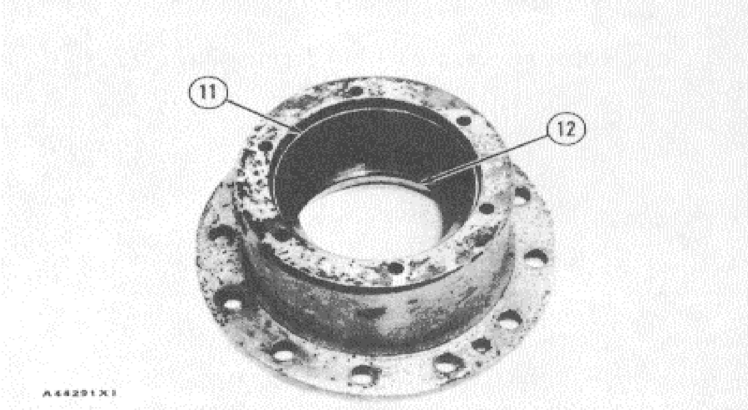


10. Remove the pinion shaft from the pinion housing with tooling (B).

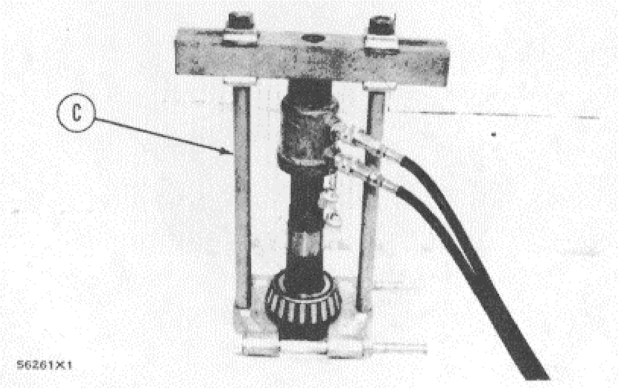


11. Remove the small bearing cone and O-ring seal on the bottom of the pinion housing.

12. Remove bearing cups (11) and (12) from the pinion housing.

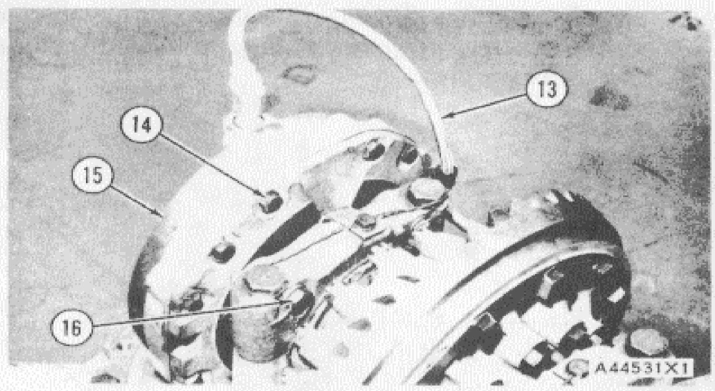


13. Remove the large bearing cone from the pinion shaft with tooling (C).



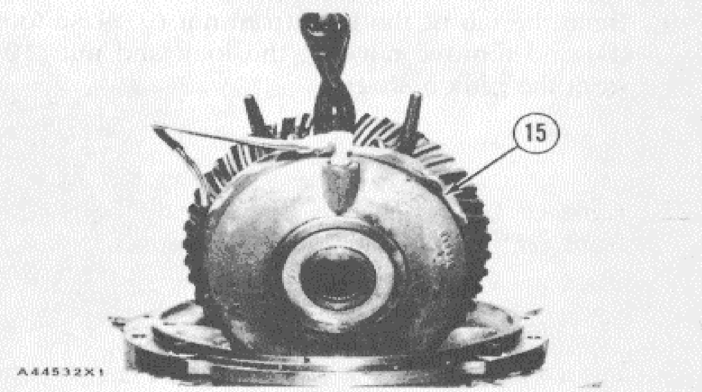
DIFFERENTIAL AND CARRIER ASSEMBLY (LOCK TYPE)

14. Fasten a hoist to the differential and carrier assembly and turn it over on stand (A) with the bevel gear up.
15. Disconnect hose assembly (13) from the carrier assembly.
16. Bend the tabs of the locks from two bolts (14). Remove two bolts (14) and install two 3/8"-16 NC forged eyebolts in lock group (15).
17. Remove the lockwire from four bolts (16) that hold lock group (15) to the carrier assembly.



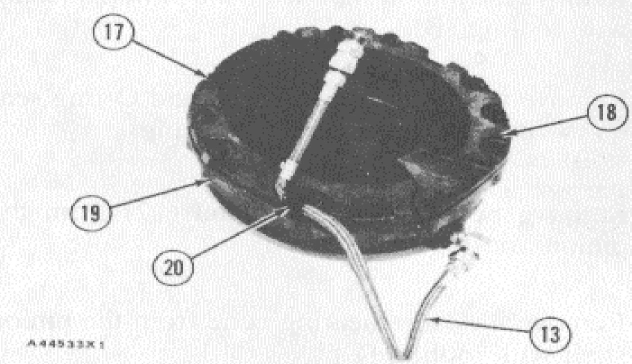
18. Fasten a hoist to lock group (15) loosen bolts (16) and remove the lock group from the carrier assembly. Weight of the lock group is 60 lb. (27 kg).

19. Remove the eyebolts from the lock group.

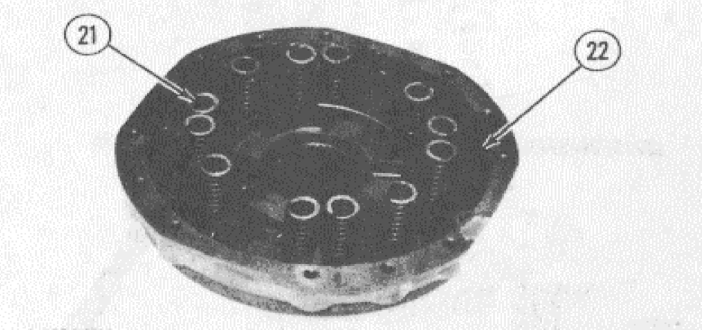


20. Disassemble the lock group as follows:
    a) Remove the lockwire and bolt that holds clip (20) to the lock group. Disconnect hose assembly (13) from the lock group.

    b) Bend the tabs of the locks from bolts (17) and remove the bolts and locks. Remove housing assembly (18) from cylinder (19).

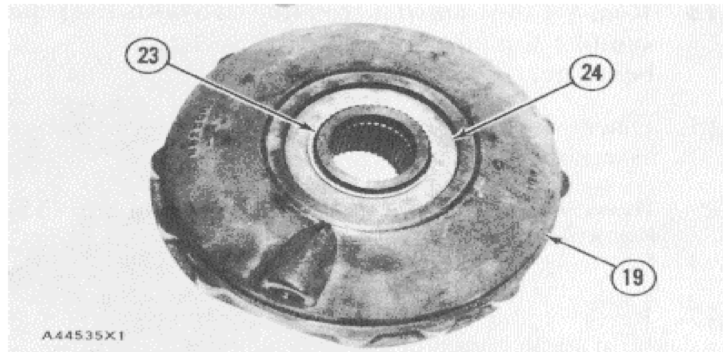


    c) Remove springs (21) from piston (22).

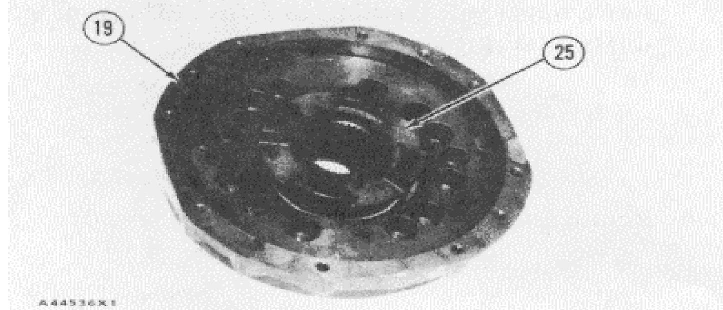


DIFFERENTIAL AND CARRIER ASSEMBLY (LOCK TYPE)

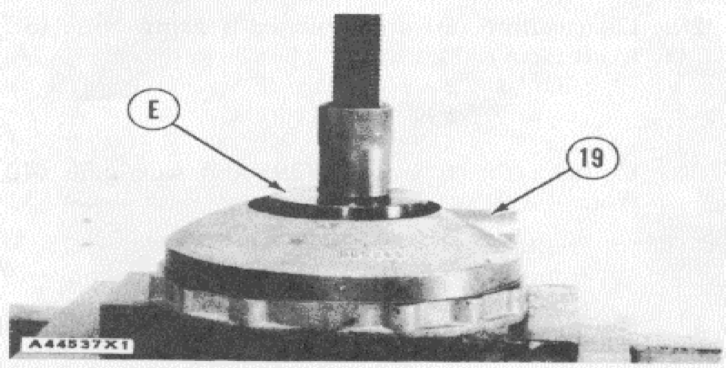
d) Remove ring (23) that holds the jaw in cylinder (19). Remove spacer (24) and the washer.



e) Remove jaw (25) and the washer from cylinder (19).



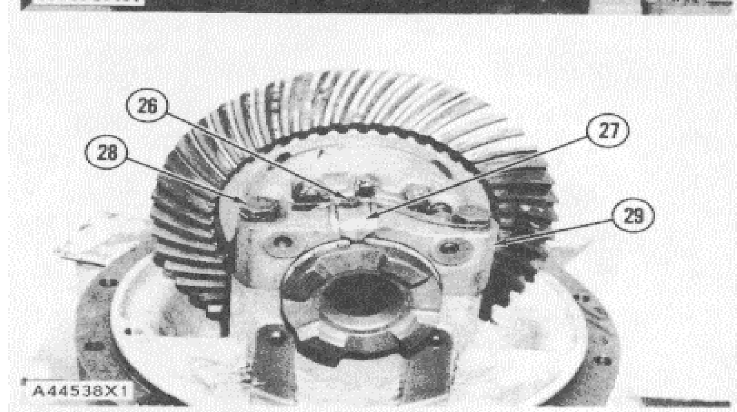
f) Use a press and tool (E) to remove the piston from cylinder (19). Remove the seals from the piston.



21. Remove the lockwire from bolts (26) and (28).

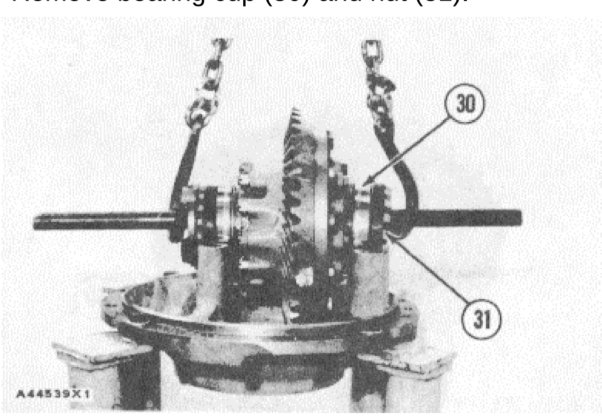
22. Remove bolts (26), locks (27) and bolts (28) from each side of the carrier assembly.

23. Put identification marks on the two bearing caps (29) for assembly purposes. Remove the bearing caps from the carrier assembly.



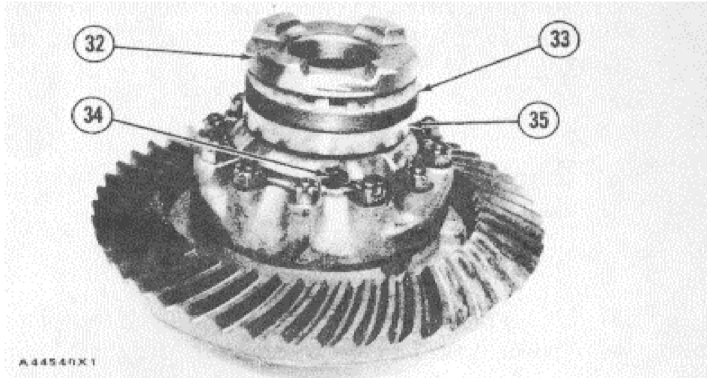
24. Put a bar through the differential group. Fasten a hoist and remove the differential group from the carrier assembly. Weight of the differential group is 115 lb. (52 kg).

25. Remove bearing cup (30) and nut (31).



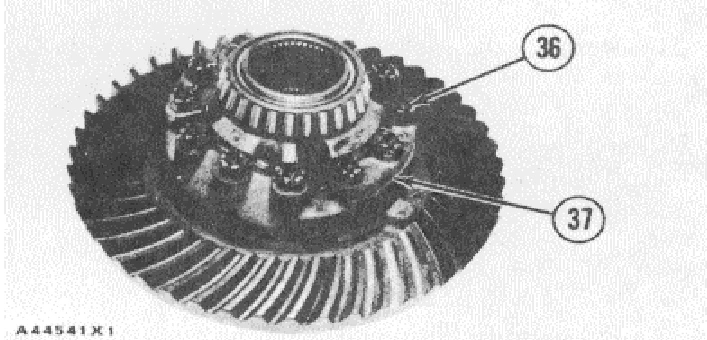
DIFFERENTIAL AND CARRIER ASSEMBLY (LOCK TYPE)

26. Remove the lockwire from the two bolts (34) and remove the bolts.

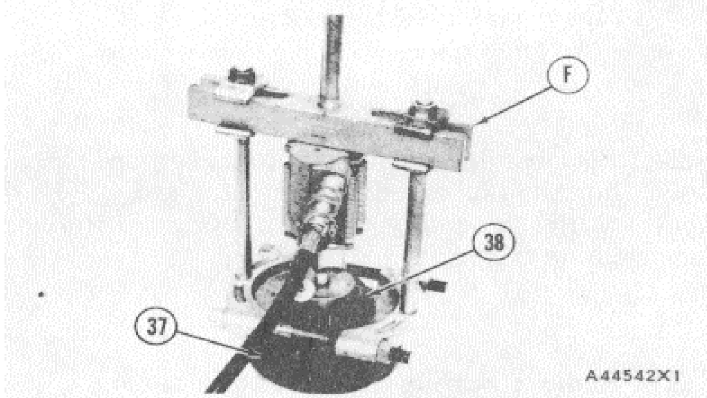


27. Remove jaw (32), nut (33) and bearing cup (35) from the differential group.

28. Remove the cotter pins from the bolts and remove nuts (36), the bolts and case (37) from the differential group.

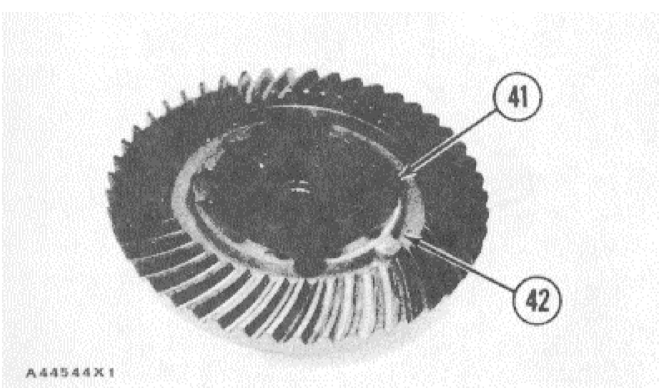


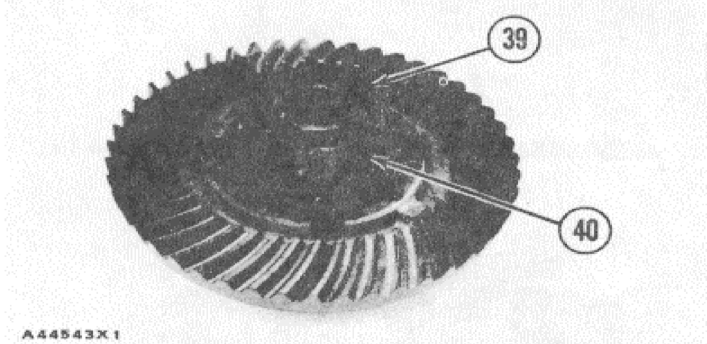
29. Use tooling (F) and remove bearing cone (38) from case (37).



30. Remove thrust washer (39) and side gear (40) from the differential group.

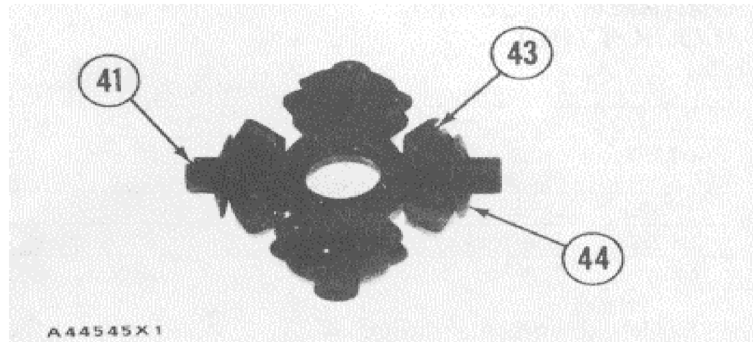
31. Remove the pinions and spider (41) as a unit from case (42).



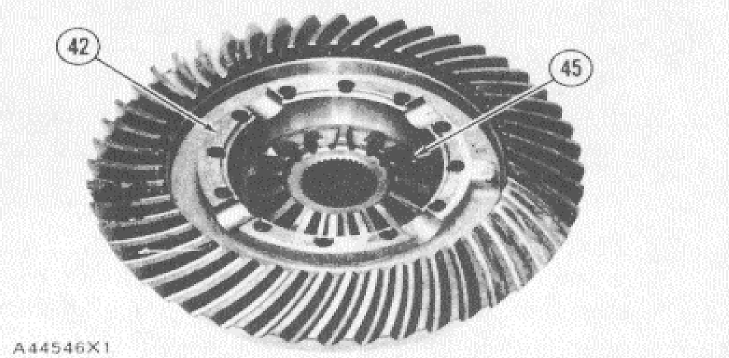


DIFFERENTIAL AND CARRIER ASSEMBLY (LOCK TYPE)

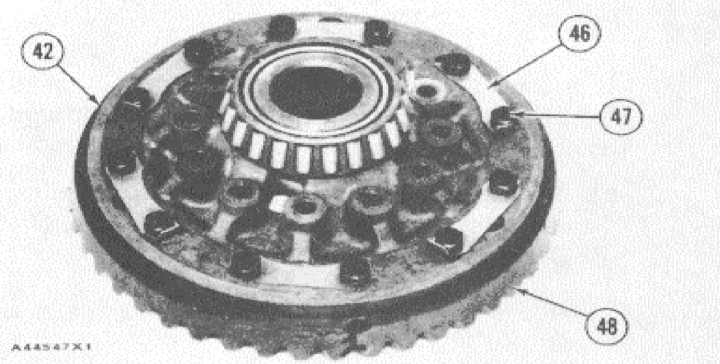
32. Remove thrust washers (44) and pinions (43) from spider (4 I).



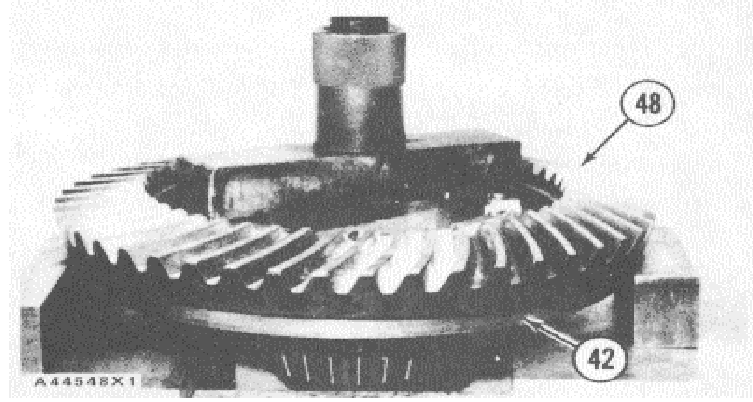
33. Remove side gear (45) and the thrust washer from case (42).



34. Bend the tabs of locks (46) from bolts (47). Remove bolts (47) and locks (46) that hold gear (48) to case (42).



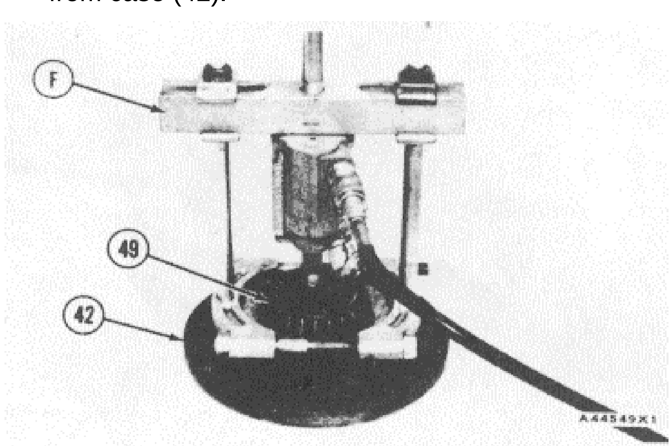
35. Put identification marks on gear (48) and case (42) for assembly purposes. Use a press and remove gear (48) from case (42).



36. If necessary remove the three dowels that hold gear (48) in position.

NOTE: Remove bearing cone (49) only if necessary. The bearing cone will have damage when removed. Use a new part for replacement.

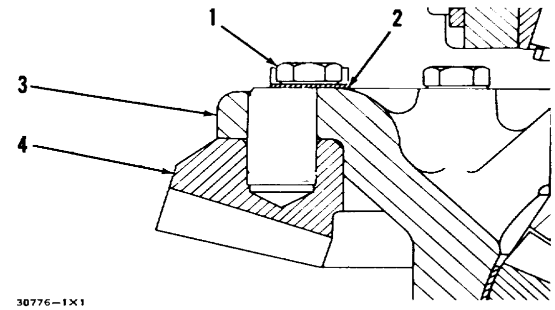
37. Use tooling (F) and remove bearing cone (49) from case (42).



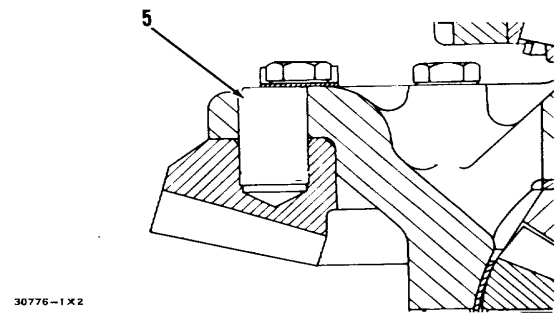
DIFFERENTIAL AND CARRIER ASSEMBLY (LOCK TYPE)

ASSEMBLE DIFFERENTIAL AND CARRIER ASSEMBLY (LOCK TYPE)

	Tools Needed	A	B	C
1P2420	Transmission Repair Stand	1		
FT957	Differential Repair Positioner Group	1		
1P520	Driver Group		1	
8S2328	Dial Test Indicator Group			1

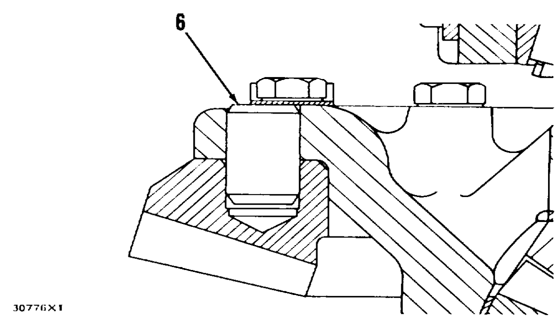


1. Make sure the flange of case (3) and the surface of gear (4) are clean and free of burrs.

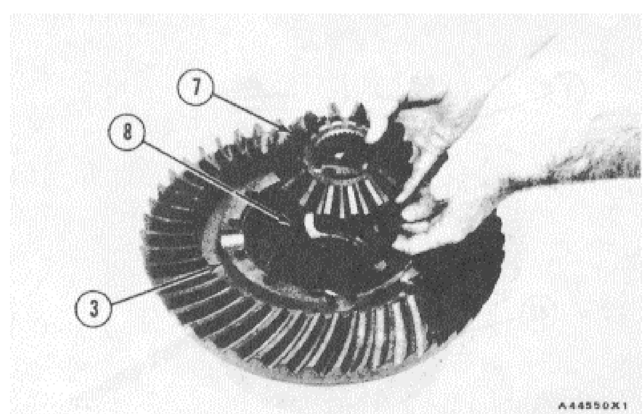


2. Heat gear (4) in oil to a maximum temperature of 250°F (135°C). Install the gear on case (3) with the mark on the gear in alignment with the mark on the case.

3. Put oil on the threads of bolts (1) and the face of washers (2) that hold gear (4) to case (3). Install the bolts, washers and locks. Tighten all bolts the same amount until they have a torque of 98 ± 9 lb. ft. (134 ± 12 N•m). Bend the tabs of the locks on the bolts.



4. If a new gear and/or cases are to be installed, install the dowels faith the foIowing procedure:
   a) Fasten the gear to the case.
   b) Make dowel holes (5) larger with a reamer to a diameter of .8640 ± .0005 in. (21.9456 ± 0.0127 N•m).
   c) Install dowels (6) even with the face of the differential case.



5. Heat the bearing cone in oil to a maximum temperature of 275°F (135°C) and install it on case (3).

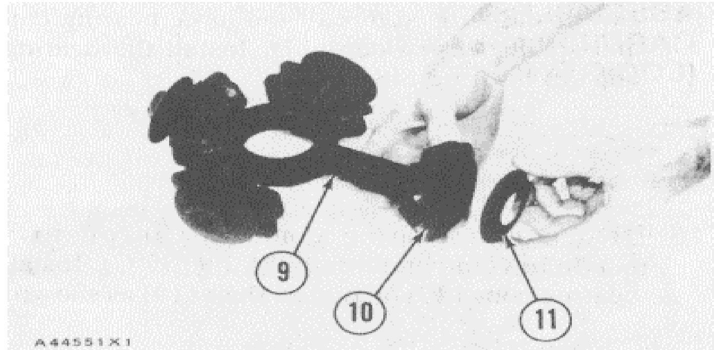
6. Put oil on the parts of the differential group.

7. Install thrust washer (8) and side gear (7) in case (3) with the groove in thrust washer (8) next to side gear (7).

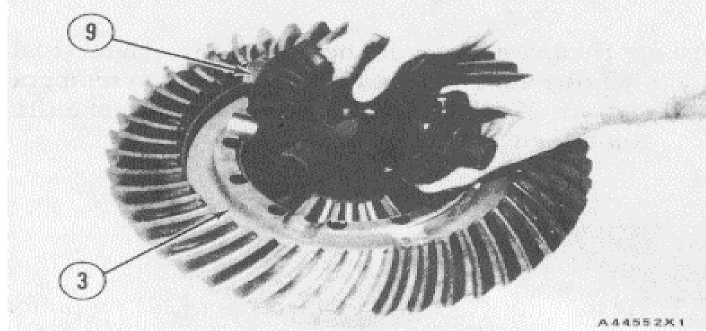
DIFFERENTIAL AND CARRIER ASSEMBLY (LOCK TYPE)

CAUTION: Make a replacement of the thrust washers for the side gears and the thrust washers for the pinions as a set.

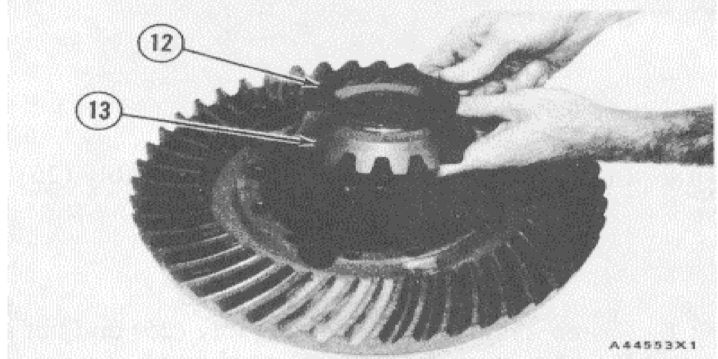
8. Install pinions (10) and thrust washers (I I) on spider (9) as shown.



9. Install spider (9) in case (3).

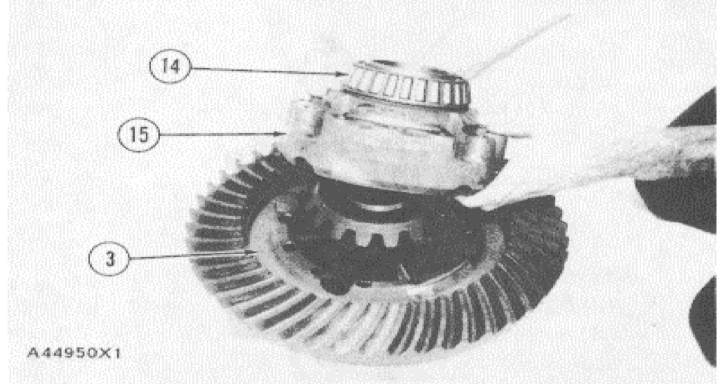


10. Install side gear (13) and thrust washer (12) with the groove in the washer next to the gear.

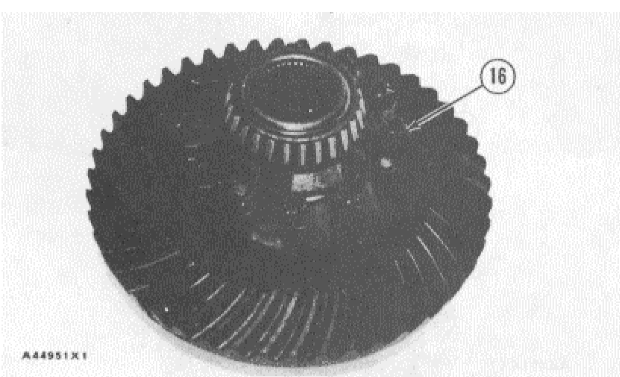


11. Heat bearing cone (14) in oil to a maximum temperature of 275°F (135°C) and install it on case (15).

12. Put case (15) in position on case (3) with the mark on case (15) in alignment with the mark on case (3).

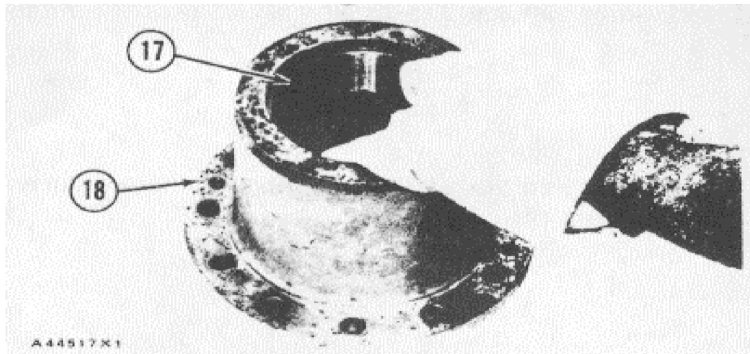


13. Install the bolts, nuts (16) and cotter pins that hold the differential cases together.

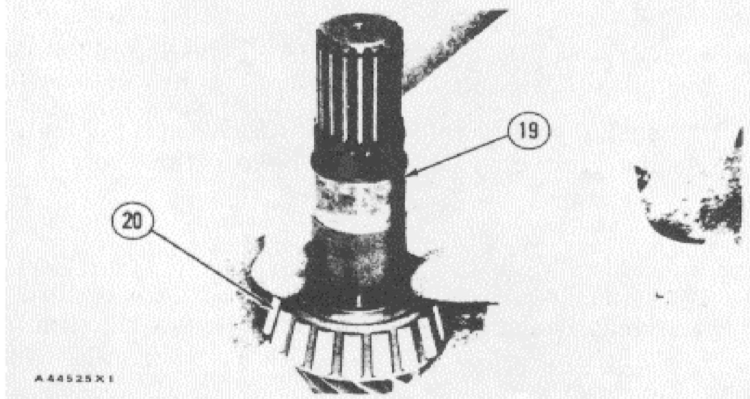


DIFFERENTIAL AND CARRIER ASSEMBLY (LOCK TYPE)

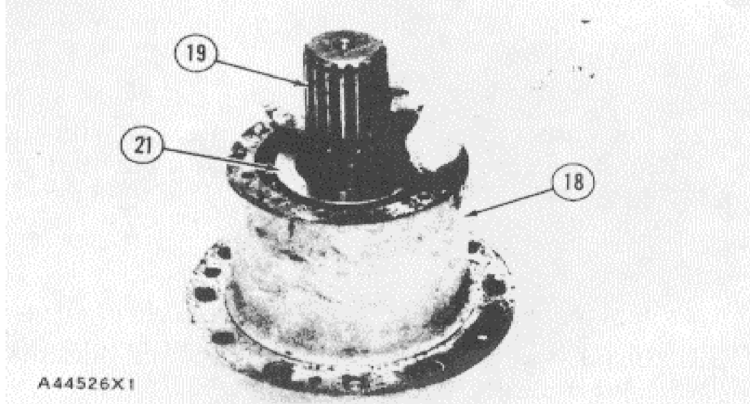
14. Lower the temperature of the large bearing cup and small bearing cup (17). Install the bearing cups in housing (18).



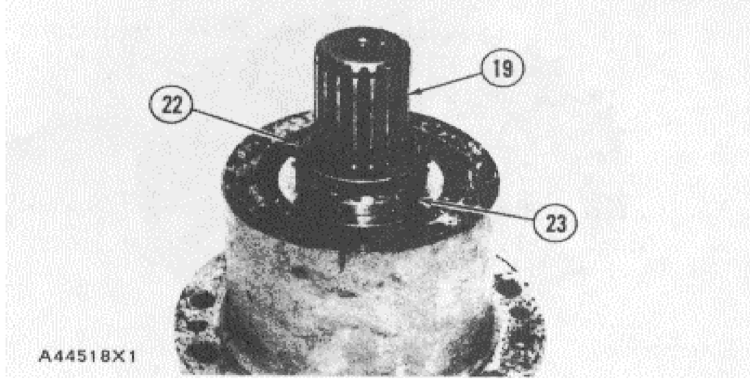
15. Heat larger bearing cone (20) in oil to a maximum temperature of 275°F (I 35°C). Install hearing cone (20) on pinion shaft (19) as shown.



16 Put pinion shaft in housing (18). Heat small bearing cone (2 I) in oil to a maximum tempera-lure of 275°F (135°C). Install bearing cone (21) on pinion shaft (19).

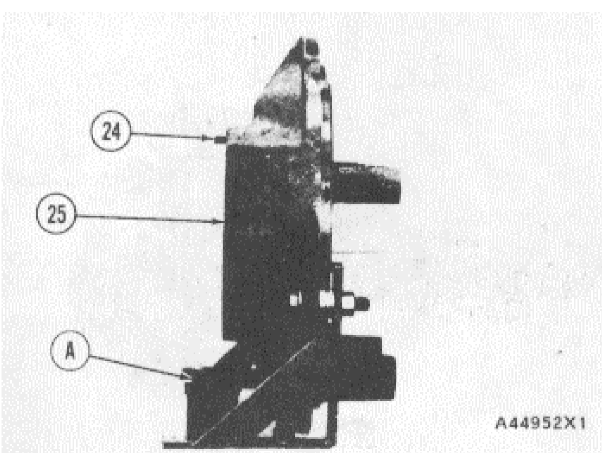


17. Install nut (23). the lock and nut (22) on pinion shaft (19). Tighten the nuts until a torque of 6 to 10 lb. in. (0.7 to 1.1 N•m) is needed to turn pinion shaft (19).



18 Install spring pin (24) in carrier assembly (25).

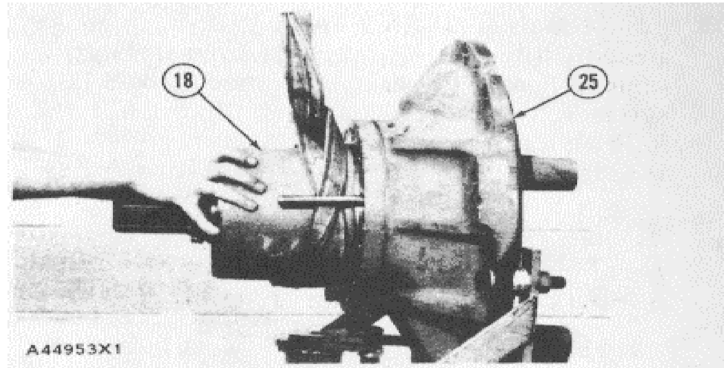
19. Fasten a hoist to carrier assembly (25) and put it in position on tooling (A) as shown.



DIFFERENTIAL AND CARRIER ASSEMBLY (LOCK TYPE)

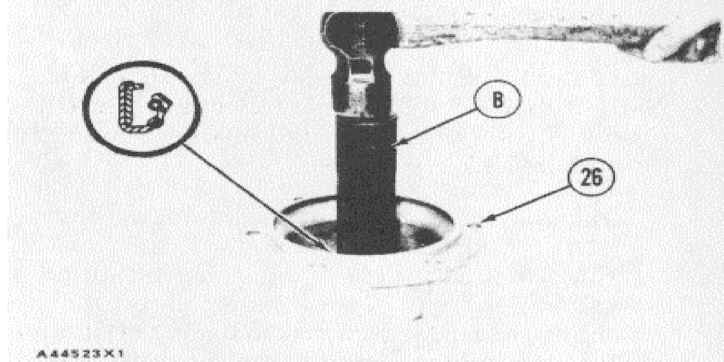
20. Install two 5/8"-16 NC x 6 in. (15.2 cm) long guide bolts in carrier assembly (25).

21. Put the shims of equal thickness to the original shims in position on the carrier assembly.



22. Put the O-ring seal on the bottom of housing (19). Fasten a hoist to the housing (18) and put it in position’ in carrier assembly (25). Install two of the bolts that hold the housing in position.

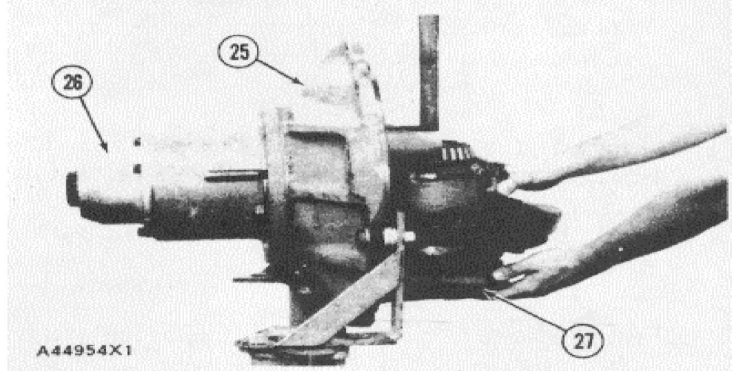
23. Use tool group (B) and install the lip type seal in retainer (26) with the lip of the seal toward the inside of the retainer as shown.



24. Install the gasket and retainer (26) on the pinion shaft housing.

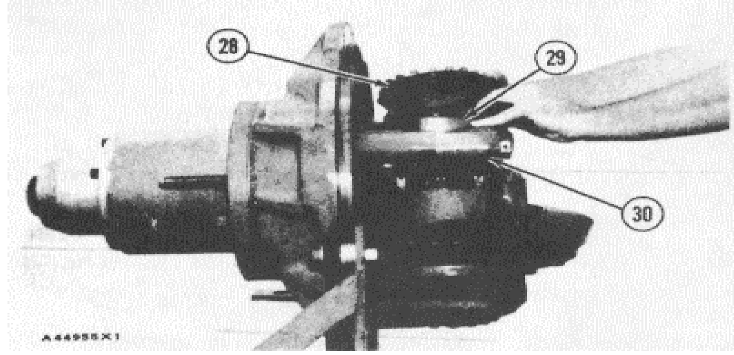
25. Fasten a hoist to the differential group and put it in position in carrier assembly (25).

CAUTION: Make sure the threads in the bearing caps and carrier assembly (25) are in alignment before the bolts are tightened.



26. Install bearing cap (27), the bearing cup and the adjustment nut.

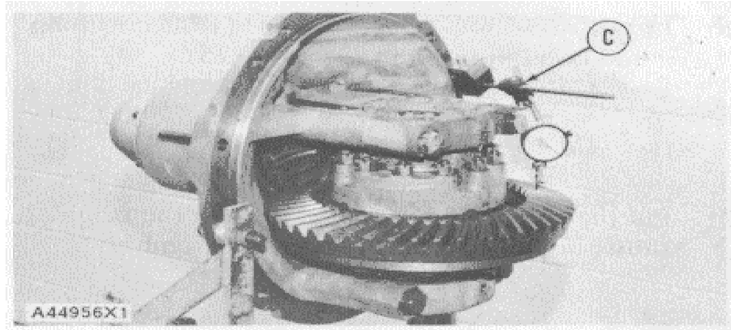
27. Install bearing cap (30), bearing cup (29) and adjustment nut (28).

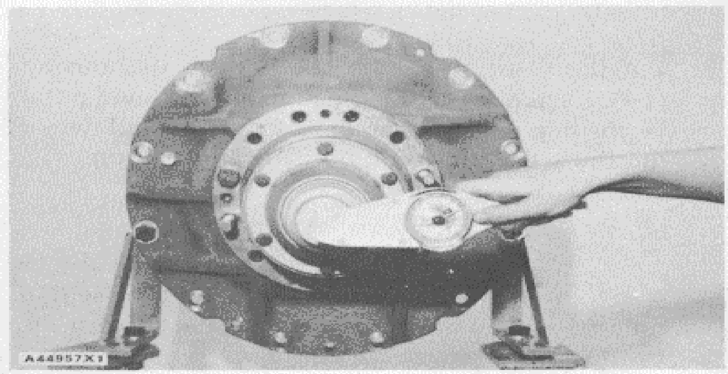


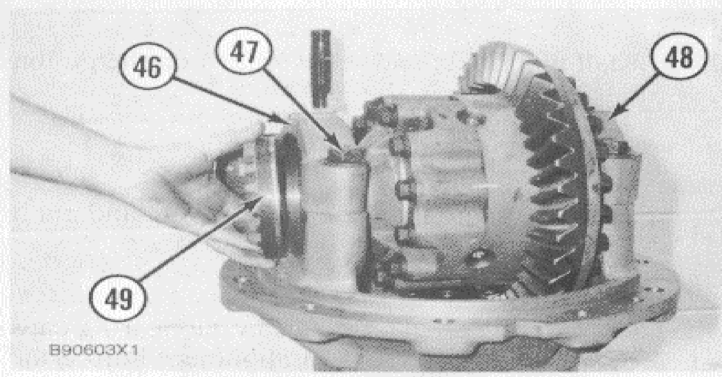
DIFFERENTIAL AND CARRIER ASSEMBLY (LOCK TYPE)

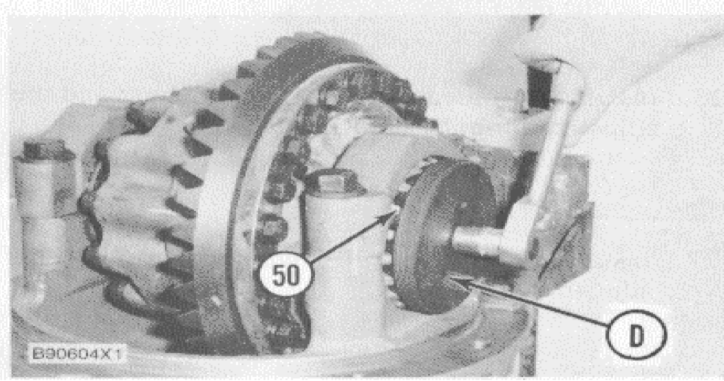
28. For Models 613BSNS and 613BSS, to make an adjustment of the differential bearing preload and gear clearance (backlash) between the bevel gear and pinion use the following procedure:
    a) Tighten the adjustment nuts until there is a small amount of preload on the bearings.
    b) Install tool group (C) on the bevel gear as shown to check the gear clearance (backlash) at four locations around the bevel gear 900 apart. Use the lowest indication on tool group (C) as the correct gear clearance (backlash) value. The correct gear clearance (backlash) is .012 + .005 or - .004 in. (0.30 + 0.12 or - 0.10 mm).
    c) If the gear clearance (backlash) is too much, loosen the upper adjustment nut and tighten the lower adjustmnent nut the same amount to change to gear clearance (backlash). If the gear clearance (backlash) is not enough, loosen the lower adjustment nut and tighten the upper adjustment nut the same amount to change the gear clearance (backlash).
    d) Tighten the upper adjustment nut until a torque of 30 to 50 lb. in. (3.4 to 5.7 N•m) is needed to turn the pinion shaft.
    e) Check the gear clearance (backlash) again as the Steps b and c.

28A. For Models 613BSNS1 and 613BSSI to make an adjustment of the differential bearing preload and gear clearance (backlash) between the bevel gear and pinion use the following procedure:
    a) Turn carrier assembly until the pinion housing is down.
    b) Tighten one of the bolts (47) on each bearing cap (46) and (48) to a torque of 70 N•m (50 lb. ft.). Tighten the other bolt on each bearing cap to a torque of 5 N•m (4 lb. ft.).
    c) Use tool (D), and tighten both bearing adjuster nuts (49) and (50) evenly until there is a small amount of backlash and zero preload on the differential bearings.
    d) Turn the carrier assembly until the pinion housing is in the horizontal position.









e) Use tool (E) and a torque wrench to measure the torque required to turn the pinion shaft. Record this torque measurement.

f) While turning bevel gear (51), use tool (D), and tighten the bearing adjuster nut on the side adjacent to the bevel gear until there is zero backlash.

g) Loosen the bearing adjuster nut to the nearest position where the bearing adjuster nut lock can be installed (maximum of one lug movement).

h) Use tool (D), and tighten the bearing adjuster nut on the side opposite the bevel gear until the torque required to turn the pinion shaft increases to 0.2 to 0.5 N-m (2 to 4 lb. in.) more than the torque measurement recorded in Step e.

i) Put an alignment mark on bearing cap (46) adjacent to one of the lugs on bearing adjuster nut (48).

j) Put an alignment mark on bearing adjuster nut (48) three lugs counterclockwise from the mark on bearing cap (46).

k) Tighten bearing adjuster nut (48) until the two marks are in alignment. If the bearing adjuster nut lock cannot be installed, tighten adjuster nut (48) until the lock can be installed.

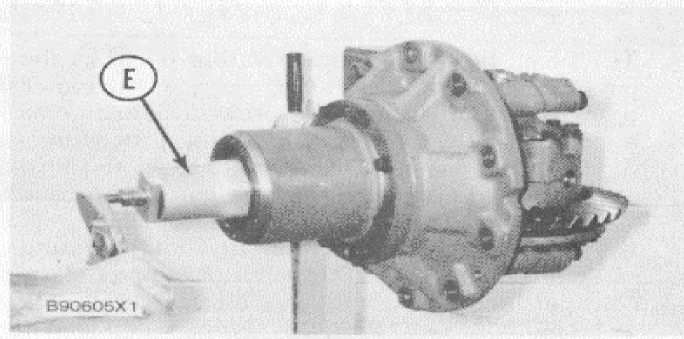
l) Use tool (C), and measure the backlash between the bevel gear and pinion. The backlash must be 0.20 to 0.42 mm (.008 to .017 in.).

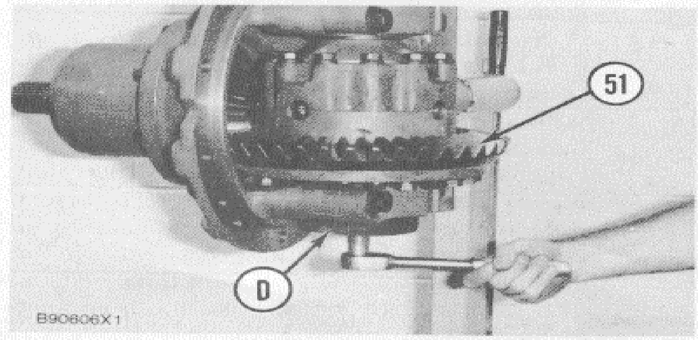
NOTE: The differential preload will be kept only if one bearing adjuster nut is loosened and the other adjuster nut is tightened the same amount.

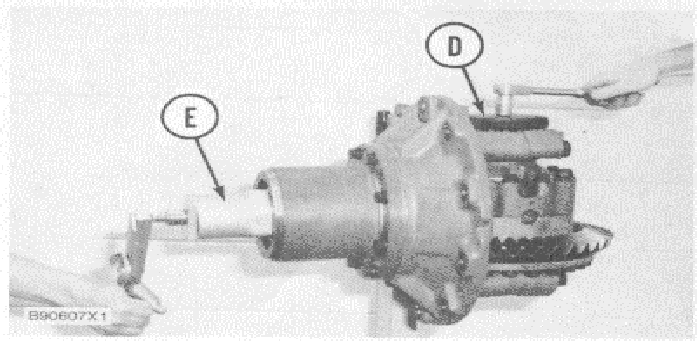
m) If backlash is too much, loosen bearing adjuster nut (49), and tighten adjuster nut (50) the same amount.

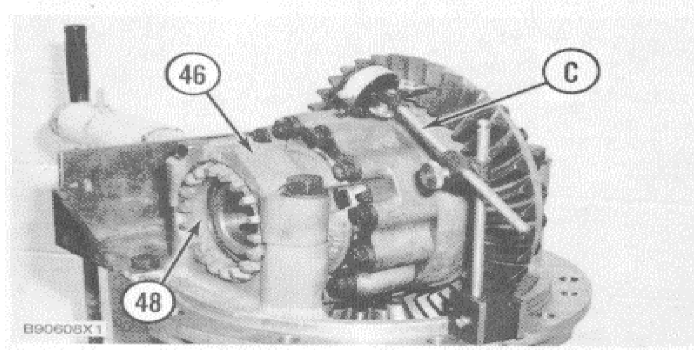
n) If backlash is not enough, loosen bearing adjuster nut (50), and tighten adjuster nut (49) the same amount.

o) Tighten bolts (47) in bearing caps (46) and (48) to a torque of 475 ± 50 N-m (350 + 37 lb. ft.).







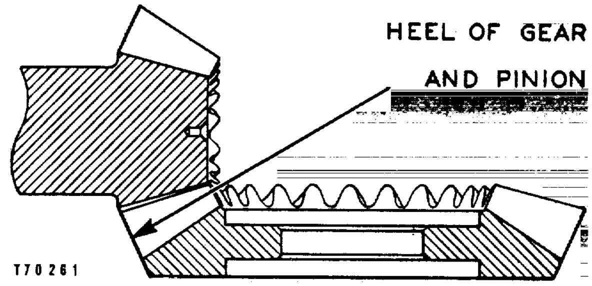


29. To check the tooth contact setting between the bevel gear and pinion after the gear clearance (backlash) and the bearing preload adjustments have been made, use the following procedure:

a) Put small amount of prussian blue, red lead or paint on be el gear teeth. Turn pinion and check marks made on bevel gear teeth.

b) With no load, correct tooth contact setting will be as shown. The area of contact starts near toe of gear and goes about 30% up the length of tooth. With this setting when load is put on gear, it will be over the correct area of teeth.

c)If bevel pinion shaft is too far away from bevel gear, short toe contact will result as shown. The teeth of pinion will be in contact with toe ends of convex faces (part that makes a curve toward the outside), and top edge of heel end of concave faces (part that makes a curve toward the inside). To correct this, move pinion shaft toward gear by a decrease of shim thickness between pinion cage and carrier. After this is done, check gear clearance (backlash) and tooth contact again.



ALIGNMENT OF BEVEL GEAR
AND PINION

DIFFERENTIAL AND CARRIER ASSEMBLY (LOCK TYPE)

d) If bevel pinion shaft is too near to center of bevel gear, short heel contact will result as shown. The teeth of pinion ill be in contact with toe ends of concave faces (part that makes a curve toward the inside) and the heel ends of convex faces (part that makes a curve toward the outside). To correct this, move pinion shaft away from gear by an increase of the shim thickness between pinion cage and carrier. After this is done, check gear clearance (backlash) and tooth contact again.

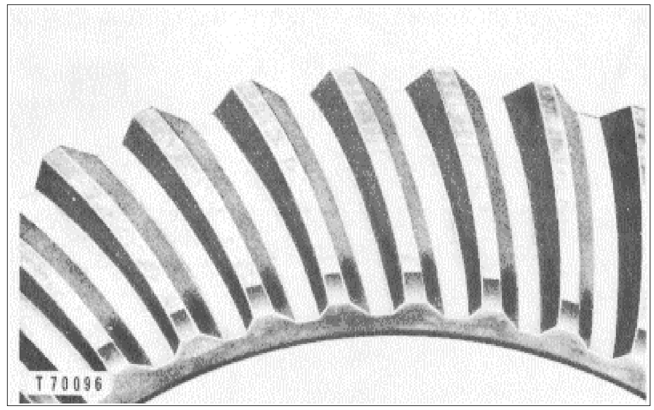
NOTE: Several adjustments of both pinion and bevel gear can be needed before correct tooth contact setting and gear clearance (backlash) is made. Always remember that a change to gear clearance (backlash) will also change the tooth contact setting. Be sure gear clearance (backlash) is in correct adjustment before tooth contact is checked.

e) After correct gear clearance (backlash) and tooth contact setting is made, remove extra prussian blue, red lead or paint from bevel gear and pinion.

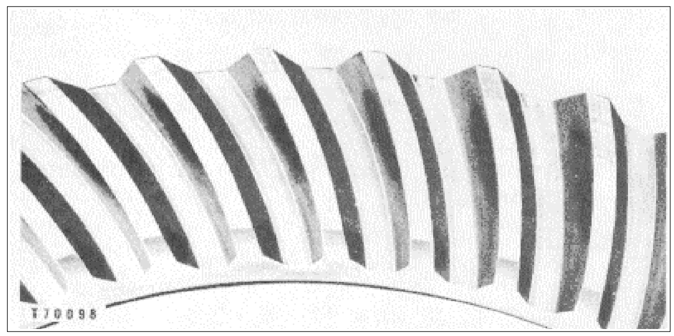
30. Remove the guide bolts and install the remainder of bolts (32) to hold the pinion shaft housing to the carrier assembly.

31. Install the locks and bolts for the adjustment nuts. Install the lockwire to hold bolts (33) and the bolts for the adjustment nuts.

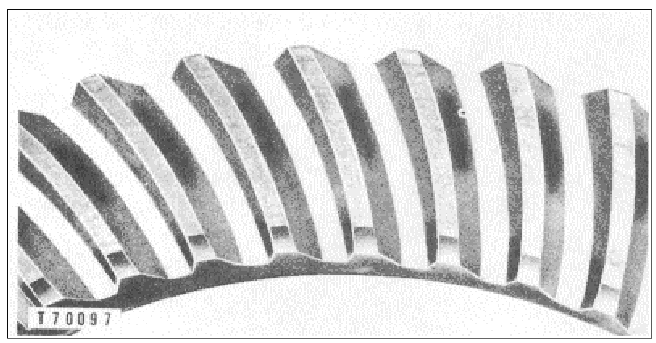
32. Put jaw (31) in position in the differential group and install the two bolts (34) and the lockwire to hold the jaw in position.



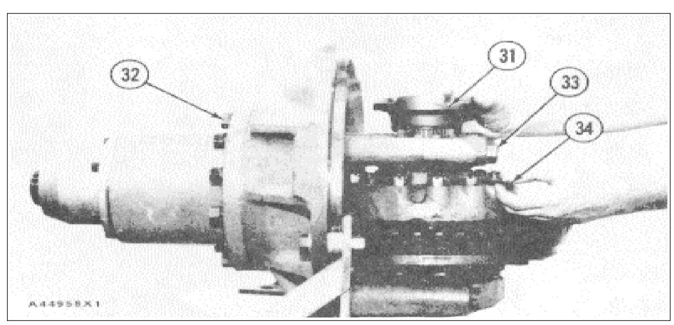
CORRECT TOOTH CONTACT SETTING



SHORT TOE CONTACT SETTING



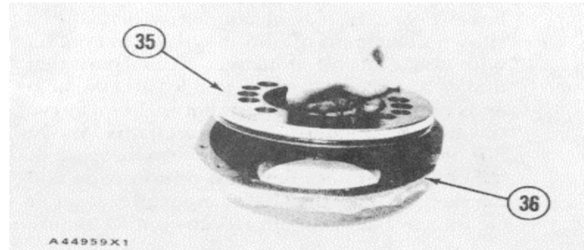
SHORT HEEL CONTACT SETTING



DIFFERENTIAL AND CARRIER ASSEMBLY (LOCK TYPE)

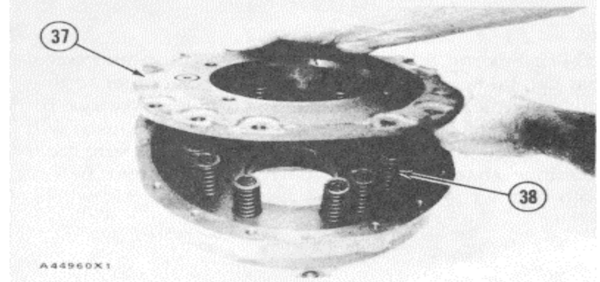
33. Assemble the lock group as follows:
    a) Put the three seals in position on piston (35).

    b) Put clean grease on the seals and install piston (35) in cylinder (36).



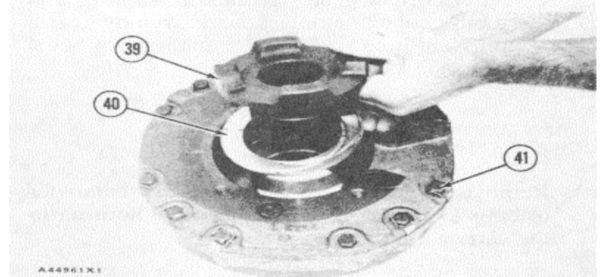
    c) Install springs (38) in the piston.

    d) Put housing assembly (37) in position on the cylinder.

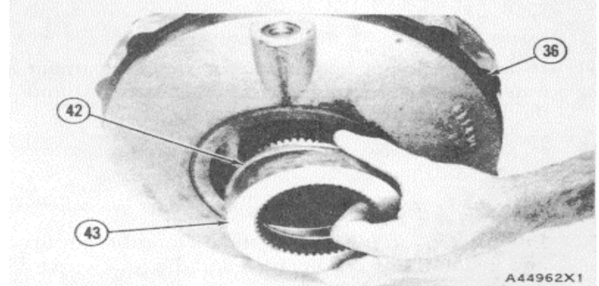


    e) Install the locks and bolts (41). Tighten the bolts evenly and bend the locks on the bolts.

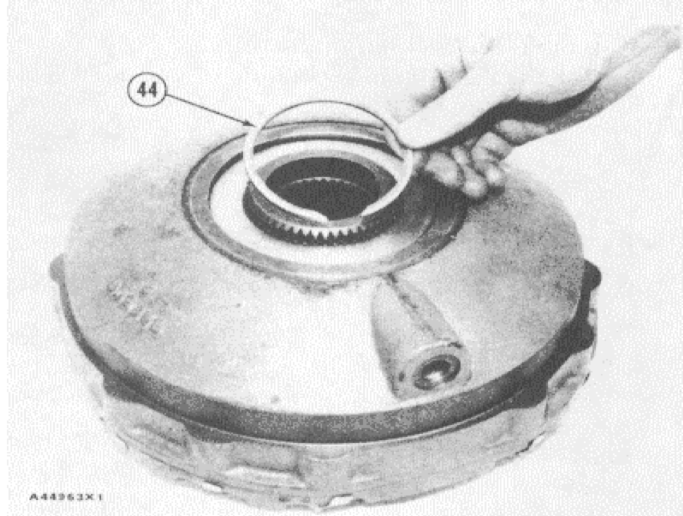
    f) Put washer (40) and jaw (39) in position in the cylinder.



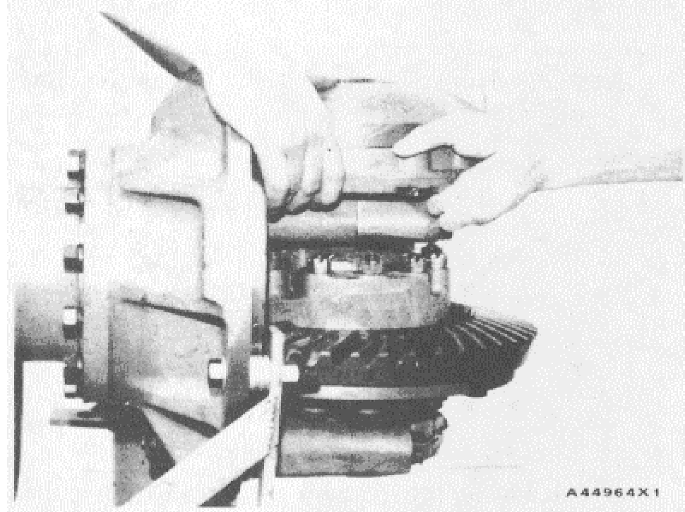
    g) Install washer (42) and spacer (43) in cylinder (36).



h) Install ring (44) to hold the jaw in position.

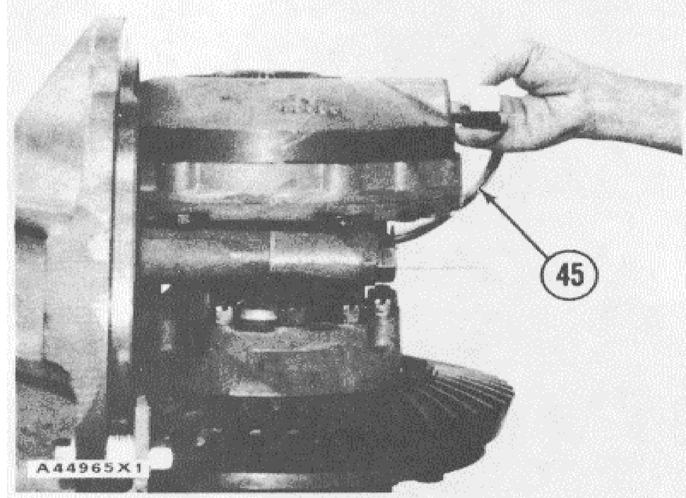


j) Put the lock group in position in the carrier assembly and install the four bolts that hold it. Install the lockwire through the bolts.



k) Connect hose assembly (45) to the carrier assembly and lock group.

l) Install the bolt that holds the clip and hose assembly (45) to the lock group. Install the lockwire.



34. Remove the differential and carrier from tooling (A). Install the yoke.

end by:
a) install differential and carrier assembly

SECTION 3

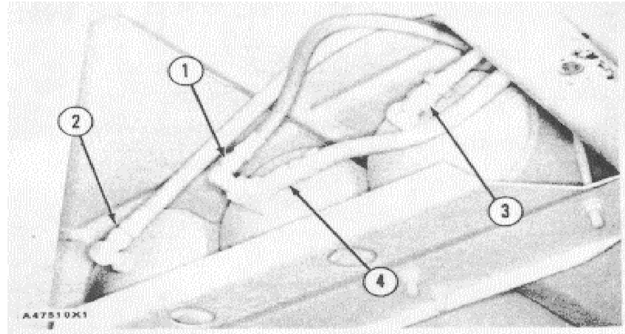
DISASSEMBLY AND ASSEMBLY

TRACTOR-SCRAPER VEHICLE SYSTEMS

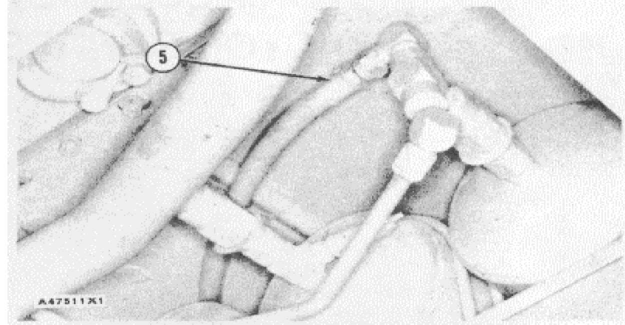
AIR RESERVOIR ASSEMBLY

REMOVE AIR RESERVOIR ASSEMBLY

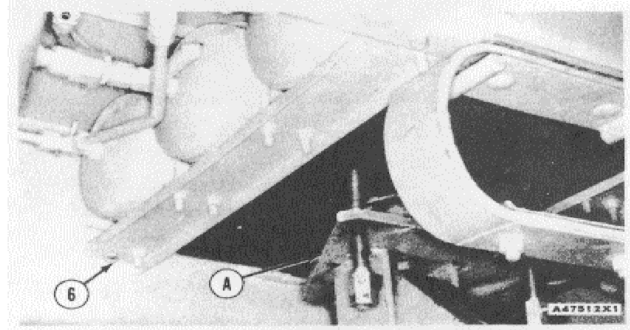
WARNING: Open the drain valves on the reservoirs and make sure all air pressure is removed from the system before any work is done.



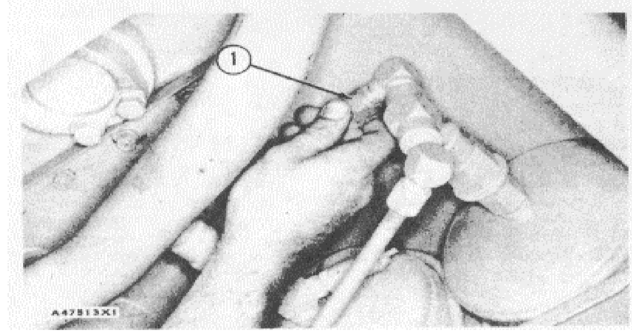
1. Disconnect hoses (1) through (4) from the front of the reservoirs. Put identification on hoses for correct installation.



2. Disconnect hose (5) from the rear of the reservoir.

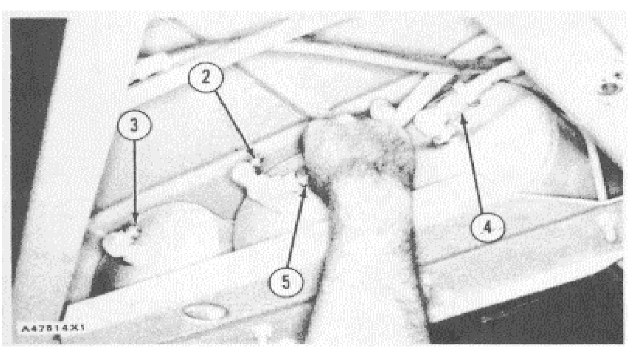


3. Put OTC Model 1790 Lo-Lift Transmission Jack (A) in position under the reservoirs. Remove four bolts (6) from the reservoir bracket. Remove the reservoir assembly. The weight of reservoir assembly is 63 lb. (29 kg).



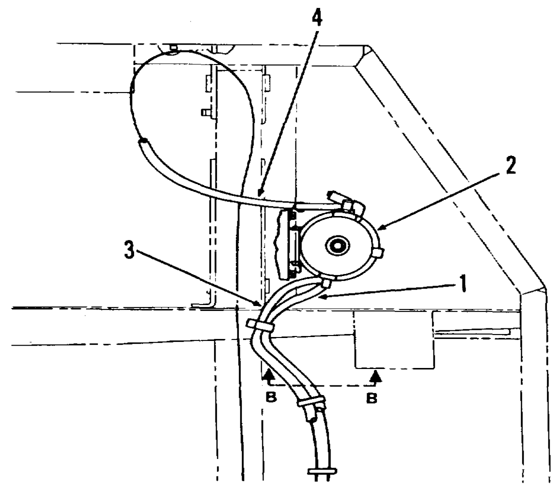
INSTALL AIR RESERVOIR ASSEMBLY

1. Put the reservoir assembly on the transmission jack and lift it in position under tractor.
2. Install the four bolts to hold the reservoir assembly and bracket.
3. Connect hose (1) at the rear of the reservoir.
4. Connect hoses (4) and (5) to the tanks. Connect hoses to the fittings (2) and (3).

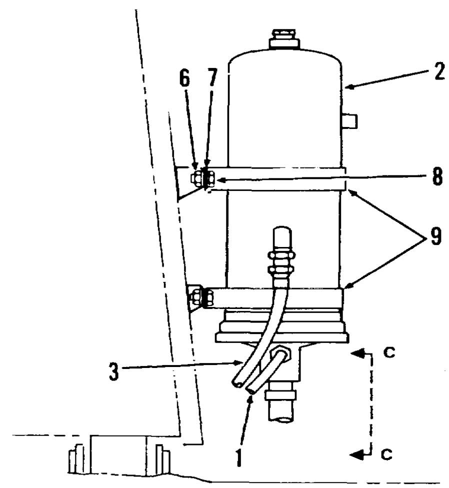


AIR DRYER (613BSNS1, 613BSS1)

REMOVE AND INSTALL AIR DRYER

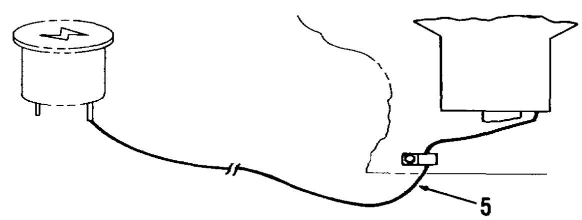


1. Position the equipment on level ground. Lower all equipment to the ground, and place blocks in the front and back of the machine. Turn the engine off.
2. Remove all air pressure from the air reservoirs and air system.
3. Disconnect the unloader air line (1) from the air dryer (2).
4. Disconnect inlet air line (3).
5. Disconnect outlet air line (4).
6. Disconnect electrical lead (5) from air dryer.



VIEW B-B

7. Remove nuts (6), washers (7), and bolts (8). Remove air dryer (2) from brackets (9).
8. Position air dryer (2) in mounting brackets (9). Secure air dryer with bolts (8), washers (7), and nuts (6).

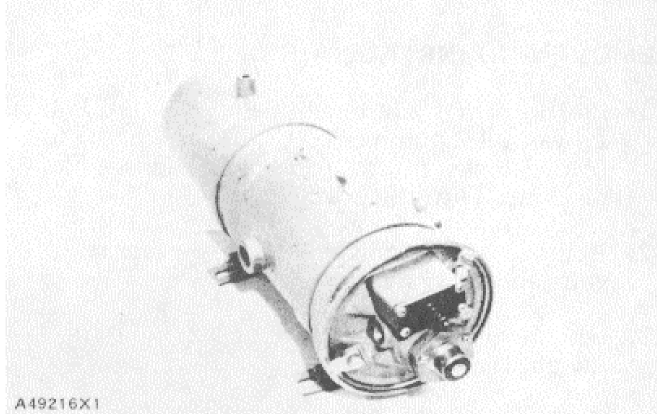


VIEW C-C

9. Connect electrical lead (5) to air dryer.
10. Connect outlet air line (4), inlet air line (3), and unloader air line (1).
11. Pressurize air system and check for leakage at the air dryer fittings.

AIR DRYER (613BSNS1, 613BSS1)

DISASSEMBLE AND ASSEMBLE AIR DRYER

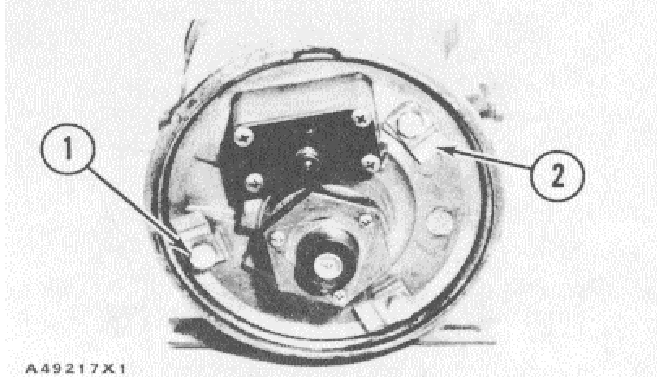


1. Put the machine on level ground. Lower all equipment to the ground, put blocks in front and in back of the wheels so the machine cannot move. Shut off the engine.

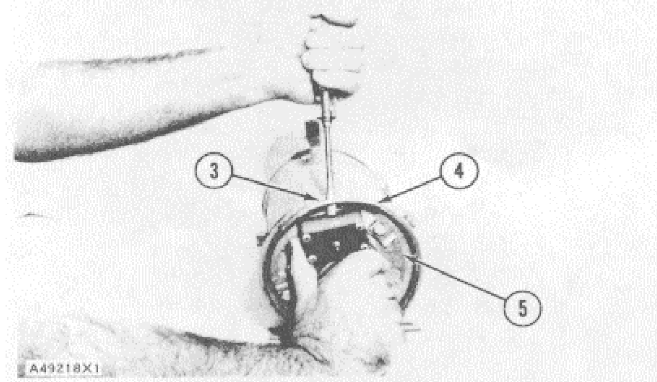
2. Remove all of the air pressure from the air reservoirs and air system. Make sure the lines to and from the air dryer are at atmospheric pressure.

3. Disconnect the unloader line from the end cover of the air dryer. Disconnect the wire at the air dryer.

NOTE: To better show the disassembly and assembly of the air dryer, it has been removed from the machine.

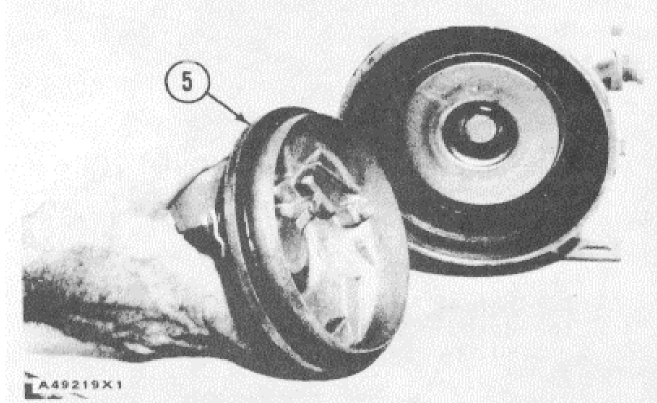


4. Loosen the bolts (I) and turn the clamps (2) 90" as shown.



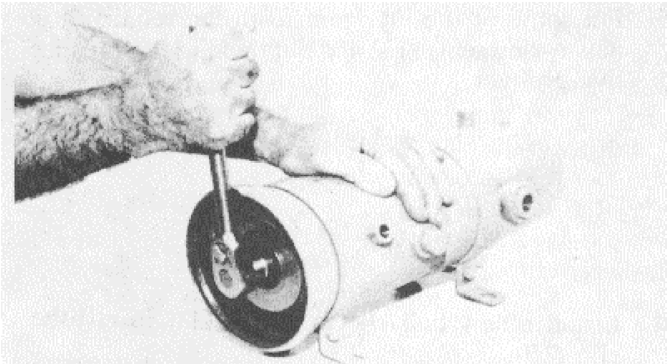
5. Push in on end cover assembly (5).

6. Put a screw driver in notch (3) and remove snap ring (4).



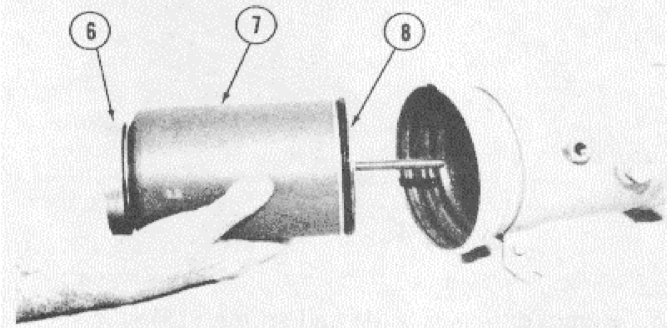
7. Remove end cover assembly (5).

AIR DRYER (613BSNS1, 613BSS1)



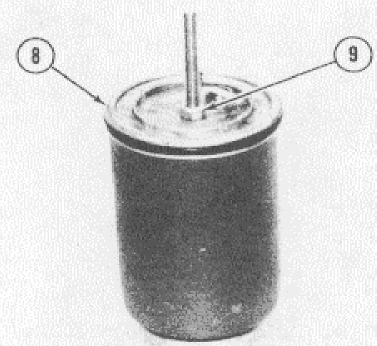
A49220X1

8. Using a 34 in. socket wrench, remove the oil filter (6), the desiccant cartridge (7) and desiccant sealing plate (8) as an assembly.



A49221X1

9. Remove the nut (9) and desiccant sealing plate (8).

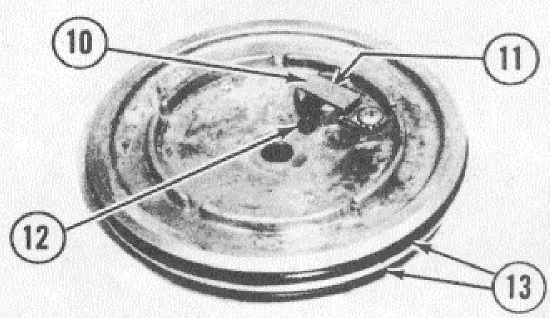


A49222X1

10. Remove the O-ring seals (13).

11. Remove the clip (10) and ball check valve (II1) under the clip.

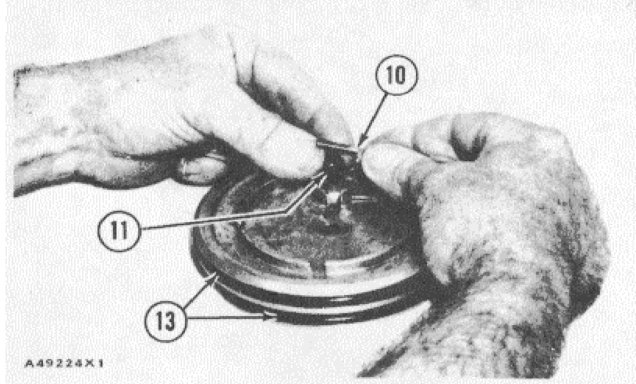
12. Clean the desiccant plate in a solvent. Make sure the purge valve orifice (12) and check valve seat are open and clean.



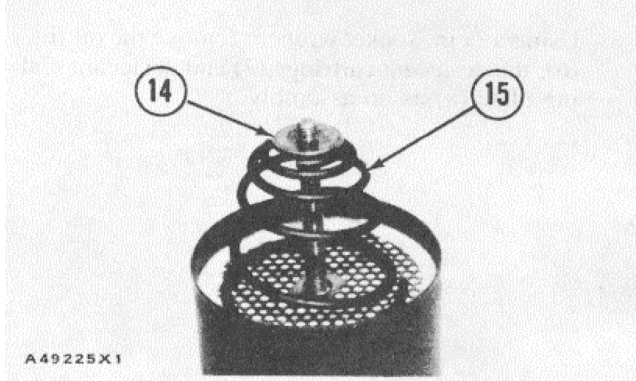
A49223X1

AIR DRYER (613BSNS1, 61 3BSS1)

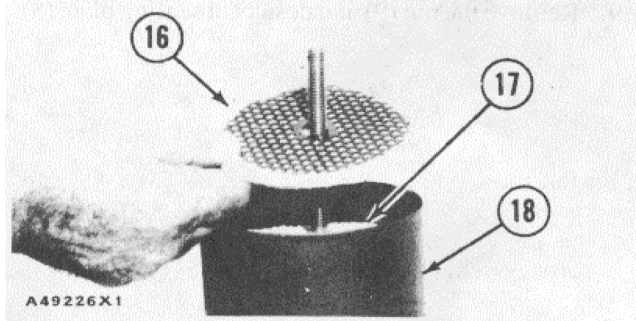
13. Put some of the lubricant from the repair kit on new o-ring seals (13) and put them in their respective grooves.



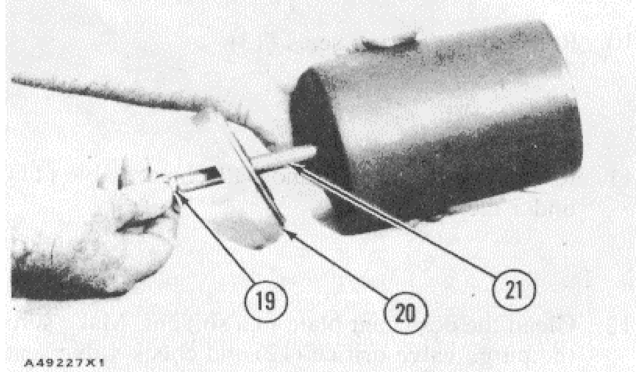
14. Install a new ball check valve (II). Install the clip (10).



15. Remove the seat (14) and spring (15).



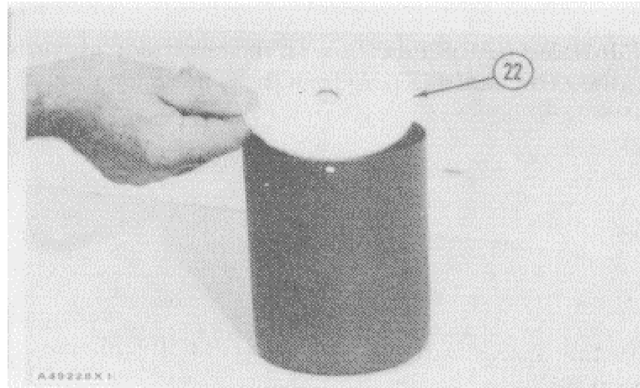
16. Remove the plate (16) and desiccant material (17) from the cartridge shell (18).



17. Remove bolt (21), washer (19) and oil filter (20).

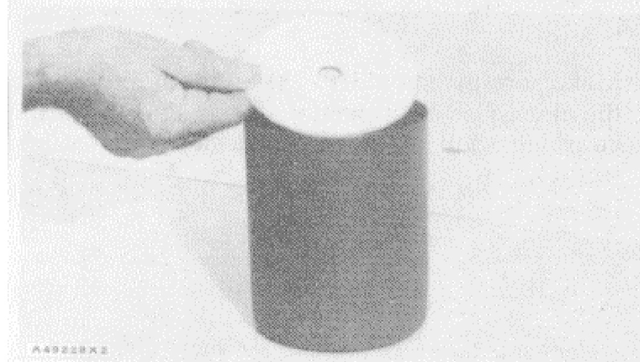
AIR DRYER (613BSNS1, 613BSS1)

18. Remove the plate (22) from the cartridge shell.



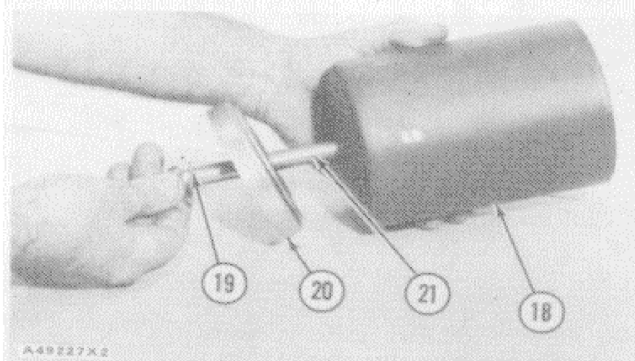
19. Clean the bolt and washer and the inside and outside of the cartridge shell.

20. Put a new plate in the bottom of the cartridge shell with the felt side (cloth side) up.

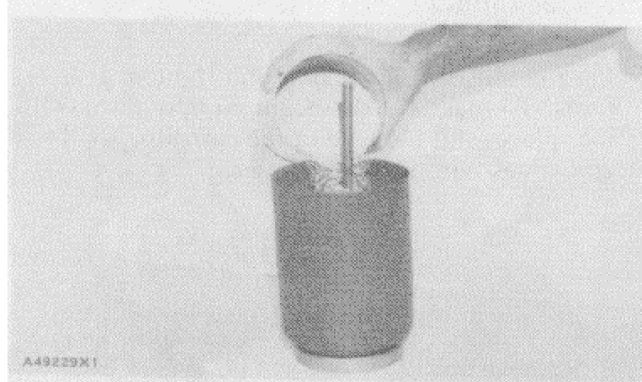


NOTE: The cloth side of the plate is always towards the desiccant.

21. Put the washer (19) and a new oil filter (20) on the bolt (2 1). Be sure the side of the oil filter that has the gasket on it is next to the bottom of the cartridge shell (18).

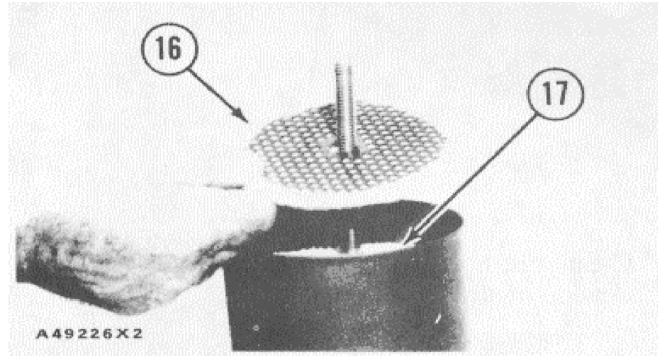


22. Put all of a package of new desiccant material in the cartridge shell. DO NOT let the bolt come out or the desiccant material will come out.

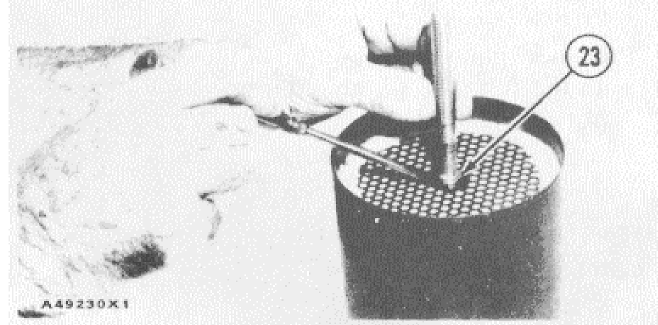


AIR DRYER (613BSNS1, 613BSS1)

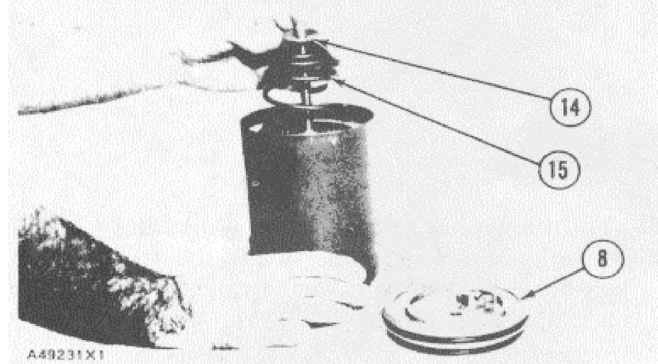
23. Install a new plate (16) with the cloth side towards the desiccant (17).



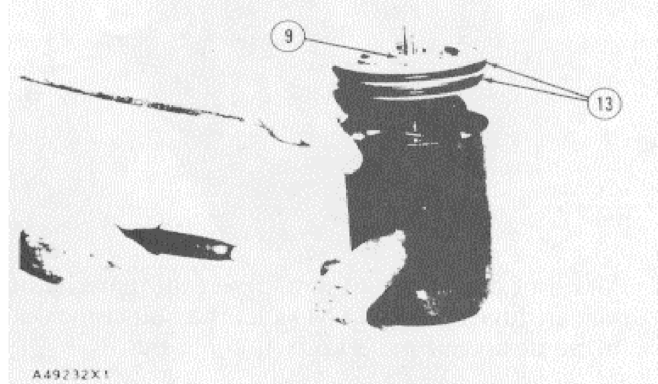
24. Make sure the shoulder (23) on the bolt is above the plate. Use a soft hammer to hit the side of the cartridge shell to make the desiccant go down (settle).



25. Put the spring (15), seat (14) and rebuilt desiccant sealing plate (8) over the bolt.

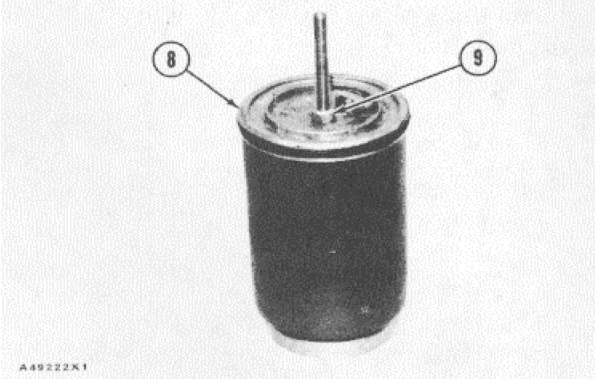


26. Put the nut (9) on the bolt and tighten it several turns. To make the desiccant go into place (settle into place), hit the side of the cartridge shell several times with a soft hammer.
27. Put some of the lubricant from the repair kit on the seals (13).



AIR DRYER (613BSNS1, 613BSS1)

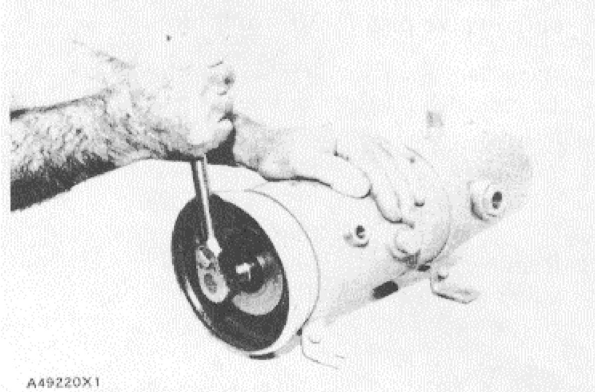
28. Tighten the nut (9) until the desiccant sealing plate (8) is in place.



29. Inspect the inside of the air dryer body to see that it is clean.

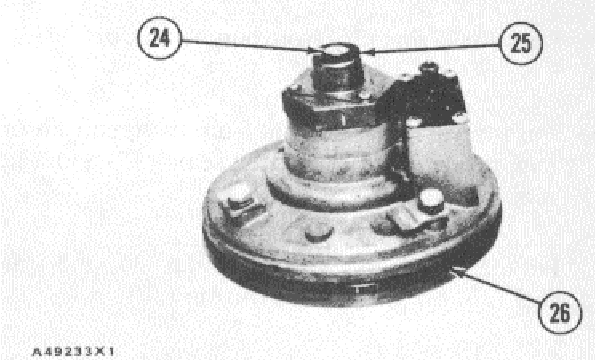
30. Put some of the lubricant from the repair kit on the o-ring seal on the purge plate assembly.

31. Install the oil filter, desiccant cartridge and purge plate assembly in the air dryer body as an assembly. Tighten the bolt to a torque of 32 lb. ft. (43N m).

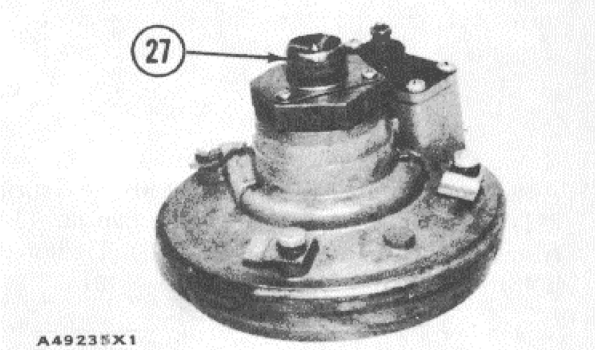


32. Remove the o-ring seal (26).

33. Remove the screw and washer (24) and diaphragm (25).

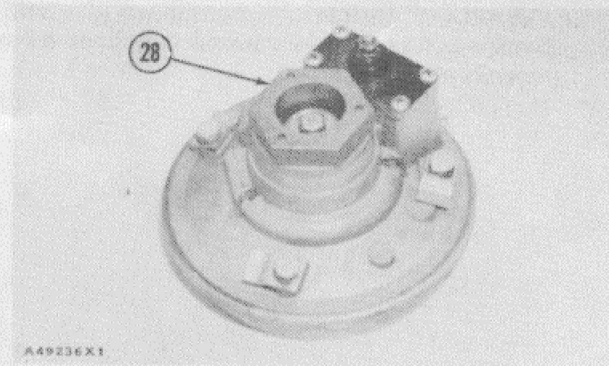


34. Remove the cover (27).



AIR DRYER (613BSNS1, 613BSS1)

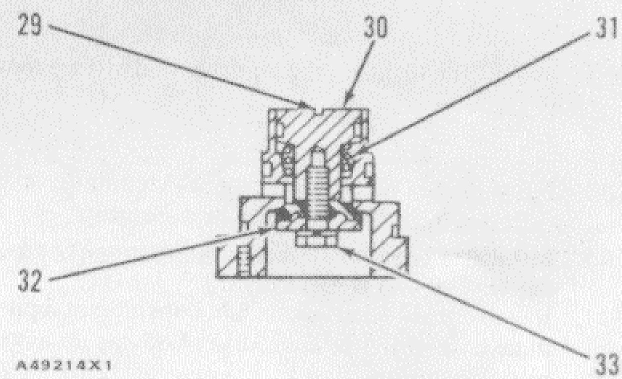
35. Remove the purge valve assembly (28).



36. Put a large screw, driver in the slot (29) to hold the purge valve piston (30) from turning.

37. Loosen the bolt (33).

38. Remove the bolt (33), purge valve (32), purge valve piston (30) and spring (31).

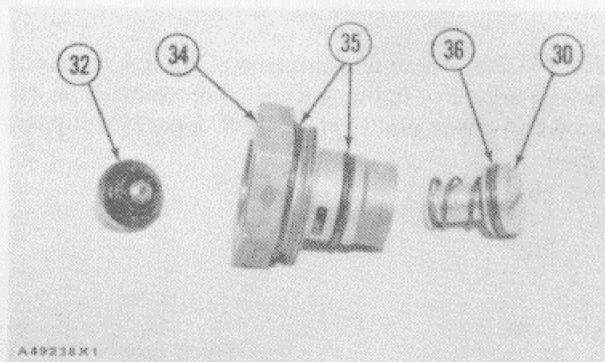


39. Remove O-ring seals (35) from cap nut (34).

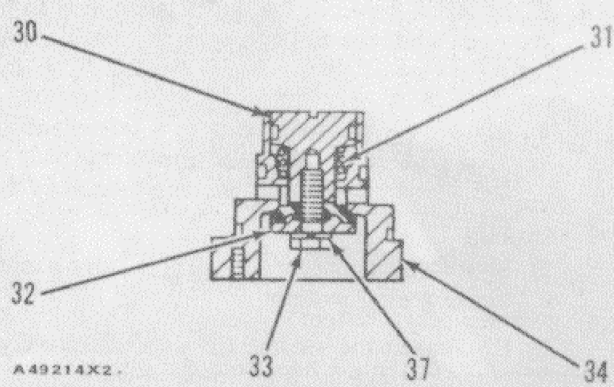
40. Remove O-ring (36) from purge valve piston (30).

41. Put some of the lubricant from the repair kit on a new purge valve (32), new seals (35) and a new seal (36).

42. Put the new seals (35) on cap nut (34) and a new seal (36) on purge valve piston (30).

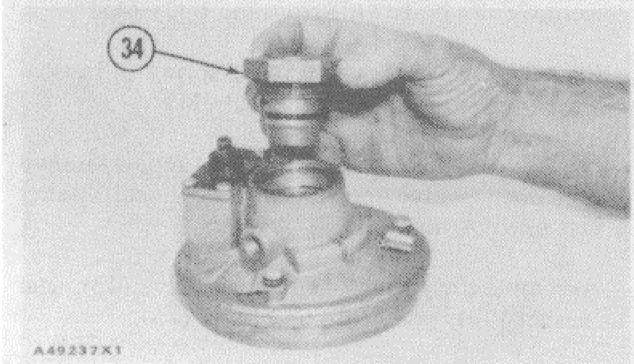


43. Assemble the purge valve piston (30), new spring (31) and new purge valve (32) in cap nut (34). Install lockwasher (37) and bolt (33). Tighten the bolt to a torque of 50 lb. in. (5.7 N.m).

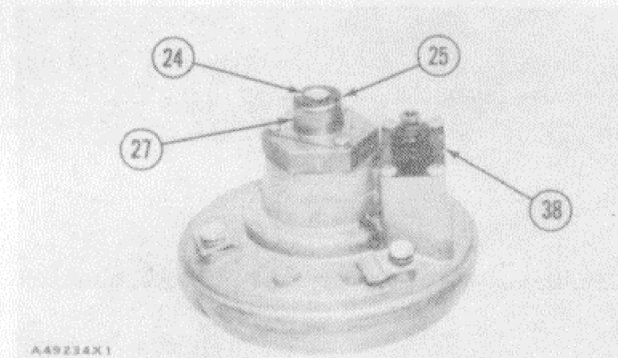


AIR DRYER (613BSNS1, 613BSS1)

44. Put some of the lubricant from repair kit on the threads of cap nut (34). Install the purge valve assembly and tighten to a torque of 180 to 250 lb. in. (20 to 28 N.m).



45. Install the cover (27), a new diaphragm (25) and the washer and screw (24).



NOTE: The heater and thermostat are not serviced. If there is a defect in the heater and thermostat, install a new end cover assembly. DO NOT remove the cover (38).

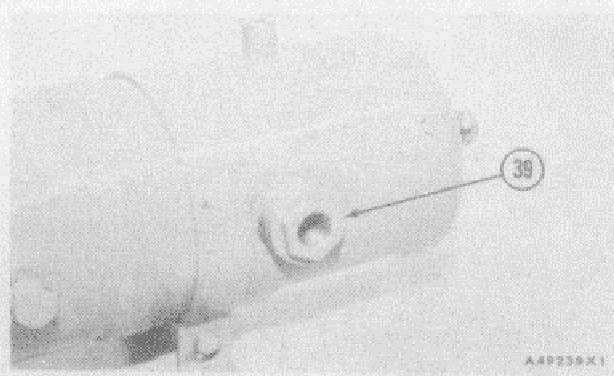
46. If the check valve in the outlet passage is to be removed while the air dryer is on the machine, do the following.

    A. Make sure the machine is in a safe place on level ground. Put blocks in front and in back of the wheels and lower all equipment to the ground.

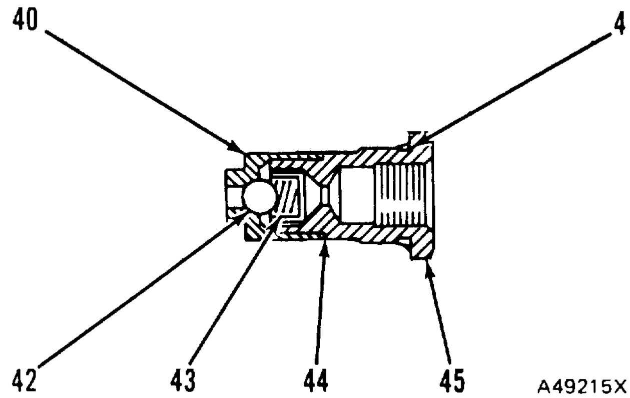
    B. Shut off the engine and let all of the air pressure out of the air system.

    C. Disconnect the air line from the check valve outlet passage.

47. Remove the check valve assembly (39).



AIR DRYER (613BSNS1, 613BSS1)



48. Remove the body (40) from the body (45).

49. Remove the check valve (42), spring (43), seal washer (44) and the o-ring seal (41).

50. Put some of the lubricant from the repair kit on a new check valve, new spring, new seal washer and new O-ring seal.

51. Assemble the spring (43), check valve (42), seal (44), body (40) and body (45).

52. Tighten the bodies together to a torque of 200 to 225 lb. in. (22 to 25 N-m).

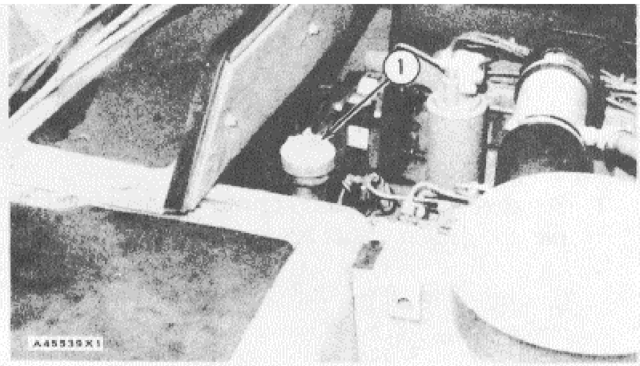
53. Install the o-ring seal (41) and install the check valve assembly.

54. Connect the air line to the check valve.

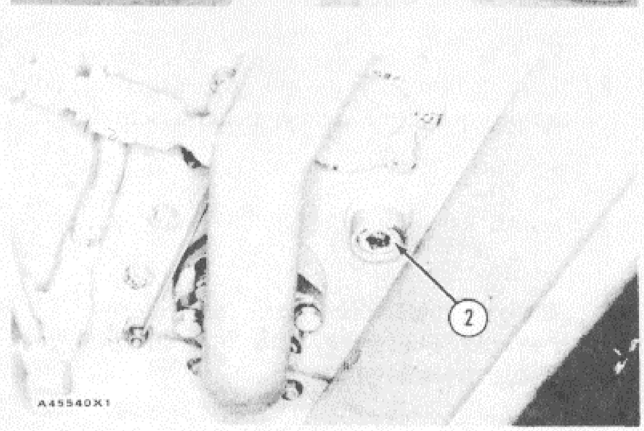
HYDRAULIC TANK

REMOVE HYDRAULIC TANK

WARNING: Before removal of the hydraulic tank lower all hydraulics, lift the hood and slowly loosen cap (1) to release pressure in the tank.

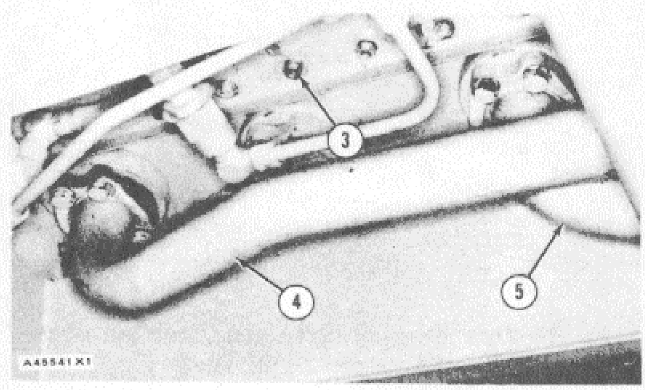


1. Remove plug (2) from the bottom of the hydraulic tank and drain the oil from the hydraulic system. The capacity of the hydraulic system is 24 U.S. gal. (91 litre).

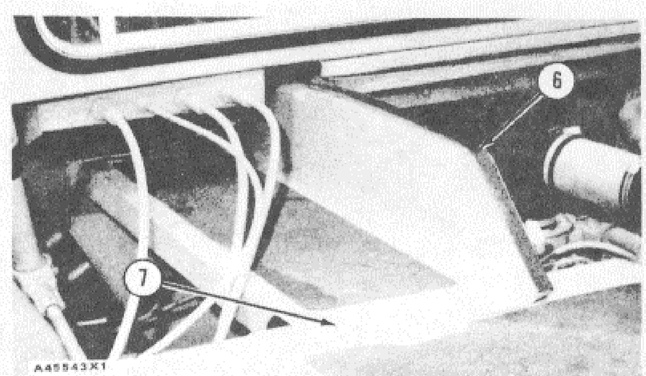


2. Remove the eight bolts, nuts (3) and lockwashers from the bottom of the tank.

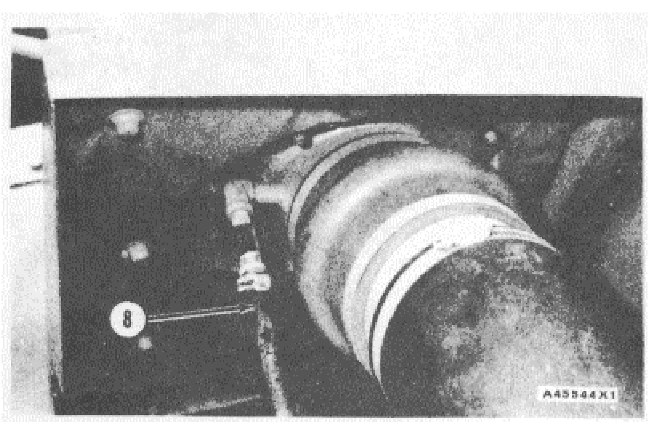
3. Disconnect tube assemblies (4) and (5) from the bottom of the hydraulic tank.



4. Remove the four bolts (7), nuts and washers that hold panel (6) in position and remove panel (6).

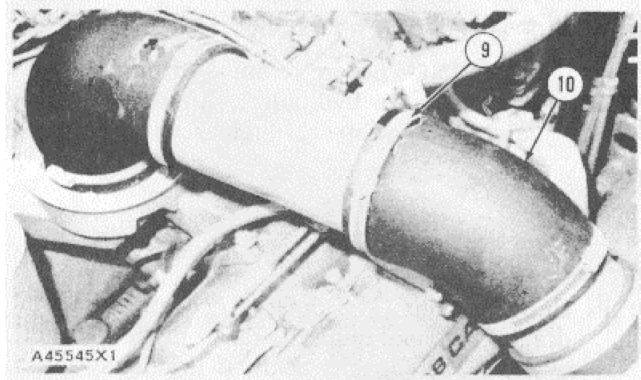


5. Loosen the clamp and disconnect hose (8) from the air cleaner housing.

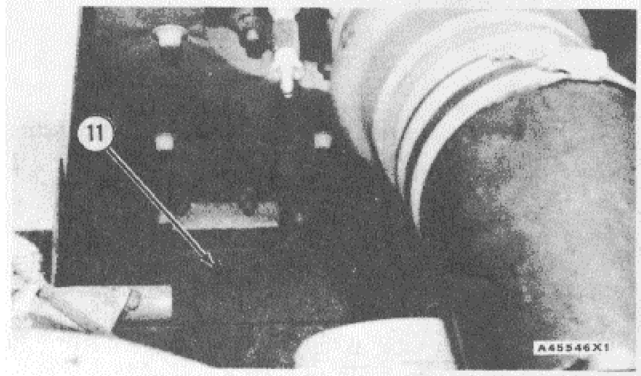


HYDRAULIC TANK

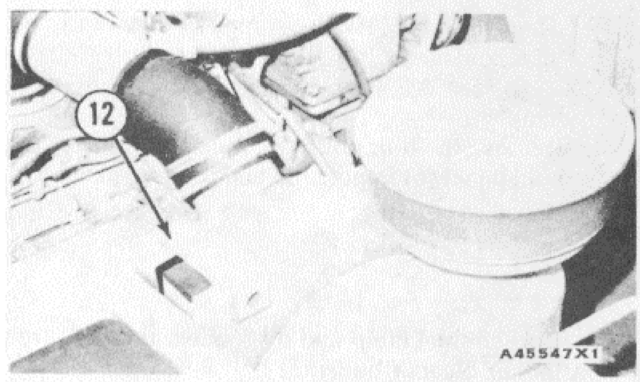
6. Loosen clamp (9) to disconnect hose (10) from the intake manifold.



7. Remove the four nuts (11) and washers that hold the air cleaner panel assembly to the machine.

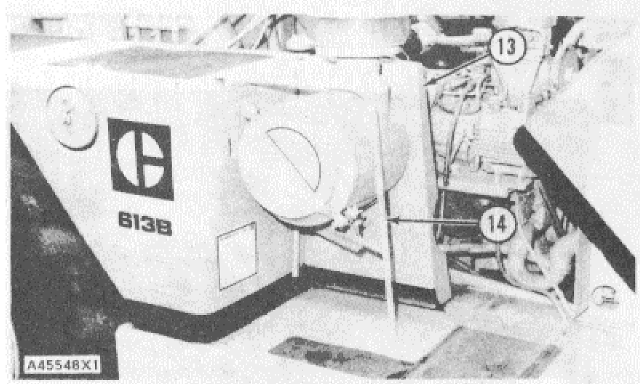


8. Remove bolt (12), the nut and washer that hold the top of the air cleaner panel assembly.

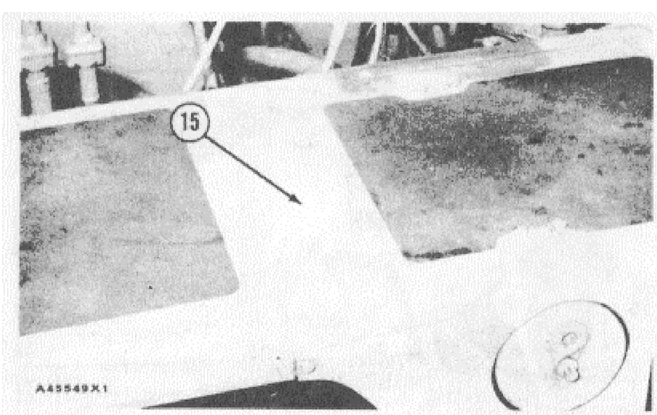


9. Remove the five bolts, the nut and washer that hold handle assembly (14) in position. Remove handle assembly (14).

10. Remove the air cleaner and panel assembly (13) as a unit.

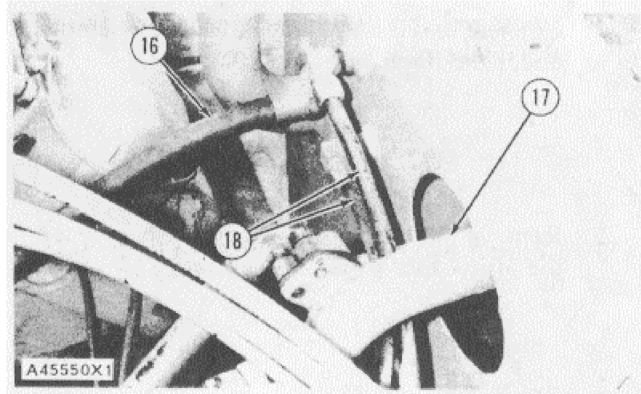


11. Remove the eight bolts (15), nuts and washers that hold the fender to the tank.

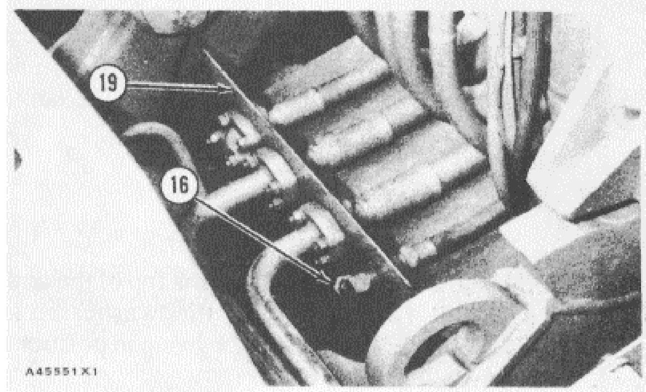


HYDRAULIC TANK

12. Disconnect hose assemblies (18) from the tank.

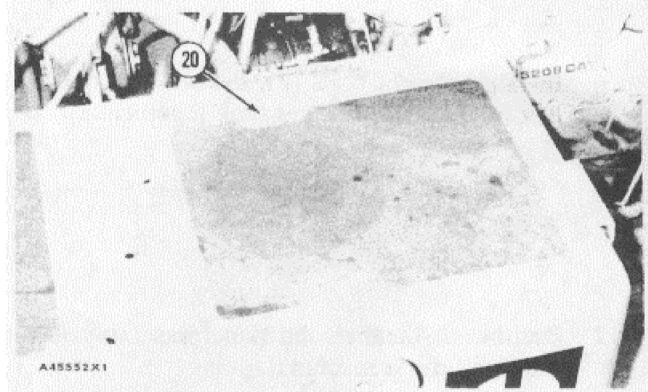


13. Remove the two bolts and washers to disconnect tube assembly (17) from the rear of the tank.



14. Disconnect hose assembly (16) from angle assembly (19) under the hitch and pull the hose assembly to the tank.

15. Remove one bolt (20) from each side of the tank that holds the filter group to the tank. Install two 7/16"-14 NC forged eyebolts in the top of the tank.

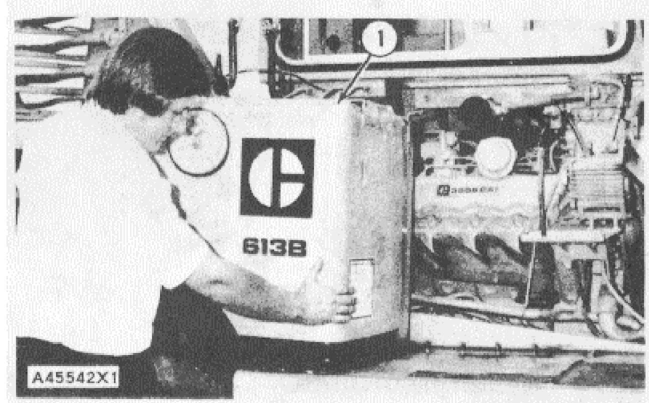


16. Fasten a hoist and remove the tank. Weight of the tank is 210 lb. (94.5 kg).

NOTE: The tank must be lifted at a small angle so the flange on tube assembly (17) will not hold the tank.

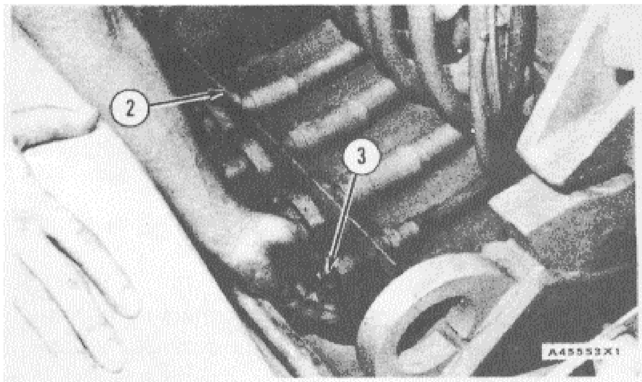
INSTALL HYDRAULIC TANK

1. Install two 7/16"-14 NC forged eyebolts in the top of tank (1). Fasten a hoist and put tank (1) in position on the machine.

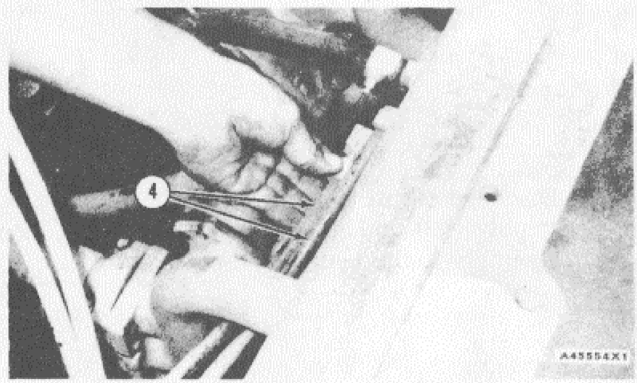


HYDRAULIC TANK

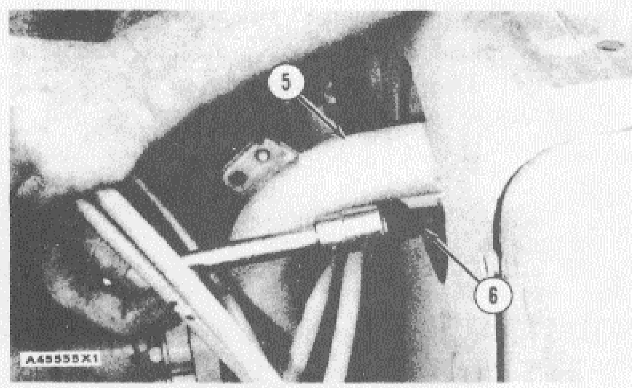
2. Connect hose assembly (3) to angle assembly (2) under the hitch and the tank.



3. Connect two hose assemblies (4) to the back of the tank.

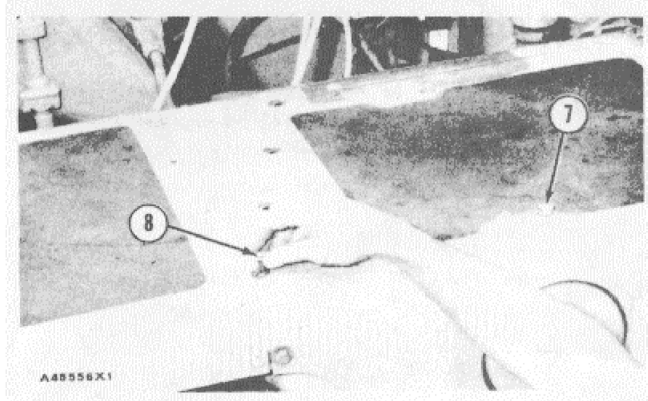


4. Make sure the O-ring seal is in position in tube assembly (5) and install the two bolts (6) and washers to hold tube assembly (5) to the tank.

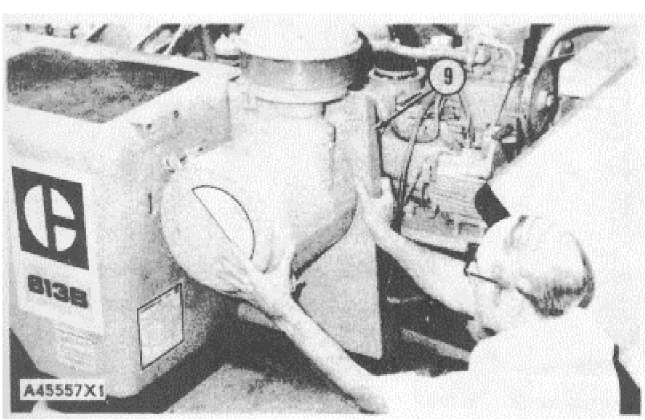


5. Remove the two eyebolts from the top of the tank and install two bolts (7), the washers and lockwashers that hold the filter group in position.

6. Install the eight bolts (8), the washers and nuts that hold the fender and tank together.

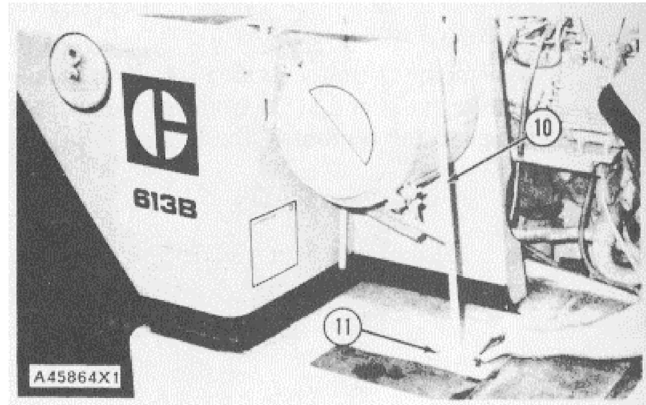


7. Put the air cleaner and panel assembly (9) in position on the machine.

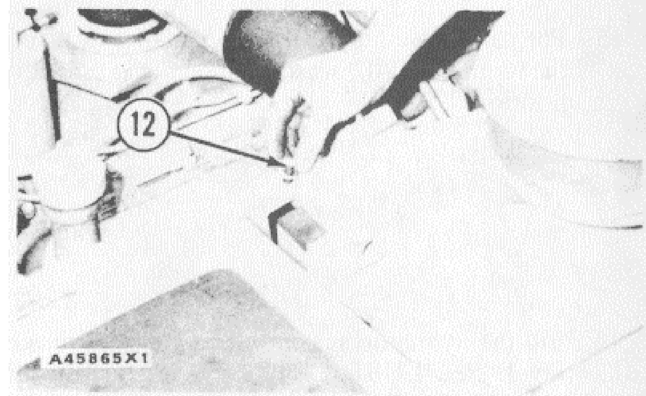


HYDRAULIC TANK

8. Put handle assembly (10) in position and install the five bolts (11), the washers and one nut to hold the handle assembly.

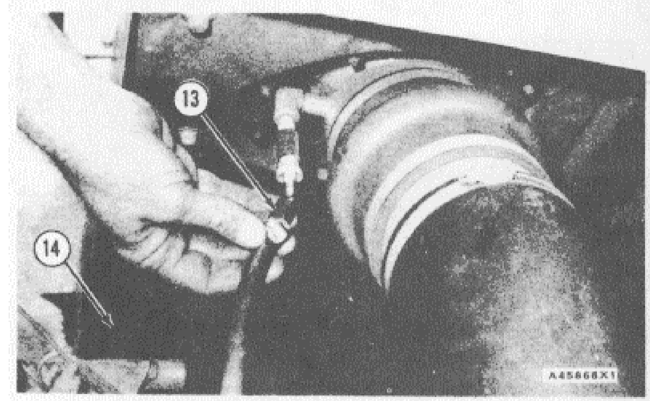


9. Install bolt (12), the washer and nut to hold the top of the air cleaner panel assembly to the tank.

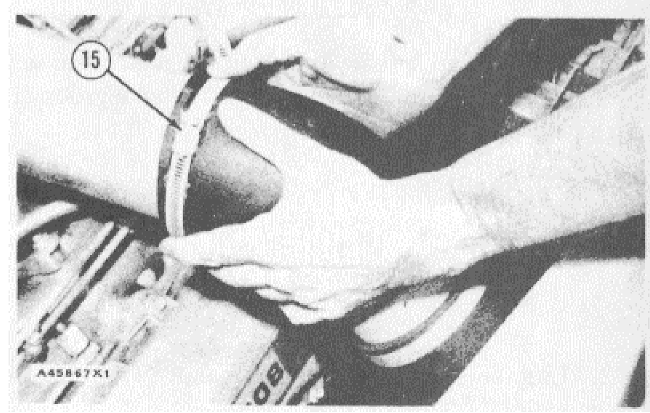


10. Install the four washers and nuts (14) to hold the bottom of the air cleaner panel assembly in position.

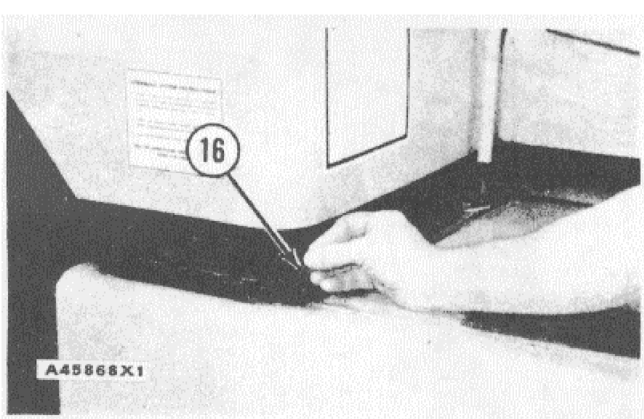
11. Connect hose (13) to the air cleaner.



12. Connect the hose the engine air intake and tighten clamp (15).

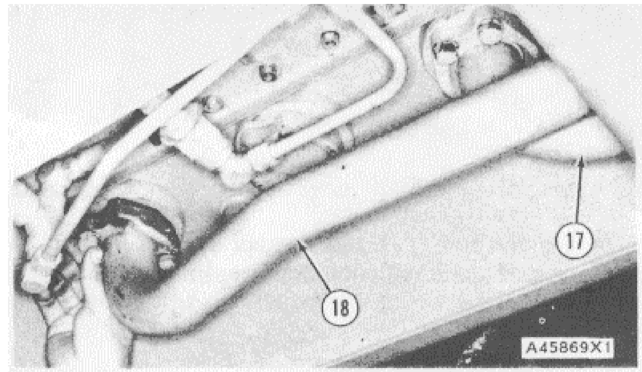


13. Install the eight bolts (16), washers and nuts that hold the tank to the frame.

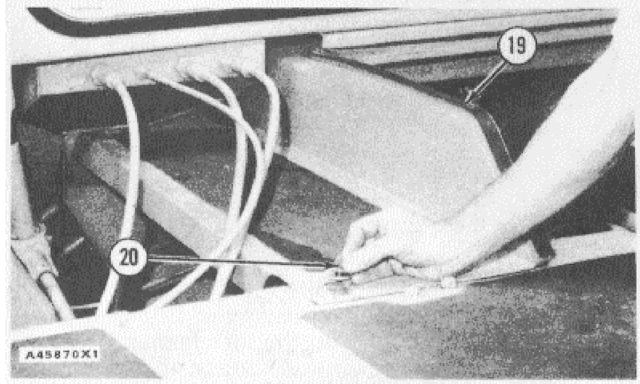


HYDRAULIC TANK, HYDRAULIC TANK OIL FILTERS AND HOUSING

14. Make sure the O-ring seals are in position on tube assemblies (17) and (18). Connect the tube assemblies to the bottom of the tank.



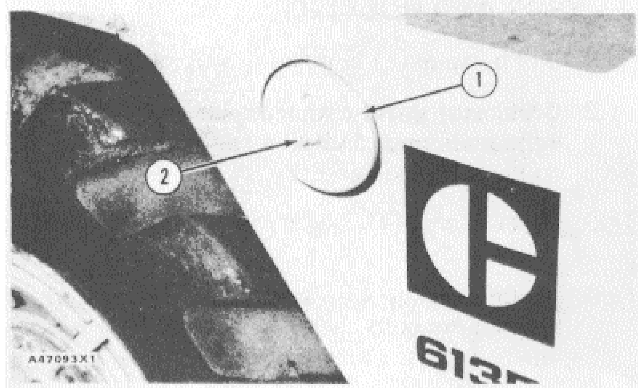
15. Put panel assembly (19) in position and install the four bolts (20), washers and nuts to hold it in position.



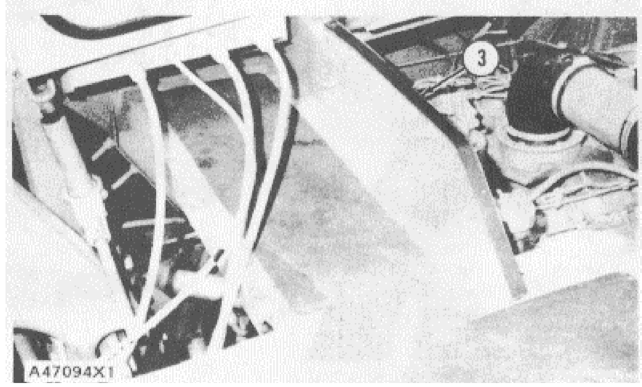
16. Fill the hydraulic system with oil to the correct level. See LUBRICATION AND MAINTENANCE GUIDE.

REMOVE HYDRAULIC TANK OIL FILTERS AND HOUSING

WARNING: Release the pressure from the hydraulic system before any work is done.



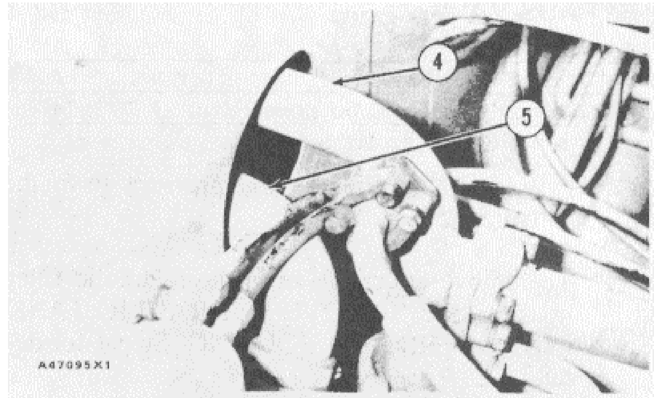
1. Hold the cover of valve group (1) to prevent seal damage. Turn bolt (2) to remove valve group (1) and the filters as a unit.



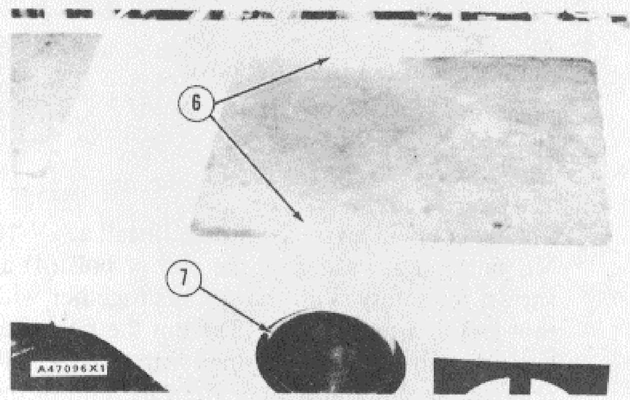
2. Lift the hood and remove panel (3) from the hydraulic tank and the cab.

HYDRAULIC TANK OIL FILTERS AND HOUSING

3. Disconnect tubes (4) and (5) from the housing found through the opening shown.



4. Remove bolts (6) that hold housing (7) to the hydraulic tank.

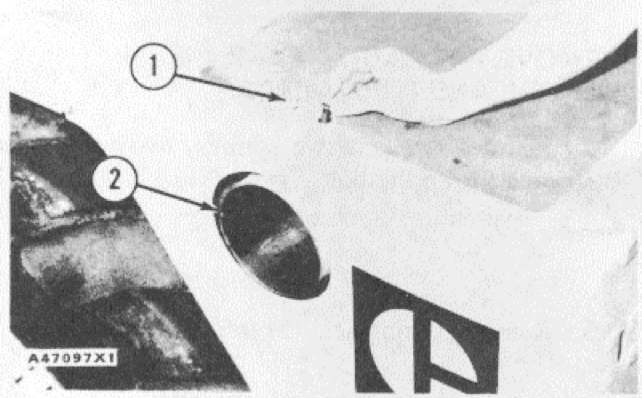


5. Lower the housing straight down until it can be turned and removed between the inside of the tire and the tractor frame.

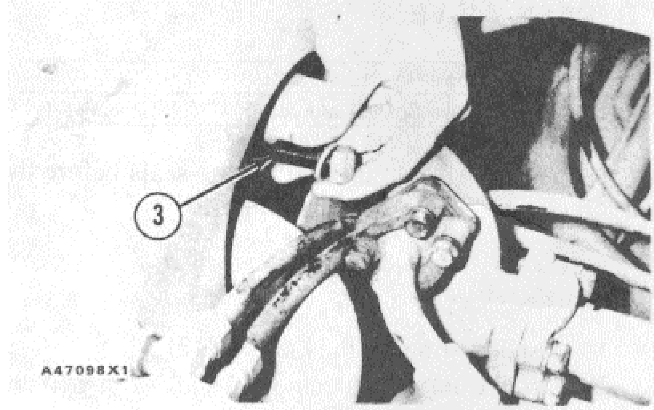
6. After the housing is removed, check the ends of tubes (4) and (5) under the fender for the condition of the O-ring seals. If the seals have damage, use new parts for replacement.

INSTALL HYDRAULIC TANK OIL FILTERS AND HOUSING

1. Put housing (2) in position and install bolts (1).

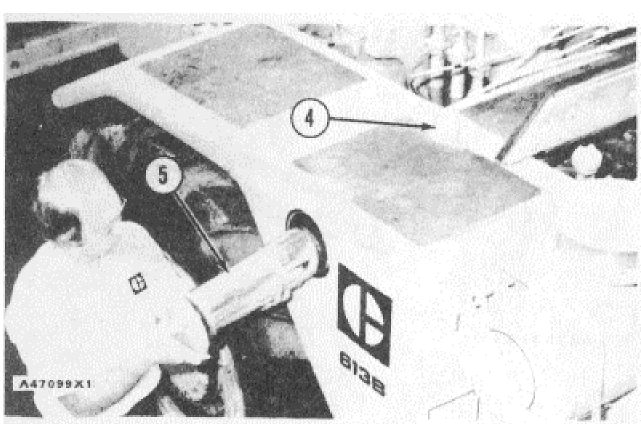


2. Make sure the O-ring seals are in position on the tube assemblies and install bolts (3) to hold them to the filter housing.



3. Install panel (4), filters (5) and the valve assembly.

4. With the plug to the top, hold the cover and tighten the bolts. Tighten the bolt to a torque of 60 + 5 lb. ft. (80 $^{+}$ 7 N. m).

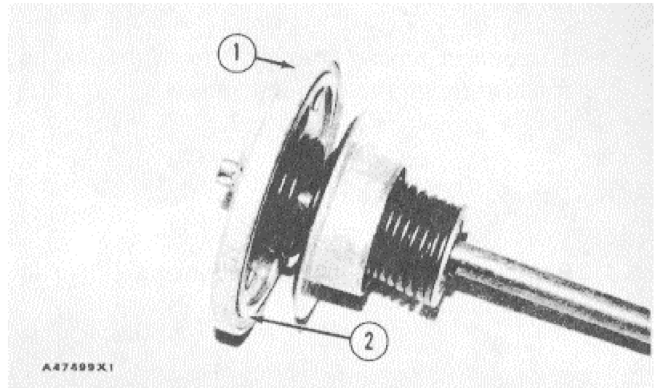


HYDRAULIC OIL FILTER BYPASS VALVE

REMOVE HYDRAULIC OIL FILTER BYPASS VALVE

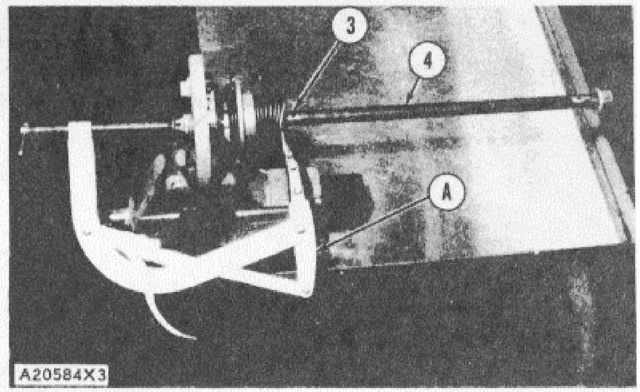
	Tools Needed	A
1P3527	Valve Spring Compressor	1

WARNING: Release the pressure from the hydraulic system.

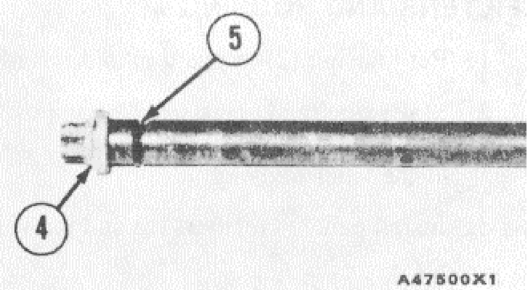


1. To remove cover (1) from the hydraulic filter housing, see REMOVE HYDRAULIC TANK OIL FILTERS AND HOUSING, Step I for details.

2. Remove seal (2) from the cover.



3. Put cover(l) in a vise as shown. Install a 3/4"-10 NC nut and a washer on the end of bolt (4) as shown for safety. Pull the springs together with tool (A) and remove pin (3) from the bolt. Release the tension on the springs with tool (A) and remove the nut and washer from the end of the bolt.



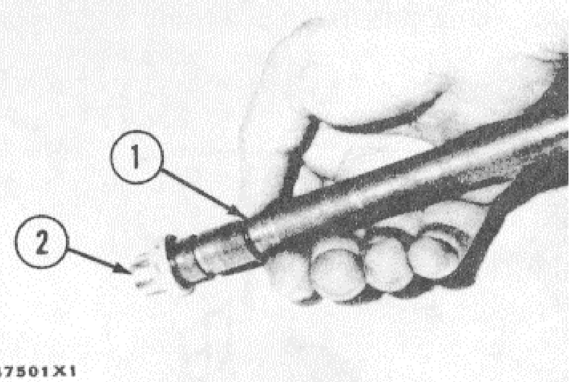
4. Remove retainer, two springs, two valves and cover from the bolt.

5. Remove O-ring seal (5) from bolt (4).

INSTALL HYDRAULIC OIL FILTER BYPASS VALVE

	Tools Needed	A
1P3527	Valve Spring Compressor	1

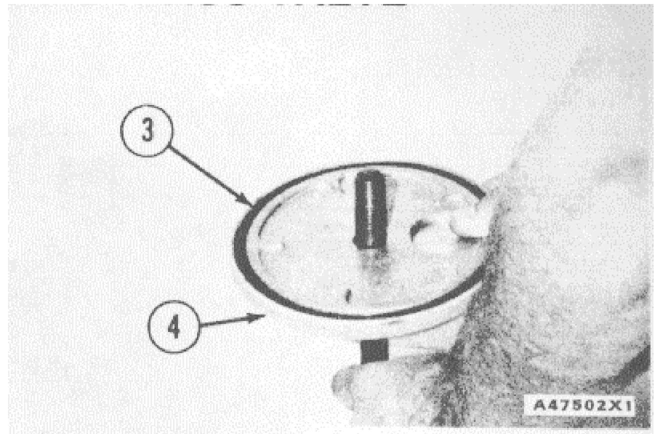
NOTE: Put SAE 10 oil on all of the seals before the hydraulic oil filter valve is assembled.



1. Install O-ring seal (1) on bolt (2).

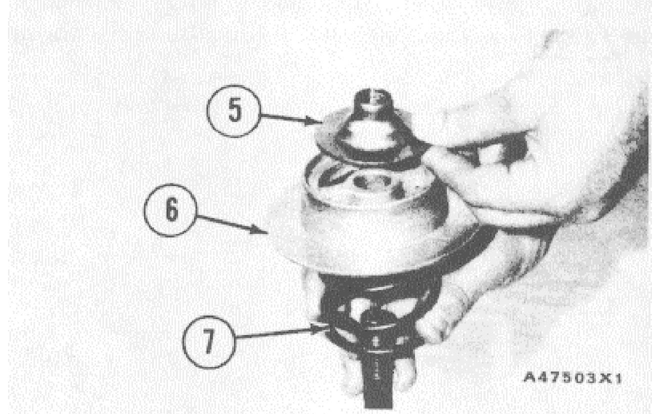
HYDRAULIC OIL FILTER BYPASS VALVE

2. Install seal (3) in cover (4).

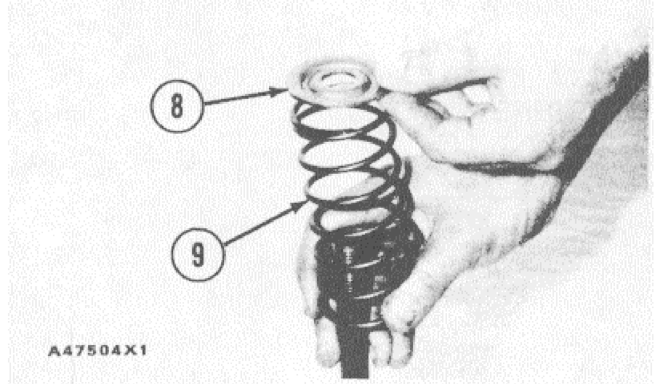


3. Install cover (4) on the bolts.

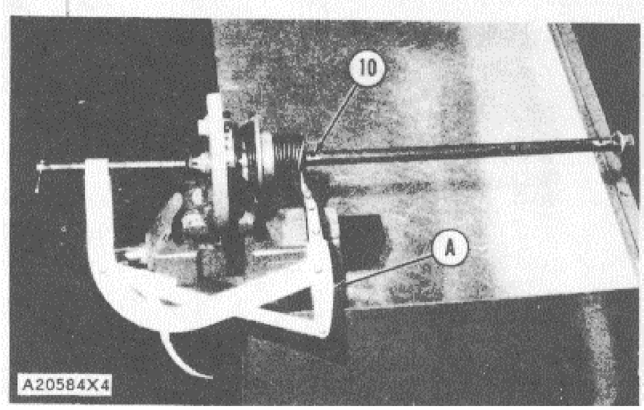
4. Install large diameter spring (7) and valves (6) and (5) on the bolt.



5. Install small diameter spring (9) and retainer (8) on the bolt.



6. Put the cover in a vise as shown. Install a 3/4"-10 NC nut and a washer on the end of the bolt as shown for safety. Pull springs together with tool (A) and install pin (10) through the bolt. Release the tension on the spring with tool (A) and remove the nut and washer from the end of the bolt.



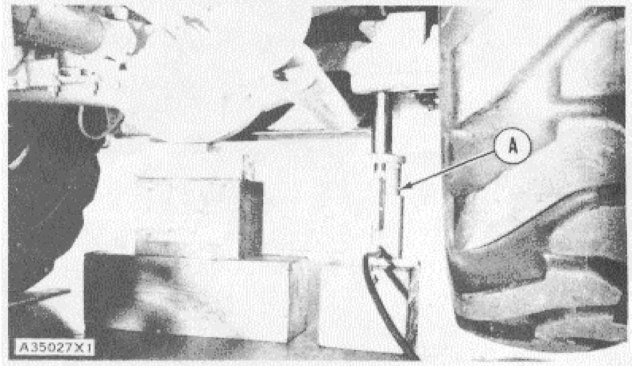
7. To install the cover to the hydraulic filter housing, see INSTALL HYDRAULIC OIL FILTERS AND HOUSING, Step 4 for details.

TRACTOR RIM AND TIRE

REMOVE TRACTOR RIM AND TIRE

	Tools Needed	A
8S7610	Base Assembly	1
8S7650	Cylinder	1
5P3100	Pump Group	1

1. Lower the scraper and put blocks In front and behind the wheels.
2. Put tooling (A) in position and lift the machine as shown.

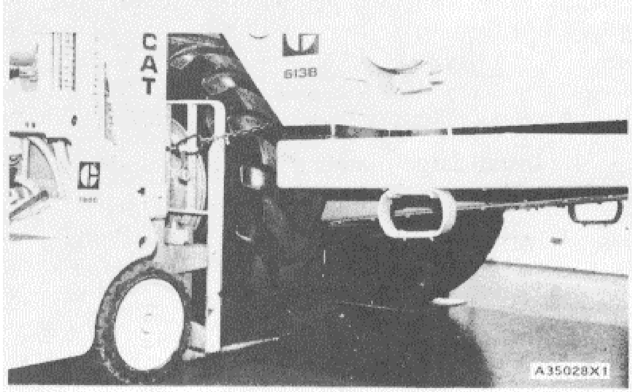


WARNING: Machine can fall off of hydraulic jack. Put blocks under the differential housing for support.

3. Remove all but one of the nuts that hold the rim to the wheel assembly.
4. Loosen the last nut approximately 12 in. (3. 18 mm).

WARNING: The tire can fall off of the lift truck. make sure the tire is fastened to the lift truck.

5. Fasten the tire to a lift truck with a chain as shown.

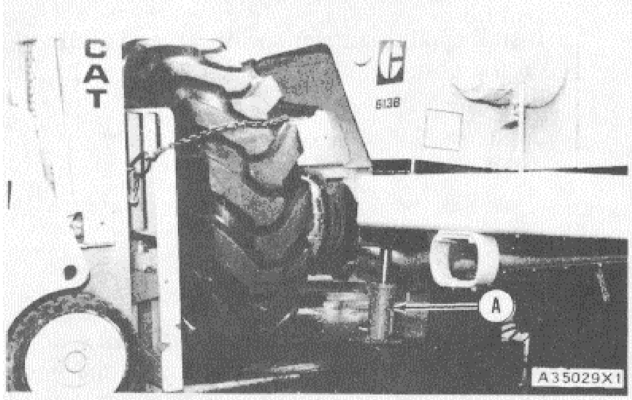


6. Remove the last nut that holds the tire in position. Remove the rim and tire. of the rim and tire is 925 lb. (421 kg).

INSTALL TRACTOR RIM AND TIRE

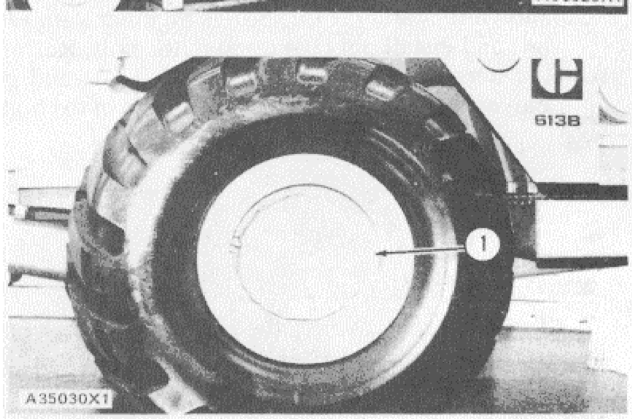
	Tools Needed	A
8S7610	Base Assembly	1
8S7650	Cylinder	1
5P3100	Pump Group	1

1. Fasten the tire to a lift truck with a chain as shown.



WARNING: Make sure tire is fastened to the lift truck.

2. Put the rim and tire in position on the machine.
3. Install four nuts that hold the rim to the wheel assembly.
4. Remove the chain and lift truck.
5. Install the remainder of nuts (1) that hold the rim and tire to the wheel assembly. Tighten the nuts to a torque of 375 - 25 lb. ft. (510 +_ 35 N-m).



6. Remove the support blocks from under the differential housing.
7. Lower the machine to the ground. Remove tooling (A) from under the machine.

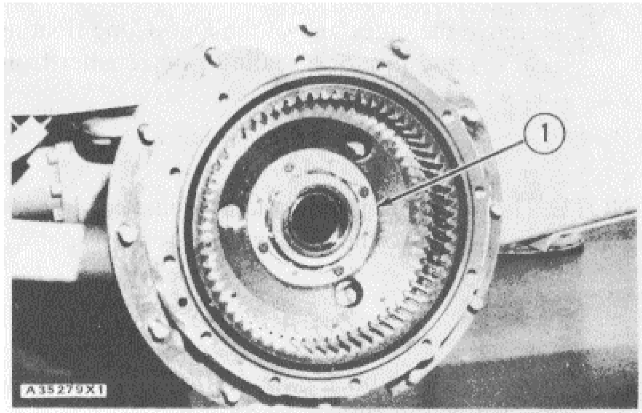
TRACTOR WHEEL ASSEMBLIES,-BEARINGS AND SEALS

REMOVE TRACTOR WHEEL ASSEMBLIES, BEARINGS AND SEALS

	Tools Needed	A	B
5P2978	Spanner Wrench	1	
FT797	Lifting Bracket		1

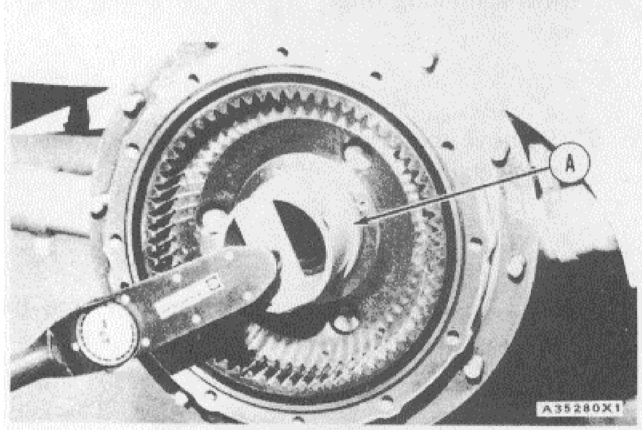
start by:
a) remove tractor rim and tire
b) remove brake head assemblies
c) remove final drives

1. Remove the lockwire and lock (1).

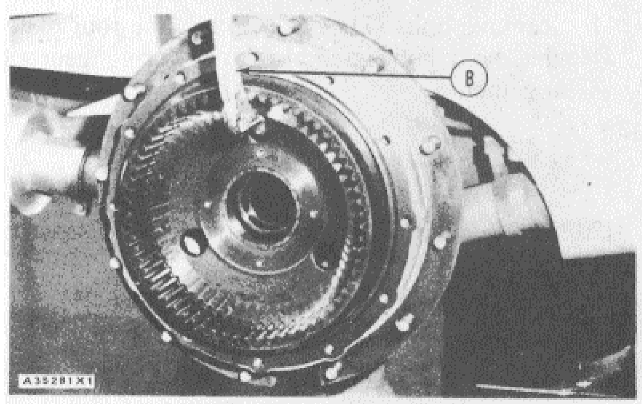


2. Fasten a hoist to the wheel assembly.

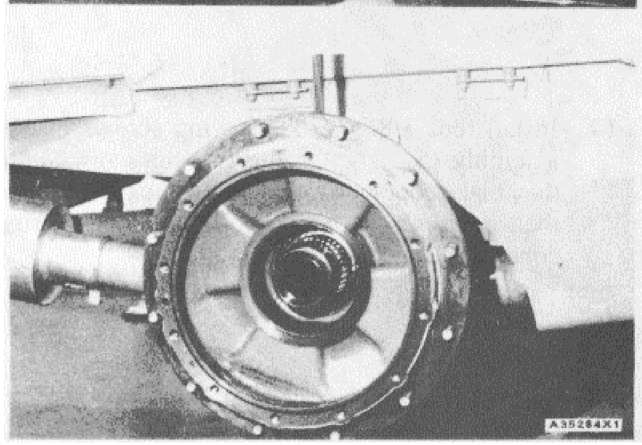
3. Use tool (A) and remove the nut that holds the wheel assembly on the spindle.



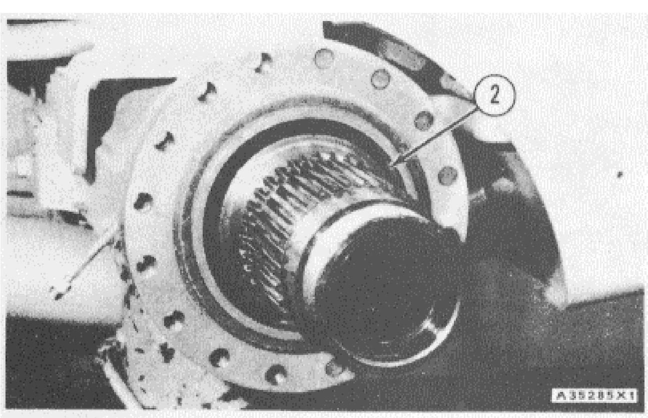
4. Use tool (B) and a hoist to remove the final drive ring gear and hub assembly. Weight of the final drive ring gear and hub assembly is 70 lb. (32 kg).



5. Remove the wheel assembly. Weight of the wheel assembly is 180 lb. (82 kg).



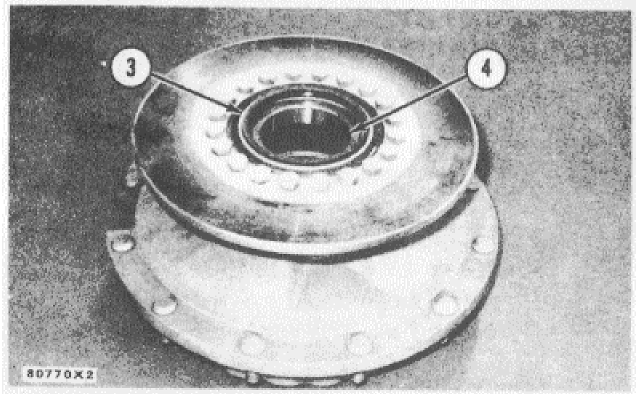
6. Remove the inner half of the Duo-Cone floating seal (2) from the spindle. Remove the rubber toric sealing ring from the metal floating ring.



TRACTOR WHEEL ASSEMBLIES, BEARINGS AND SEALS

7. Remove the outer half of the Duo-Cone floating seal (3) and the toric sealing ring retainer from the wheel assembly.

NOTE: The toric sealing ring retainer must be removed evenly or damage to the retainer will result.

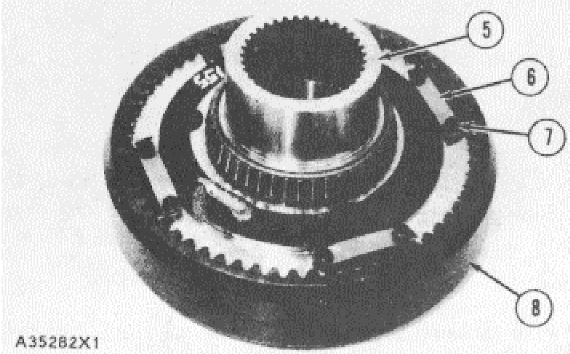


8. Remove the rubber toric sealing ring from the metal floating ring.

9. Remove the O-ring seal from the toric sealing ring retainer.

10. Remove the inner bearing cone (4) from the wheel assembly.

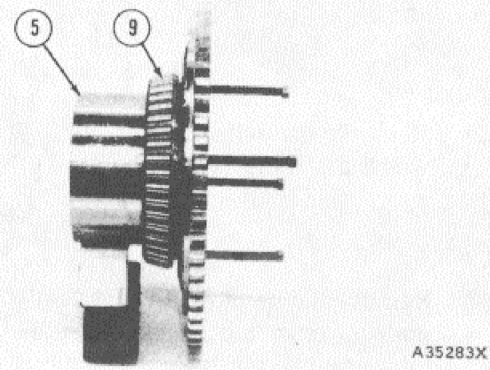
11. Remove bolts (7), locks (6) and the four plates that hold hub assembly (5) and ring gear (8) together.



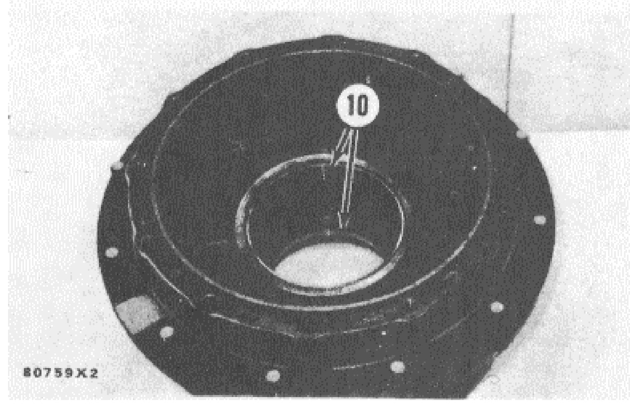
12. Remove hub assembly (5) from ring gear (8).

13. Remove the bushing from hub assembly (5).

14. Install four 3/8"-16 NC forcing screws in hub assembly (5). Tighten the forcing screws until they make contact with bearing cone (9). Tighten the forcing screws evenly to remove the bearing cone from the hub assembly.

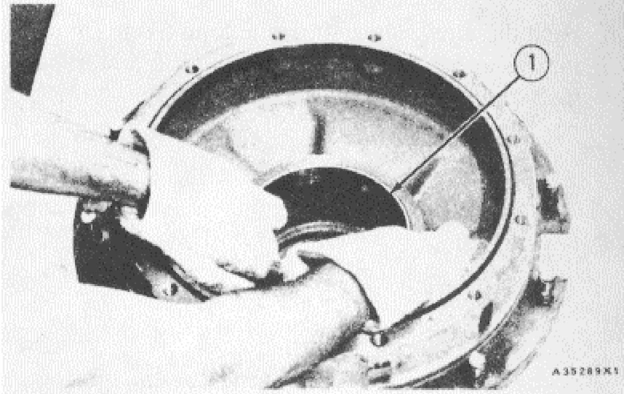


15. Remove the inner and outer bearing cups (10) from the wheel assembly.



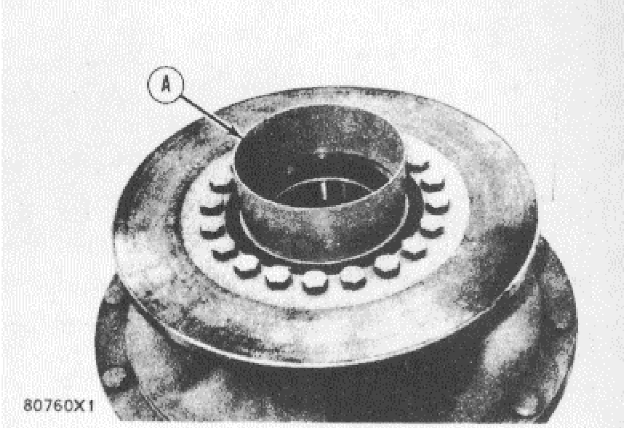
INSTALL WHEEL ASSEMBLIES, BEARINGS AND SEALS

	Tools Needed	A	B	C	D	E
2S8027	Seal Installer	1				
1 P531	Handle		1			
1 P524	Drive Plate		1			
1P514	Drive Plate		1			
FT524	Lifting Bracket			1		
FT797	Lifting Bracket				1	
5P2978	Spanner Wrench					1



1. Lower the temperature of the inner and outer bearing cups for the wheel assembly.

2. Install outer bearing cup (1) in the wheel assembly.



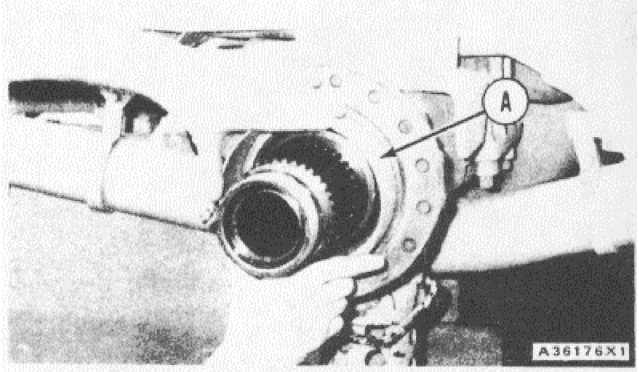
3. Install the inner bearing cup in the wheel assembly.

4. Install the inner bearing cone in the wheel assembly.

5. Install the O-ring seal on the toric sealing ring retainer.

6. Install toric sealing ring retainer in the wheel assembly.

NOTE: The rubber seals and all surfaces that make contact with the seals must be clean and dry. After installation of the seals, put oil on the contact surfaces of the metal seals.

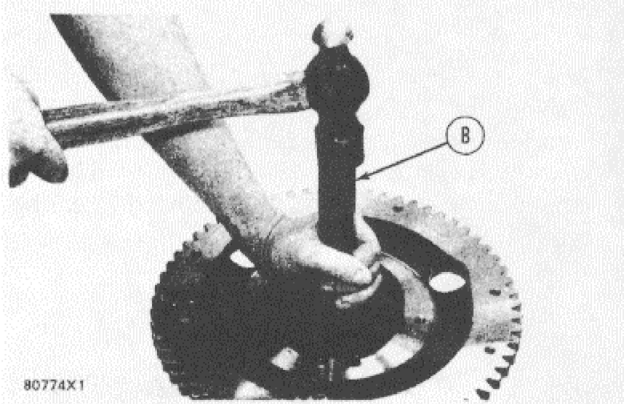


7. Install the two rubber toric sealing rings on the two metal floating seals.

8. Install the outer half of the Duo-Cone floating seal in the wheel assembly with tool (A).

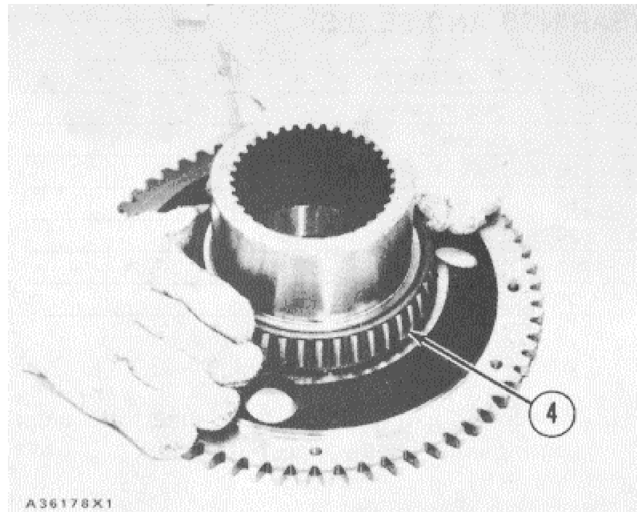
9. Install the inner half of the Duo-Cone floating seal on the spindle with tool (A).

10. Install the bushing in the hub assembly with tooling (B).

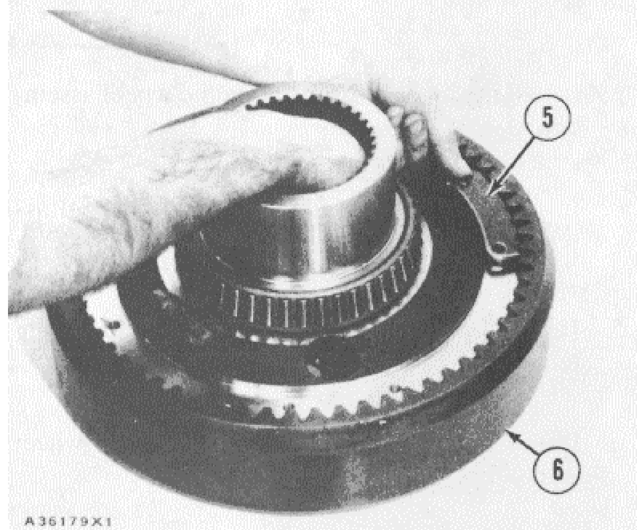


TRACTOR WHEEL ASSEMBLIES, BEARINGS AND SEALS

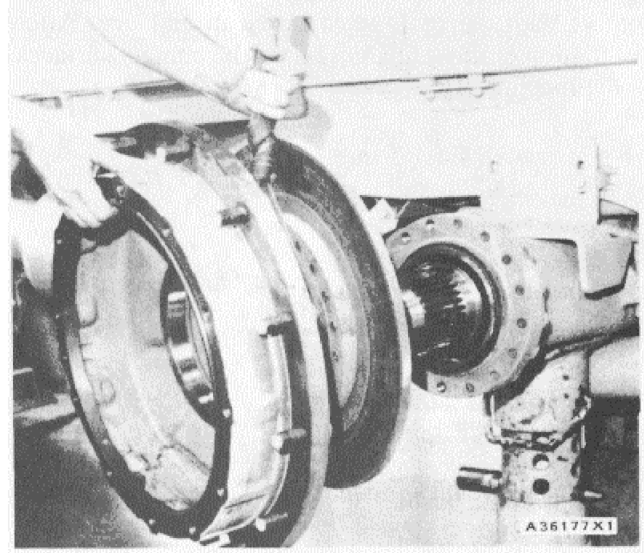
11. Heat the wheel outer bearing cone (4) in oil to a maximum temperature of 275°F (135°C). Install the bearing on the hub assembly.



12. Install the hub assembly in ring gear (6). Install plates (5), the locks and bolts to hold the hub assembly in position.

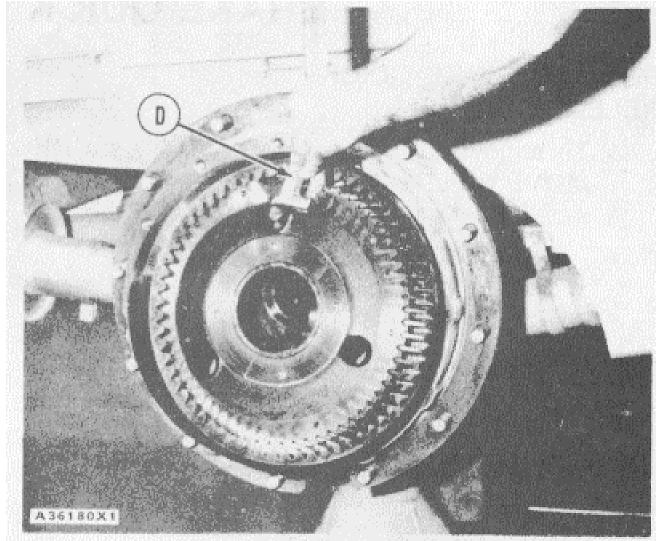


13. Use tool (C) and fasten a hoist to the wheel assembly. Put the wheel assembly in position on the machine.



TRACTOR WHEEL ASSEMBLIES, BEARINGS AND SEALS

14. Use tool (D) and fasten a hoist to the hub assembly and gear. Put the hub assembly and gear in position on the machine.



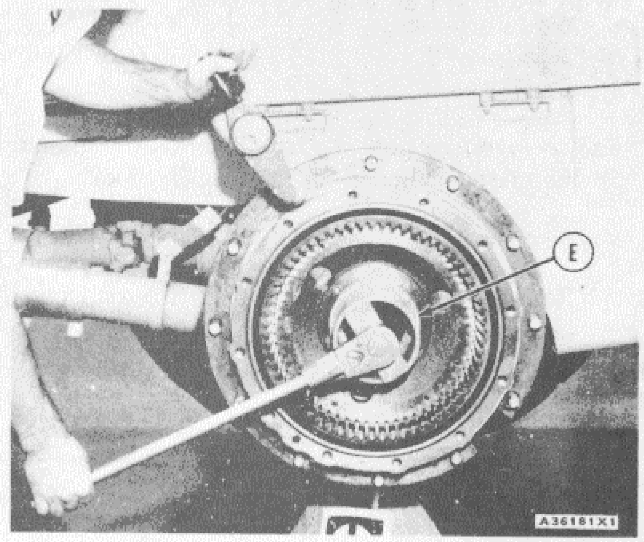
15. Install the nut on the spindle.

16. Tighten the nut with tool (E) while the wheel is turned with a 8 in. (203 mm) long lb. in. (N. m) 9S7354 torque wrench. The torque must be 75 ± 25 lb. in. (8.50 ± 2.83 N. m). For other Ib. in. torque wrenches, the correct torque indication can be found with this formula:

$$C= \frac{A \times T}{A + B}$$

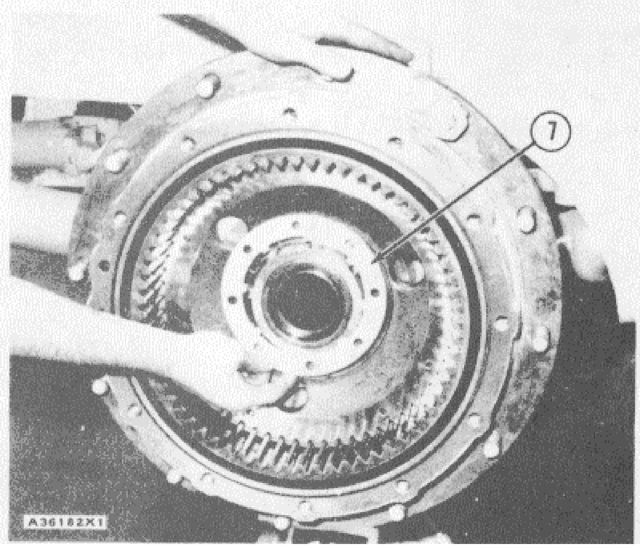
"C" is the torque wrench reading.
"A" is the length of the torque wrench.
"B" is the distance from the center of the wheel to the wheel stud.
"T" is torque on bearings [T = 160 ± 50 lb. in. (18.1 ± 5.7 N. m)].

NOTE: The torque wrench must be installed on wheel nut so it is in line with the center of the wheel as shown.



17. Turn wheel slowly at a constant speed for one or two turns to check troque reading after adjustment has been made.

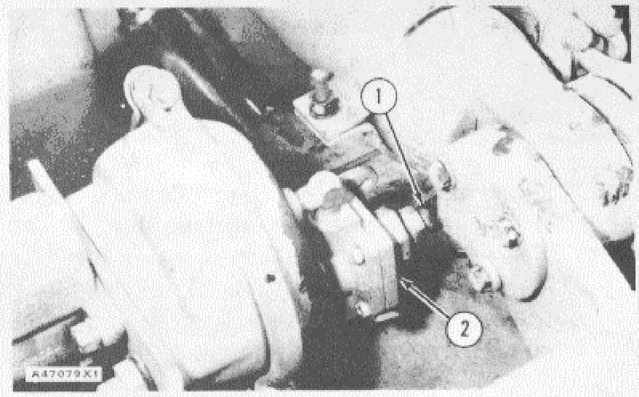
18. Install lock (7) on the nut. Tighten the nut more if needed to get the lock in alignment with bolt holes. Install the bolts and lock wire.
    end by:
    a) install final drives
    b) install brake head assemblies
    c) install tractor rims and tires



BRAKE QUICK RELEASE VALVE

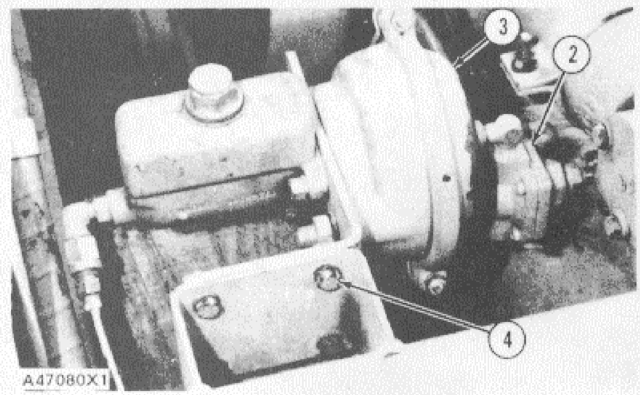
REMOVE BRAKE QUICK RELEASE VALVE

1. To remove the rear cover assembly, see REMOVE EJECTOR CYLINDER for details.



2. Disconnect tube (1) from quick release valve (2).

3. Put wooden blocks from the top of the fuel tank to just below the master cylinder.

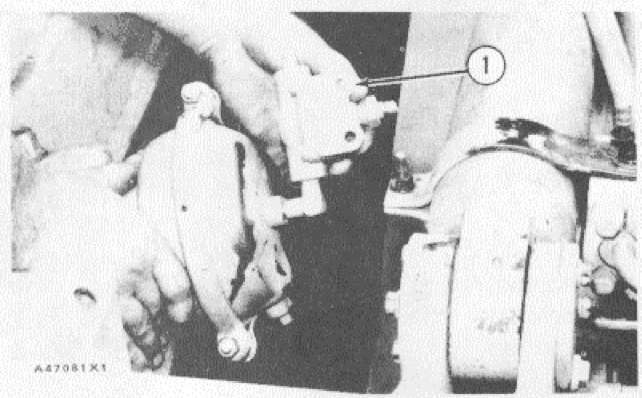


4. Remove four bolts (4) from the bracket and put the master cylinder on the wooden blocks.

5. Remove quick release valve (2) from chamber (3).

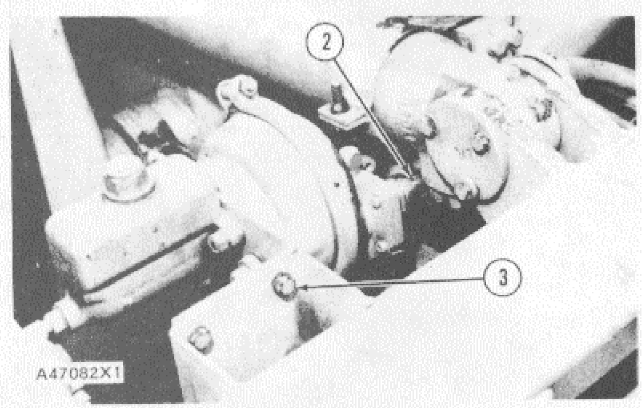
INSTALL BRAKE QUICK RELEASE VALVE

1. Install quick release valve (1) on the chamber.



2. Install four bolts (3) to the bracket and remove the wooden blocks.

3. Connect tube (2) to the valve.

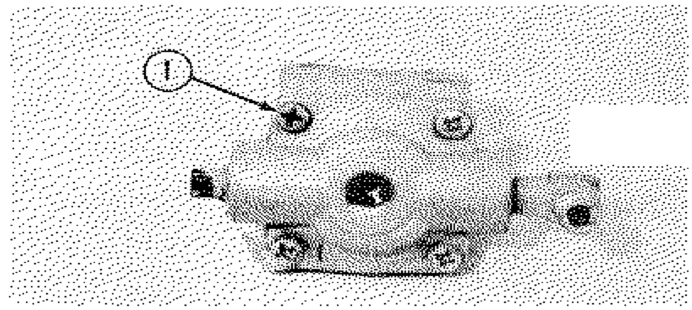


4. To install the rear cover assembly, see INSTALL EJECTOR ASSEMBLY for details.

BRAKE QUICK RELEASE VALVE

DISASSEMBLE BRAKE QUICK RELEASE VALVE

start by:
a) remove brake quick release valve



A47083X1

1. Remove screws (1) from the valve.

2. Remove the valve from diaphragm (2) and seal (3).

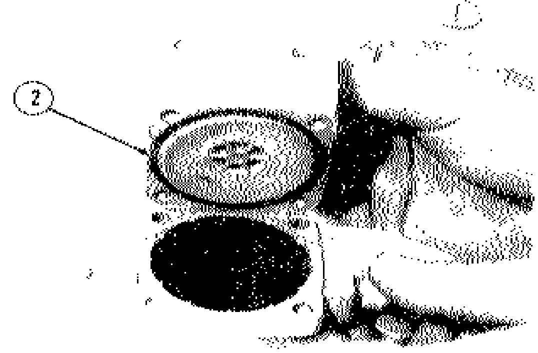
A47084X1

ASSEMBLE BRAKE QUICK RELEASE VALVE

1. Install diaphragm (1) on the valve.

A47085X1

2. Install seal (2) in the groove.



3. Put the valve together and install the screws.

end by:
a) install brake quick release valve

A47086X1

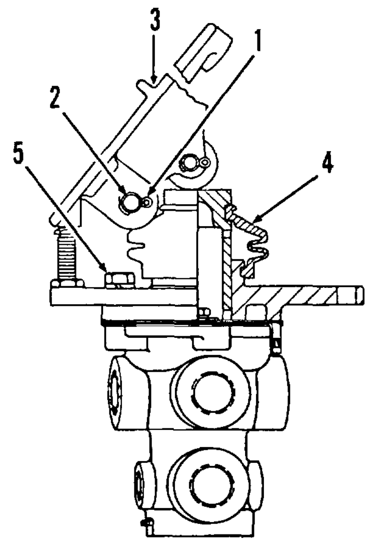
BRAKE CONTROL VALVE

REMOVE AND INSTALL BRAKE CONTROL VALVE

1. From inside the cab area, remove cotter pin (1) and pin (2) from the brake pedal (3).

2. Remove brake pedal (3) and rubber cover (4).

3. Move the floor mat enough to remove three screws and lockwashers (5) that hold the valve in position.



4. From under the cab, disconnect tube and hose assemblies (6), (7), and (8) from the brake valve (9).

NOTE: Apply identification tags to the tube and hose assemblies for installation purposes.

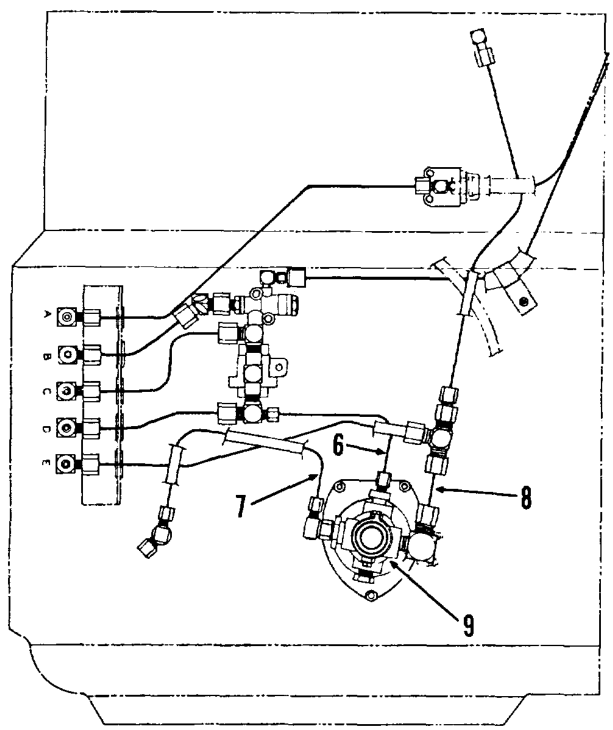
5. Remove brake valve (9).

6. Place brake valve (9) in position and connect tube and hose assemblies (8), (7), and (6) to their correct locations on the brake valve.

7. Install three screws and washers (5) to hold the valve from inside the cab.

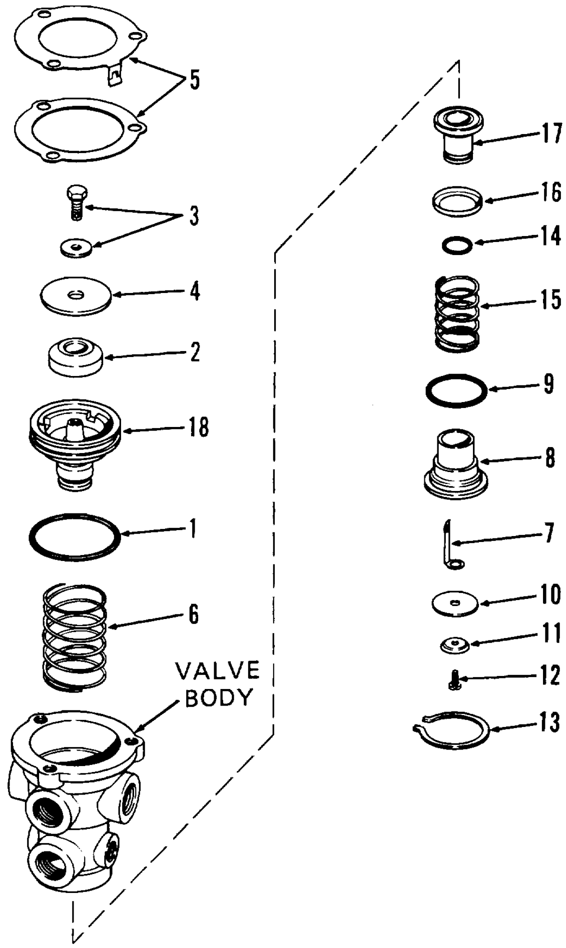
8. Install rubber cover (4) over the valve.

9. Secure brake pedal (3) with pin (2) and cotter pin (1).



BRAKE CONTROL VALVE

Disassemble And Assemble Brake Control Valve



Start By:
a. remove brake control valve

1. Remove bolt and washer (3), seat (4), retainer and gasket (5), rubber spring (2), piston assembly (18), and spring (6) from the body.

2. Remove seal (1) from piston assembly (18).

3. Remove ring (13), bolt (12), washer (11), diaphragm (10), and spring (7) Remove seat (8), O-ring seal (9), spring (15), retainer (16) and valve (17).

4. Remove seal (14) from valve (17) Check the condition of all the seals. If any are worn or damaged, make a replacement of the seal with a new part.

NOTE: The following steps are for the assembly of the brake control valve.

5. Install seal (14) on valve (17) Install valve (17), retainer (16), spring (15), O-ring seal (9), and seat (8)

6. Install spring (7), diaphragm (10), washer (11), bolt (12), and ring (13).

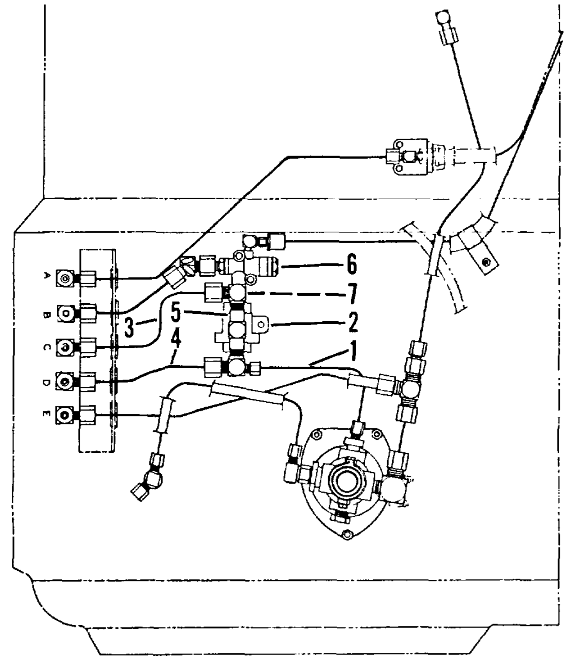
7. Install seal (1) on piston assembly (18). Install spring (6), piston assembly (18), retainer and gasket (5), seat (4), and bolt and washer (3).

End By:

a. install brake control valve

DOUBLE CHECK VALVE

REMOVE AND INSTALL DOUBLE CHECK VALVE



1. Disconnect tube assembly (1) from check valve (2).

NOTE: Tag tube assemblies as they are removed. This will aid in reassembly.

2. Disconnect tube assemblies (3) and (4) from tee (5). Remove tee (5) from check valve (2).

3. Disconnect check valve (2) from valve (6) at fitting (7).

4. Remove nut (8), washer (9), bolt (10), and check valve (2).

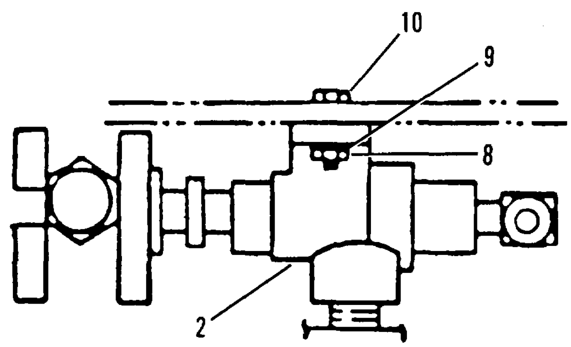
5. Secure check valve (2) with bolt (10), washer (9), and nut (8).

6. Connect check valve (2) to valve (6) at fitting (7).

7. Connect tee (5) to check valve (2).

8. Connect tube assemblies (4) and (3) to tee (5).

9. Connect tube assembly (1) to check valve (2).



DISASSEMBLE AND ASSEMBLE DOUBLE CHECK VALVE

1. Remove two screws (1), washer (2) and tag (3).

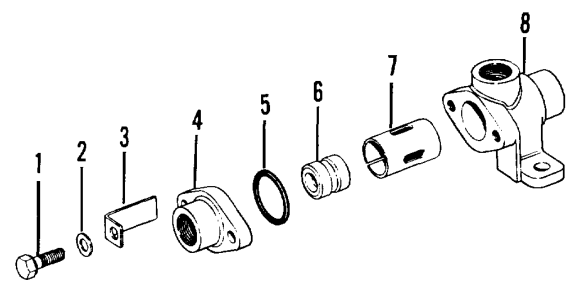
2. Remove cap (4) and seal (5).

3. Remove shuttle (6) and sleeve (7) from body (8). Inspect shuttle (6) and sleeve (7) for excessive wear or damage; replace as necessary.

4. Install sleeve (7) and shuttle (6) into body (8).

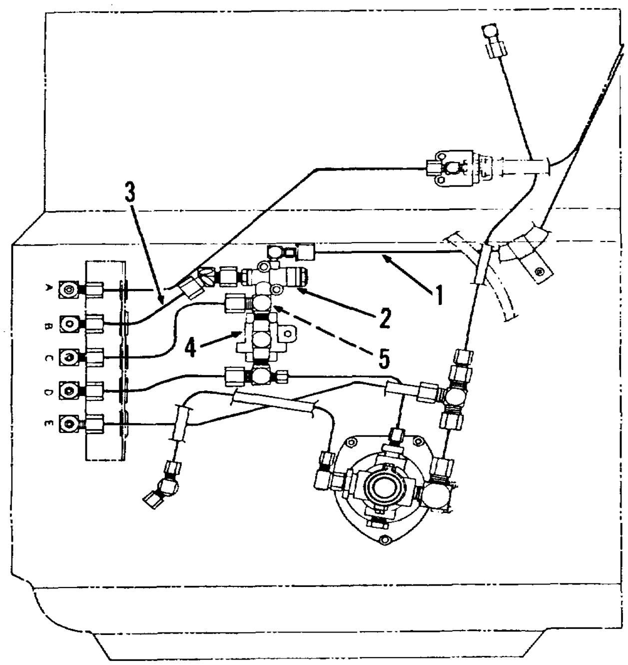
5. Install seal (5) and cap (4).

6. Install and tighten two screws (1) with tag (3) and washer (2).



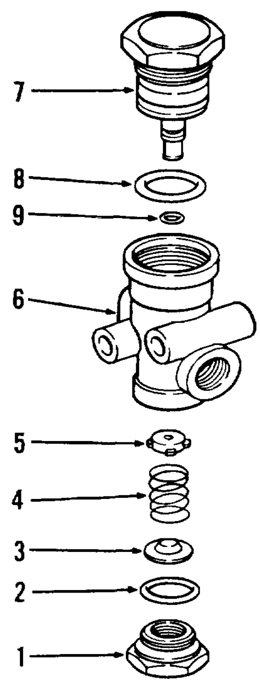
EMERGENCY PILOT VALVE

REMOVE AND INSTALL EMERGENCY PILOT VALVE



1. Disconnect tube assembly (1) from pilot valve (2).
2. Disconnect tube assembly (3).
3. Disconnect pilot valve (2) from double check valve (4) at fitting (5).
4. To install pilot valve (2), connect pilot valve to double check valve at fitting (5).
5. Connect tube assembly (3) and tube assembly (1) to check valve (2).

DISASSEMBLE AND ASSEMBLE EMERGENCY PILOT VALVE



1. Remove nut (1), seal (2), spring guide (3), spring (4), and valve (5) from valve body (6).
2. Remove exhaust valve assembly (7) and seals (8) and (9).
3. Inspect seals for damage. Inspect bore for nicks and scoring. Replace parts as necessary.
4. Install seals (9) and (8) with exhaust valve assembly (7).
5. Install valve (5), spring (4), spring guide (3), seal (2), and nut (1).

DIFFERENTIAL LOCK VALVE

REMOVE AND INSTALL DIFFERENTIAL LOCK VALVE

Refer to page 3-283 for illustration.

1. Remove spring (I) from back of the differential lock pedal (2).

2. Remove cotter pin (3) and washers (4).

3. Slide differential lock pedal (2) off of pin (5).

4. Remove nut (6) and rubber boot (7) from differential lock valve (8).

5. From underneath the cab area, disconnect tube assembly (9) from elbow (10). Remove elbow (10) from the differential lock valve (8).

6. Disconnect tube assembly (11) from elbow (12) and remove differential lock valve. Separate elbow (12) from valve (8).

7. To install valve, connect elbows (12) and (10) to differential lock valve (8).

8. Connect tube assemblies (11) and (9) to elbows (10) and (12).

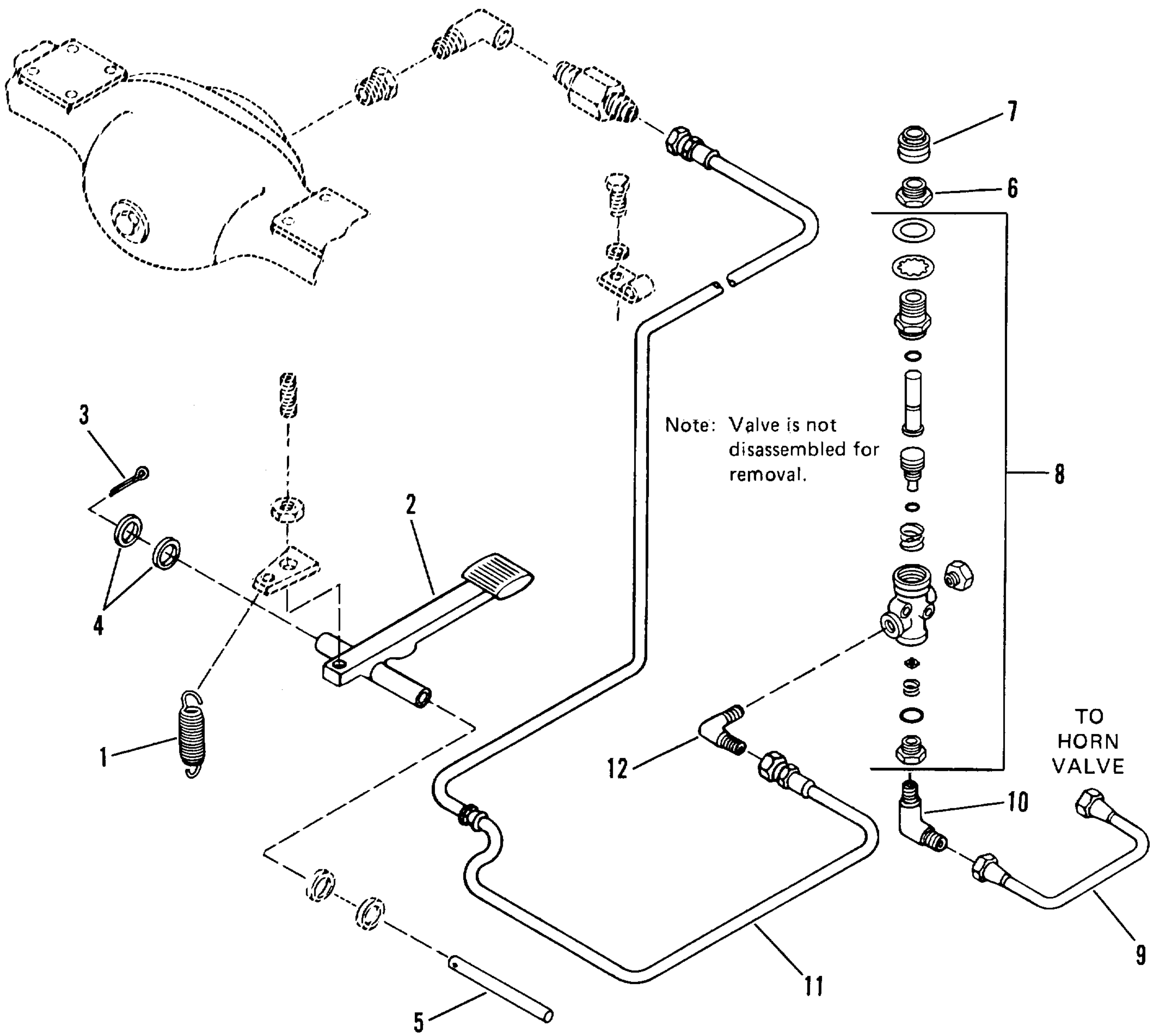
9. Position differential lock valve (8) in hole in cab floor.

10. Install nut (6) with rubber boot (7).

11. Slide differential lock pedal (2) onto pin (5).

12. Install washers (4) and cotter pin (3).

13. Secure spring (1) to the back of the differential lock pedal (2).

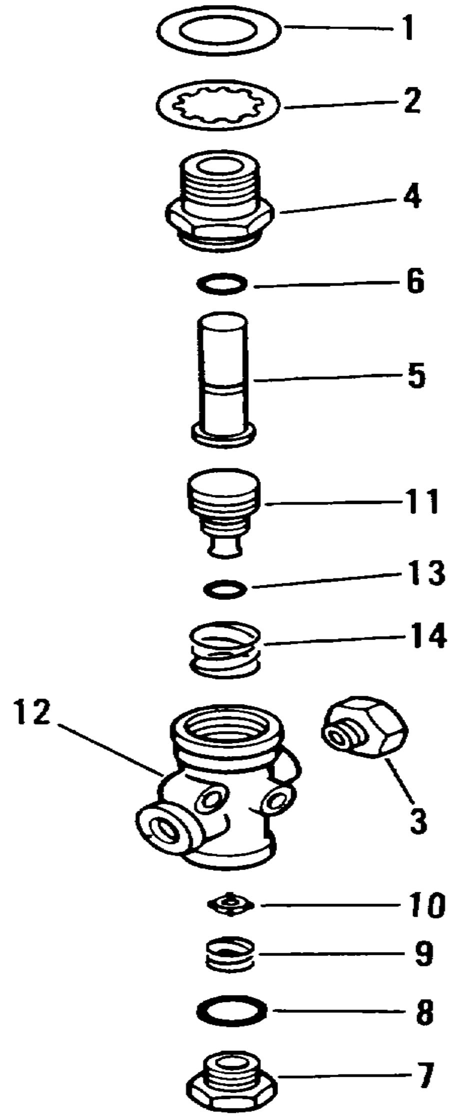


DIFFERENTIAL LOCK VALVE

DIFFERENTIAL LOCK VALVE

DISASSEMBLE AND ASSEMBLE DIFFERENTIAL LOCK CONTROL VALVE

1. Remove washer (1) and lockwasher (2).
2. Remove exhaust valve assembly (3).
3. Remove plunger guide (4).
4. Remove plunger (5) from guide (4). Inspect seal (6) for damage or excessive wear; replace if necessary.
5. Remove fitting (7) and seal (8), spring (9), and valve (10). Inspect sealing surfaces of valve (10) for nicks or excessive wear; replace valve as necessary.
6. Remove spool (11) from the valve body (12).
7. Remove seal (13) from spool (11).
8. Remove spring (14).
9. To assemble valve, install spring (14), seal (13), and spool (11).
10. Install seal (6), plunger *(5).* and guide (4) in valve body (1 2).
11. Install valve (10), spring (9), seal (8), and fitting (7).
12. Install and tighten exhaust valve (3).



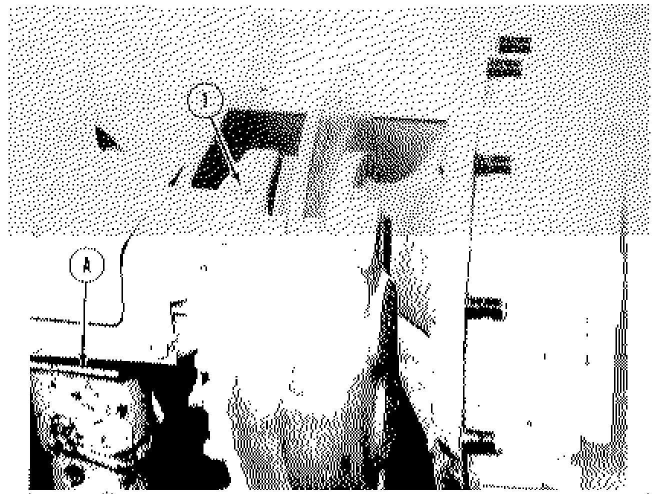
BRAKE LININGS

REMOVE BRAKE LININGS

	Tools Needed	A
8S7640	Stand	1
8S7611	Tube	1
8S7615	Pin	
8S8048	Saddle1	

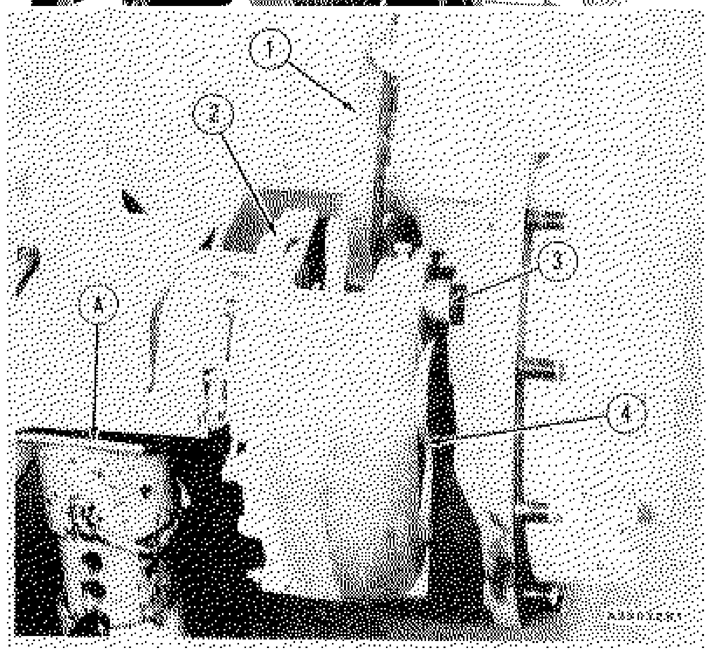
start by:
a) remove rim and tire (tractor or scraper)

1. Remove the hydraulic jack used to lift the machine to remove the tire.
2. Install tooling (A) for safety.
3. Loosen bolts (I) that hold the anchor pins in
4. Pull the anchor pins out of the head assembly .75 in. (19. 1 mm).
5. Open the bleed valves to release any pressure on the brake pistons.



CAUTION: To prevent damage to pistons and seals, do not make an application of the brakes x hen brake linings are removed. The pistons must not move out of their bores as the brake linings are removed. If the pistons and seals move out of their bores, the brake head must be removed to install the pistons.

6. Remove the brake linings.



INSTALL BRAKE LININGS

	Tools Needed	A
8S7640	Stand	1
8S7611	Tube	1
8S7615	Pin	1
8S8048	Saddle	1

1. Push the brake pistons into the brake. This gives clearance for the new' brake linings.
2. Install brake linings (1) in brake head assembly
3. Push anchor pins (3) into brake head assembly
4. Make sure there is .010 in. (0.25 mm) or more distance between the anchor pins and wheel disc. Tighten bolts (2) to hold the anchor pins.
5. Close the brake line bleed valves.
6. Remove (bleed) the air from the hydraulic brake system. See AIR REMOVAL FROM BRAKES in TESTING AND ADJUSTING.
7. Remove tooling (A). Put the hydraulic jack into position used to lift the machine for tire installation.

end by:
a) install rim and tire (tractor or scraper)

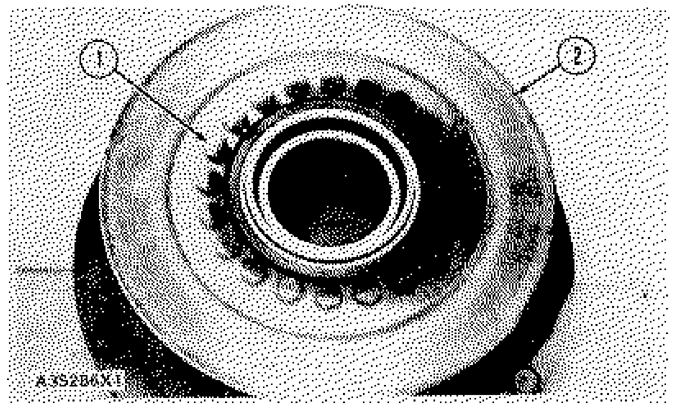
WHEEL BRAKE DISCS, BRAKE HEAD ASSEMBLIES

REMOVE WHEEL BRAKE DISCS

a) remove tractor or scraper wheel assemblies, bearings and seals

1. Remove bolts (1).

2. Remove disc (2).

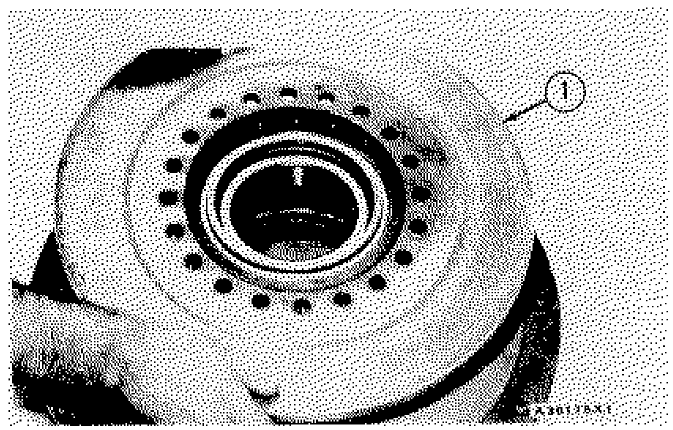


INSTALL WHEEL BRAKE DISCS

1. Put disc (1) in position on the wheel assembly.

2. Install the bolts that hold the disc to the wheel assembly and tighten them to a torque of 195 ± 20 Ib.ft. (265 ± 25 N.m).

a) install tractor or scraper wheel assemblies, bearings and seals



REMOVE BRAKE HEAD ASSEMBLIES

	Tools Needed	A
857640	Stand	1
8S7611	Tube	1
8S7615	Pin	1
8S8048	Saddle	1

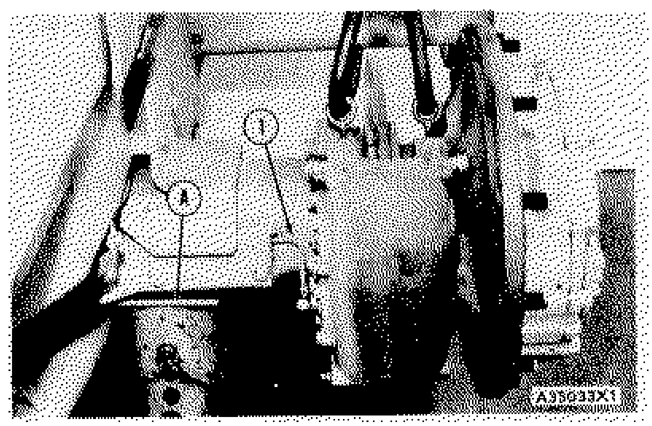
start by:
a) remove rim and tire (tractor or scraper)

NOTE: The tractor brake head assembly is shown. The scraper brake head assembly procedure is the same.

1. Remove the hydraulic jack used to lift the machine to remove the tire. Install tooling (A) for safety.

2. Disconnect brake line (I) from-the brake head assembly.

3. Remove the bolts that hold the anchor pins in position. Pull the anchor pins out of the head assembly .75 in. (19.05 mm).



NOTE: If necessary push the brake linings from the wheel disc to remove the brake head assembly.

4. Install two 3/8"-16 NC forged eyebolts in the brake head assembly and fasten a hoist as shown.

BRAKE HEAD ASSEMBLIES

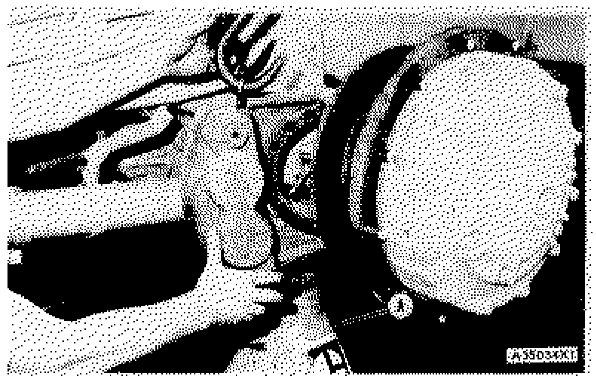
5. Remove the eight bolts that hold the brake head assembly to the axle housing.

NOTE: The center two bolts can not be removed completely because of the clearance between the brake head assembly and the brake line guard. Remove these bolts with the brake head assembly.

6. Remove the brake head assembly. Weight of the brake head assembly is 90 lb. (41 kg).

CAUTION: The two anchor pins and brake linings are free to fall out of the brake head assembly and must be held in position.

INSTALL BRAKE HEAD ASSEMBLIES



	Tools Needed	A
8S7640	Stand	1
8S7611	Tube	1
8S7615	Pin	1
8S8048	Saddle	1

1. Fasten a hoist to the brake head assembly with two 3/8"-16 NC forged eyebolts.
2. Put two of the bolts that hold the brake head assembly to the axle housing in the center two holes of the brake head assembly bracket.

CAUTION: Make sure the two anchor pins and brake linings are held in position when the brake head assembly is installed.

3. Put the brake head assembly in position on the machine and tighten the bolts to a torque of 225 ± 25 lb.ft. (300 ± 35 N.m).
4. Remove the forged eyebolts and hoist from the brake head assembly.
5. Push the anchor pins into the brake head assembly. Make sure there is .010 in. (0.25 mm) or more distance between the anchor pins and wheel disc. Install the two bolts to hold the anchor pins.
6. Connect the brake line to the brake head assembly.
7. Remove (bleed) the air from the hydraulic brake system. See AIR REMOVAL FROM BRAKES in TESTING AND ADJUSTING.
8. Remove tooling (A). Put into position the hydraulic jack used to lift the machine for tire installation.

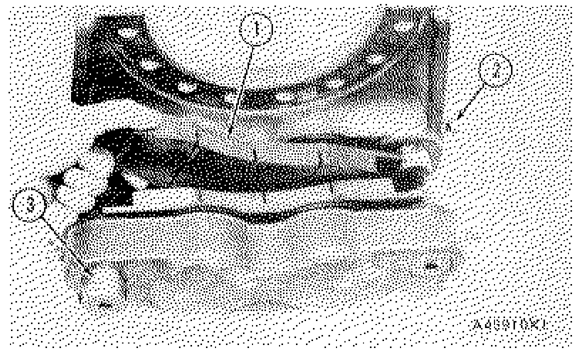
end by:

a) install rim and tire (tractor or scraper)

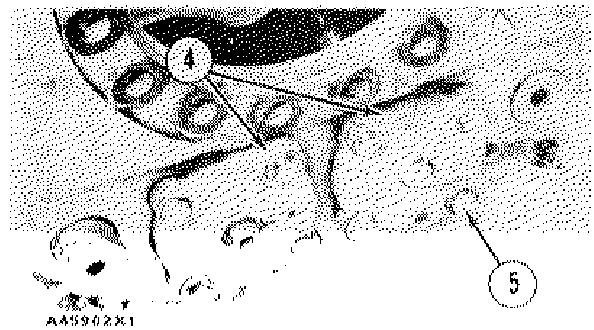
BRAKE HEAD ASSEMBLIES

DISASSEMBLE BRAKE HEAD ASSEMBLIES

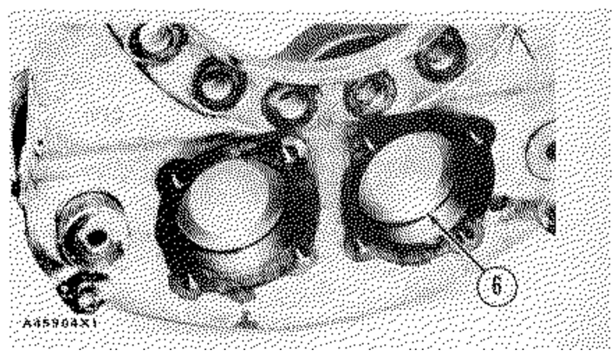
start by:
a) remove brake head assemblies



1. Loosen bolts (2) that hold pins (3) in position and push pins (3) out to remove brake linings (1).



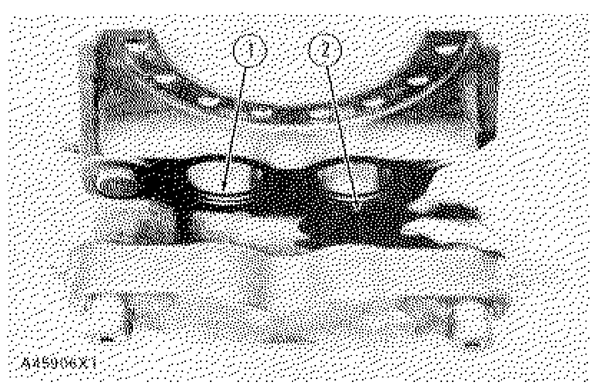
2. Remove bolts (5) and caps (4).



3. Remove four pistons (6) and the boots from the brake head assembly.

4. Remove the boots from the pistons and the seals from the piston bores.

ASSEMBLE BRAKE HEAD ASSEMBLIES



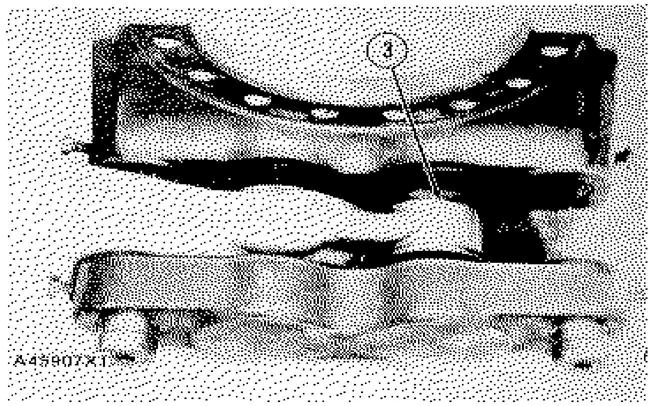
	Tools Needed	A
5P3569	Piston Press	1
1P495	Drive Plate	1

1. Install seals (I) in the four piston bores.

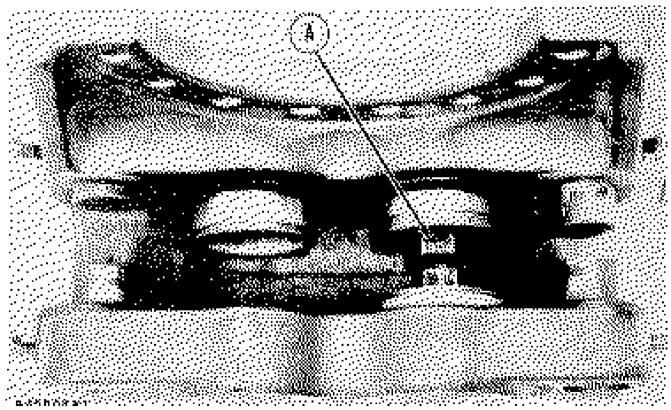
2. Install boots (2) in the piston bores with the lip of the boot in the groove of the bore.

BRAKE HEAD ASSEMBLIES

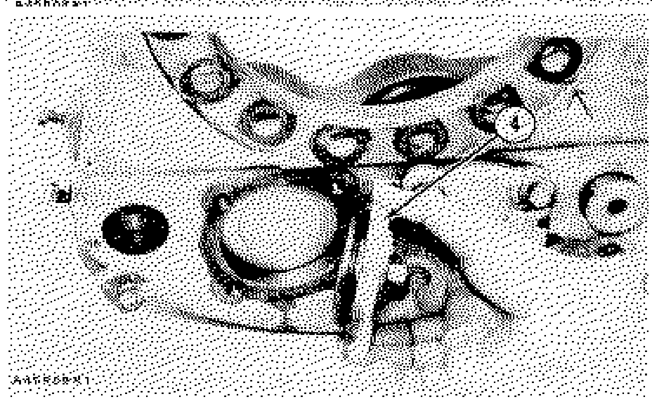
3. Install the four pistons (3) in the bores of the brake head through the boots.



CAUTION: The ends of the pistons must be through the boots before the pistons are pushed into the bores or the damage to the boots will be the result.

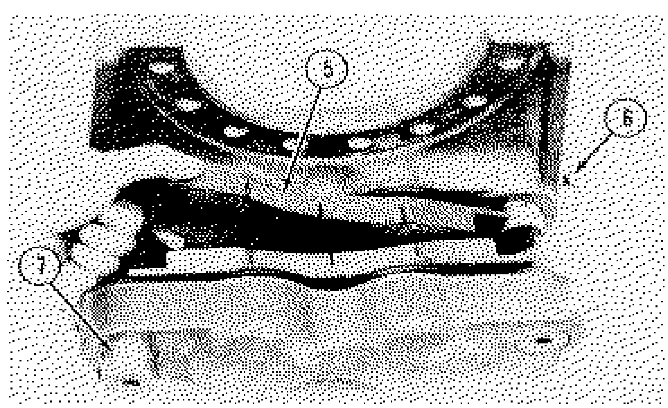


4. Use tooling (A) to push the pistons in the bores. Put the lip of the boots in the groove of the pistons.



5. Install the O-ring seals on the two caps (4) and install the caps on the brake head.

6. Put brake linings (5) in position and push pins (7) in to hold them. Tighten bolts (6) to hold the pins.
   end by:



a) install brake head assemblies

BRAKE MASTER CYLINDER AND ACTUATOR
(TRACTOR AND SCRAPER)

REMOVE AND INSTALL TRACTOR BRAKE MASTER CYLINDER AND ACTUATOR

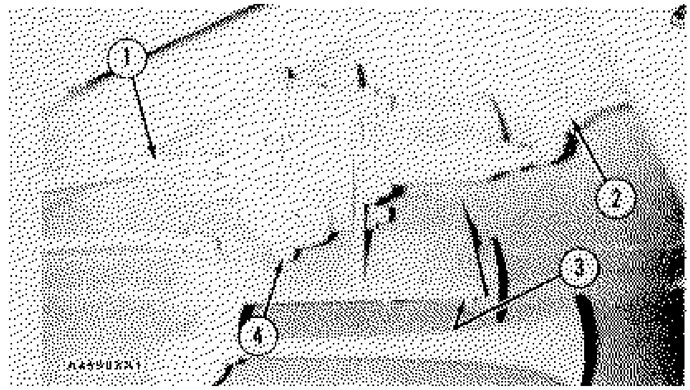
1. Disconnect hose assembly (I) and brake line (2) from master cylinder and actuator (4).

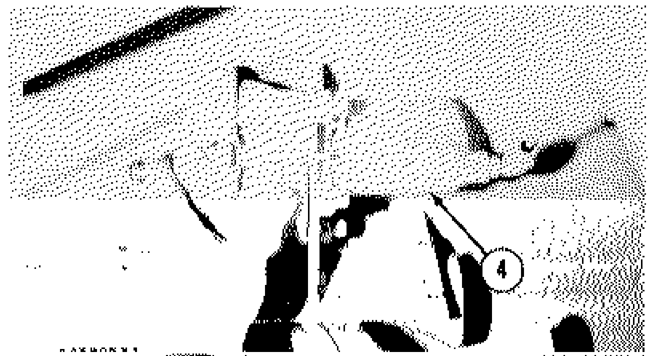
2. Remove four bolts (3) and remove master cylinder and actuator(4).

3. Put master cylinder and actuator (4) in position under the front left side of the tractor frame and install the bolts to hold it.

4. Connect hose assembly (I) and brake line (2) to master cylinder and actuator (4).

5. Remove (bleed) the air from the hydraulic brake system. See AIR REMOVAL FROM BRAKES in TESTING AND ADJUSTING.





REMOVE AND INSTALL SCRAPER BRAKE MASTER CYLINDER AND ACTUATOR

1. Disconnect wire (3) from alarm (1). Remove bolts (2) fasten a hoist and remove the cover assembly. Weight of the cover assembly is 135 lb. (61 kg).

2. Disconnect hose assembly (5) and brake line (6) from master cylinder and actuator (4).

3. Remove four bolts (7) and remove master cylinder and actuator (4).

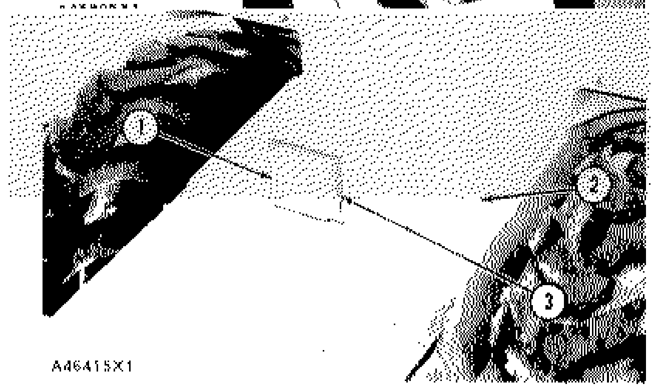
4. Put master cylinder and actuator (4) in position in the scraper frame and install the bolts to hold it.

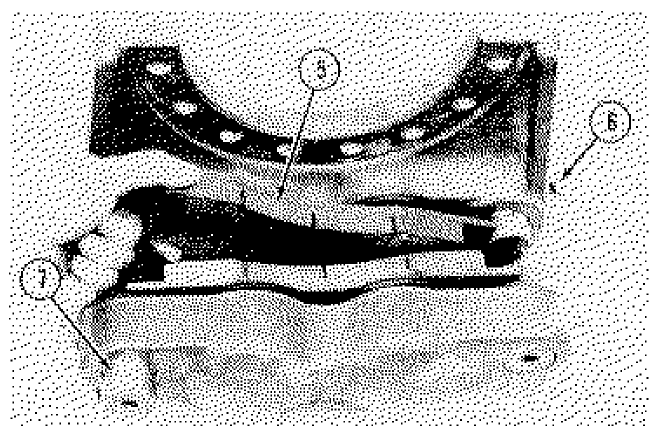
5. Connect brake line (6) and hose assembly (5) to master cylinder and actuator (4).

6. Remove (bleed) the air from-the hydraulic brake system. See AIR R-EMOVALTFROM BRAKES in TESTING AND ADJUSTING.

7. Put the cover assembly in position on the scraper and install bolts (2) to hold it.

8. Connect wire (3) to alarm (1).



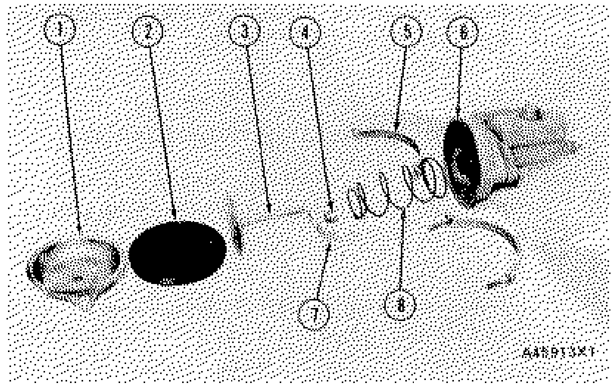


BRAKE MASTER CYLINDER AND ACTUATOR

DISASSEMBLE BRAKE MASTER CYLINDER AND ACTUATOR (TRACTOR OR SCRAPER)

start by:
a) remove master cylinder and actuator (tractor or scraper)

WARNING: Plate assembly (I) has spring tension. Hold the plate assembly in position when band assembly (5) is removed.



1. Remove the bolts and nuts to remove band assembly (5).

2. Remove plate assembly (1), diaphragm (2), rod assembly (3) and indicator (7), retainer (4) and spring (8) from plate assembly (6). Remove the seal from the inside of retainer (4).

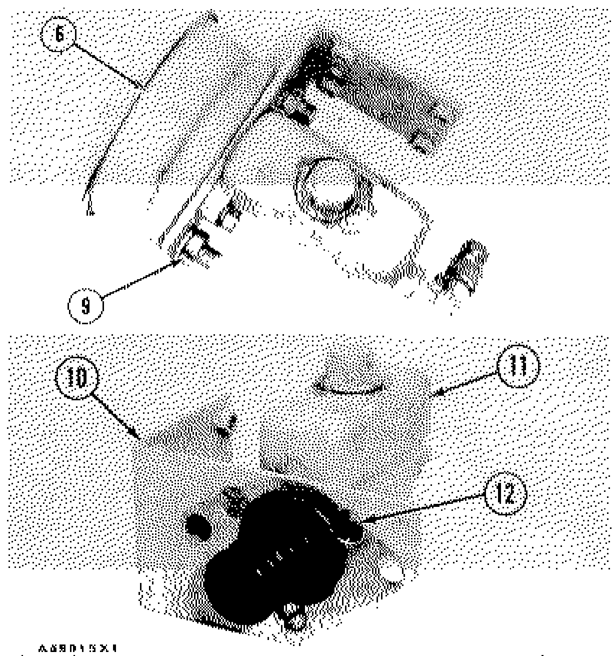
3. Remove two nuts (9) and remove plate assembly (6).

4. Remove three screws (12), the nuts and lockwashers to remove cylinder assembly (11) from bracket assembly (10).

5. Remove boot (13) from cylinder assembly (11).

6. Remove lockwire (19), plate (18), piston (20), cup (17), spring (16), valve (15) and seat (14) from cylinder assembly (11).

NOTE: A master cylinder rebuild kit is available. The kit includes the valve, seat, cup, piston assembly and lock. When the master cylinder is disassembled for service, always install a repair kit.



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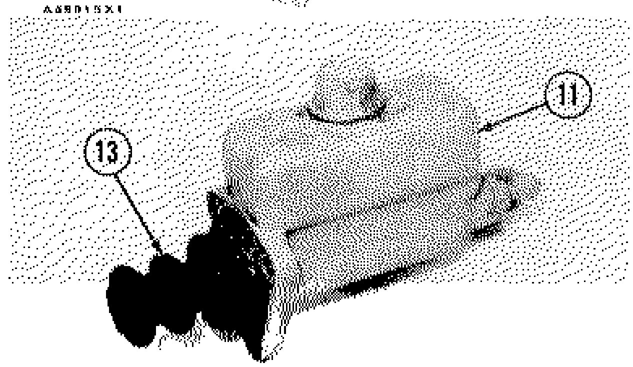
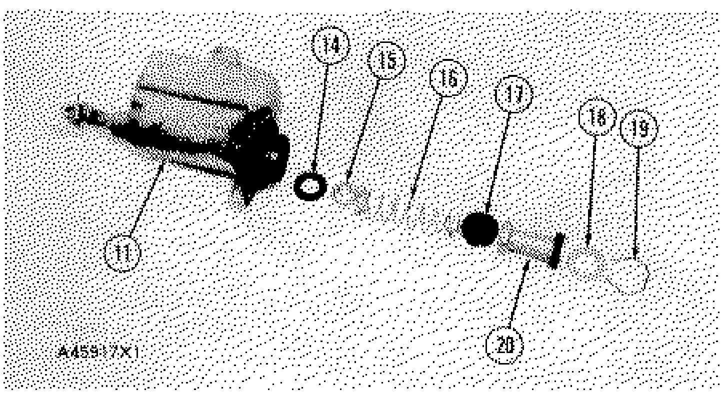


A45916X1



ASSEMBLE BRAKE MASTER CYLINDER AND ACTUATOR (TRACTOR OR SCRAPER)

1. Put brake fluid on all parts for lubrication.

2. Install seat (1), valve (2), spring (3), cup (4), piston (8), plate (5) and lockwire (6) in cylinder assembly (7).

CAUTION: Make sure lockwire (6) fits correctly in the groove in cylinder assembly (7) and piston (8) returns against plate (5).

3. Install boot (10) on cylinder assembly.

4. Install cylinder assembly in bracket assembly (9) and tighten the three screws (1I) and nuts to hold it.

5. Put plate assembly (12) in position on the bracket assembly and install the two nuts that hold it.

6. Install the seal in retainer (13) and install the retainer in the boot.

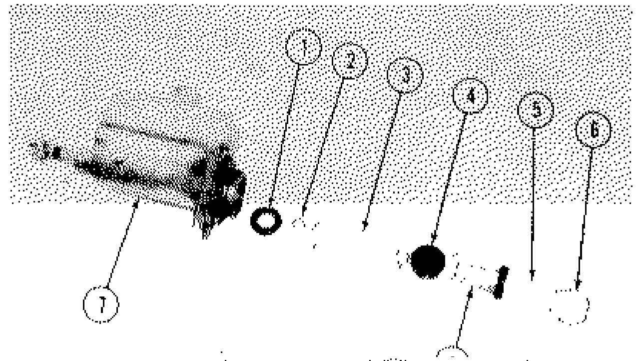
7. Install indicator (16) on rod assembly (14). Install spring (15) and rod assembly (14).

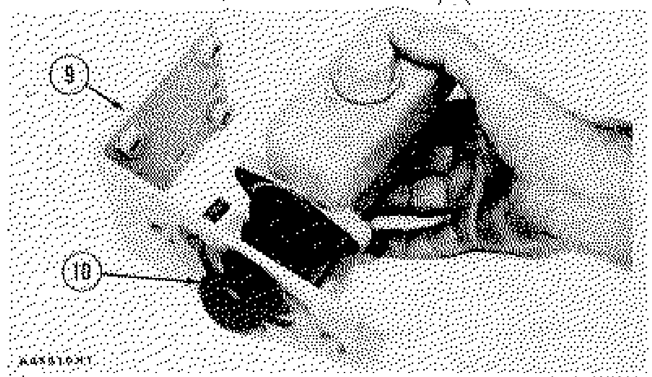
8. Install diaphragm (18) and plate assembly (17).

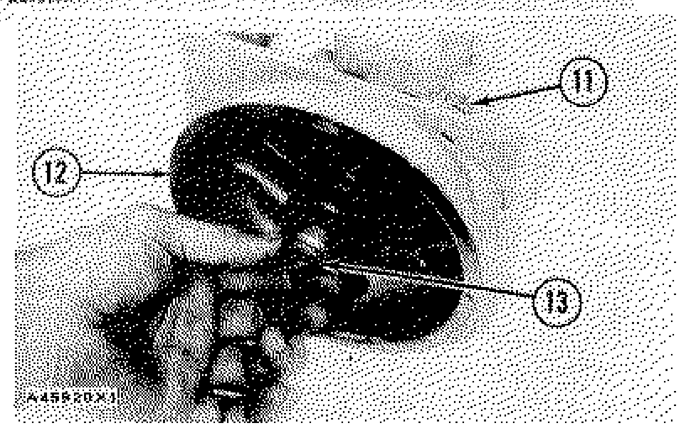
9. Install the band assembly to hold plate assembly (17) to plate assembly (12).

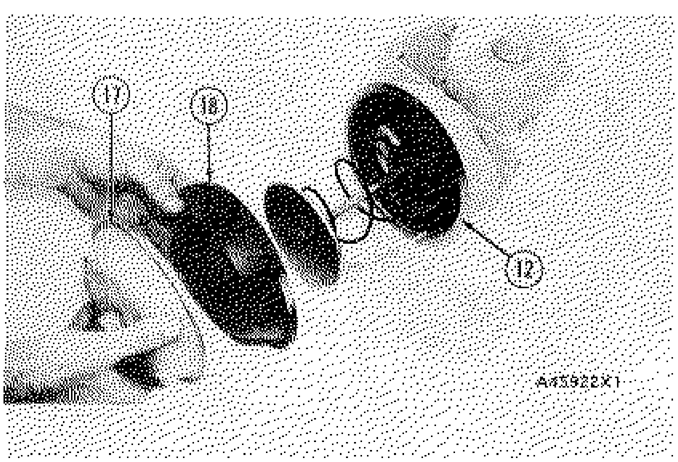
end by:
a)install master cylinder and actuator(tractor or scraper)

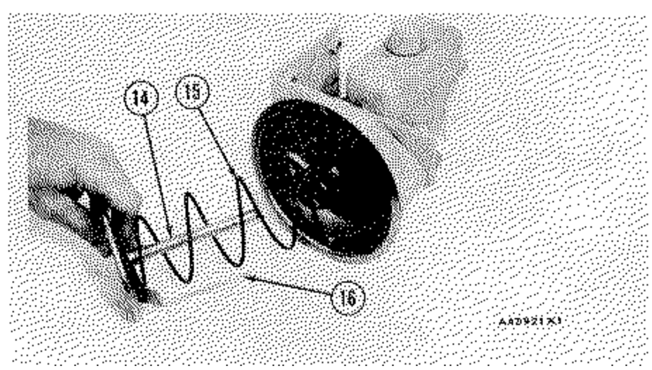
NOTE: When reconditioning is done to the hydraulic brake system, use caution to prevent introduction of foreign material into the brake fluid. Damaged or worn rubber parts is an indication of other fluids in the brake system. Flush and clean the system with denatured alcohol or brake fluid.







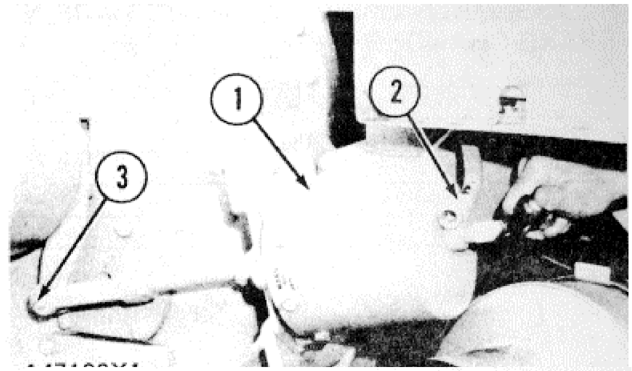




EMERGENCY AND PARKING BRAKE CHAMBER

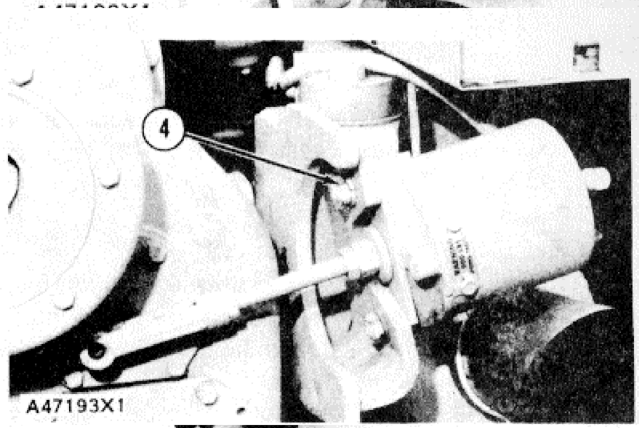
REMOVE EMERGENCY AND PARKING BRAKE CHAMBER

1. Disconnect air line (2) from brake chamber assembly (1).



2. Release the parking brake with shop air pressure of 70 psi (4.9 kg/cm2) or (480 kPa). Remove the cotter pin and pin (3).

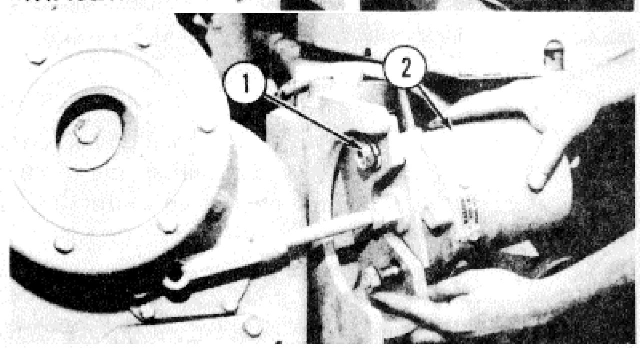
3. Remove two nuts (4) and lockwashers. Remove the brake chamber assembly from the machine.



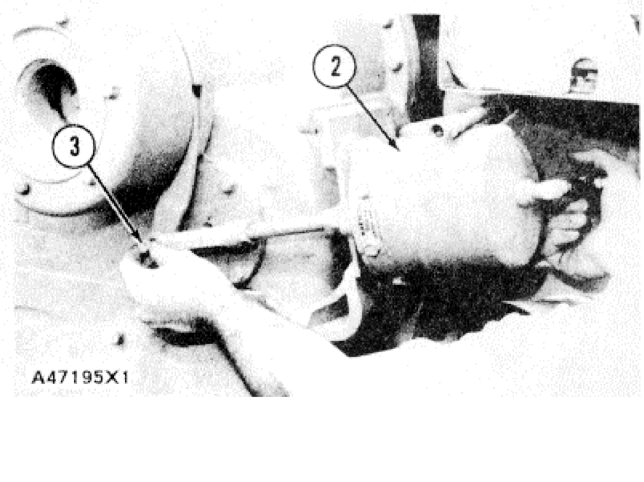
A47193X1

INSTALL EMERGENCY AND PARKING BRAKE CHAMBER

1. Put brake chamber assembly (2) in position and install the two lockwashers and nuts (1) to hold it. Make sure the warning plate on the brake chamber assembly is toward the rear of the machine and can be seen.



2. Activate brake chamber assembly (2) with shop air pressure at 70 psi (4.9 kg/cm2) or (480 kPa). Connect the rod end to the parking brake lever with pin (3) and cotter pin.



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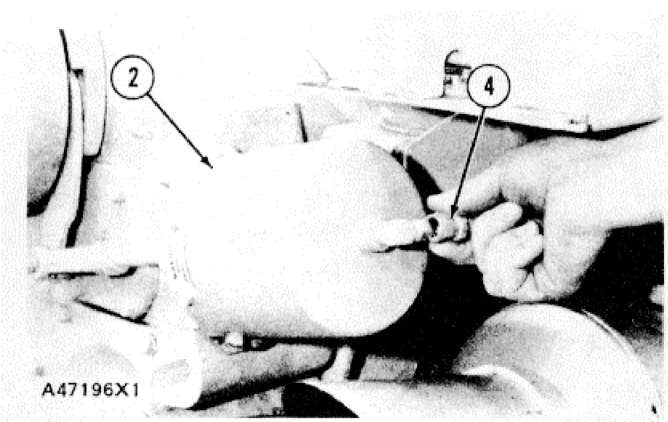
3. Connect air line (4) to brake chamber assembly (2).



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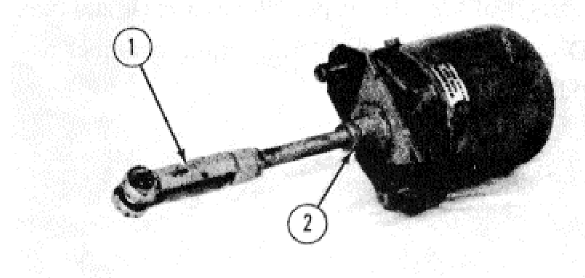
EMERGENCY AND PARKING BRAKE CHAMBER

DISASSEMBLE EMERGENCY AND PARKING BRAKE CHAMBER

	Tools Needed	A
8H684	Ratchet Box Wrench	1
8F3672	Plate	1
8B7548	Puller Assembly	1
8B7549	Leg	2

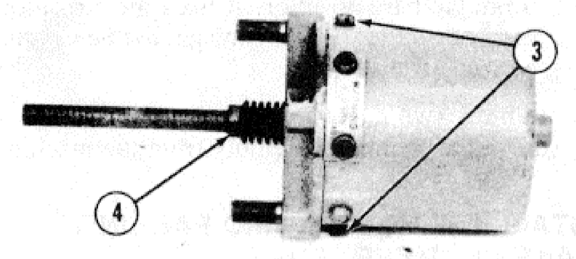
start by:
a) remove emergency and parking brake chamber

1. Remove yoke (1) and two adjusting nuts (2) from the rod.



A50055X1

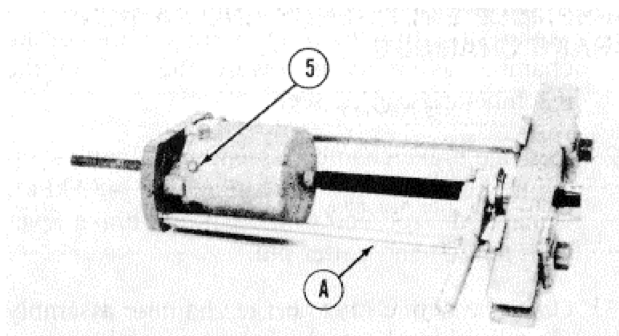
2. Remove two bolts (3) one on each side of chamber. Remove retaining ring (4) from the rubber boot.



A06290X3

3. Install the chamber in tooling (A). Put force down on the top of the chamber with the puller screw. Remove the remainder of bolts (5) around the base of the chamber.

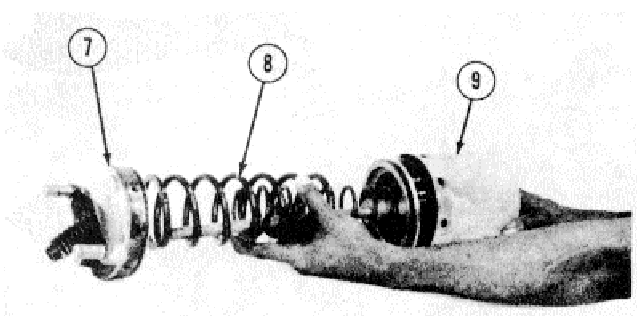
WARNING: The large spring inside of chamber is under 900 .(4000 N) force.



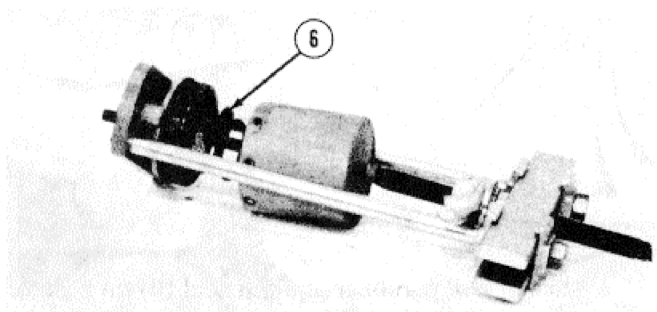
A06697X2

4. Gradually release spring (6) as the puller screw is turned counterclockwise until all spring force is gone. Remove the chamber from tooling (A).

5. Remove base assembly (7), the spring and rod assembly (8) from cylinder (9).



A06289X3



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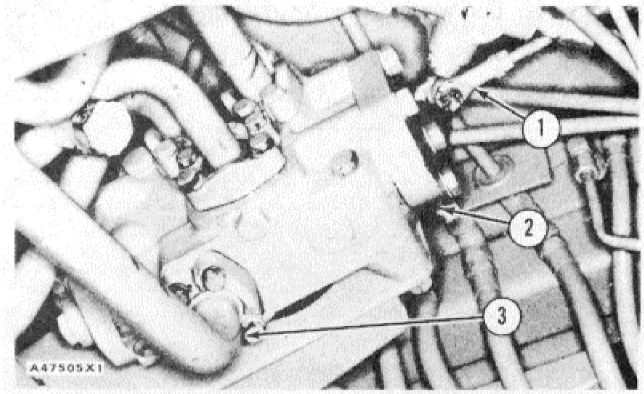
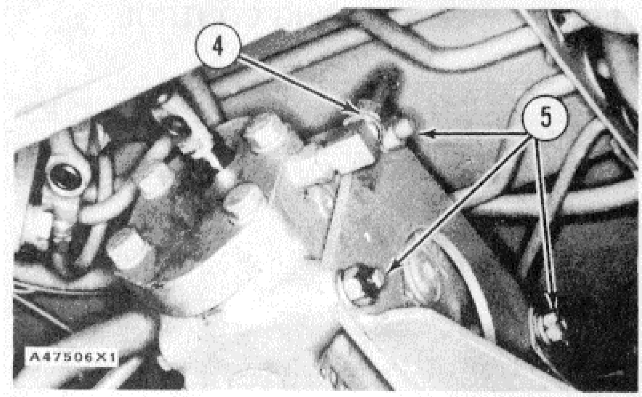
6. Kemove large and small springs (10) from the rod. Remove felt and rubber seals (11) from the bases of the rod. Inspect the two seals and make replacements if necessary.



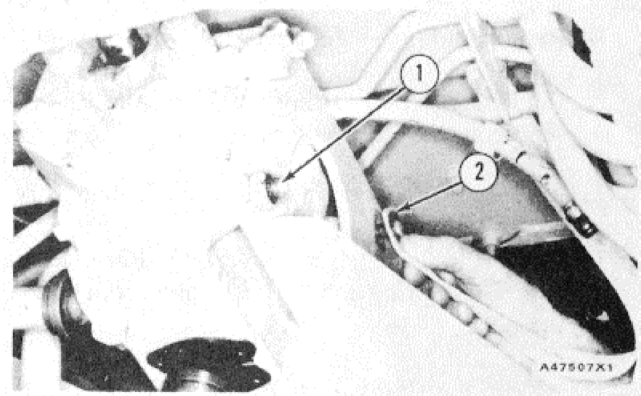
7. Remove rubber boot (13) and O-ring seal (12) from the base assembly. Check the condition of the seal. If the seal has damage, use new parts for replacement.



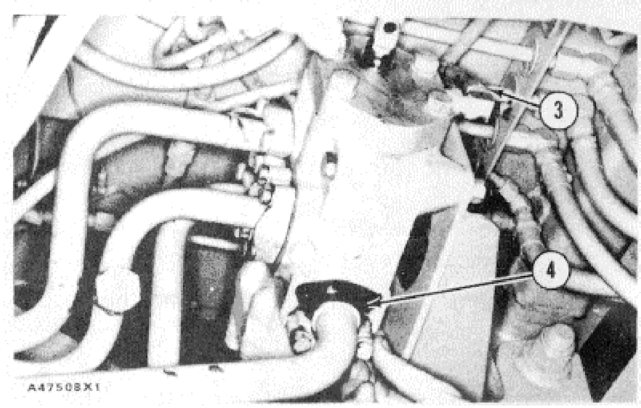
ASSEMBLE EMERGENCY AND PARKING BRAKE CHAMBER

	Tools Needed	A
8H684	Ratchet Box Wrench	1
8F3672	Plate	1
8B7548	Puller Assembly	1
8B7549	Leg	2

1. Install a new O-ring seal (1) on base assembly. Install rubber boot (2) on base assembly.

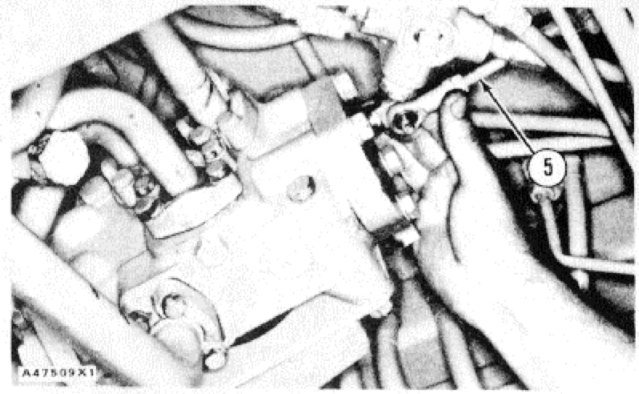


2. Install a new rubber and felt seal (4) on base of the rod. Install small and large springs (3) on the rod.

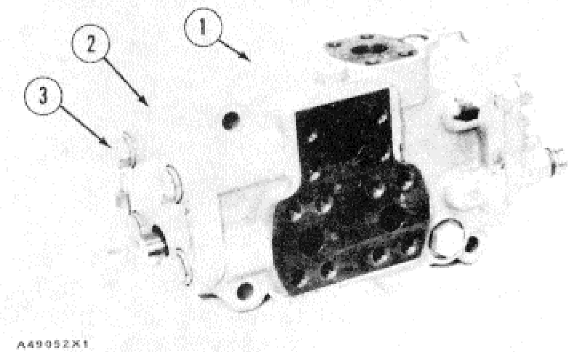


EMERGENCY AND PARKING BRAKE CHAMBER

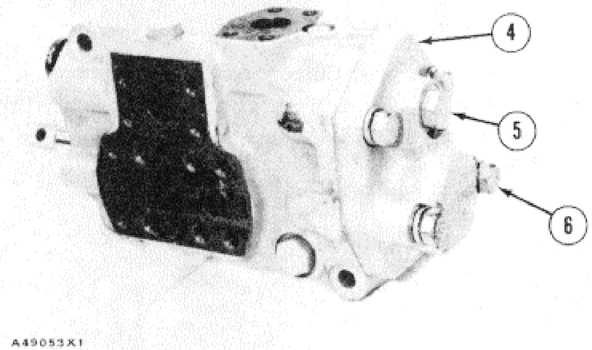
3. Install base assembly (5), spring and rod assembly (6) into cylinder (7).



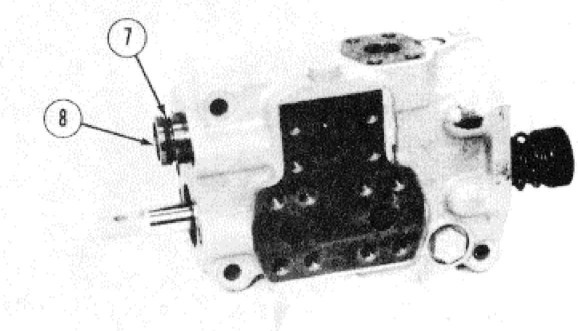
4. Put chamber into position in tooling (A) and put it under compression. Install all but two of the bolts (8).Remove chamber from tooling (A).



5. Install the other two bolts (10) on each side of chamber. Install retaining ring (9) on the rubber boot.



6. Install two adjusting nuts (12). Install yoke (11)on the rod.
end by:
a) install emergency and parking brake chamber



PARKING BRAKE

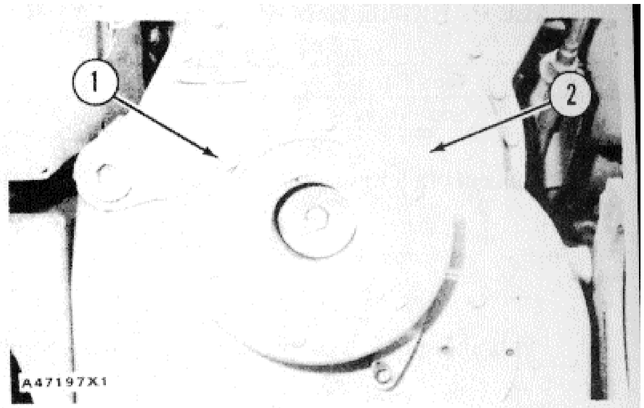
REMOVE PARKING BRAKE

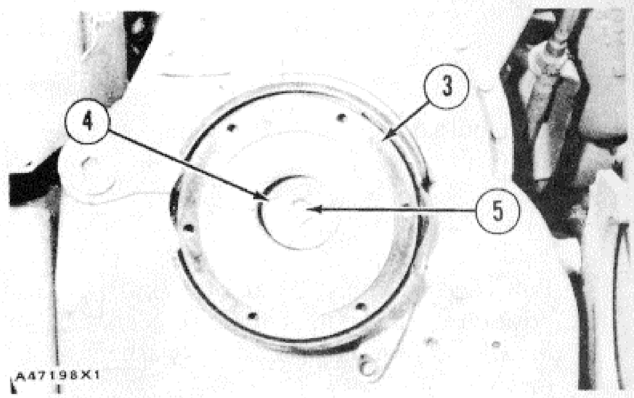
	Tools Needed	A
1 P541	Brake Pliers	1

start by:

a) remove parking brake chamber assembly*

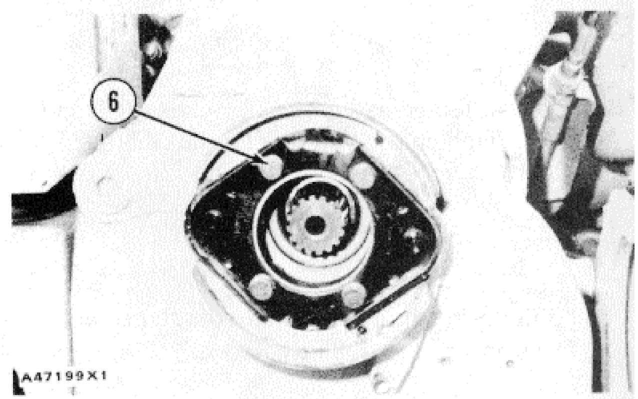
*NOTE: The parking brake chamber assembly does not have to be removed. See this operation to disconnect the parking brake linkage.



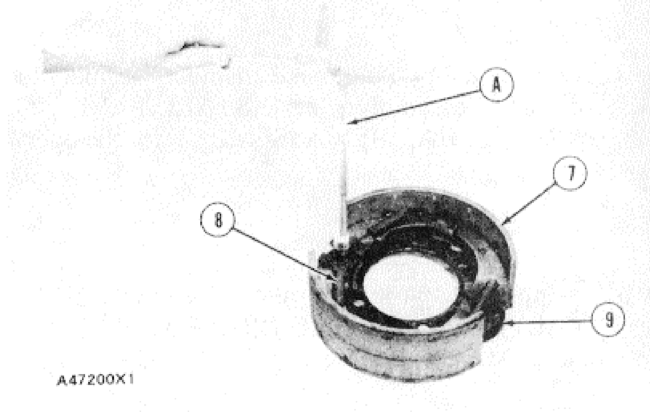


1. Remove bolts (I) and drum (2).

2. Remove bolt (5), retainer (4) and flange assembly (3).



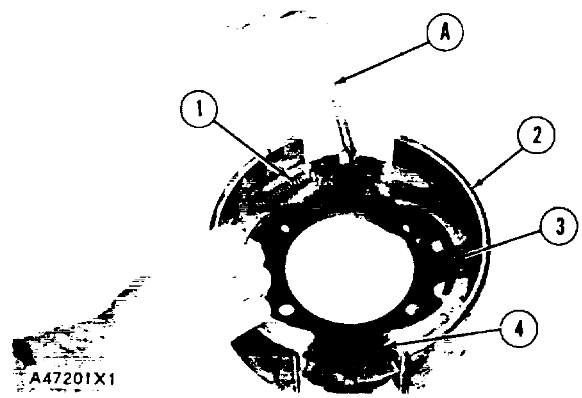
3. Remove bolts (6) and remove the parking brake group and the lever assembly.



4. Use tool (A) to remove springs (8). Remove brake shoes (7) from plate assembly (9).

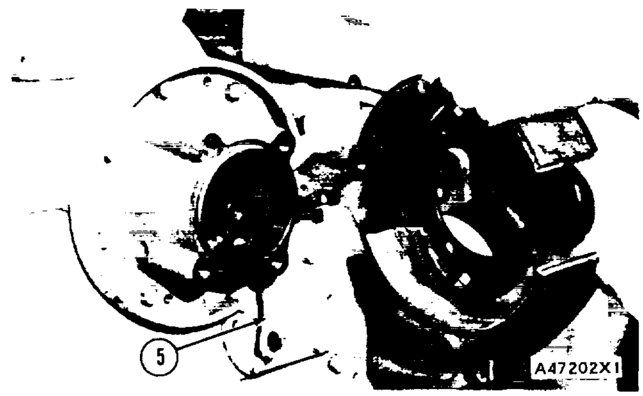
INSTALL PARKING BRAKE

	Tools Needed	A
1 P541	Brake Pliers	1



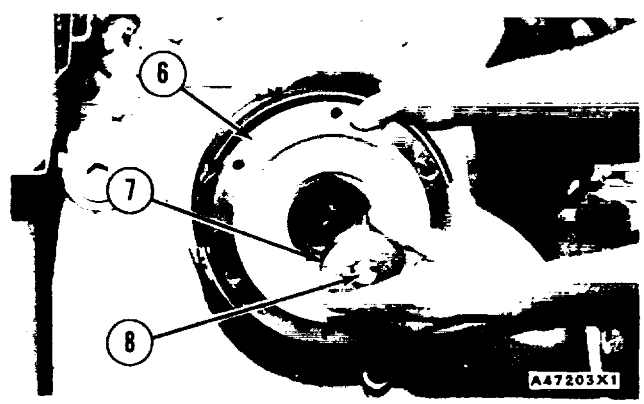
1. Connect brake shoes (2) together with spring (4).

2. Put brake shoes (2) in position on plate assembly (3).



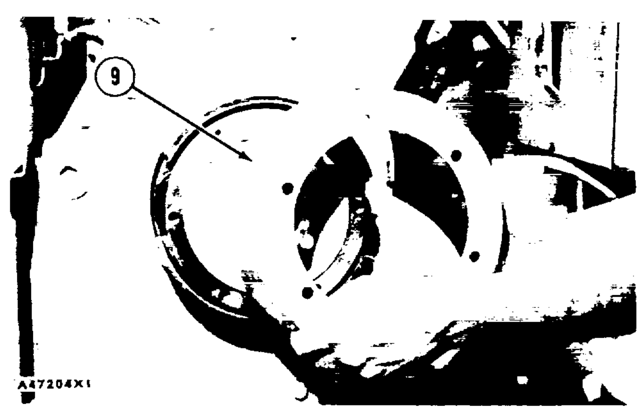
3. Use tool (A) to install two springs (1).

4. Put lever assembly (5) and the brake group in position on the output transfer gears case and install the four bolts and lockwashers to hold them.



5. Install flange assembly (6), retainer (7) and bolt (8). Tighten the bolt to a torque of 80 + 5 Ib.ft. (110 +7 N.m).

6. Put drum (9) in position on the flange assembly and install the bolts to hold it.



7. Connect the parking brake chamber assembly to the lever assembly. See INSTALL PARKING BRAKE CHAMBER ASSEMBLY for the operation.

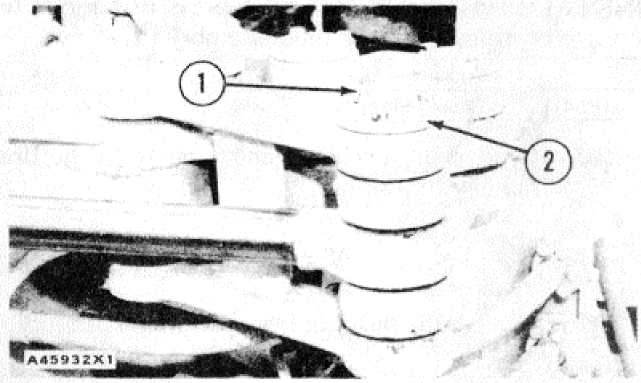
8. Adjust the parking brake. See CONTROL VALVE FOR PARKING BRAKE in TESTING AND ADJUSTING section for this adjustment.

STEERING LINKS

REMOVE STEERING LINKS

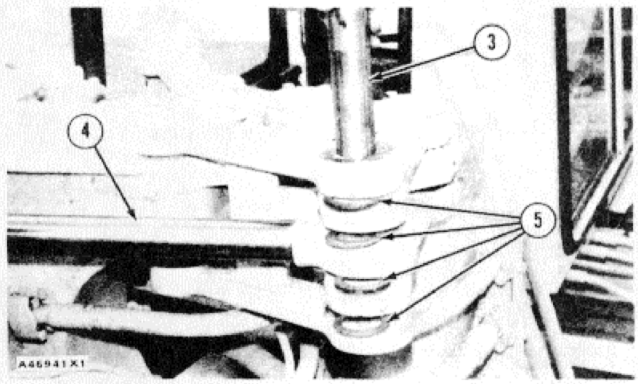
	Tools Needed	A	B	C
1P510	Driver Group	1		
5F9882.	Adapter		1	
1P3485	Adapter.		1	
5P7428	Adapter		1	1
7F9540	Hydraulic Puller		1	1
9S5559	Stud		1	1
1P543	Nut		1	1
5P3100.	Pump Group		1	1
9S5565	Collar			1

1. Remove bolts (1) and plate (2).



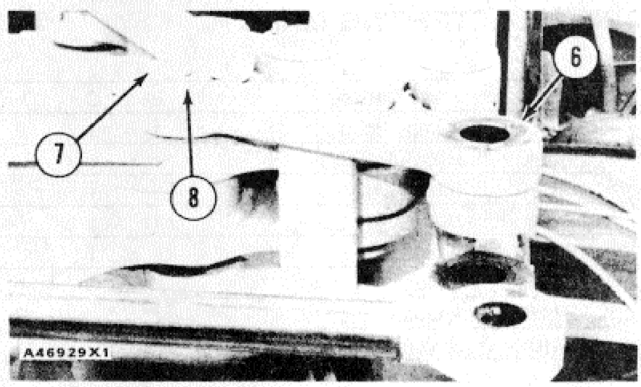
2. Remove the fitting from the bottom of shaft (3) and use a hammer and brass punch to remove shaft (3) from the top of the link assemblies to disconnect steering cylinder rod (4).

3. Remove shims (5).



4. Remove bolts (7) and plate (8). Remove the fitting from the bottom of the shaft and use a hammer and soft punch to remove the shaft from the top of link assembly (6).

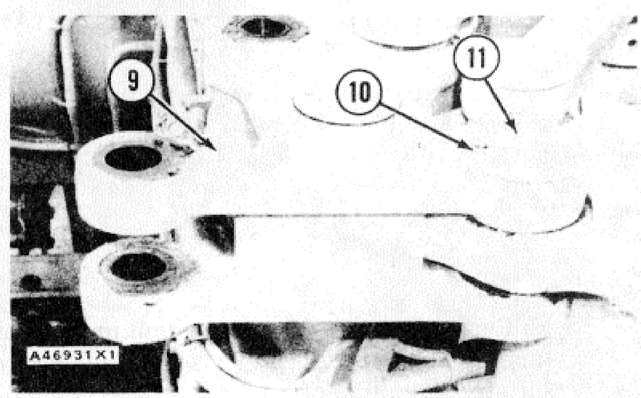
5. Remove link assembly (6) and the shims.



6. Remove the bolts and plate (10).

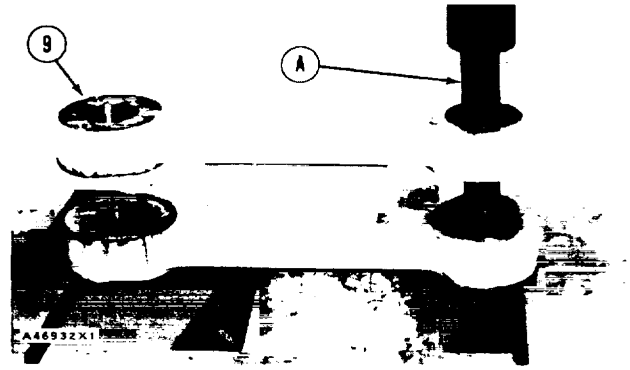
7. Use a hammer and soft punch to remove shaft (11) from the top of link assembly (9).

8. Remove link assembly (9) and the shims.

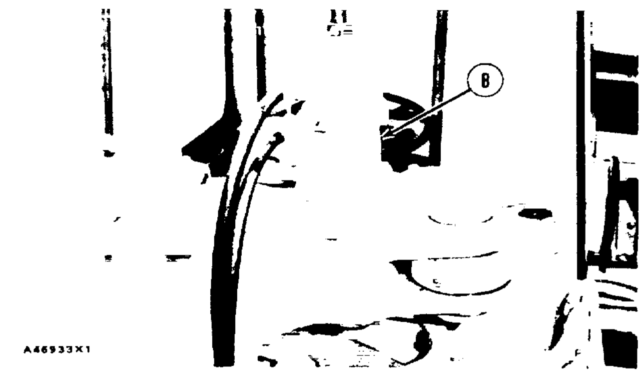


STEERING LINKS

9. Use tool group (A) and a press to remove the bearings from the link assembly (9).



10. Remove the bushings and tube from the draft frame with tooling (B).

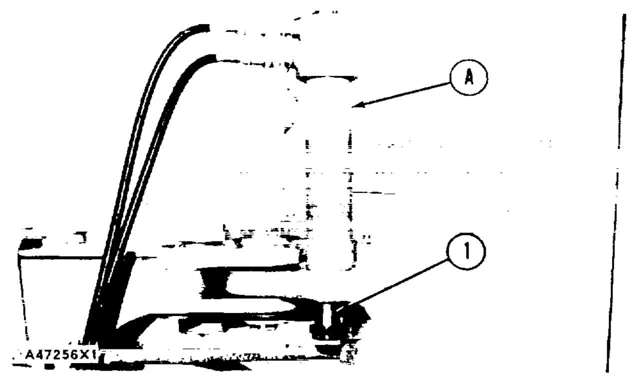


11. Remove the bushing from the hitch with tooling (C).

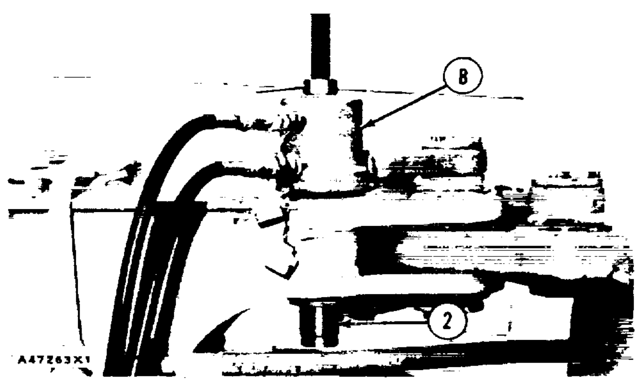
INSTALL STEERING LINKS

	Tools Needed	A	B	C	D
5P3100	Pump Group	1	1	1	
7F9540.	Hydraulic Puller	1	1	1	
9S5559	Stud	1	1	1	
1P543	Nut	1	1	1	
1P1834	Adapter	1		1	
9S5565	Collar	1		1	
5P7428	Adapter		1		
1P510.	Driver Group				1

1. Install bushing (1) in the hitch with tooling (A).

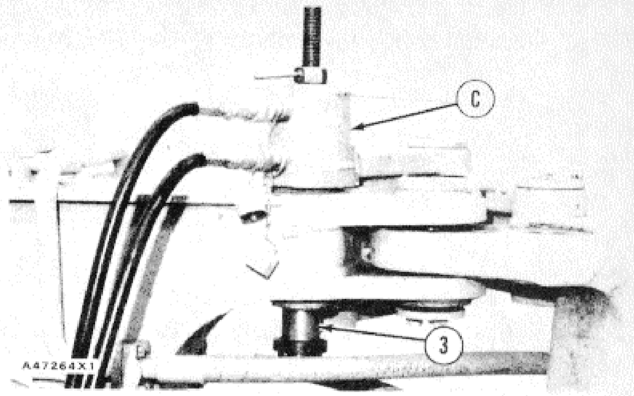


2. Pull upper bearing (2) into position in the draft frame with tooling (B) until it is even with the top surface of the frame.



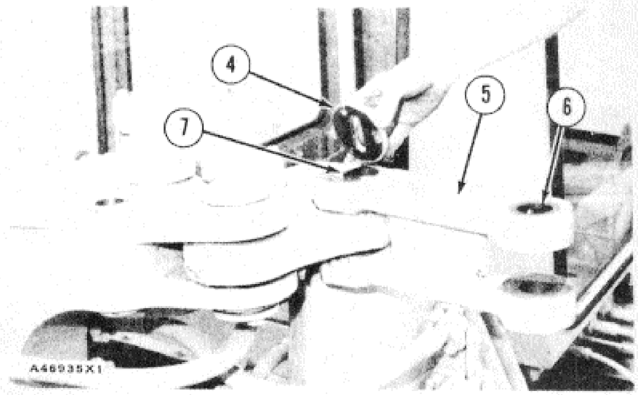
STEERING LINKS

3. Pull the tube and lower bearing (3) into position in the draft frame with tooling (C) until the bearing is even with the bottom surface of the frame.



4. Use tool group (D) and a press to install bearings (6) in link assembly (5).

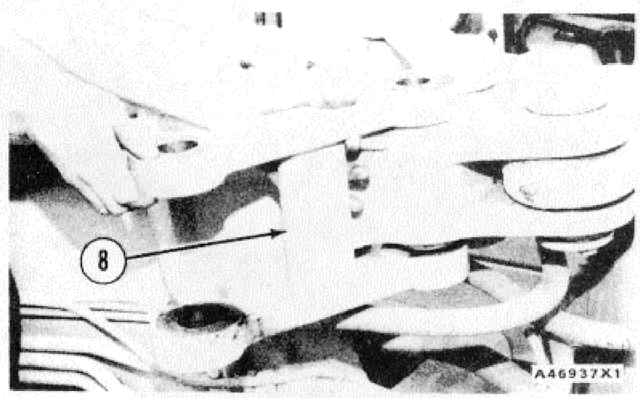
5. Put link assembly (5) and the shims in position on the hitch. Install shaft (7), plate (4) and the bolts.



6. Put link assembly (8) and the shims in position on the draft frame.

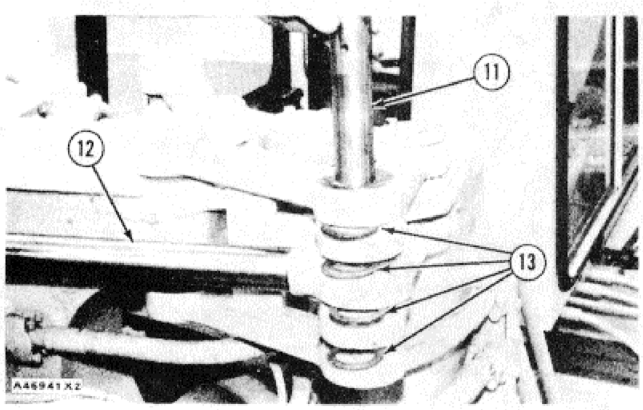
7. Install shaft (10), plate (9) and the bolts.

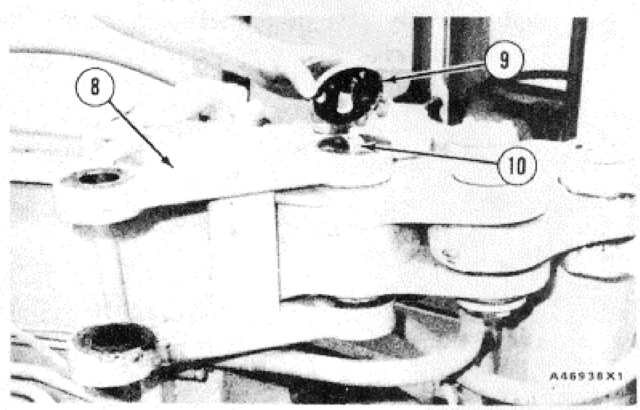
8. Install the fitting in the bottom of shaft (10).



9. Put shims (13) as needed and steering cylinder rod (12) in position and install shaft (1I). Install the plate and bolts to hold shaft (11) and install the fitting in the bottom of the shaft.

10. Put clean grease in the fittings for the steering system.

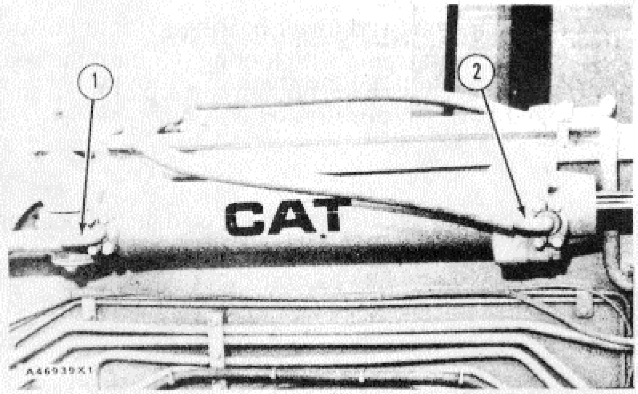




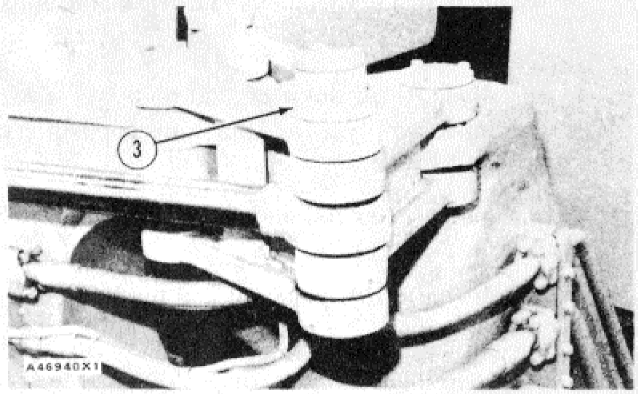
STEERING CYLINDERS

REMOVE STEERING CYLINDERS

1. Disconnect hose assemblies (I) and (2) from the steering cylinder.

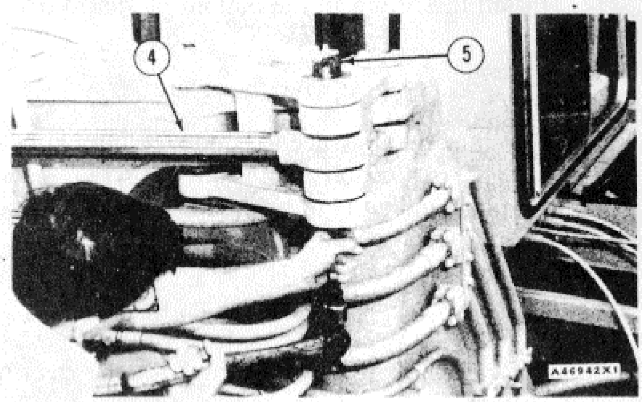


2. Remove the bolts and plate (3) from the steering link assemblies.



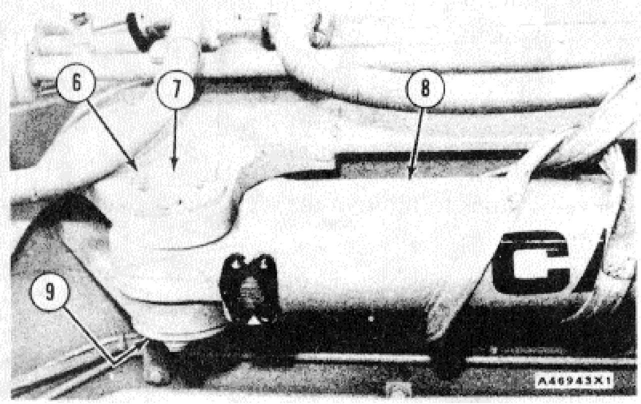
3. Remove the fitting from the bottom of shaft (5). Use a hammer and soft punch to remove the shaft from the top of the link assemblies to disconnect rod (4).

4. Fasten a hoist to steering cylinder assembly (8).



5. Remove bolts (6) and plate (7). Remove bolts and plate (9). Use a hammer and soft punch to remove the shaft from the draft frame.

6. Remove steering cylinder assembly (8) and shims from the machine. The weight of the cylinder assembly is 120 lb (54 kg).



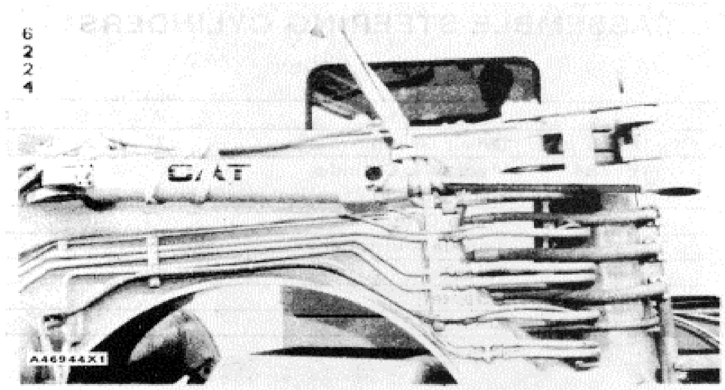
STEERING CYLINDERS

INSTALL STEERING CYLINDERS

1. Fasten a hoist to the steering cylinder assembly and put it in position on the machine.

2. Install plate (3) and the bolts on the draft frame.

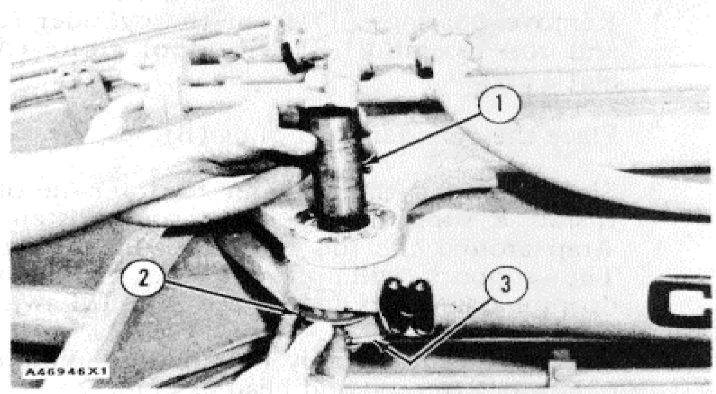
3. Put washer (2) in position between the cylinder assembly and draft frame.



4. Install shaft (1), the plate and bolts to hold it.

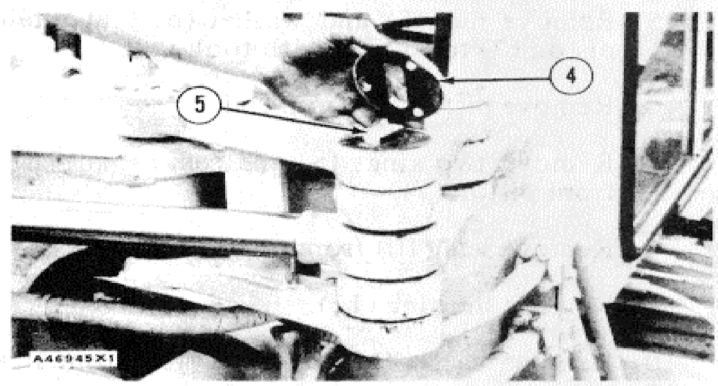
5. Put the cylinder rod and shims needed in position.

6. Install shaft (5), plate (4) and the bolts. Install the fitting in the bottom of shaft (5).



7. Remove the hoist from the steering cylinder assembly.

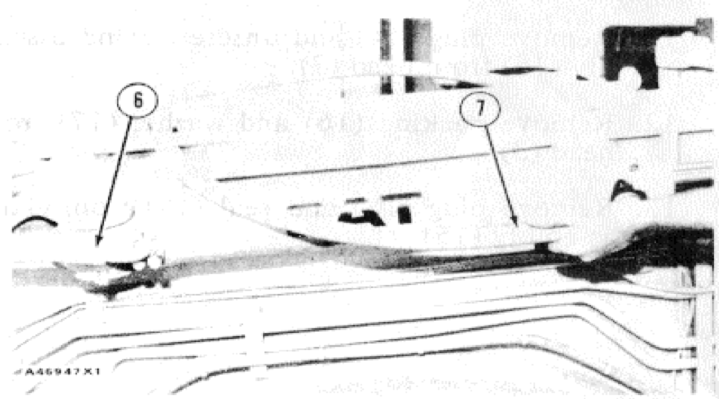
8. Connect hose assemblies (6) and (7) to the steering cylinder assembly.



9. Put clean grease in all fittings for the steering system.

NOTE: Turn the machine from full right right to full left several times to remove the air from the steering system.

10. Check the hydraulic oil and fill to the correct level.



STEERING CYLINDERS

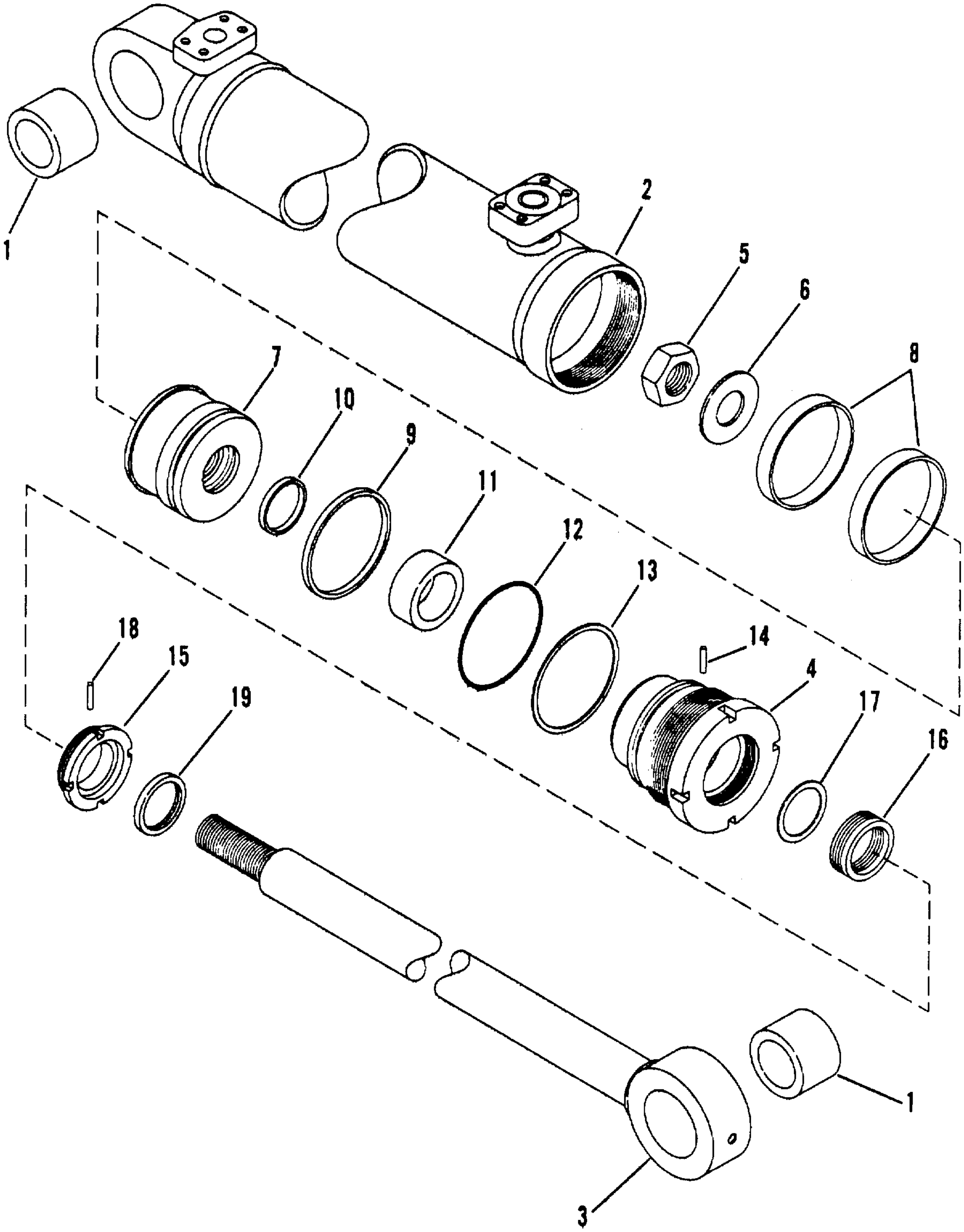
DISASSEMBLE STEERING CYLINDERS

	Tools Needed	A	B	C
1P510	Driver Group	1		
1P1784	Hydraulic Cylinder Repair Stand		1	
5P3100	Pump Group			1
1P850	Torque Multiplier			1
1P8S1	Adapter			1
1P852	Adapter			1
55S6077	Socket			1

1. Remove bearings (1) from the cylinder (2) and rod assembly (3) with tool group (A)
2. Place the cylinder on tooling (B)

Refer to page 3-305 for illustration.

3. Slowly extend the cylinder to drain the oil. Install a support under the rod. Fasten a strap around the rod to secure the support. The support will prevent the rod from dropping as the cylinder head is pulled away.
4. Unscrew head assembly (4) and pull cylinder (2) away from rod and head assembly.
5. Remove nut (5) and washer (6) that retains piston (7) to rod (2) with tooling (C).
6. Remove piston (7) from rod.
7. Remove two rings (8) and seal assembly (9) from piston (7).
8. Remove seal (10) from piston.
9. Remove bushing (11).
10. Remove seal (12) and ring (13) from head (3).
11. Remove plug (14) and unscrew gland assembly (15) from head (3).
12. Remove packing (16) and washer (17) from head (3).
13. Remove plug (18) and seal (19) from gland assembly (15).


1
2
5
6
7
8
10
9
11
12
13
18
15
19
14
4
17
16
1
3

ASSEMBLE STEERING CYLINDERS

	Tools Needed	A	B	C	D	E	F
5P2980	Seal Installer	1					
1P510	Driver Group		1				
1P764	Seal Guide			1			
4S9181	Seal Expander				1		
1P1784	Hydraulic Cylinder Repair Stand					1	
5P3100	Pump Group					1	
1P850	Torque Multiplier						1
1P851	Adapter						1
1P852	Adapter						1
5S6077	Socket						1

1. Use tool (A) to install washer (17) in head (4).

2. Install packing (16).

3. Use tool group (B) to install seal (19) in gland assembly (15). Install plug (18).

4. Install backup ring (13) and seal (12) on head (4).

5. Screw gland assembly (15) into head (4) and install plug (14).

6. Position the cylinder assembly (2) and rod (3) on tooling (E).

7. Partially thread head (4) onto cylinder assembly (2).

8. Install tool (C) on rod (3). Apply clean hydraulic oil on the seal lips in the head (4). Push the cylinder assembly (2) and head (4) onto rod (3).

9. Unscrew head (4) from cylinder assembly (2). Remove tool (C).

10. Use tool (D) to enlarge plastic seal assembly (9). Install seal assembly (9) and rings (8).

11. Install seal (10) and bushing (11).

12. Install piston (7), washer (6) and nut (5) on rod (3).

13. Tighten nut (5) with tooling (F) to a torque of 1200 ± 120 lb. ft. (1620 ± 160 N•m).

14. Apply clean hydraulic oil on seal (9) and rings (8). Also apply clean hydraulic oil to seal (12) and backup ring (13).

15. Slowly push the cylinder assembly (2) onto piston (7) and head (4) until head can be threaded in cylinder (2). Be careful not to damage o-ring seal and backup ring on head (4).

16. Make sure rod (2) is fully extended from the cylinder assembly and screw head assembly into cylinder.

17. Remove the cylinder from tooling (E).

18. Use a press and tool group (B) to install bearings (1) in the cylinder assembly (2) and rod (3).

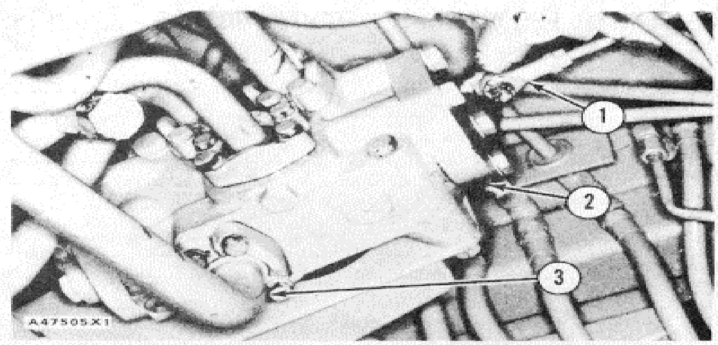
Refer to page 3-305 for illustration.

STEERING CONTROL VALVE

REMOVE STEERING CONTROL VALVE

1. Drain the hydraulic tank. The total system capacity is 24 U.S. gal. (91 litre).

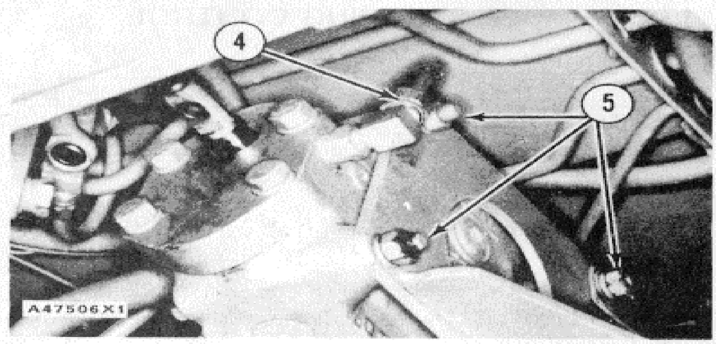
2. Remove the cotter pin and nut from the bolt and disconnect linkage (I) from valve (2).



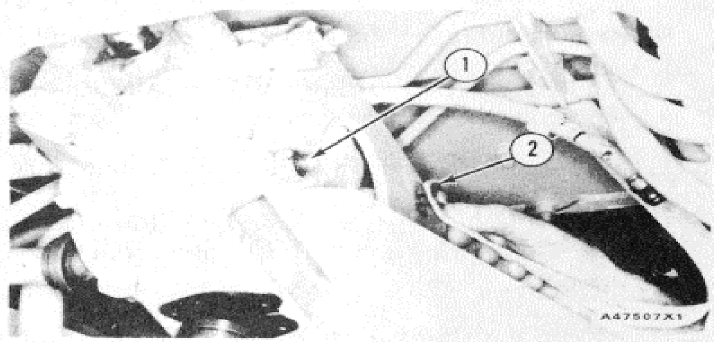
3. Disconnect four tubes (3) from the valve.

4. Disconnect hose (4) from the valve.

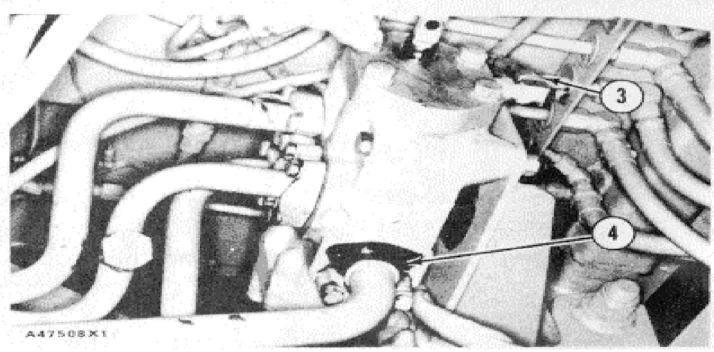
5. Remove bolts (5) that hold the valve to the bracket. Use two men to remove the valve. The weight of the valve is 50 lb. (23 kg).



1. Use two men to put control valve in position. Install bolts (1) and nuts in the bracket. Make sure ground cable (2) is installed on the top rear bolt.

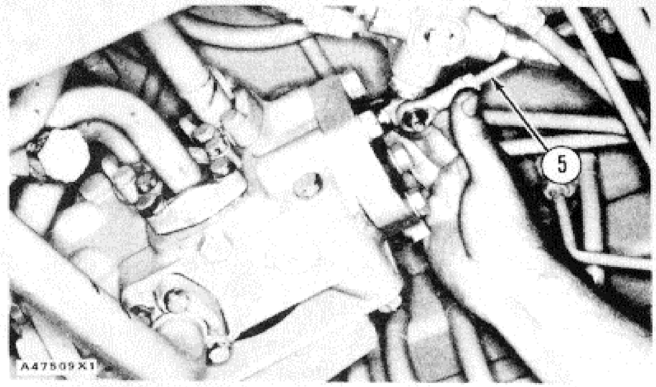


2. Install hose (3) on the valve. Connect four tubes (4) to the valve.



STEERING CONTROL VALVE

3. Connect linkage (5) to the valve and install the bolt, nut and cotter pin.



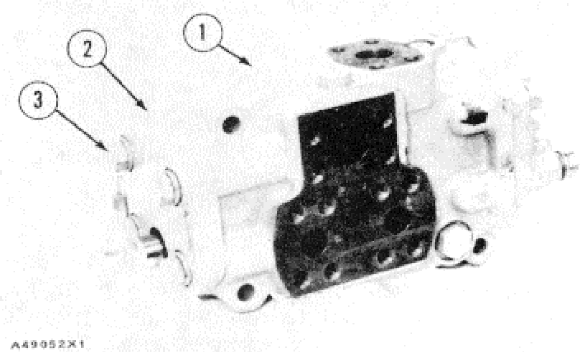
4. Fill the hydraulic tank with oil.

DISASSEMBLE STEERING CONTROL VALVE

	Tools Needed	A	B
1P3075	Puller Group	1	
2P8312	Retaining Ring Pliers		1

start by:
a) remove steering control valve

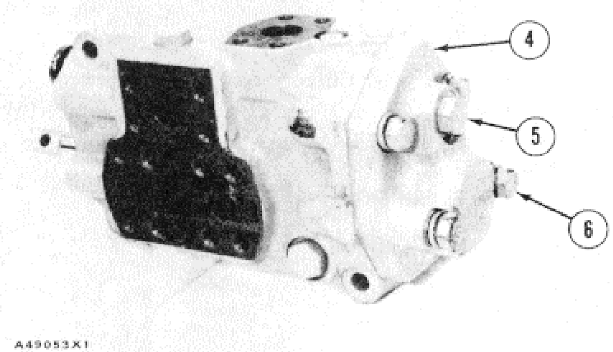
NOTE: Check the condition of the O-ring seals as the seals are removed. If the seals have damage, use new parts for replacement.



1. Remove bolts (3) and cover (2) from body (1).

2. Remove the two O-ring seals and the lip-type seal from the inside of cover (2).

NOTE: Remove the guide pilot for replacement only.

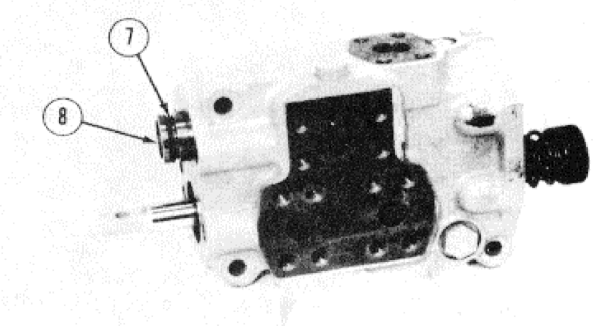


3. Remove plug (5) from cover (4). Remove the shims, the spring and the pilot valve from behind the plug.

NOTE: Keep the shims together for reference during installation.

4. Remove bolts (6) and cover (4) from the body.

5. Remove the four O-ring seals from cover (4).

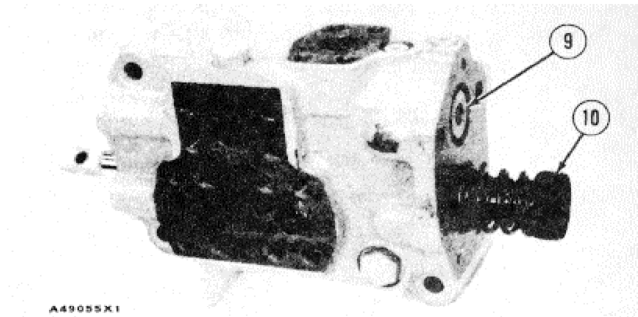


6. Remove spacer (8) from the body. Remove the valve and two springs from behind the spacer.

7. Remove O-ring seal (7) from spacer (8).

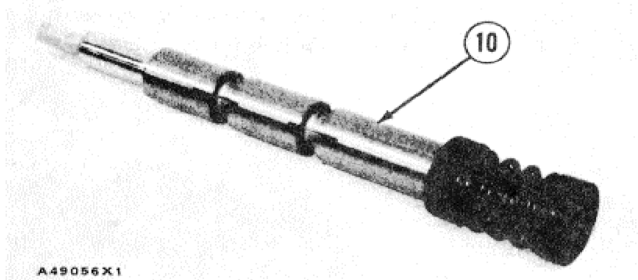
STEERING CONTROL VALVE

8. Remove spool (10) from the body. Remove seat (9), springs and flow control valve from body. Remove O-ring seal from seat (9).



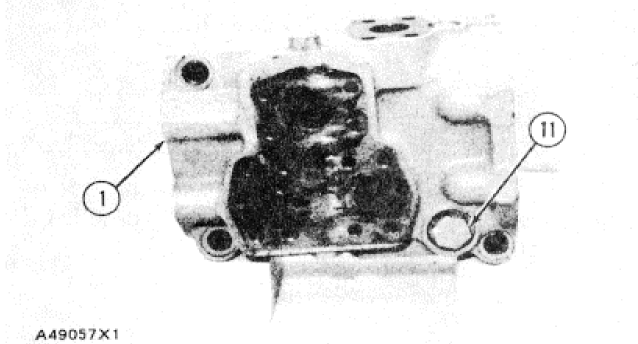
9. Remove the bolt from stem (10). Use caution and loosen bolt slowly because of springs.

10. Remove the retainers, the spring, the washers and the shims from the end of the stem.



NOTE: Keep the shims together for installation purpose.

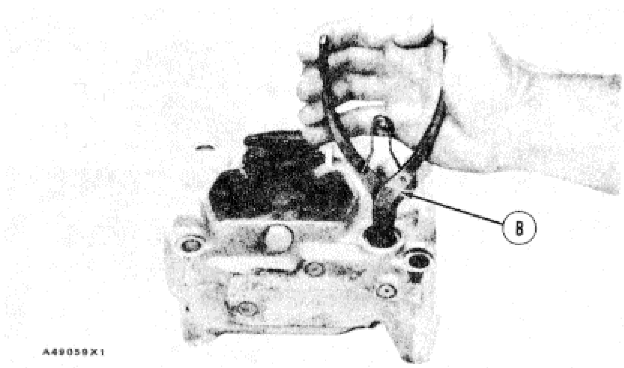
11. Remove plug (11) and O-ring seal from body (1).

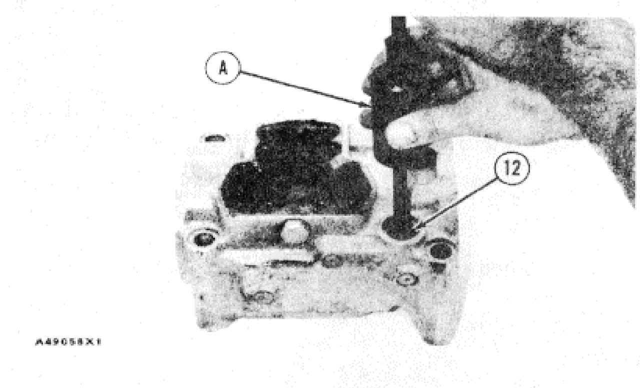


12. Remove top seat (I2) from the body with tooling (A). Remove the check ball with a magnet.

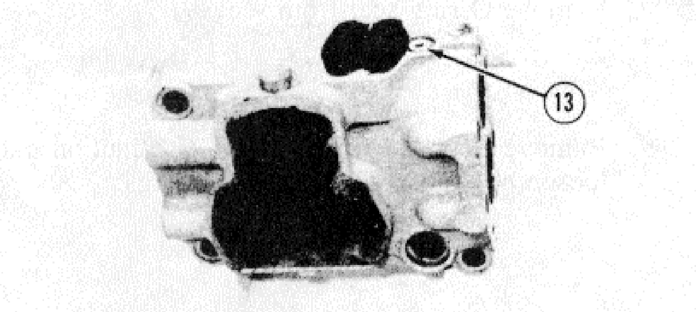
13. Remove the bottom seat with tool (B).

NOTE: Do not remove the bottom seat if not damaged.



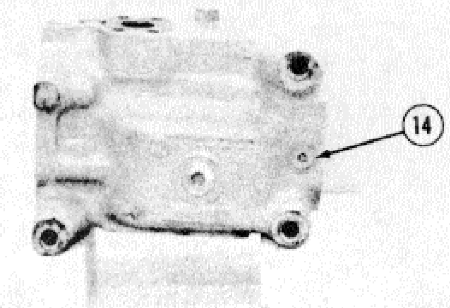


14. Remove plug (13) and the O-ring seal from the body. Put a long allen wrench in the hole and remove the plug from the body.



A49060X1

15. Turn the body as shown. Remove plug (14) and O-ring seal from the body. Remove the spring and the check ball from behind the plug.

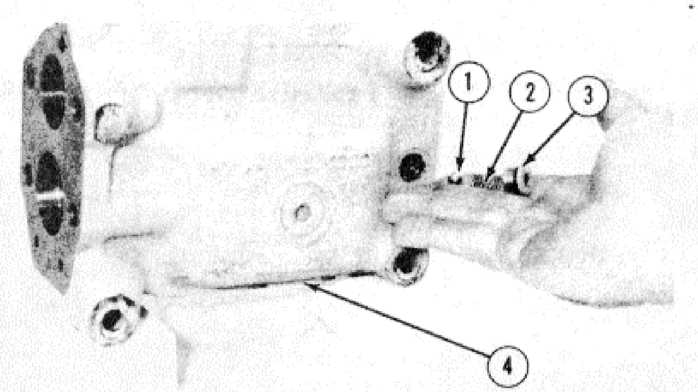


A49061X1

ASSEMBLE STEERING CONTROL VALVE

	Tools Needed	A
1P510	Driver Group	1

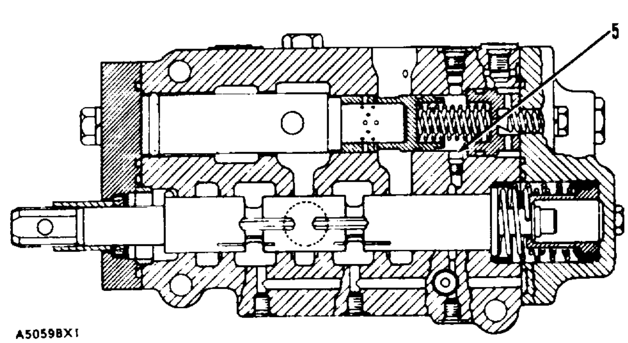
1. Make sure all of the parts are clean and free of dirt and foreign material. Put clean hydraulic oil on all of the parts of the valve.



A49062X1

2. Install the O-ring seal on plug (3). Install check ball (1), spring (2) and plug (3) in body (4).

3. Install plug (5) with a long allen wrench. Tighten the plug to a torque of 10 ± 2 lb. ft. (14 ± 3 N•m).

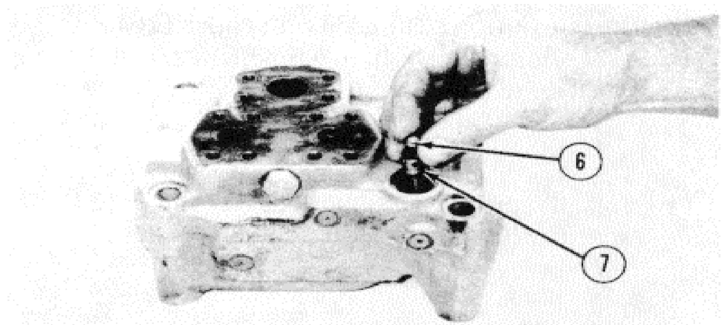


A50598X1

4. Install the plug in the top of the body.

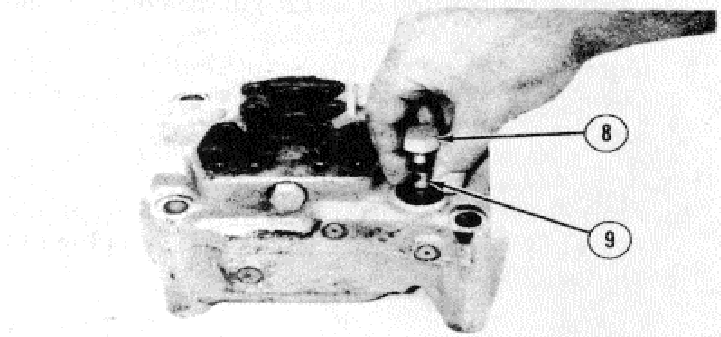
STEERING CONTROL VALVE

5. Turn the body as shown. Install bottom seat (7) and check ball (6) in the body.



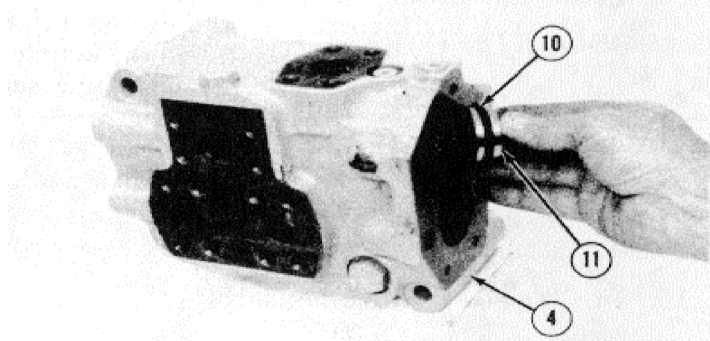
A49063X1

6. Install the O-ring seal on plug (8). Install top seat (9) and plug (8) in the body.



A49064X1

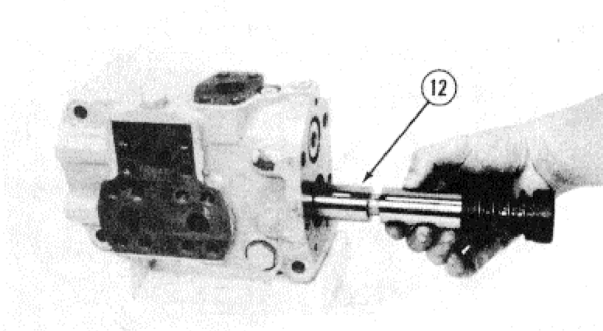
7. Install O-ring seal (10) on seat (11). Install the seat in body (4).



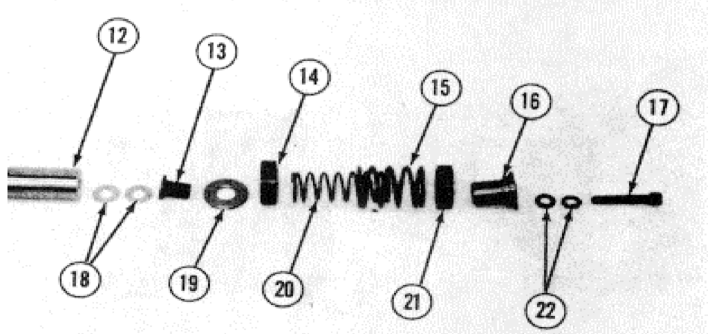
A49065X1

8. Install shims (18), retainer (13), washer (19), retainer (14), springs (20) and (15), retainer (21) and retainer (16) to spool (12) with bolt (17) and washers (22).

9. Install spool (12) in the body.



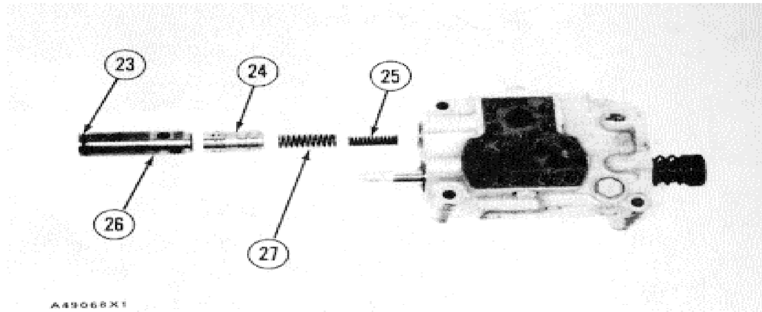
A49067X1



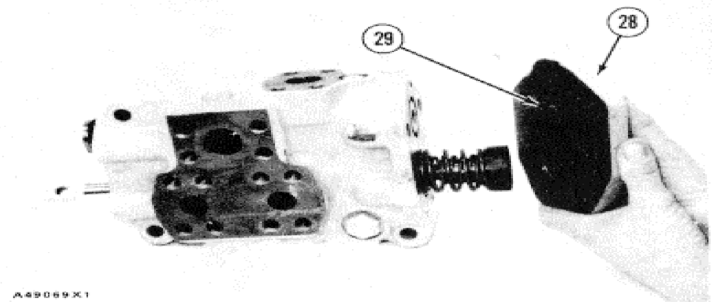
A49066X1

STEERING CONTROL VALVE

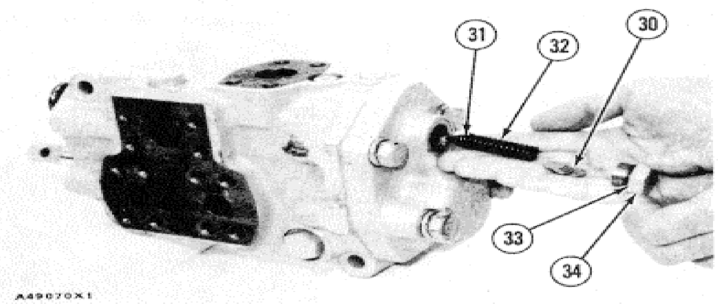
10. Install O-ring seal (23) on spacer (26).
11. Install springs (25) and (27), valve (24) and spacer (26) in the body.



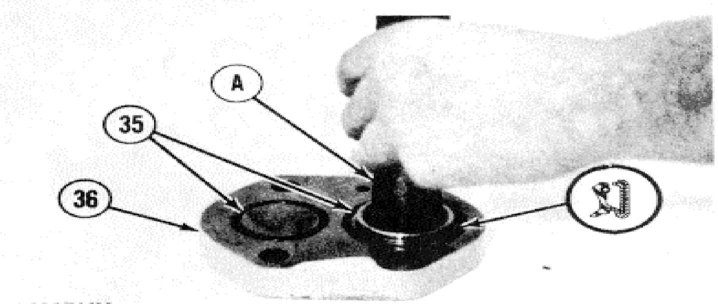
12. Install four 0-ring seals (29) in the cover. Install cover (28) on the body.



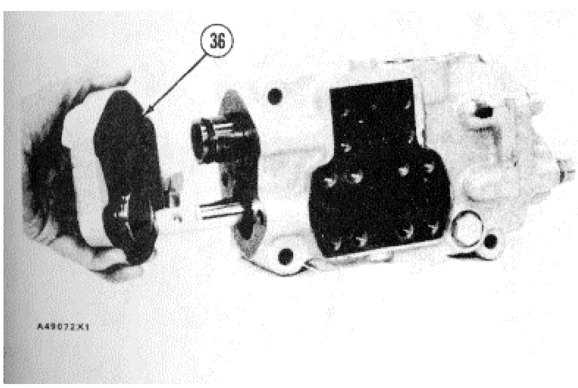
13. Install O-ring seal (33) on plug (34). Install pilot valve (31), spring (32), shims (30) and plug (34) in the cover.



14. Install O-ring seals (35) in cover (36). Install the lip type seal in the cover with tooling (A). Install the seal until it makes contact with the counter-bore in the cover and with the lip of the seal toward the outside of the cover.



15. Install cover (36) on the body.
end by:
a) install steering control valve



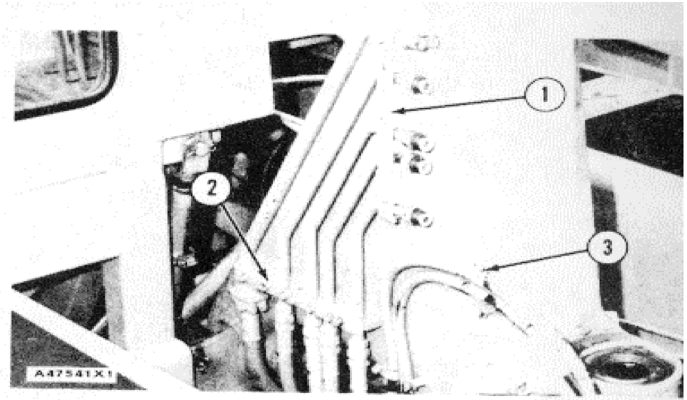
HITCH

REMOVE HITCH

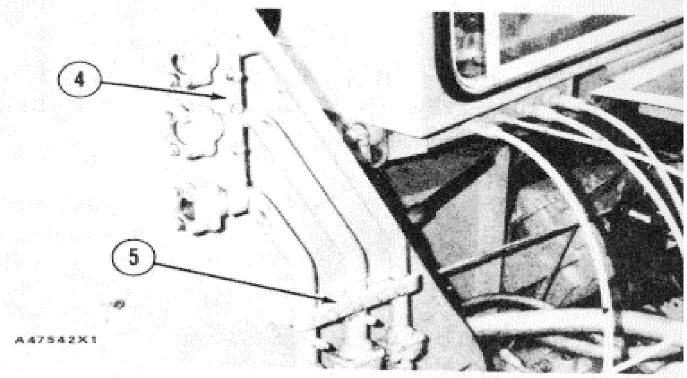
	Tools Needed	A	B
2P8287	Box Wrench	1	
2P8286	Adapter	1	
2P8285	Tubular Arm	1	
FT600	Cable Saver		1

start by:
a) separation of tractor and scraper

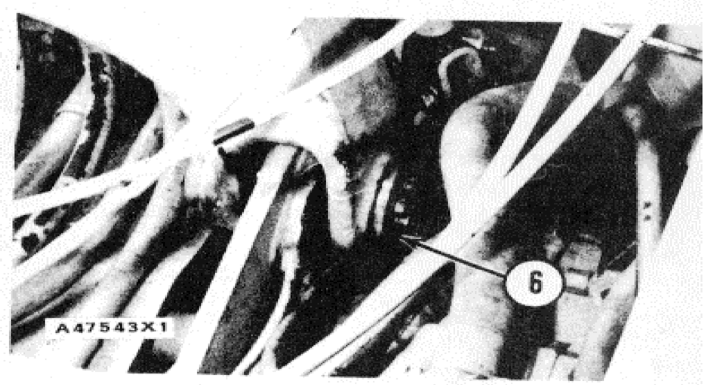
1. Remove four bolts (3) and clamps (1) and (2) from left side of hitch.



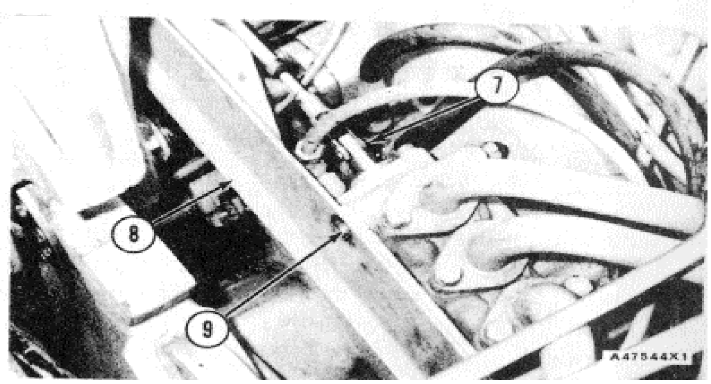
2. Remove clamps (4) and (5) from right side of hitch.



3. Remove bolts and washer (6) from the front horizontal pin.

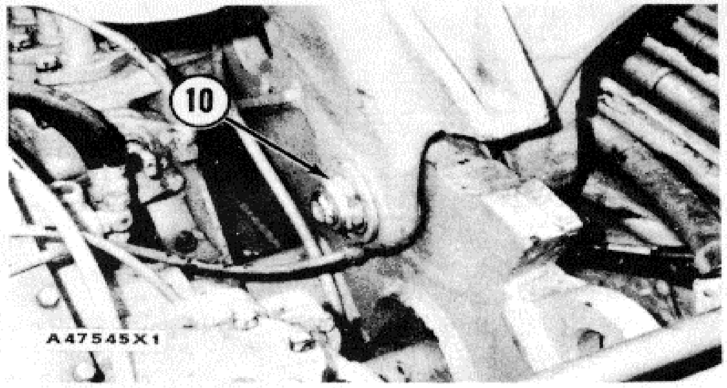


4. Remove wood blocks from each side of the hitch and tilt it to the right. Remove cotter pin and pin (7) from the elevator control valve. Remove three bolts (9) and move bracket (8) away from the hitch.

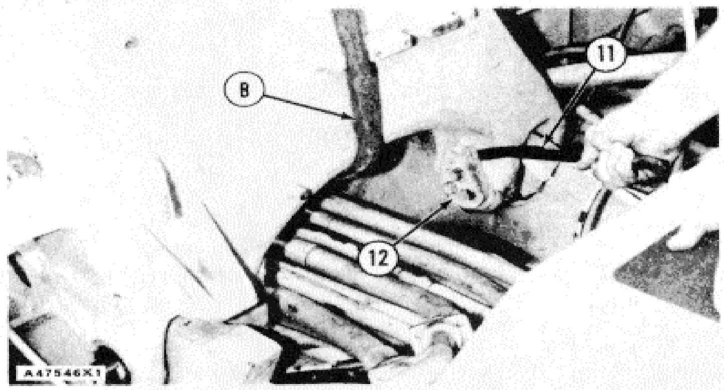


HITCH

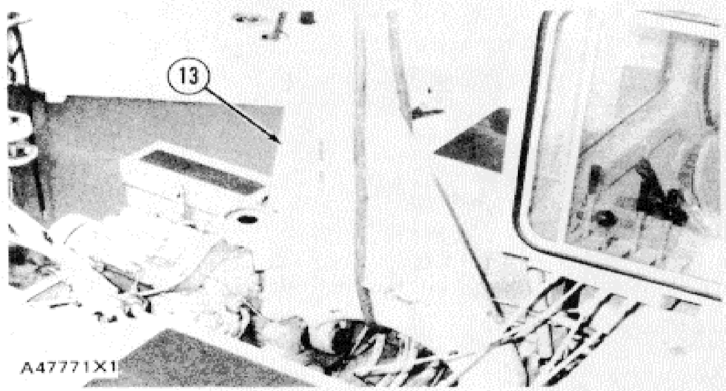
5. Tilt the hitch to the left and remove nut (10) and washer from the rear horizontal pin with tooling (A).



6. Fasten a hoist to the hitch with tool (B) and a lifting strap. Use crowbar (11) to remove front pin (12) and rear pin.



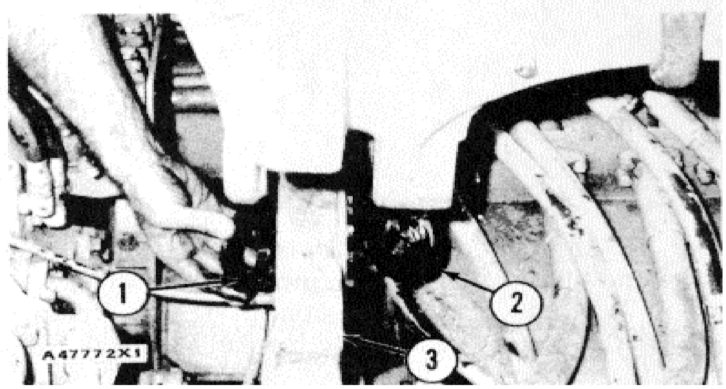
7. Remove hitch (13) from the tractor. After hitch is removed, two rings can be removed from rear of the hitch. The weight of the hitch is 600 lb. (270 kg).



INSTALL HITCH

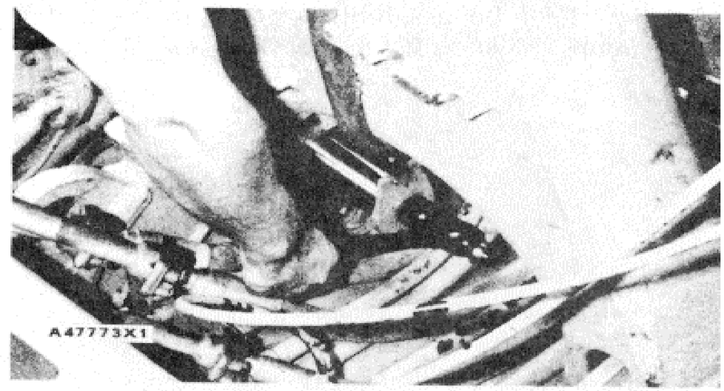
	Tools Needed	A
2P8287	Box Wrench	1
2P8286	Adapter	1
2P8285	Tubular Arm	1

1. Fasten a hoist to the hitch and put in position as shown. Put IP808 Multipurpose Type Grease on rings (1) and (2). With the thickest ring to the front, install rings in frame (3) with chamfer on outside diameter of both rings toward each other.

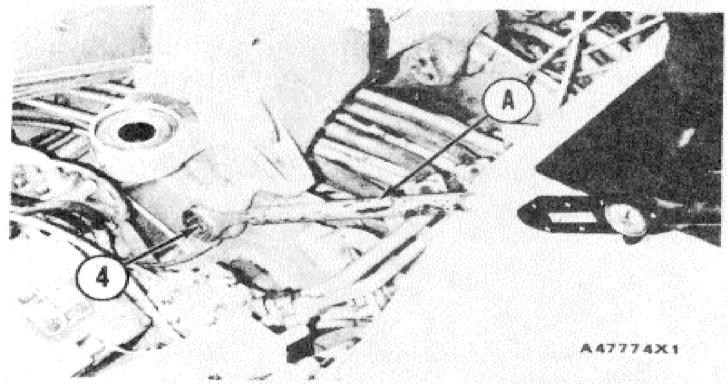


HITCH

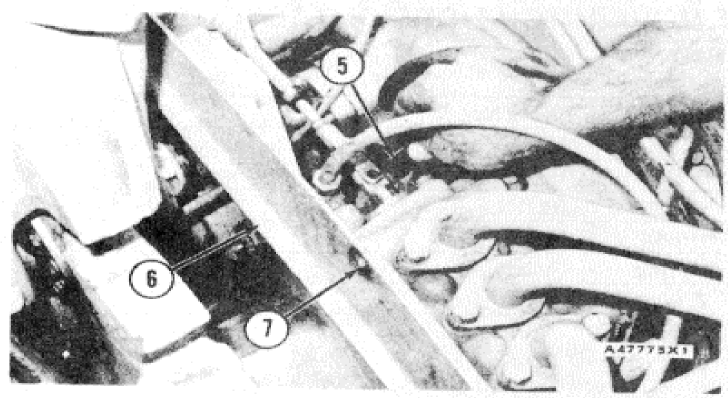
2. Install front and rear horizontal pins.



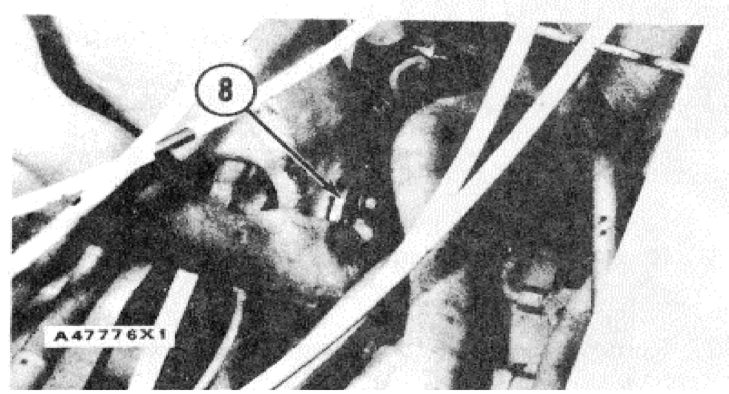
3. Install the washer and nut (4) on the rear horizontal pin. Tighten the nut with tooling (A) to a torque of 375 to 425 lb. ft. (510 to 580 N•m).



4. Put bracket (6) in position and install bolts (7) to the elevator control valve. Put the control cable in position and install pin (5) and cotter pin.

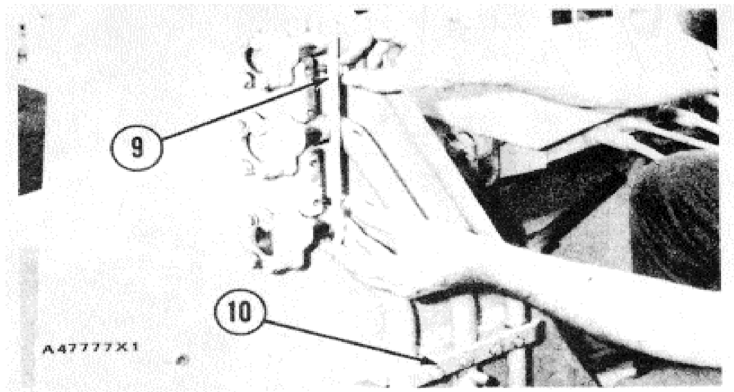


5. Install washer (8) and bolts to the front horizontal pin. Install blocks under each side of the hitch and remove the hoist.



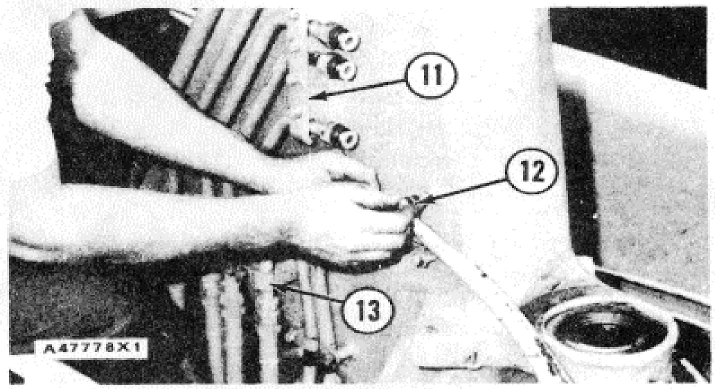
HITCH, HITCH HORIZONTAL BEARINGS

6. Put the tube assemblies in position. Install clamps (9) and (10) to the right side of hitch.



7. Put the tube assemblies in position. Install clamps (1) and (13) and bolts (12) to the left side of hitch.

a) connection of tractor and scraper

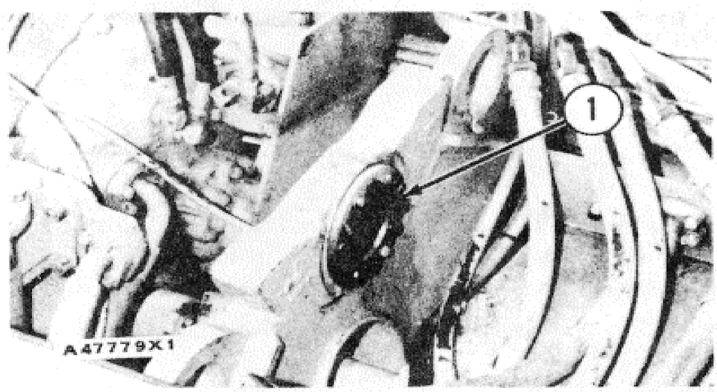


REMOVE HITCH HORIZONTAL BEARINGS

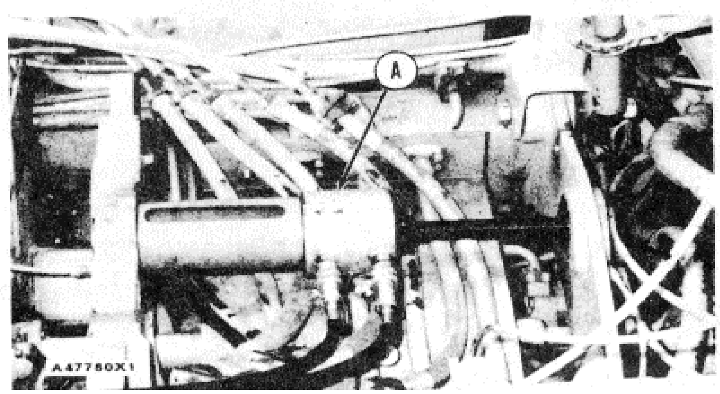
	Tools Needed	A
5P3100	Pump Group	1
5H9817	Puller Assembly1	
9S5558	Stud	1
1P544	Nut	1
1P1835	Pulling Adapter	1
7F6068	Sleeve	1

start by:
a) remove hitch*

*NOTE: Hitch is removed for photo illustations only. Bearings can be removed without separation of tractor and scraper if hitch is lifted enough for clearance to do work.



1. Remove the bolts and ring (1) from the frame.



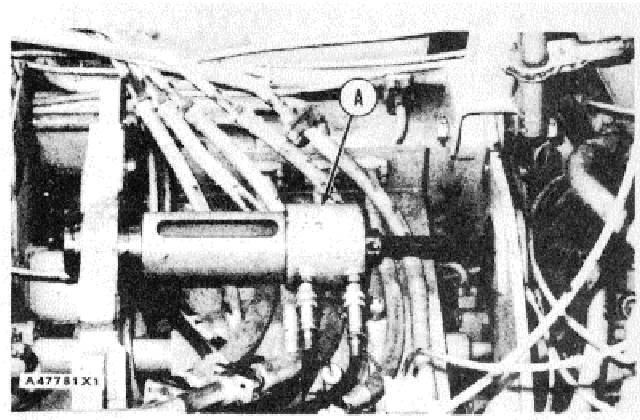
2. Remove the front and rear bearings with tooling (A).

HITCH HORIZONTAL BEARINGS, HITCH VERTICAL BEARINGS

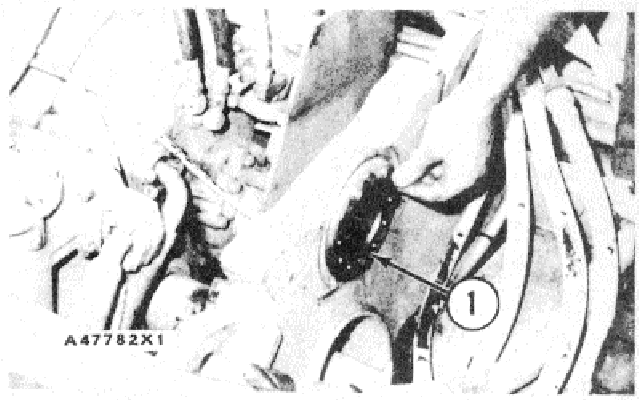
INSTALL HITCH HORIZONTAL BEARNINGS

	Tools Needed	A
5P3100	Pump Group	1
5H9817	Puller Assembly	1
9S5558	Stud	1
1P544	Nut	1
1P1840	Pulling Adapter	1
7F6068	Sleeve	1

1. Install front and rear bearings with tooling (A).



2. Install ring (1) and bolts to the frame.



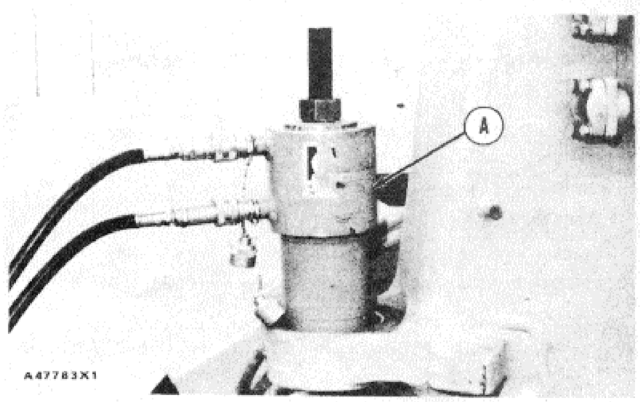
end by:
a) install hitch

REMOVE AND INSTALL HITCH VERTICAL BEARINGS

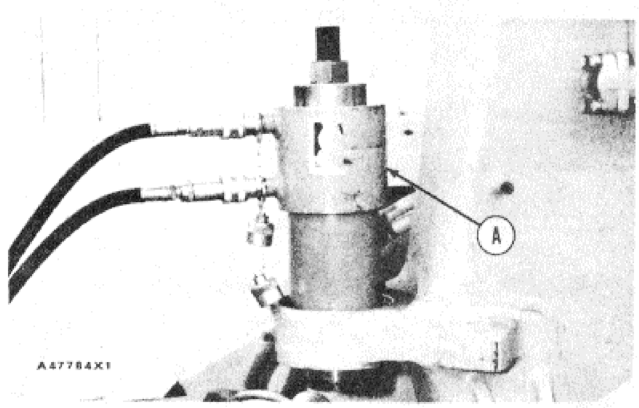
	Tools Needed	A
5P3100	Pump Group	1
5H9817	Puller Assembly	1
5P4184	Stud	1
7539	Nut	1
1P1835	Pulling Adapter	1
5F7693	Spacer	1

start by:
a) separation of tractor and scraper

1. Remove top and bottom bearings with tooling (A) from the hitch.



2. Install top and bottom bearings with tooling (A). Turn spacer (5F7693) around for the installation.



end by:
a) connection of tractor and scraper

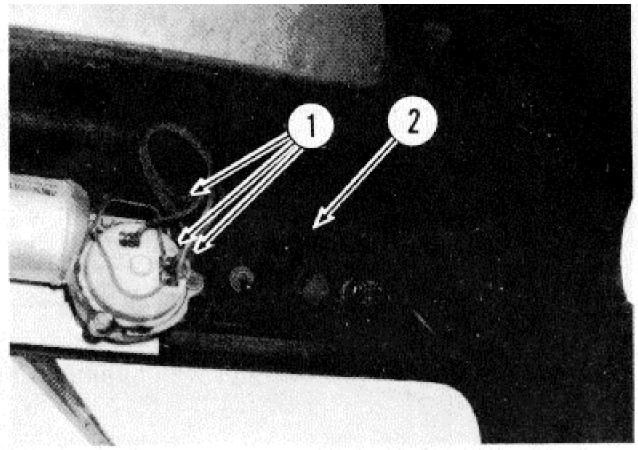
ROLL-OVER PROTECTIVE STRUCTURE

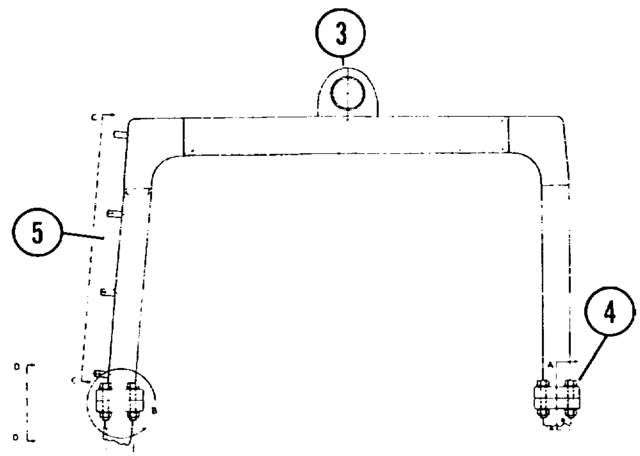
REMOVE ROLL-OVER PROTECTIVE STRUCTURE

1. Disconnect three wires at their quick disconnects (1).
2. Remove two nuts, four washers and two screws securing control panel (2) and lay panel across the gage panel on the dash.
3. Attach hoist to lifting eye (3).
4. Remove sixteen nuts, washers, and bolts (4).
5. Lift roll-over protective bar from tractor.

INSTALL ROLL-OVER PROTECTIVE STRUCTURE

1. Attach hoist to lifting eye (3).
2. Place roll-over protective bar in place with windscreen (5) to front.
3. Install sixteen bolts, washers and nuts (4).
4. Position control panel (2) and replace two screws, four washers and two nuts.
5. Reconnect wires at their quick disconnects (1).





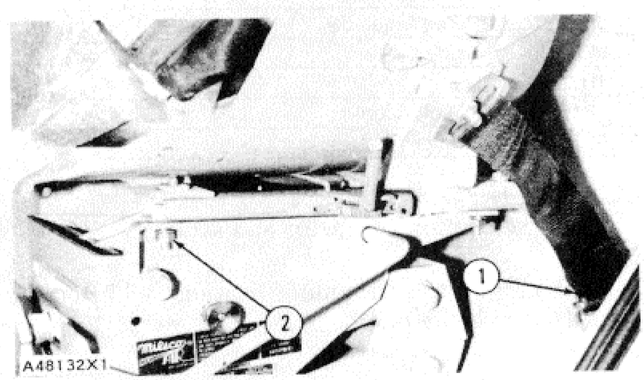
SEAT

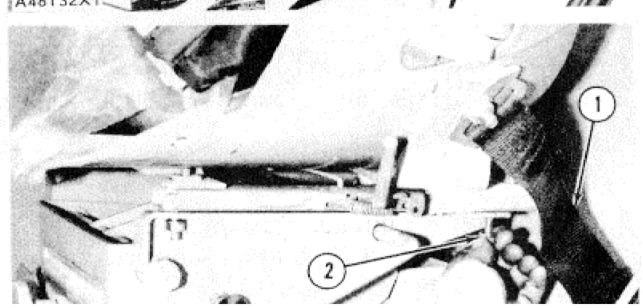
REMOVE SEAT

1. Remove four nuts (2) from the seat frame.
2. Disconnect seat belt (1) from the eyebolts on the cab.
3. Remove the seat from the cab.

INSTALL SEAT

1. Put the seat in position and connect seat belt (1) to the eyebolts.
2. Install four nuts (2) to the seat.

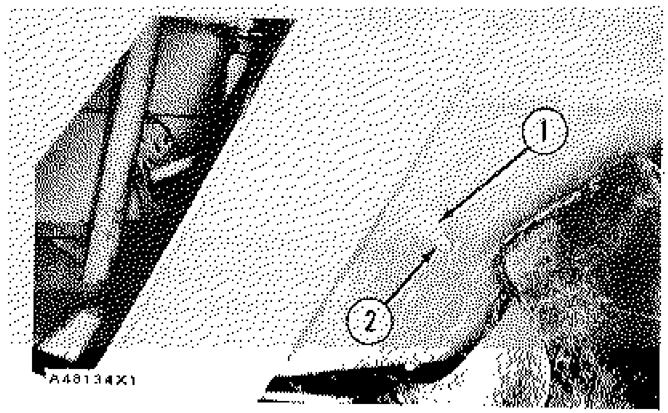




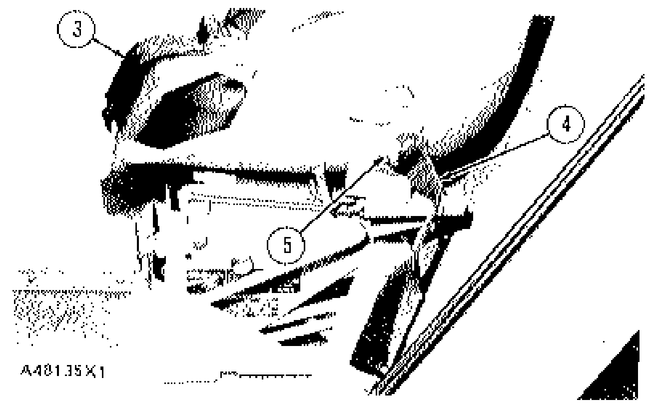
SEAT BELT

REMOVE SEAT BELT

1. Remove nut (1) from the back of the cab.
   Remove eyebolt (2) from inside the cab.

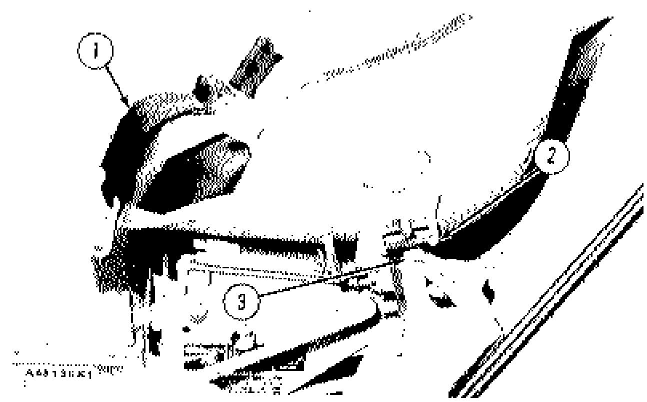


2. Remove nut (5) from the seat. Remove both parts of the seat belt (4) and (3).

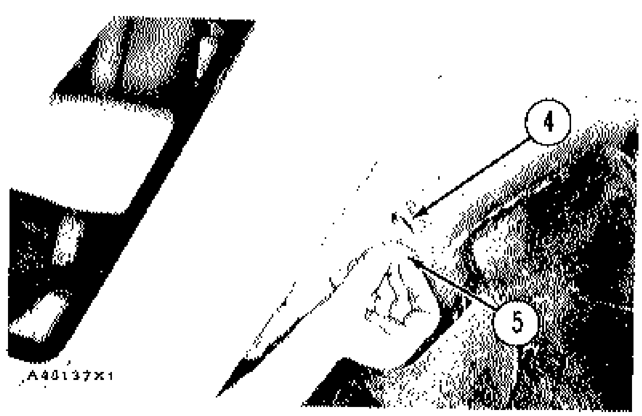


INSTALL SEAT BELT

1. Install belt (1) through the seat. Put belt (2) in position and install nut (3).



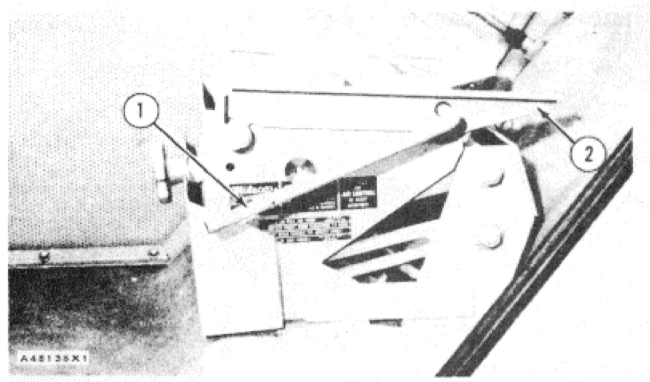
2. Put eyebolt (4) through the cab and install nut (5).



SEAT FRAME

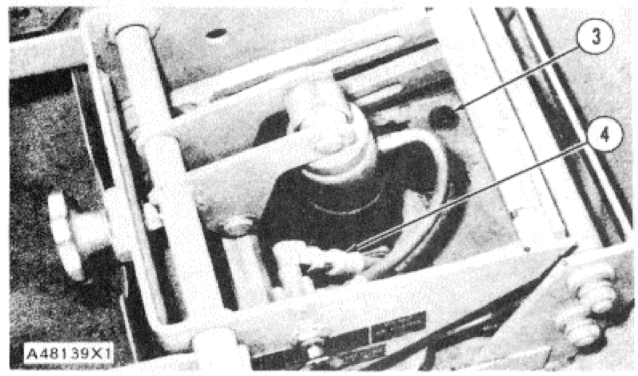
REMOVE SEAT FRAME

start by:
a) remove seat



WARNING: Open the drain valves on the reservoirs and make sure all air pressure is removed from the system before any work is done.

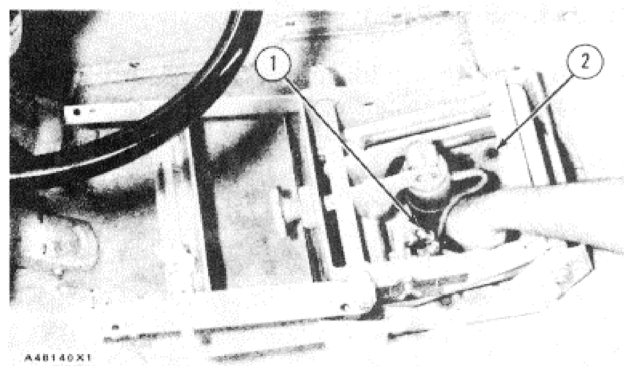
1. Lift up on lever (1) and put tilt assembly (2) forward.



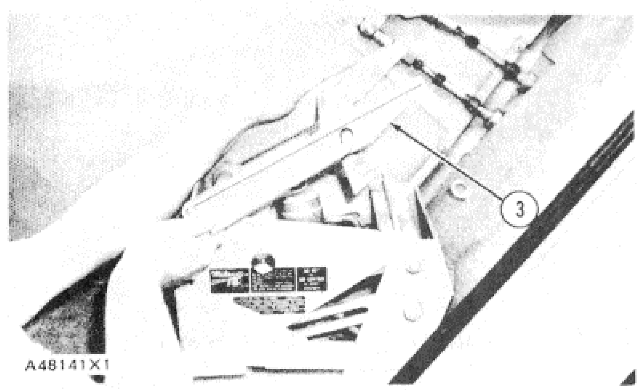
2. Disconnect air line (4) from the valve. Remove four bolts (3) from the frame. Remove the seat frame from the cab.

INSTALL SEAT FRAME

1. Put the seat frame in the cab. Install four bolts (2) to the frame. Connect air line (1) to the valve.



2. Move tilt assembly (3) backward and in position.



end by:
a) install seat

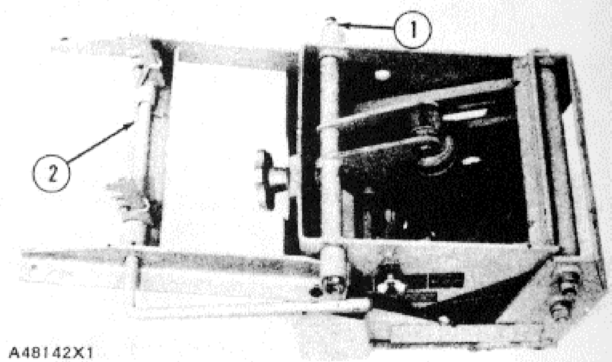
SEAT FRAME

DISASSEMBLE SEAT FRAME

start by:

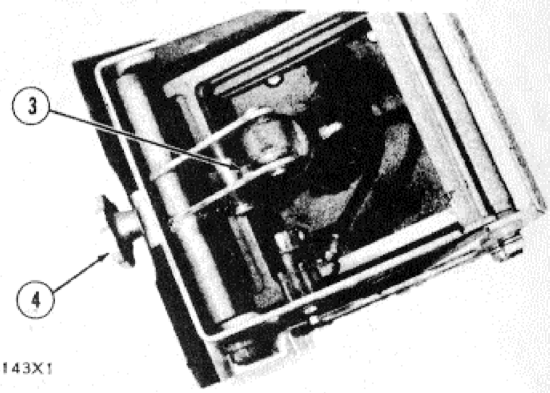
a) remove seat frame

1. Remove nut (1) and pull the stud out the other side. Remove tilt assembly (2) from the frame.



A48142X1

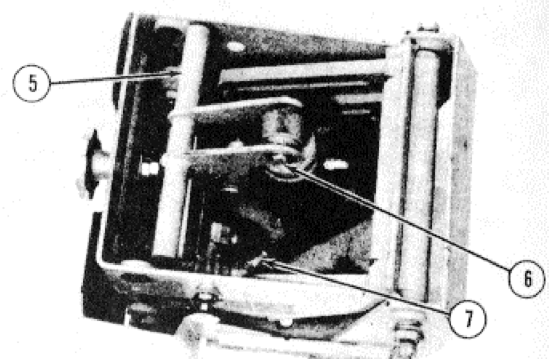
2. Remove the cotter pin and nut (3) from the end of handle (4). Turn the handle until adjustment screw is free.



A48143X1

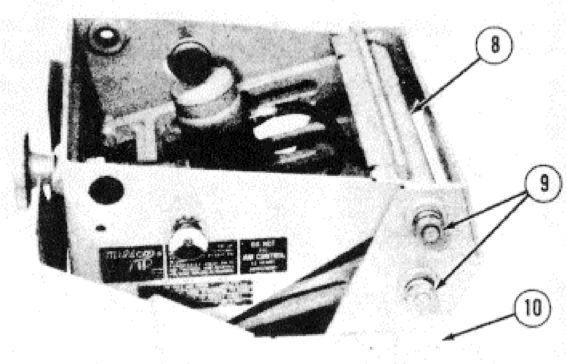
3. Remove clip and pin (6) from adjustment assembly (5). Remove the adjustment assembly from the frame.

4. Disconnect air line (7) from the valve.



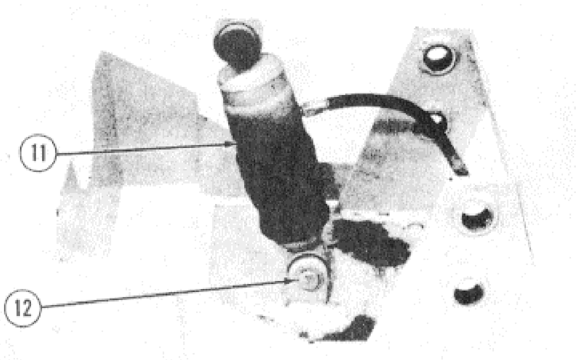
A48144X1

5. Remove nuts (9) and sleeves from the studs. Pull the studs out the other side. Remove support assembly (8) from base assembly (10).



A48145X1

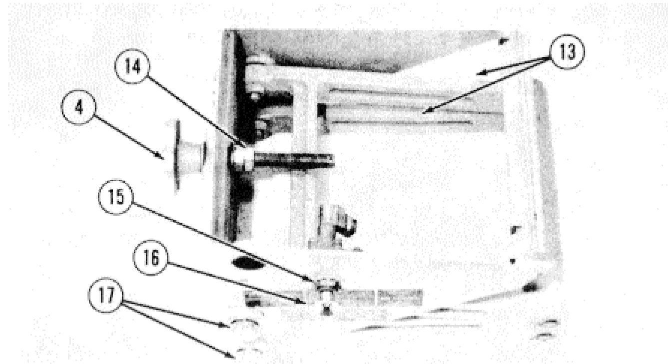
6. Remove clip and pin (12) from the bracket. Remove shock absorber (1) from the bracket.



A48146X1

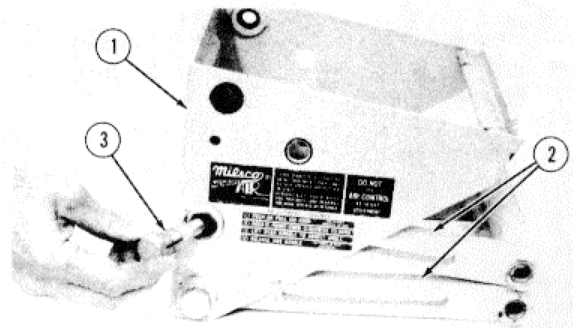
SEAT FRAME

7. Remove the screw from knob (16). Remove the knob and nut (15) from the valve. Remove the valve from the support assembly.



A48147X1

8. Remove nuts (14) and washer from the handle (4). Remove the handle and washer from the support assembly.

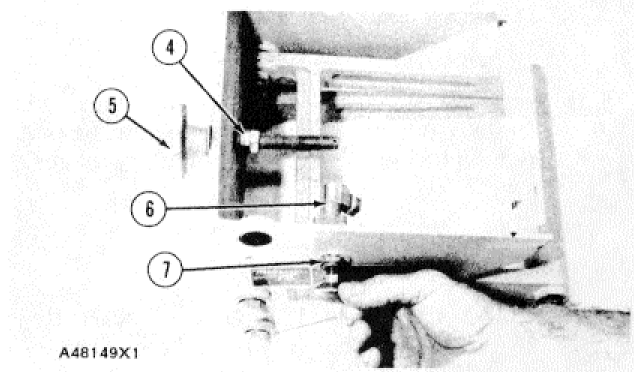


A48148X1

9. Remove four bolts (17) from the two arms (13). Remove the arms from the support assembly.

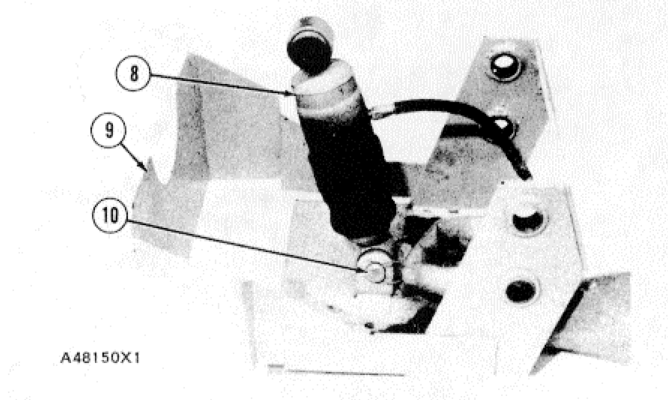
ASSEMBLE SEAT FRAME

1. Put arms (2) in position and install four bolts (3) in support assembly (1).



A48149X1

2. Put handle (5) in position and install washers and nuts (4). Put valve (6) in position and install nut (7). Install the knob and screw on the valve.

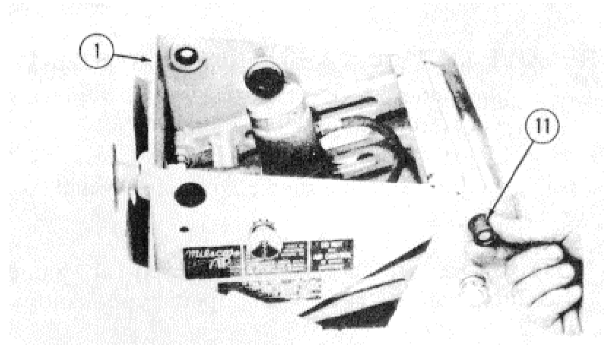


A48150X1

3. Install shock absorber (8) in the bracket of base assembly (9) and install pin (10) and the clip.

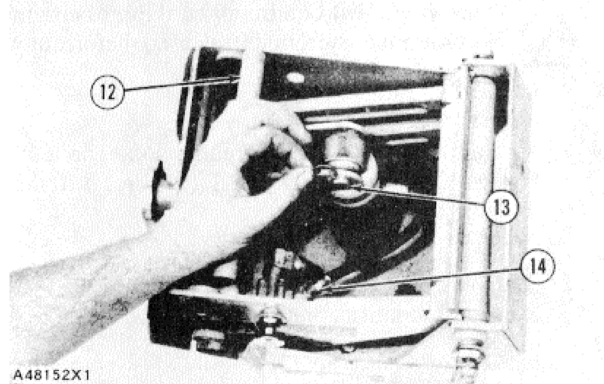
SEAT FRAME

4. Put support assembly (1) in the base assembly and install studs, sleeves (I 1) and nuts.



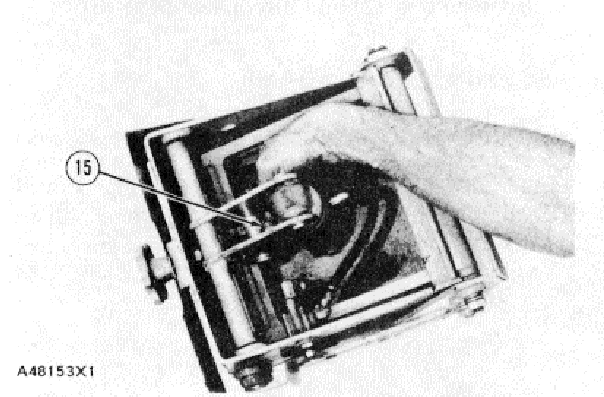
A48151X1

5. Connect air line (14) to the valve. Put adjustment assembly (12) in position and install pin (13) and clip.



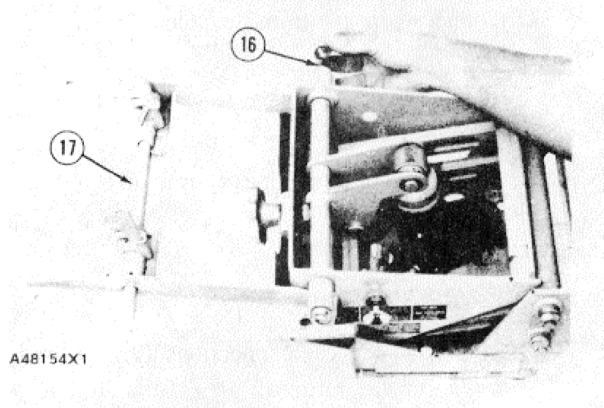
A48152X1

6. Turn the screw in the adjustment assembly. Install nut (15) and cotter pin on the end of the screw.



A48153X1

7. Put tilt assembly (17) in position. Install the stud (16) through the support assembly. Install the nut on the stud.
   end by:
   a) install seat frame



A48154X1

REMOVE CAB 6325-11

start by:

a) remove crankcase guard*

*This operation is in the Engine Disassembly and Assembly.

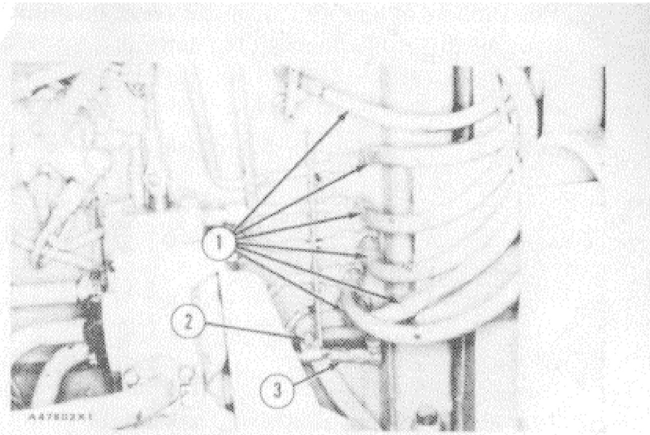
NOTE. Procedure shown uses enclosed cab. Same procedure can be used for open type canopy (ROPS).

WARNING: Make sure all of the pressure in the hydraulic system IS released before any, lines are disconnected.

1. Drain the oil from the hydraulic tank. The total s) stem capacity) is 24 U.S. gal. (91 litre). Lift the hood.

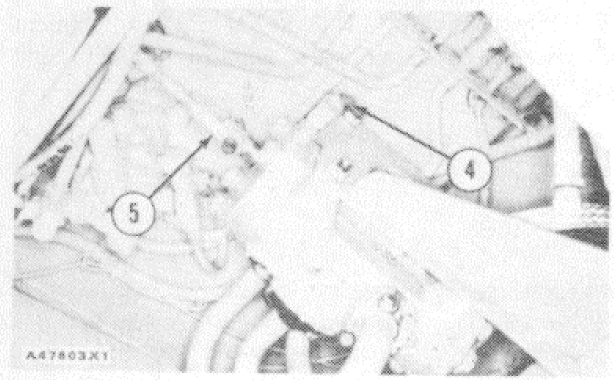
2. Disconnect hoses (1) from under the cab. Put caps and identification on the lines.

3. Remove bolt (2) and disconnect hose (3).



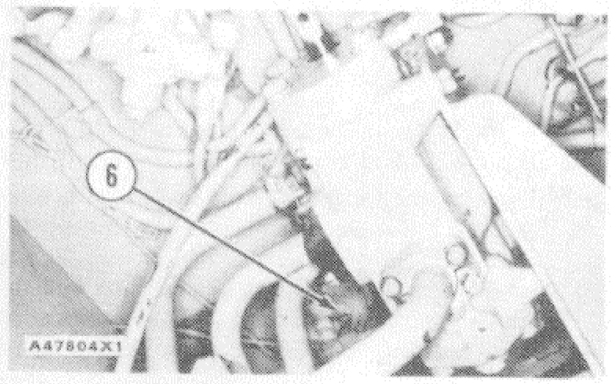
VIEW FROM UNDER CAB

4. Disconnect hose (4) from the steering control valve. Remove the cotter pin, nut and bolt to disconnect steering linkage (5) from the control valve.



VIEW FROM UNDER CAB

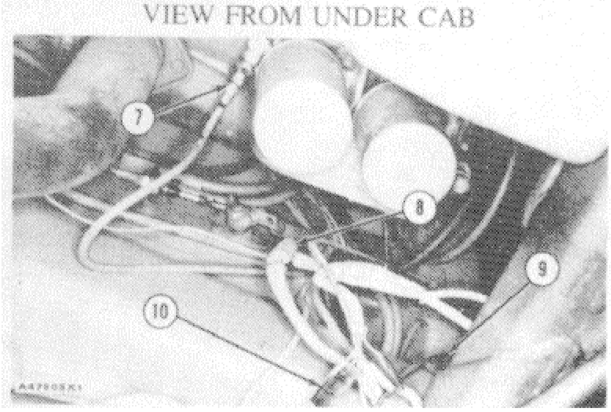
5. Disconnect wire (6) from the solenoid.



VIEW FROM UNDER CAB

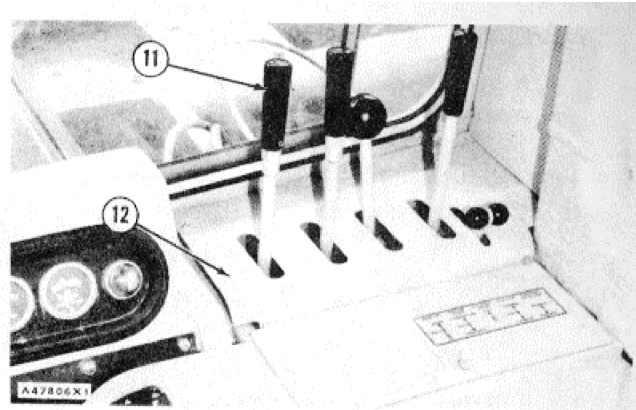
6. Disconnect oil pressure line (7) from oil filters on the left side of engine.

7. Disconnect electrical connections (8), (9) and (10).

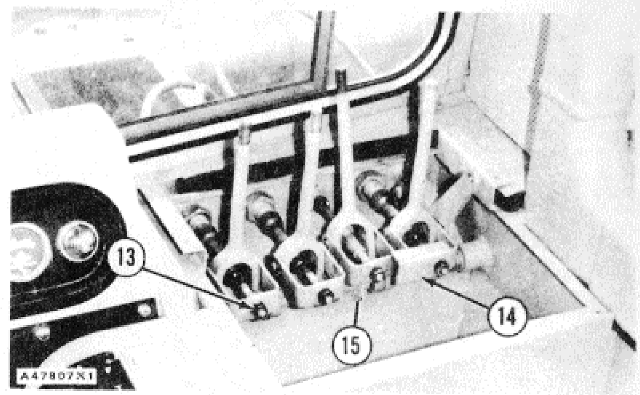


CAB

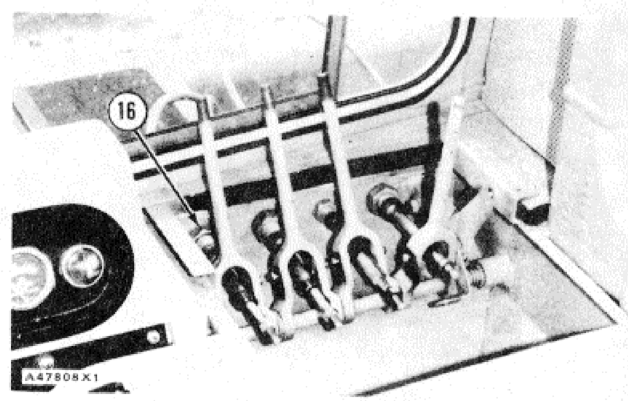
8. Remove knobs (II11) from the levers. Remove cover assembly (12).



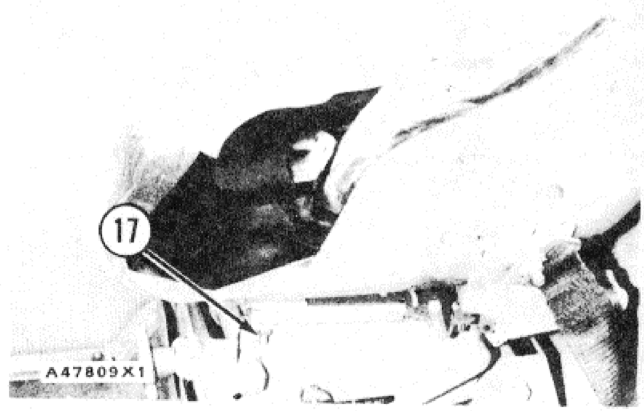
9. Remove four nuts (13), angle (14) and links (15) from the cables.



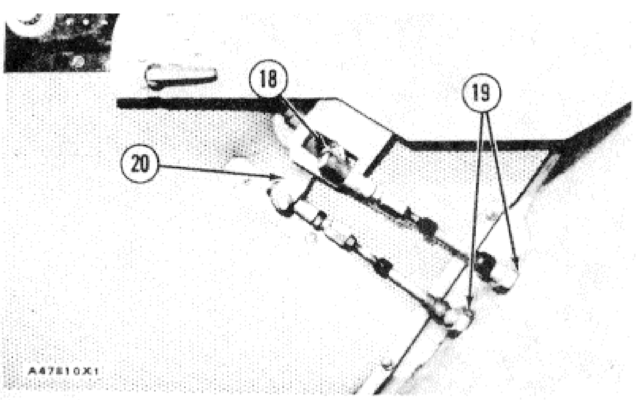
10. Remove the nuts and the rubber protectors from the cables. Remove nuts (16) from the cables. Remove the extension from the elevator speed control cable.



11. Remove four nuts (17) from the bottom on the seat. Disconnect each side of the seat belt from the eyebolts found on the cab. Remove the seat from the cab.

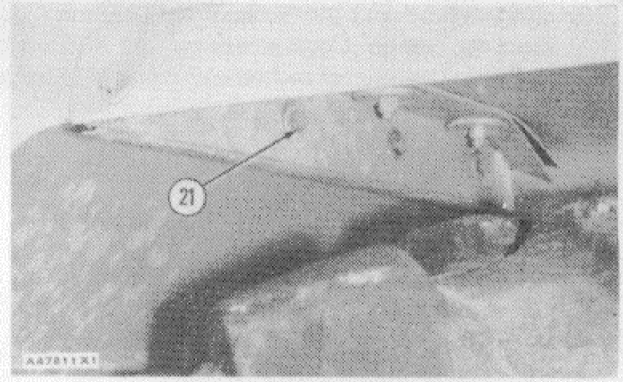


12. Disconnect top cable and remove pin (18) from lever (20). Turn the lever slightly and remove the lower cable. Remove nuts (19), extensions and rubber protectors from the cables and pull the cables out the back of the cab. Put identification on the cables for reference during installation.



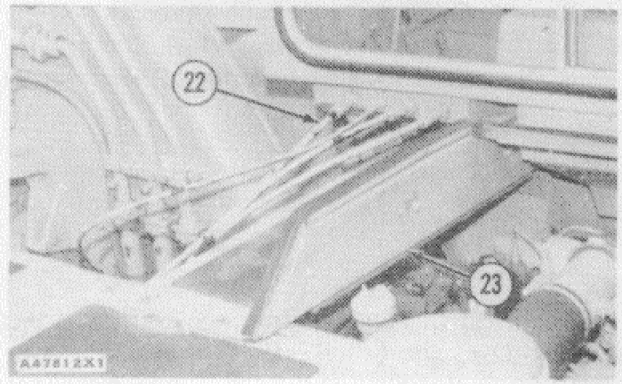
CAB

13. Remove four bolts (21) that connect the fender to the cab.



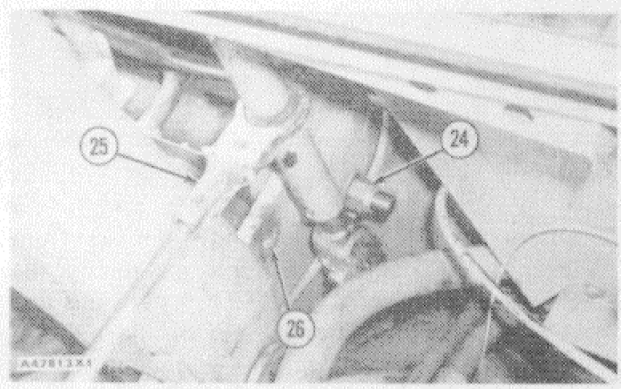
VIEW FROM UNDER FENDER

14. Put identification on cables (22) and remove them from the cab. Remove panel assembly (23).

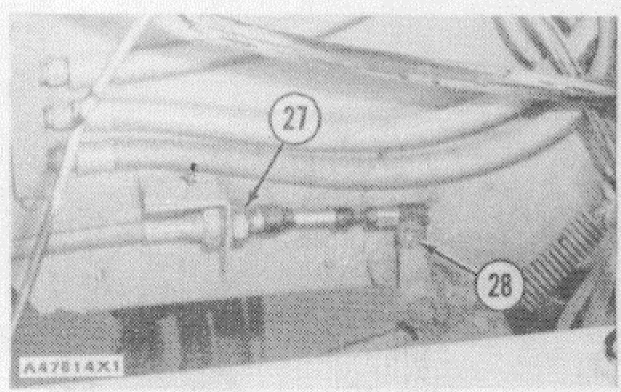


15. Remove jack (25) from top and bottom connections. Put bottom of jack in alignment with hole (26) in frame and install pin and clip. Install top of jack in original position.

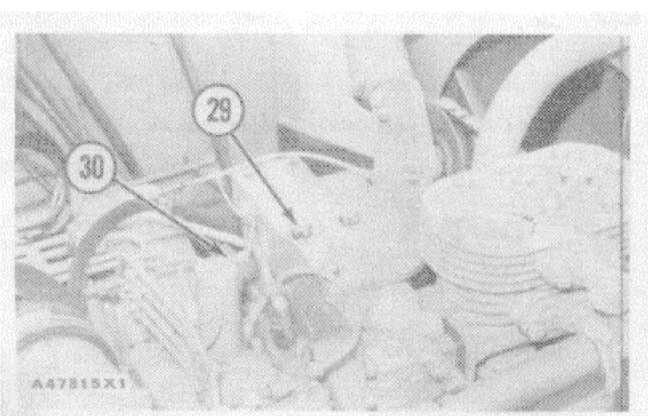
16. Remove nut, bolt (24) and jack bracket from the cab. Remove the right front bolt found behind the rubber strip. Tilt the cab with the jack.



17. Remove nut (28) from the cable. Remove nut (27), extension and rubber protectors from the cable and slide it out of the bracket. Put marks on the cable for adjustment at installation.

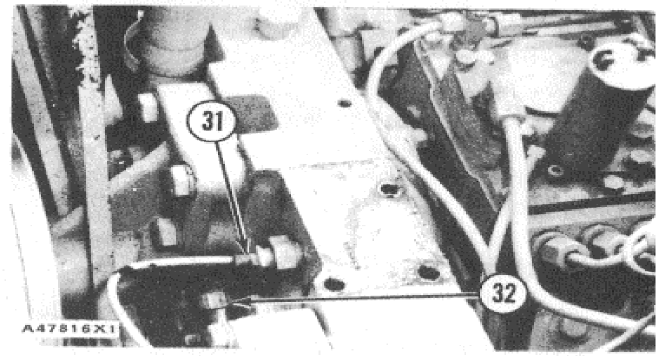


18. Disconnect wire (30) from the solenoid. Remove the tension from the air compressor belt. Remove bolts (29) from the angle. Remove the angle.

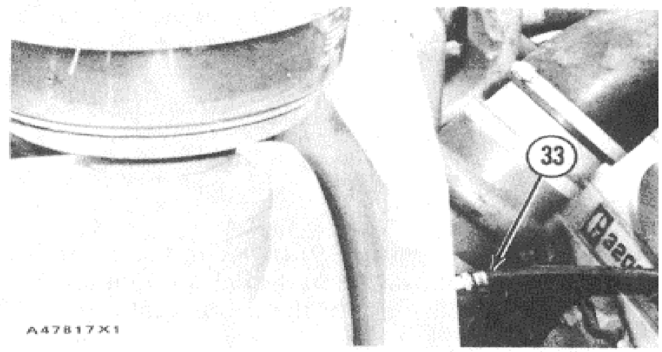


CAB

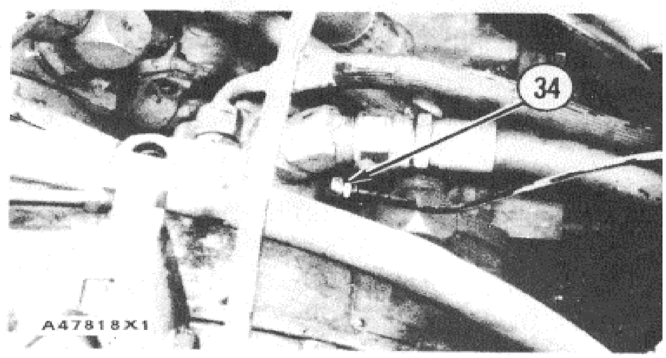
19. Disconnect water temperature sensing unit (3 1) from the engine. Coolant will run out if it is not drained. Disconnect tachometer cable (32) from the engine.



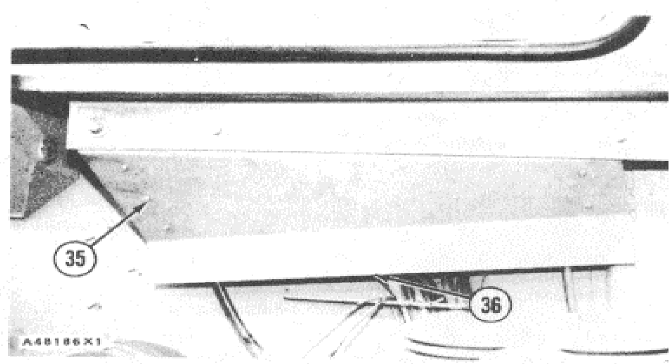
20. Disconnect hose (33) from the air cleaner.



21. Disconnect torque converter oil temperature sensing unit (34) from the left side of the converter.

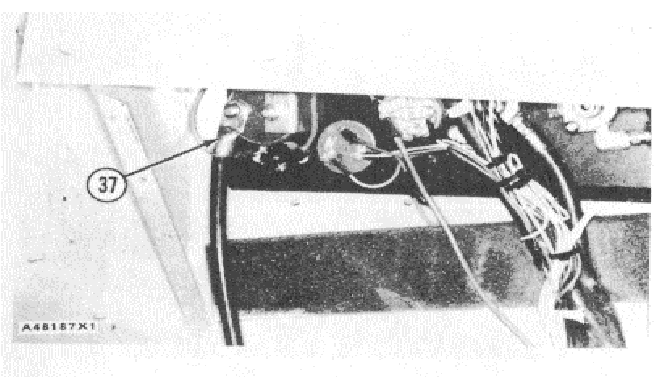


22. Remove screws (35) and cover (36) from right side of cab.

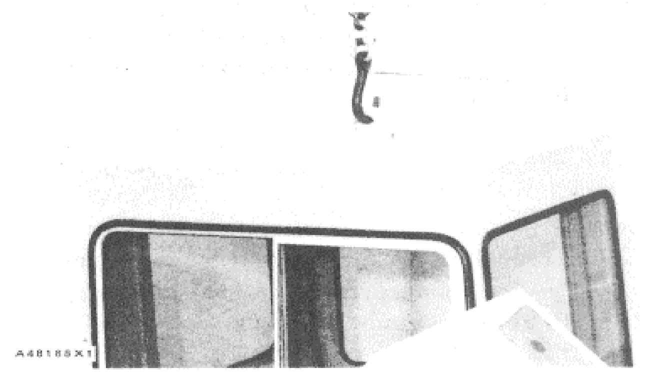


WARNING: Disconnect the negative cable at the battery'.

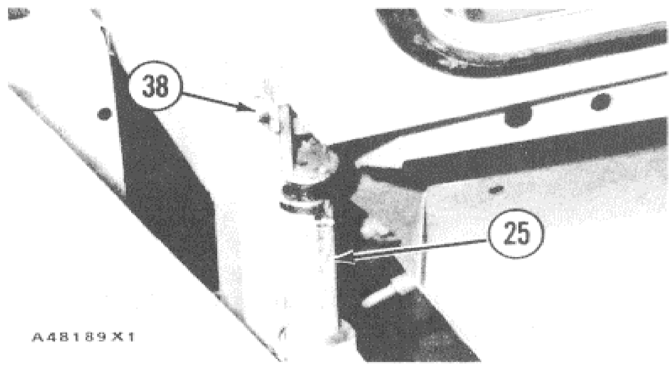
23. Disconnect batter3y cable (37) from the back of the disconnect switch.



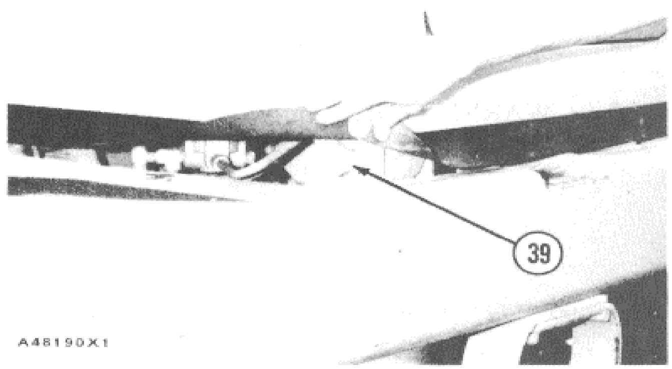
24. Use the jack and lower the cab. Fasten a hoist to the lift eye on top of the cab.



25. Remove clip and pin (38) from jack (25).



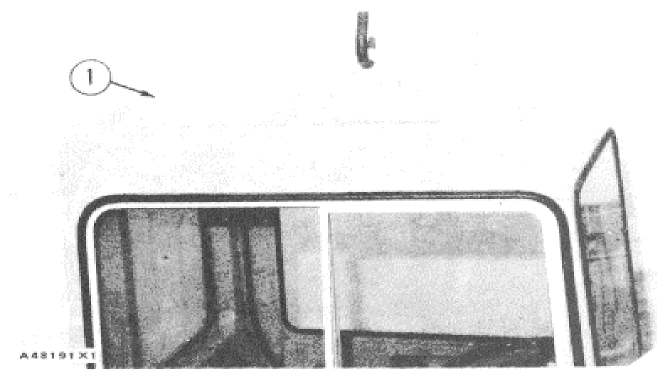
26. Remove two bolts (39) (front and rear) from the left side of the cab. Lift the cab straight up off the frame. The weight of the cab is 3,500 lb. (1575 kg).



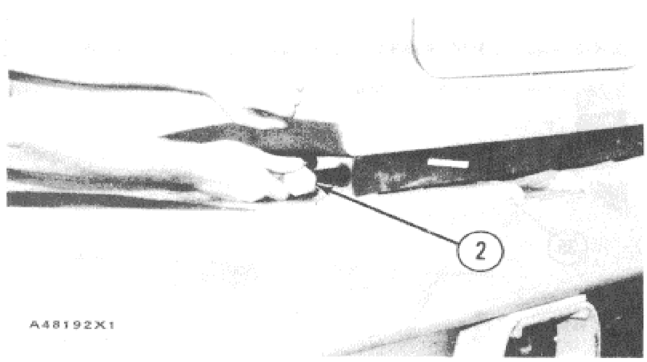
INSTALL CAB

NOTE: Procedure shown uses enclosed cab. Same procedure can be used for open type canopy (ROPS).

1. Fasten a hoist to the lifting eye on top of cab (I1 and put the cab in position on the frame.

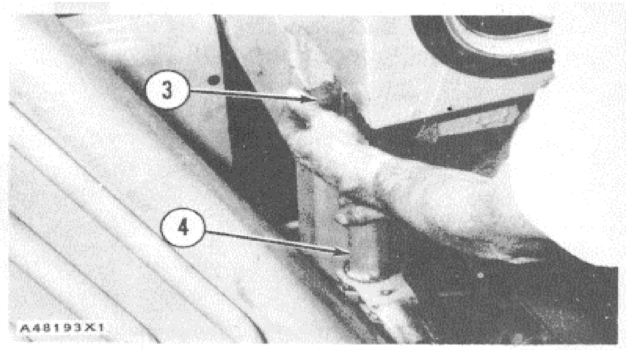


2. Install two bolts (2) (front and rear) on the left side of the cab.

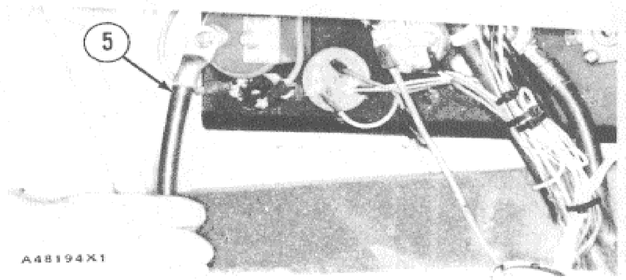


CAB

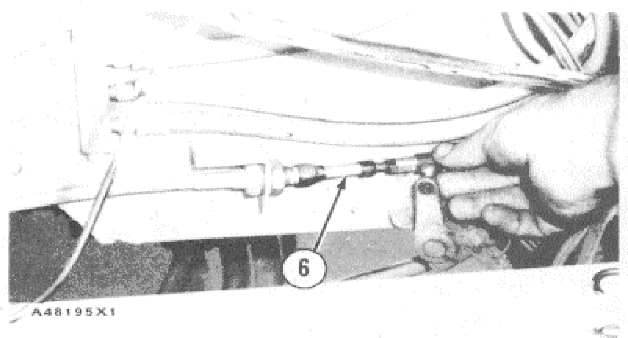
3. Fasten jack (4) to the right rear of the cab with pin (3) and clip. Remove the hoist and tilt the cab.



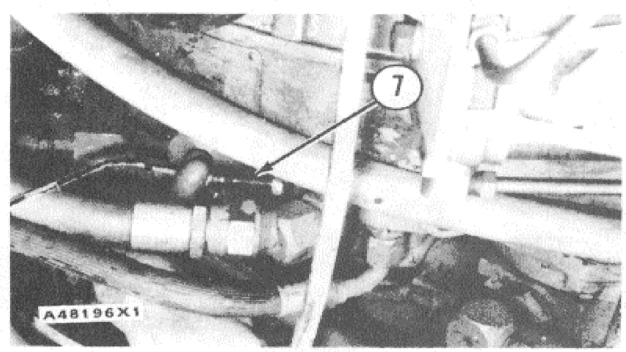
4. Connect battery cable (5) to the back of the disconnect switch. Install the cover that is protection for the battery cable.



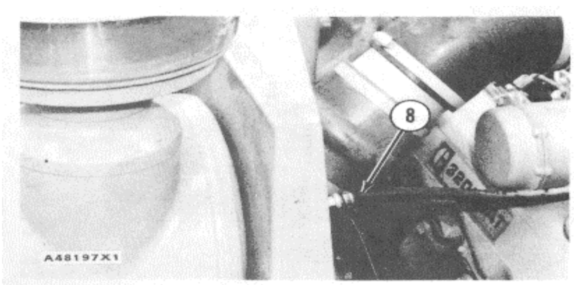
5. Connect governor cable (6) at the bracket and lever. Check the travel of the accelerator pedal in the cab, and linkage at the governor to make sure the adjustment is correct.



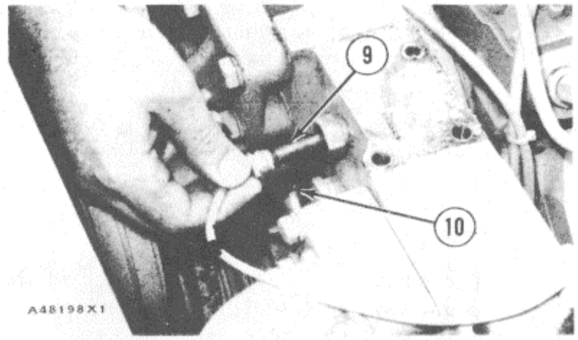
6. Connect torque converter temperature sensing unit (7) to the converter.



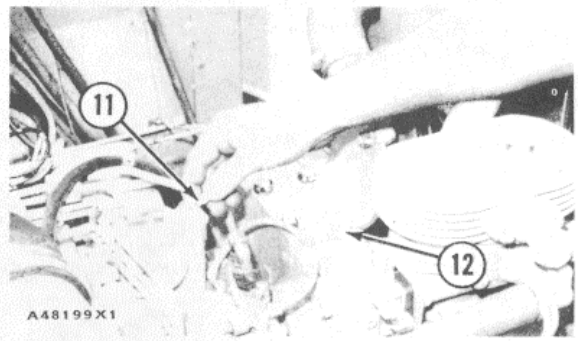
7. Connect hose (8) to the air cleaner.



8. Connect tachometer cable (10) to the engine. Connect water temperature sensing unit (9) to the engine.

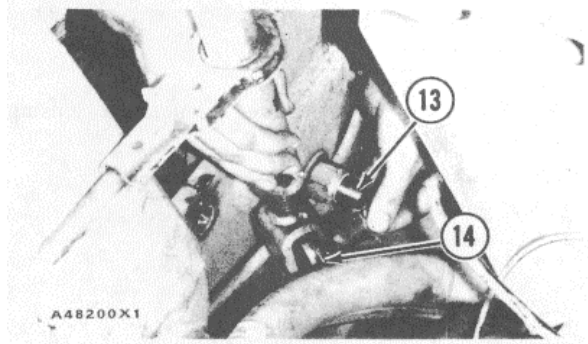


9. Connect wire (11) to the solenoid. Install angle bracket (12) tot he timing cover housing and make reference to TM 5-3825-226-10 for the correct adjustment to the belt.



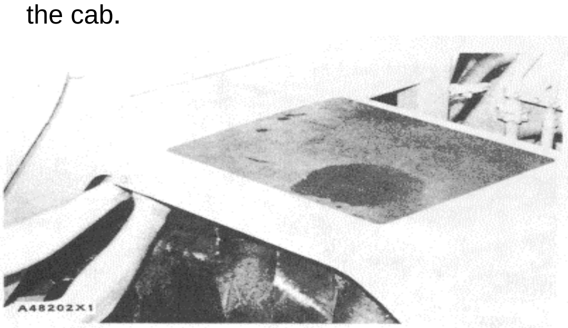
10. Lower the cab and install two bolts (13) and nuts to the cab. Install bracket (14) to the rear bolt for the jack. Remove the jack from the frame and install it on bracket (14) as shoe n.

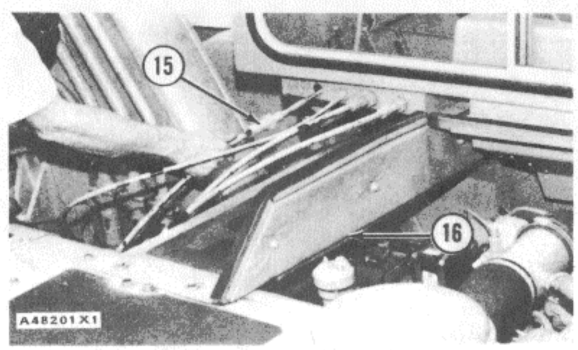
NOTE: Make sure the jack is put on the bracket before the machine is moved. The hitch will hit the jack if not removed from the frame.



11. Install panel assembly (16). Put cables (15) in position through the holes in the cab.

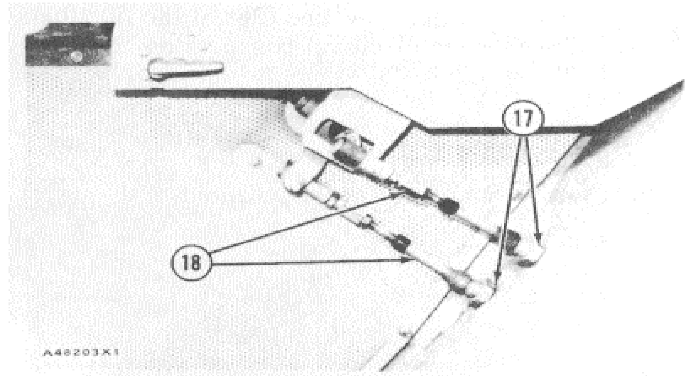
12. Install the four bolts that connect the fender and the cab.



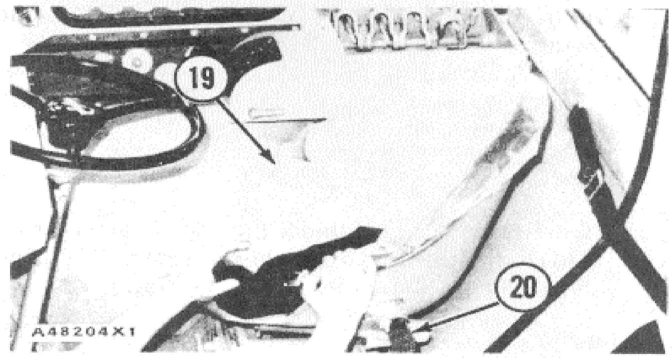


CAB

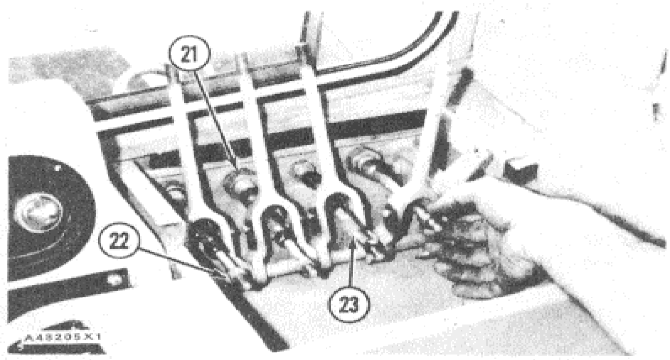
13. Put cables (18) in position through cab and install the rubber protectors, the extensions and nuts (17). Install lower cable on the lever. Install the pin through the lever. Install the top cable as shown. To adjust linkage, see LINKAGE ADJUSTMENTS FOR THE TRANSMISSION HYDRAULIC CONTROLS in POWER SHIFT TRANSMISSION, TESTING AND ADJUSTING.



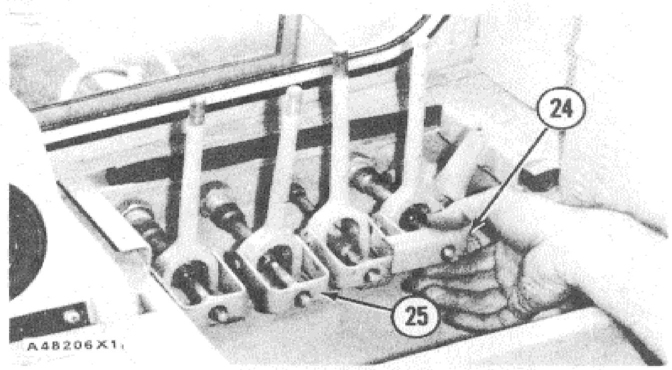
14. Install seat (19) in the cab and connect seat belt (20) to the eyebolts.



15. Install four nuts (21), rubber protectors, extension (23) and four nuts (22) to the cables.

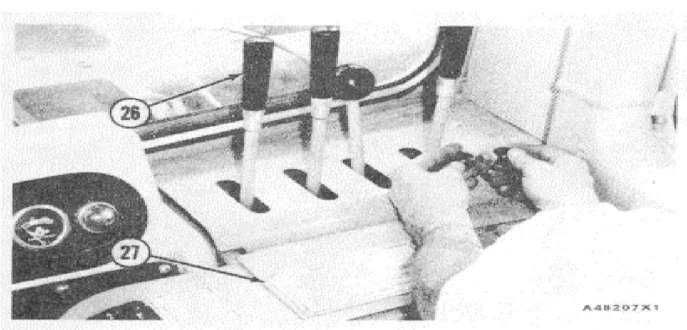


16. Install links (25) and angle (24). Install the nuts on the ends of the cables.



NOTE: Use nuts (22) to adjust the leers in their correct vertical position.

17. Install cover assembly (27) and knobs (26).



CAB

18. Connect oil pressure line (28) at the oil filters. Connect three electrical connections (29).

19. Connect wire (30) to the solenoid.

20. Connect linkage (32) to the control valve with bolt, nut and cotter pin. Connect hose (31) to the control valve.

21. Connect hoses (33) under the cab. Connect hose (34) to the fitting. Connect ground strap (35) and hose (34) to the cab with the bolt and washer.

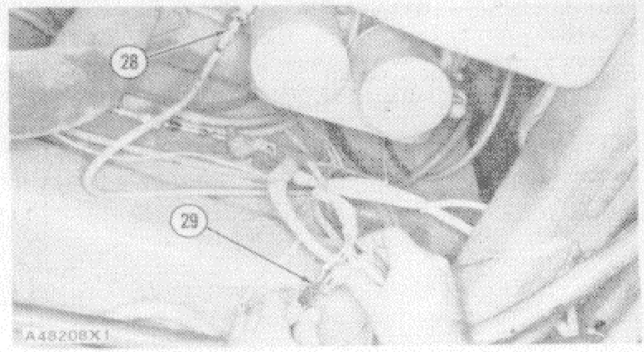
22. Connect the battery cable.

23. Fill the cooling system.

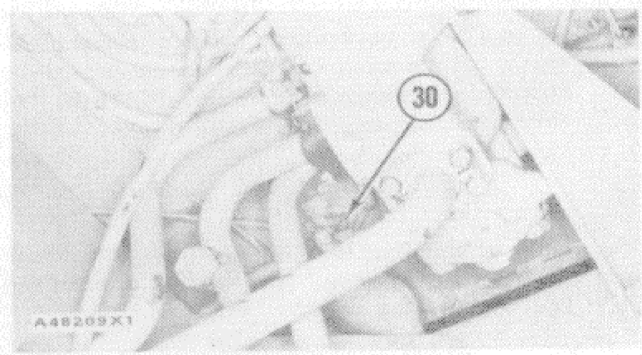
24. Lower the hood.

end b):
a) install crankcase guard*

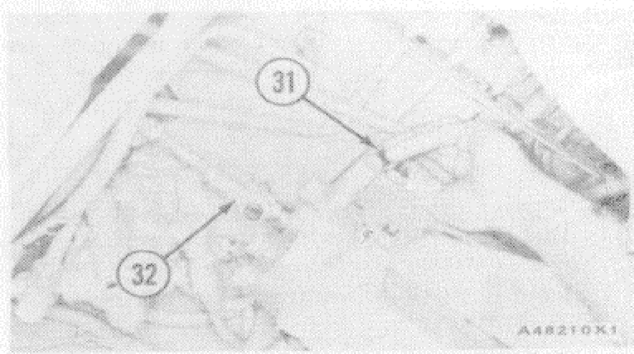
*This operation is in the Engine Disassembly and Assembly.



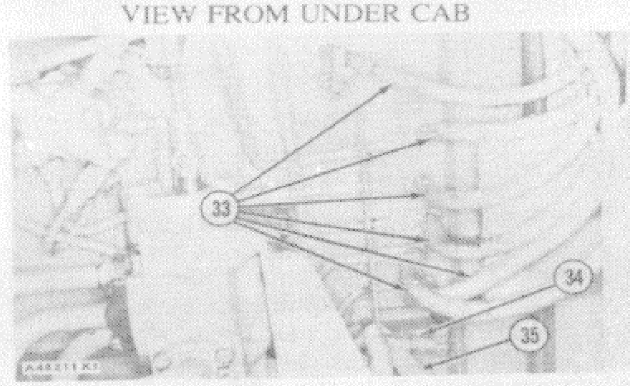
VIEW FROM UNDER ENGINE



VIEW FROM UNDER CAB



VIEW FROM UNDER CAB

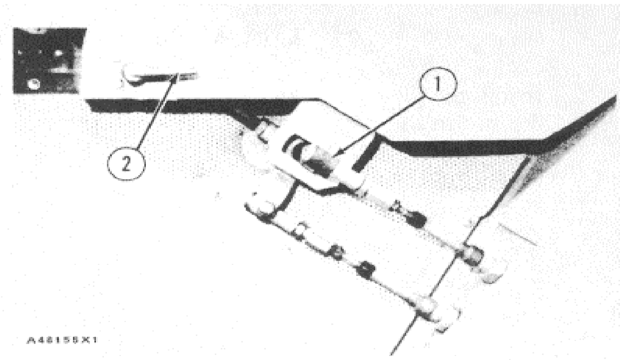


VIEW FROM UNDER CAB

TRANSMISSION CONTROL LINKAGE

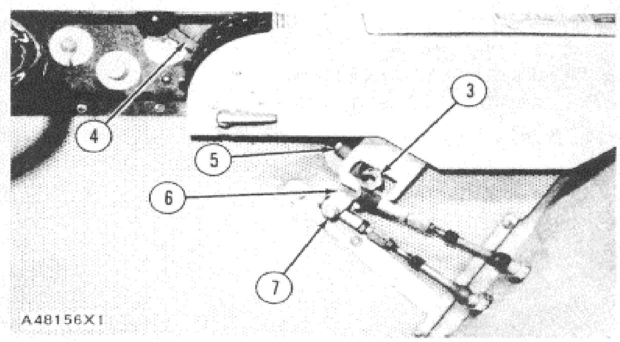
REMOVE TRANSMISSION CONTROL LINKAGE

NOTE: The seat is removed for photo illustration only.



1. Make sure handle (2) is on the "OFF" position.

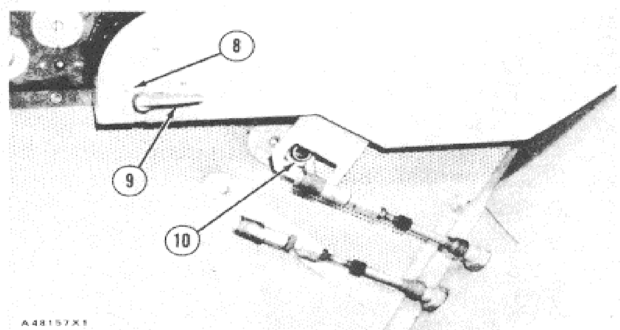
2. Disconnect transmission cables (1) at the pin.



3. Loosen locknut (5) and remove shift lever (4) from lever (6).

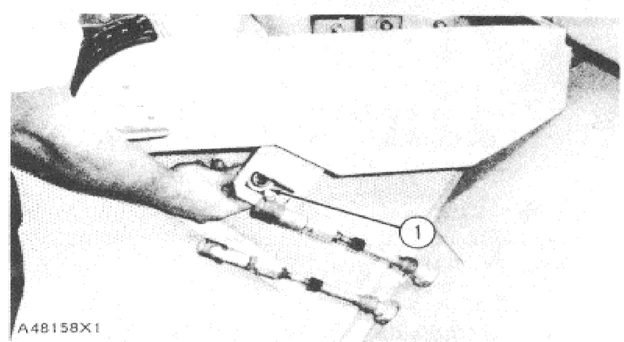
4. Remove nut (7). Remove the nut on back of pin (3). Pull the pin out and remove lever (6).

5. Remove the bolt that holds rod end (10) in position from the inside of the compartment. Remove the rod end.



6. Remove three bolts (8) and lower shift lock handle (9) through opening (slot) in the console. Remove the rod assembly, spring and spacer as a unit. Remove the pin from handle (9). Remove the handle and the plate from the rod.

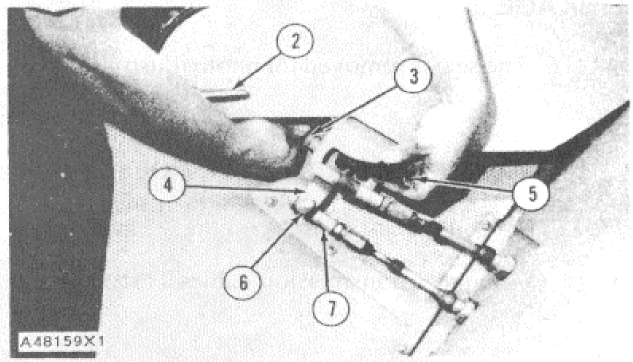
INSTALL TRANSMISSION CONTROL LINKAGE



1. Put the rod end (1) in position and install the bolt from the inside of the compartment.

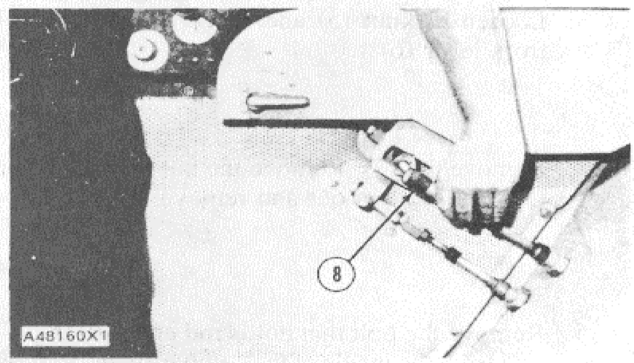
TRANSMISSION CONTROL LINKAGE,
HYDRAULIC VALVE CONTROL LEVERS

2. Install the plate and handle (2) to the rod. Install the pin in the handle. Install the rod assembly, spring and spacer in the console. Install the three bolts to the plate.



3. Put cable (7) through lever (4) and install nut (6). Put lever (4) in position over the rod end and install pin (5) through the lever and the rod end. Install the nut on the back of pin (5).

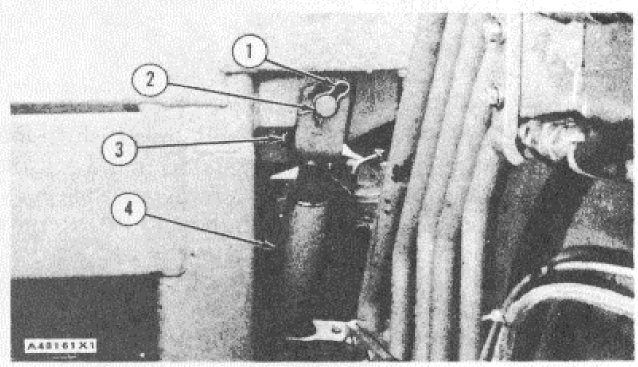
4. Turn the shift lever in lever (4) and tighten locknut (3).



5. Install transmission cable (8) to the pin.

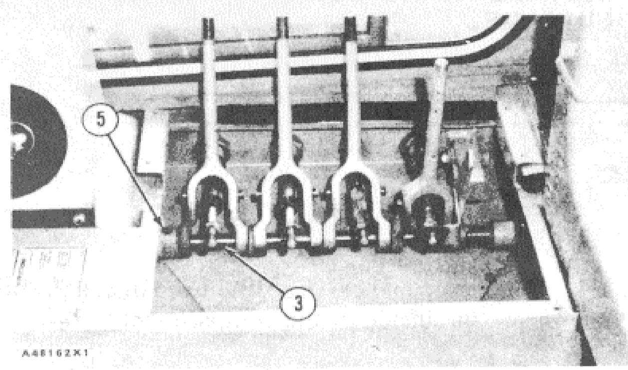
REMOVE HYDRAULIC VALVE CONTROL LEVERS

	Tools Needed	A
1P510	Driver Group	1



1. Remove clip (I) and pin (2) from jack (4). Pull the jack free of the cab so shaft (3) can be re- moved.

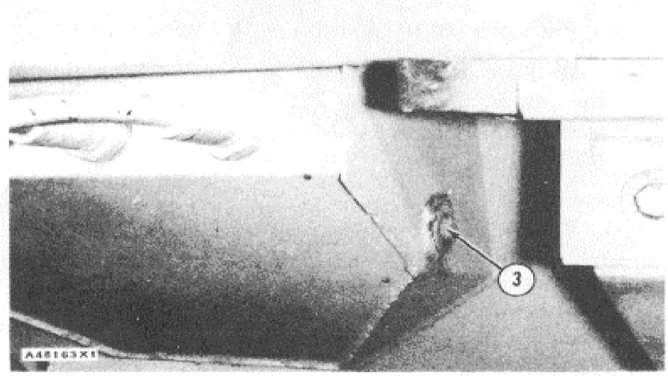
2. To remove the knobs, the cover assemble and the links from inside the cab, see REMOVE CAB, Steps 8 and 9 for details.



3. Loosen setscrew (5) on shaft (3).

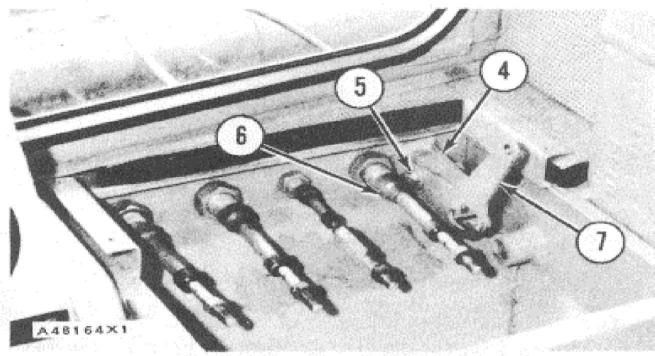
HYDRAULIC VALVE CONTROL LEVERS

4. Use a short punch and remove shaft (3) from the opening outside the cab. As the shaft is removed the levers, washers, link and spring will fall in the compartment.



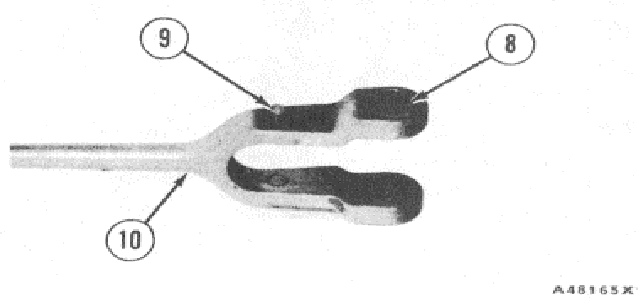
NOTE: Put a plug in hole in the bottom of the compartment to prevent the loss of any parts.

5. Keep lever (7) in the position as shown until the setscrew on the back side of bracket (4) is loosened. This will release spring tension on a small ball directly behind lever (7). After the lever moves freely lower it and remove the ball, the spring and the setscrew.



6. Remove bolt (5) and cable (6) so lever (7) can be removed.

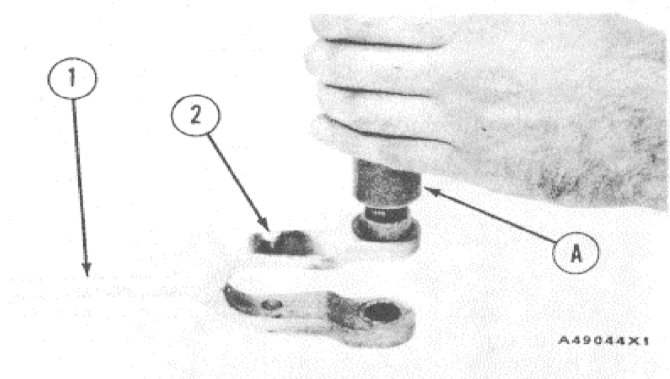
7. Remove bushings (8) from control lever (10) with tooling (A). Remove dowels (9) from the control lever.



NOTE: The dowels on the rear control lever only are different lengths.

INSTALL HYDRAULIC VALVE CONTROL LEVERS

	Tools Needed	A
1P510	Driver Group	1

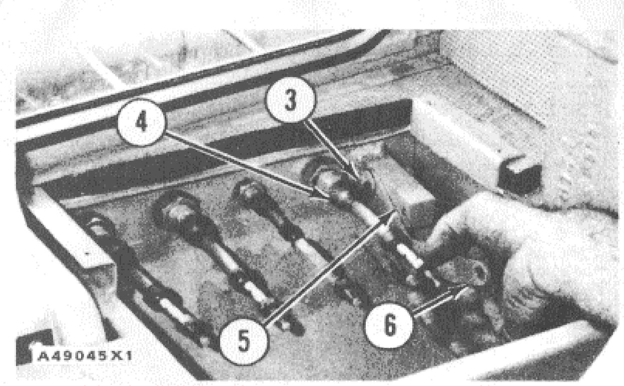


1. Install dowels (2) in control lever (I).

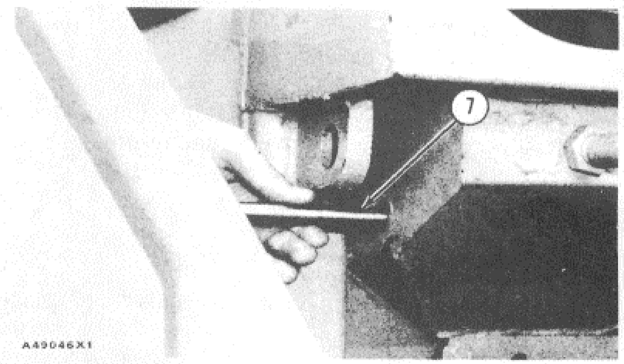
2. Put 8M8059 Bearing Mount on the outside diameter of the bushings and install them with tooling (A).

HYDRAULIC VALVE CONTROL LEVERS

3. Put lever (6) in position as shown and install bolt (3) to the bracket. Install cable (4) in the cab.

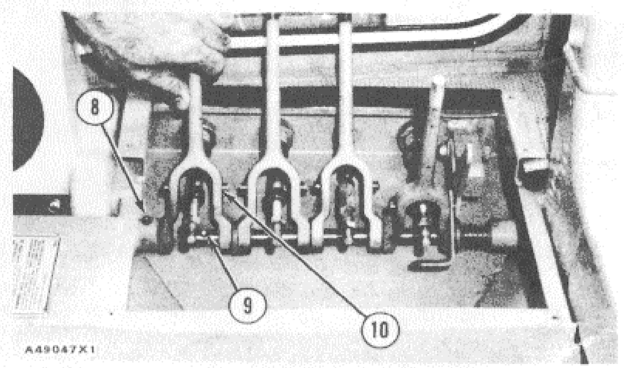


4. Install ball (5), the spring and the setscrew in the bracket. Move lever (6) up so the ball is in a notch in the lever. Tighten the setscrew until the correct tension is on the spring.



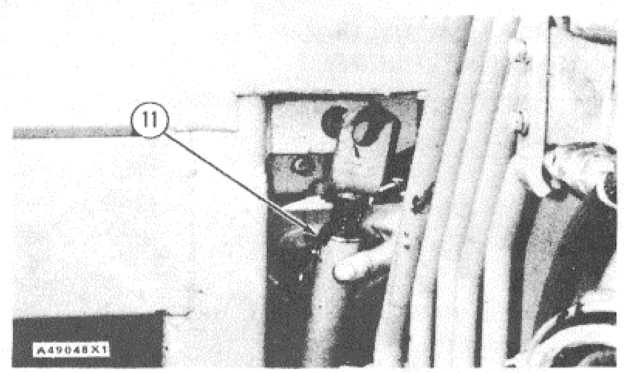
5. Install shaft (7) in the cab.

6. Install the spring, the two washers, the link, the three levers, the two washers and the lever (10) as the shaft is installed.



7. Tighten setscrew (8) in hole (9) in the shaft. Put the levers in position as shown.

8. To install the links, the cover assembly, the knobs and correct procedure for all adjustments, see INSTALL CAB Steps 16 and 17 for details.



9. Put jack (11) in position and install the pin and the clip.

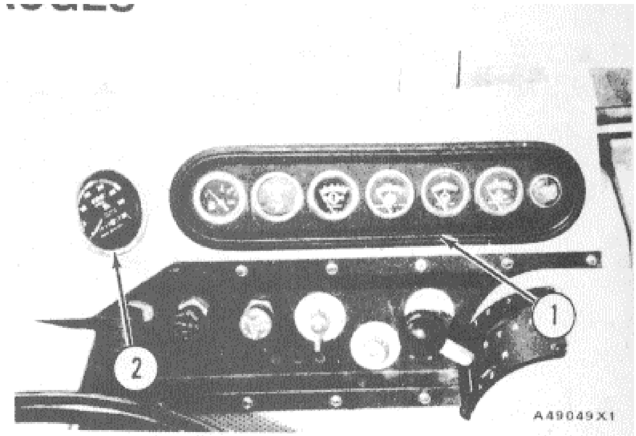
DASH GAUGES

REMOVE DASH GAUGES

	Tools Needed	A
5H4845	Seal Installer	1

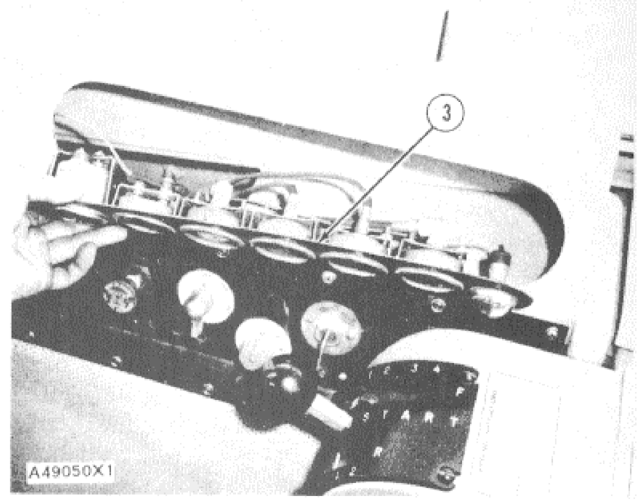
1. Remove tachometer (2) from the dash.

   a) Access to the tachometer is through the opening below the tachometer.
   b) Disconnect the tachometer cable from the back of the tachometer.
   c) Remove the two nuts from the bracket in back of the tachometer.
   d) Pull the tachometer out of the dash.



2. Remove rubber seal (I) from the rubber strip with tool (A).

3. Pull panel (3) forward and remove the rubber strip from around the panel.



INSTALL DASH GAUGES

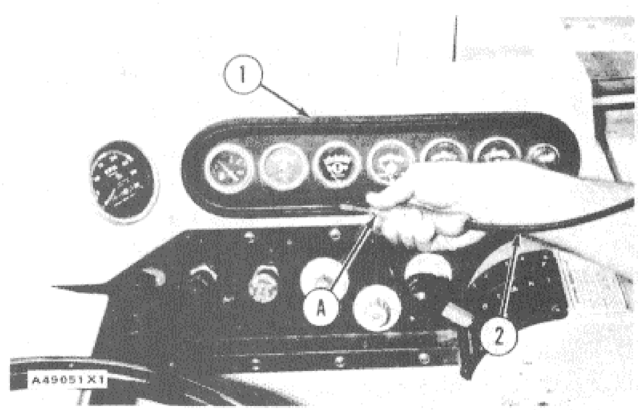
Tools Needed		A
8F3336	Seal Filler	1

1 Put the tachometer in position in the dash. Install the two nuts on the bracket and connect the tachometer cable.

2. Install rubber strip (I) around the panel. Put the panel in position in the dash as shown.

3. Put a solution of soap and water around the opening in the strip.

4. Install rubber seal (2) in the rubber strip with tool (A).



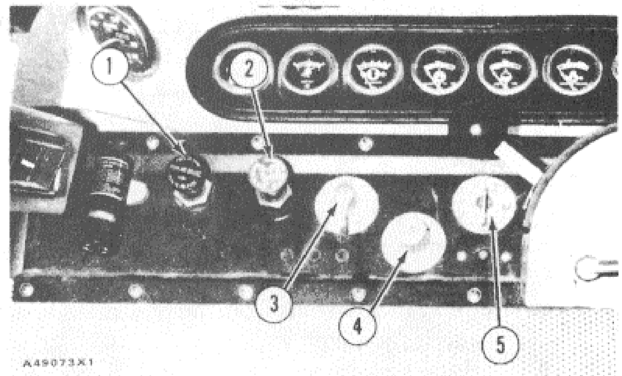
DASH CONTROLS AND SWITCHES

REMOVE DASH CONTROLS AND SWITCHES

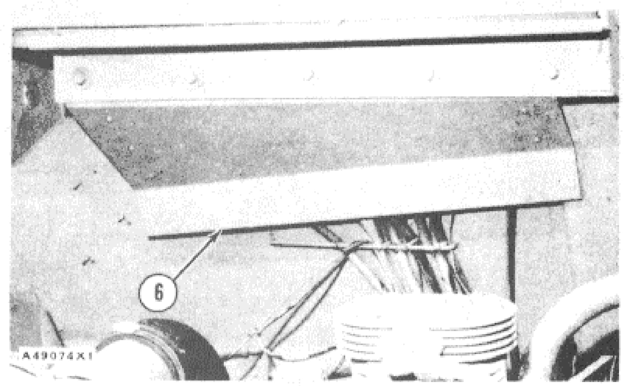
1. Remove parking brake (I) and emergency) brake (2) control valves from the dash.

   a) Remove the pin, the knob and the nut from the control valves.

2. Remove start switch (3), light switch (4) and disconnect switch (5) from the dash.
   a) Remove the screw, the knob and the nut from the start and light s, itches. Remove the nuts from the disconnect switch.



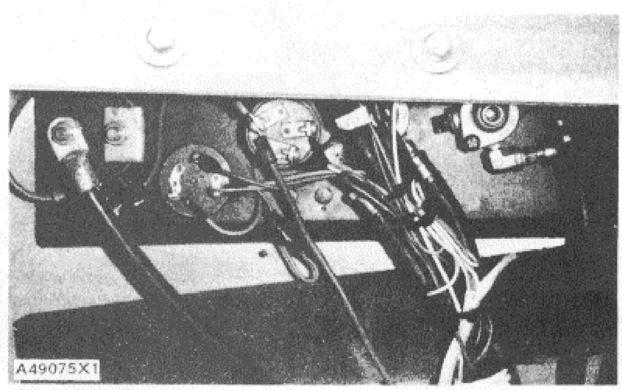
3. Tilt the cab, see REMOVE CAB for details. Remove corer (6).



NOTE: Put identification on hose and wires correct installation.

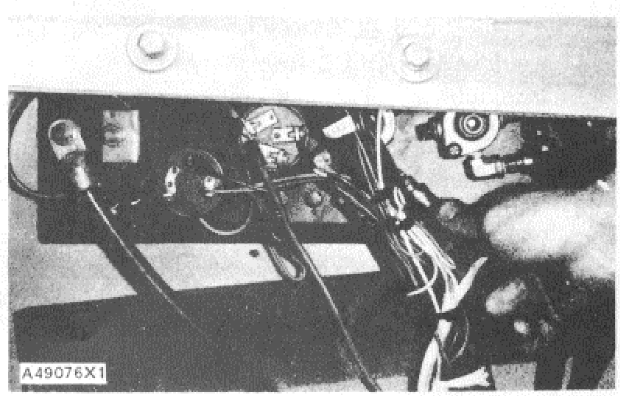
4. Disconnect the wires from the switch if a switch is to be removed. Disconnect the hoses if a control is to be removed.

WARNING: If the disconnect switch is removed, disconnect the negative cable at the battery .



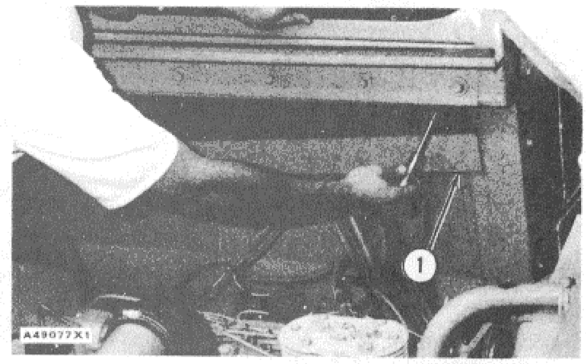
INSTALL DASH CONTROLS AND SWITCHES

1. Install the wires or hoses to the correct switch or valve.



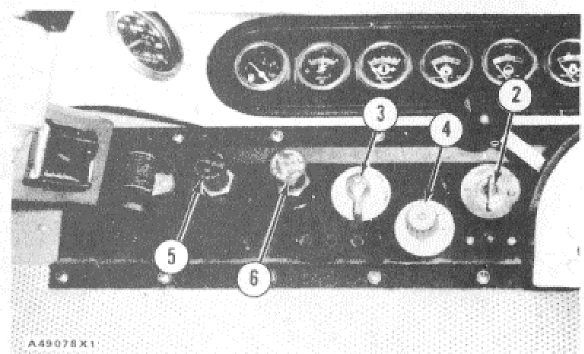
DASH CONTROLS AND SWITCHES, PARKING/EMERGENCY BRAKE CONTROL VALVE

2. Install cover (1) and lower the cab. See INSTALL CAB for details.



3. Install the nut to disconnect switch (2). Install the nut, the knob and the screw to start switch (3) and light switch (4).

4. Install the nut, the knob and the pin to emergency brake (6) and parking brake (5) control valves.

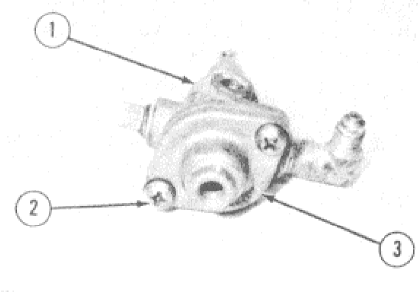


DISASSEMBLE PARKING/EMERGENCY BRAKE CONTROL VALVE

start by:
a) remove parking/emergency brake control valve

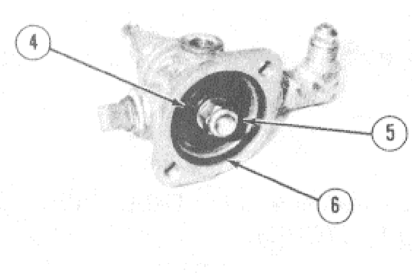
*NOTE: This operation is in REMOVE DASH CONTROLS AND SWITCHES.

I. Remove screws (2) from valve body (1). Remove cover (3).



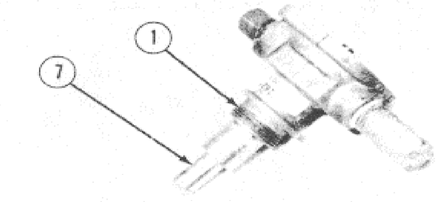
2. Remove nut (5) and the washer from the shaft.

3. Remove rubber spacer (4) and ring (6) from the valve body.



PARKING/EMERGENCY BRAKE CONTROL VALVE

4. Remove shaft (7) and the spring from valve body (I).

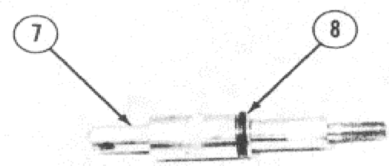


5. Remove seal (8) from shaft (7).

A49081X1

ASSEMBLE PARKING/EMERGENCY BRAKE CONTROL VALVE

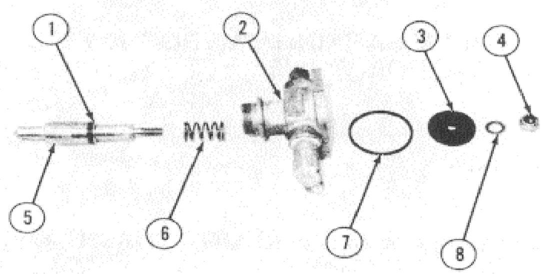
1. Install seal (1) on shaft (5). Install spring (6) on the shaft and put the shaft in valve body (2).



2. Install ring (7) in the val\fs20 e body. Install spacer (3), washer (8) and nut (4) on the shaft. Hold the end of the shaft and tighten the nut.

A49082X1

3. Install cover (9) on valve body) (2) and install the screw.

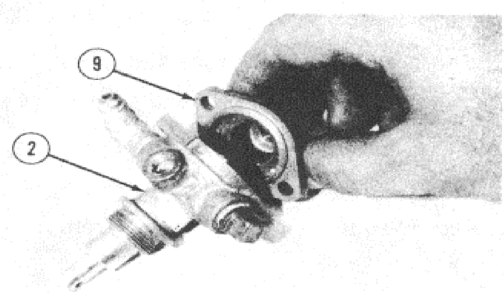


A49083X1

end by:

a) install parking/emergency brake control valve*

*NOTE: This operation is in INSTALL DASH CONTROLS AND SWITCHES.



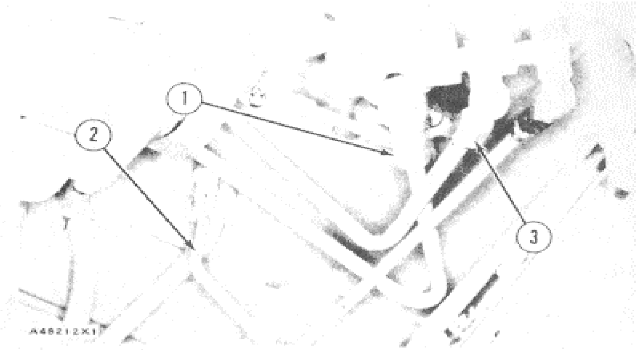
A49084X1

STEERING COLUMN

REMOVE STEERING COLUMN

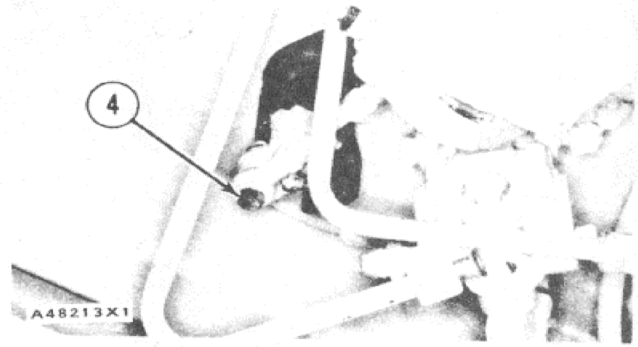
	Tools Needed	A	B
1H3107	Puller Assembly	1	
8B7551	Bearing Puller Attachment	1	
8H684	Ratchet Box Wrench	1	
T774	Spacer	1	
1P2852	Spanner Wrench		1

I. Remove tube (2) from the machine. Disconnect tubes. (I) and (3) from the brake valve



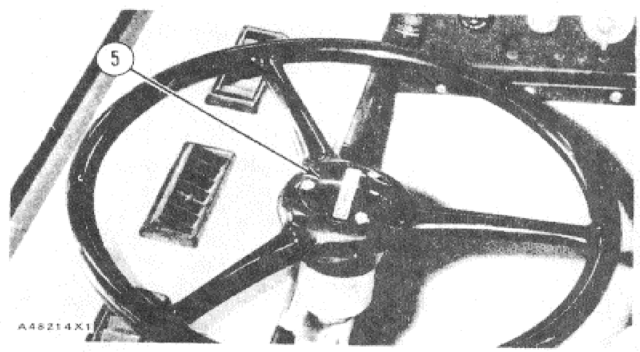
VIEW FROM UNDER CAB

2. Remove cotter pin. nut and bolt (4) from the lever on the end of the steering column.

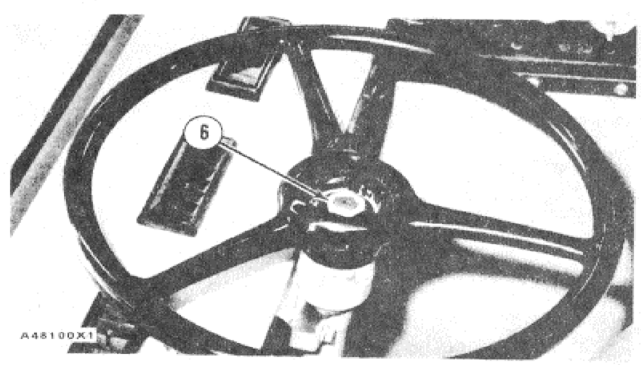


VIEW FROM UNDER CAB

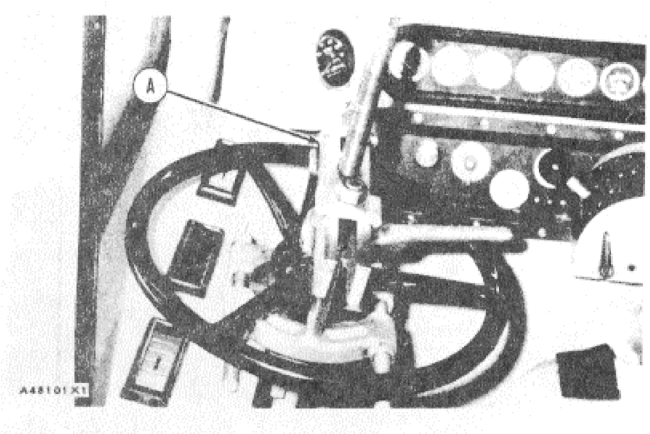
3. Remove screws, cover (5) from the steering wheel. Remove the three spacers under the cover.



4. Remove nut (6) from the shaft.

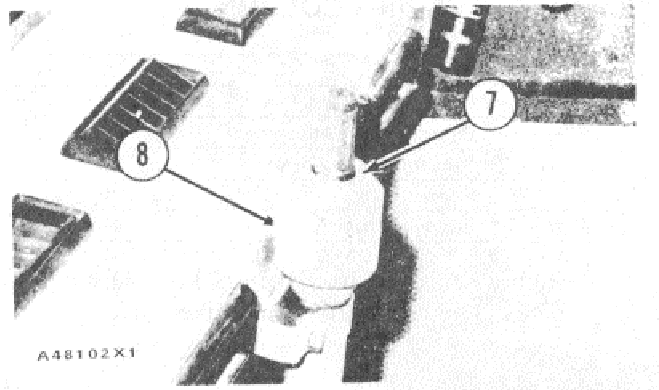


5. Install tooling (A) and remove the steering wheel.



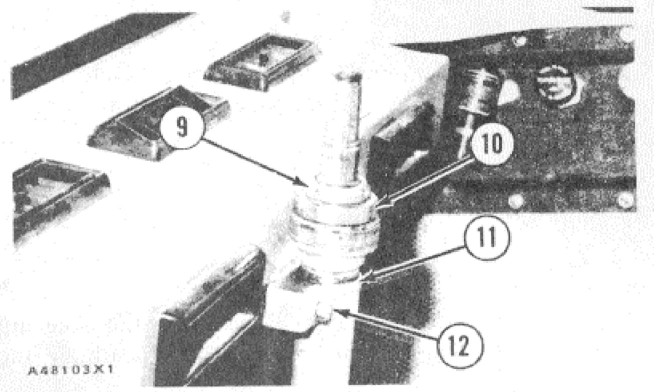
STEERING COLUMN

6. Remote nut (8) with a 2 ’/4 in. open end wrench. Remove seal (7) from nut (8).

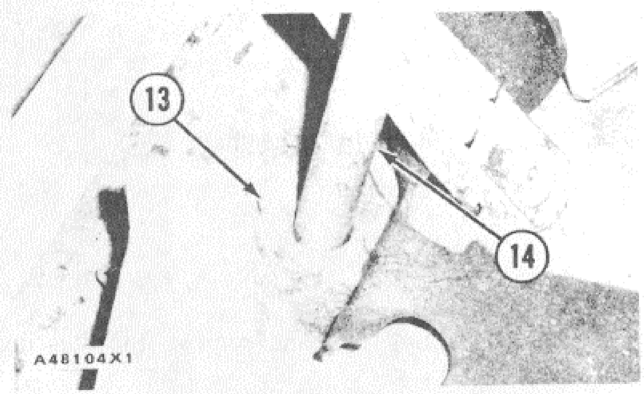


7 Remove nut (9) with tool (B). Remote hearing(10) from the shaft.

8. Remove two bolts (12) from the steering column clamp. Remove clamp (ll) from the steering column.



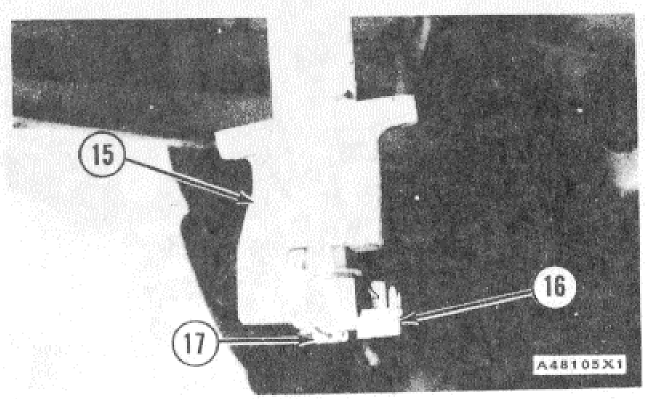
9. Move the mat enough to remove bolts (13). Then lower column (14) as far as possible.



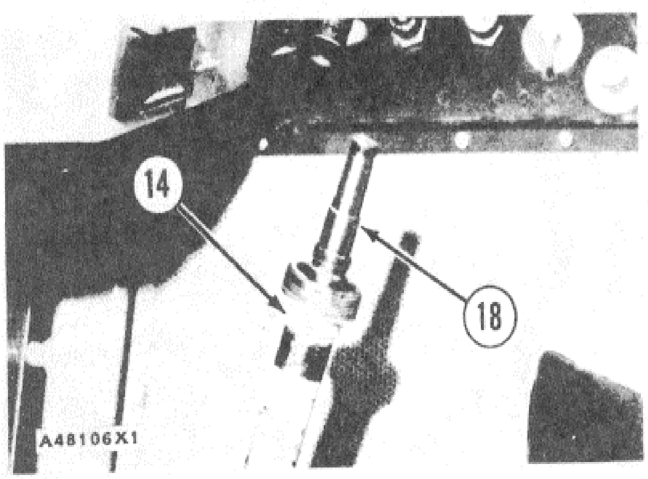
10. Remove the wire from bolt (17). Remove bolt (17) and the washer from end of shaft.

11. Remove lever (16) with a hammer. Remove the key from the shaft.

12. Turn stop (15) off the column.

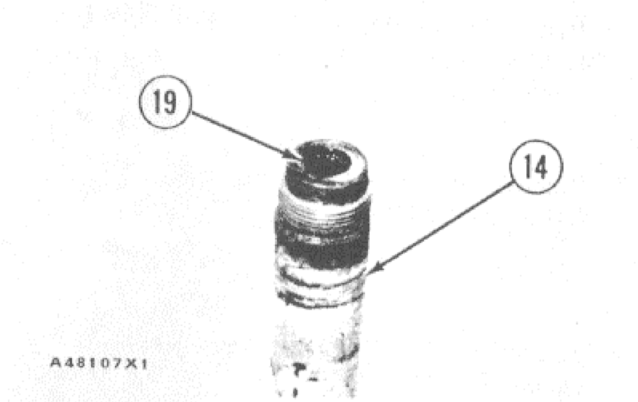


13. Remove steering column (14) from the cab. Remove shaft (18) from the column.



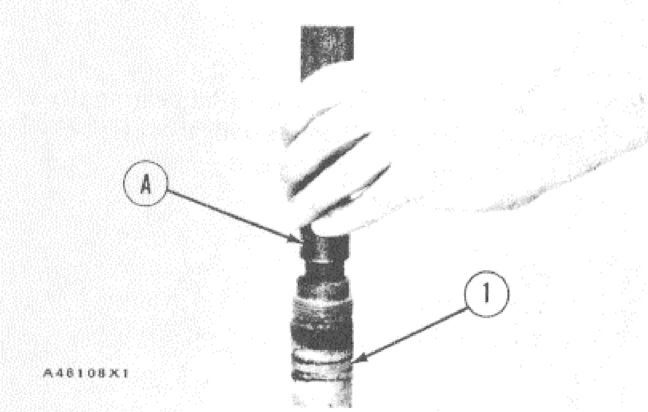
STEERING COLUMN

14. Remove bearing (19) from the bottom of the column (14).



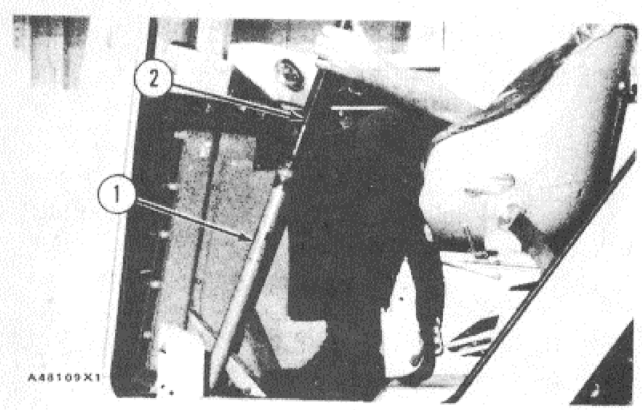
INSTALL STEERING COLUMN

	Tools Needed	A	B
1P510	Driver Group	1	
1P2852	Spanner Wrench		1

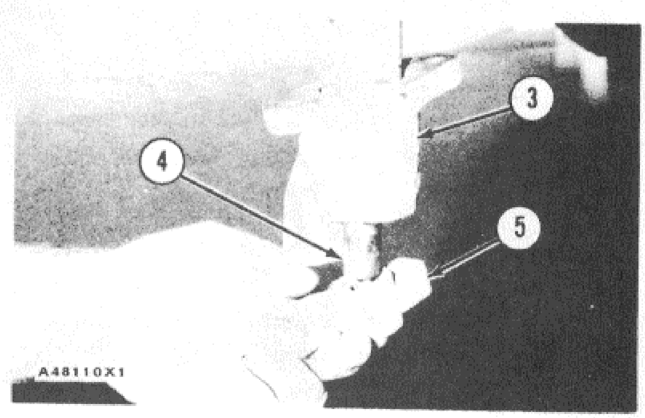


I. Install the bearing with tooling (A) in the bottom of column (I).

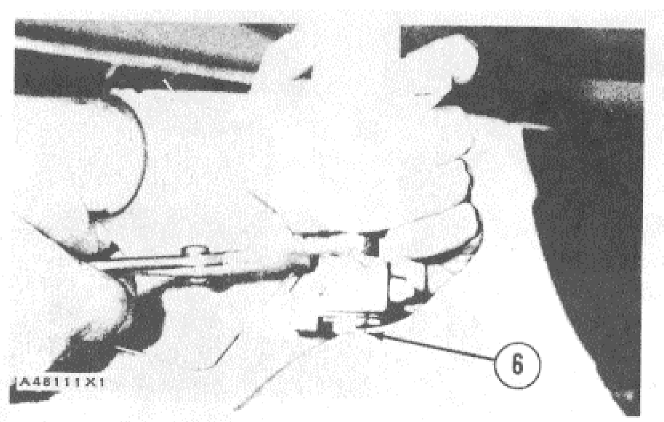
2. Install column (I) in the cab. Install shaft (2) in the column. Lower the column as far as possible.



3. Turn stop (3) on to the column. Install key (4) and lever (5) on the end of the shaft.

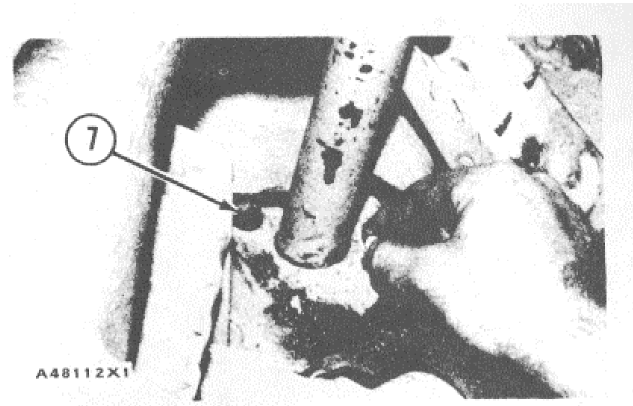


4. Install the washer and bolt (6) to the end of the shaft. Install the wire through bolt (6) and around shaft as shown.

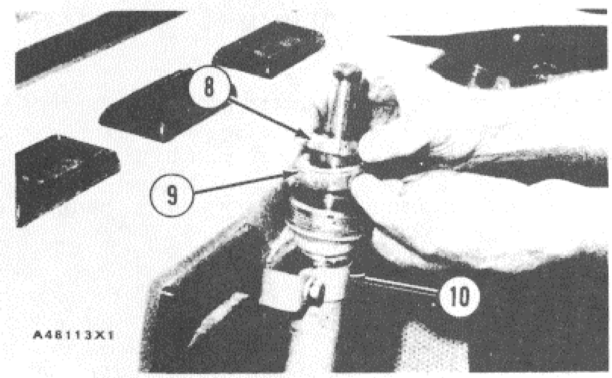


STEERING COLUMN

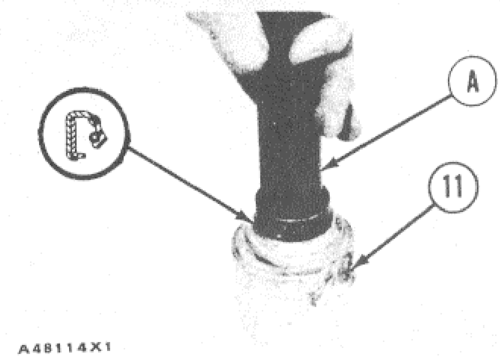
5. Lift the column in position and install bolts (7).



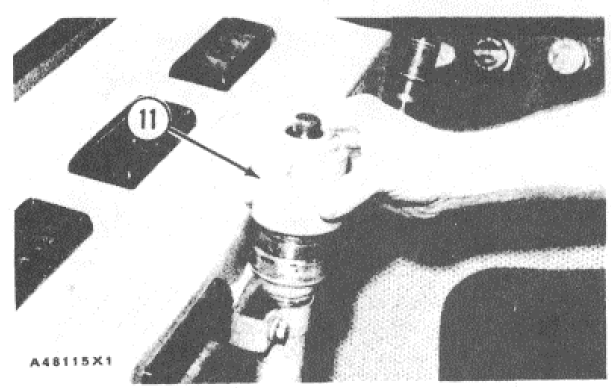
6. Install clamp (10) to the bracket. Put bearing (9) in position and install nut (8) with tool (B).



7. Install the seal even with the surface with tooling (A). The lip of the seal is toward the inside of nut (II).

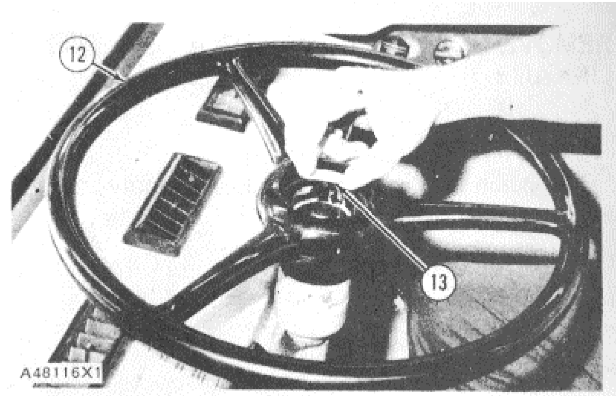


8. Install nut (II) on the column. Tighten the nut with a 2 1/4 in. open end wrench. Hold the column with a chain wrench.

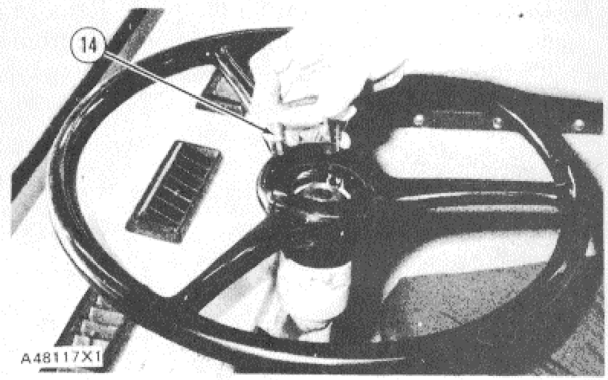


STEERING COLUMN

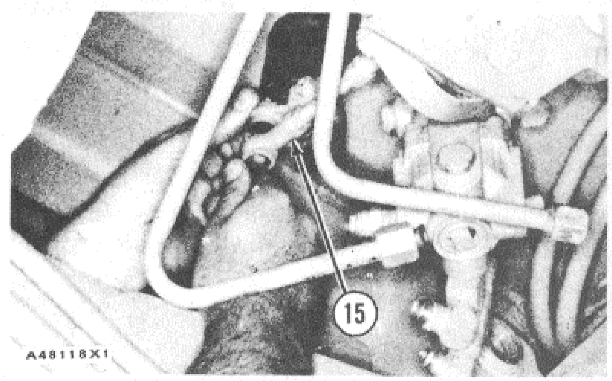
9. Install steering wheel (12) and nut (13) on the shaft.



10. Install spacers (14) on the screws. Install the cover and tighten the screws.

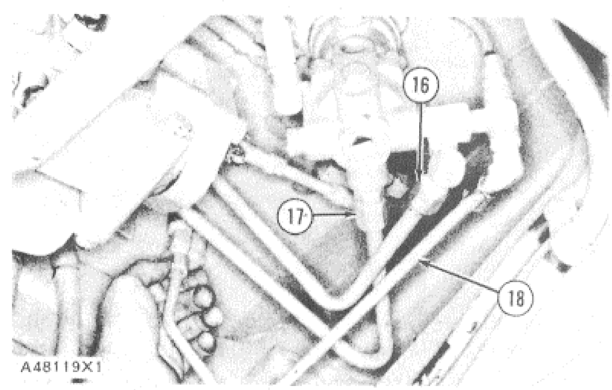


11. Connect linkage (15) to the lever with bolt, nut and cotter pin.



VIEW FROM UNDER CAB

12. Connect tubes (16) and (17) to the brake valve. Install tube (18) to the brake valve and horn valve.



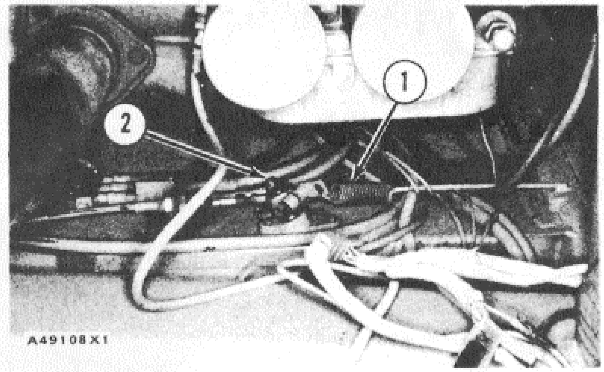
VIEW FROM UNDER CAB

GOVERNOR CONTROL LINKAGE

REMOVE GOVERNOR CONTROL LINKAGE

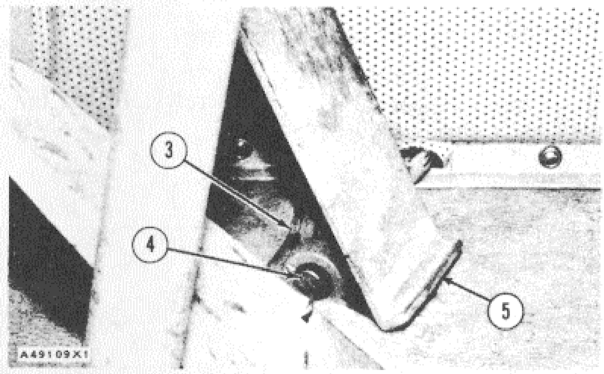
start by:
a) remove crankcase guard*

*This operation is in the Engine Disassembly and Assembly.

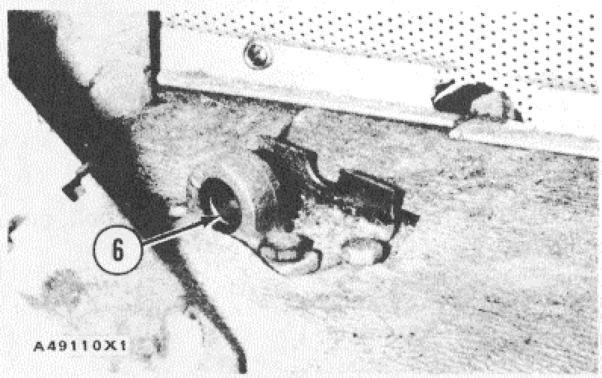


VIEW FROM UNDER ENGINE

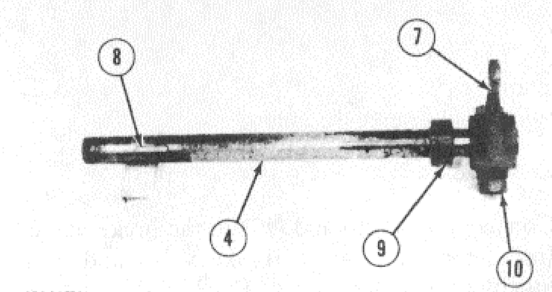
I. Disconnect spring (I) from the plate. Remove nut (2) and disconnect the governor cable from the lever.



2. Loosen bolt (3) in back of the pedal. Remove shaft (4) from the cab. Remove pedal (5).



3. Remove bushing (6) from the bracket.

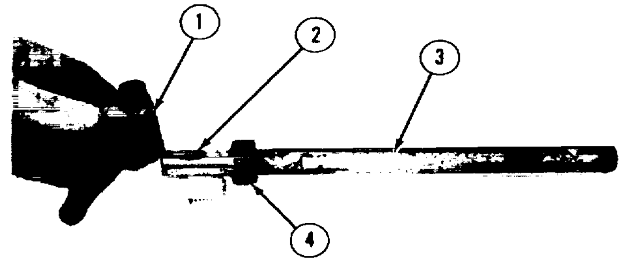


4. Remove key (8). Loosen nut (10) and remove lever (7) from shaft (4). Remove the key under the lever and slide bushing (9) off the shaft.

GOVERNOR CONTROL LINKAGE

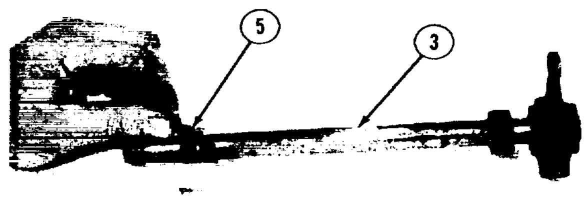
INSTALL GOVERNOR CONTROL LINKAGE 1265-12

1. Put bushing (4) on shaft (3). Install key (2) and lever (I) on shaft (3). Tighten the nut.



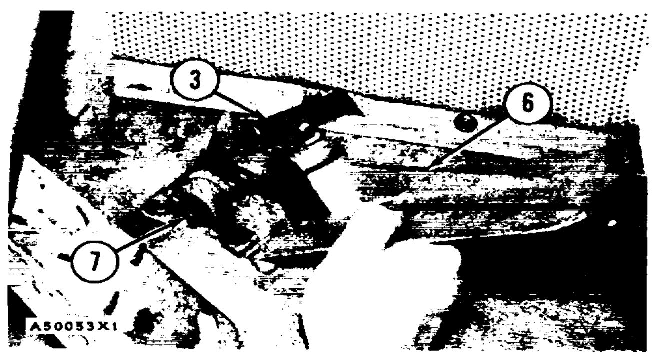
A49112X1

2. Install key (5) on the shaft (3).

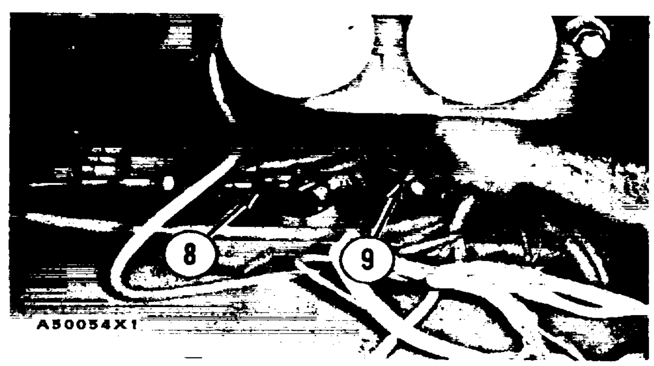


A50052X1

3. Install bushing (7) in the bracket. Put pedal (6) in position and install shaft (3) through the pedal and the bracket.



4. Connect governor cable (8) to the lever. Connect spring (9) to the plate.



end by:

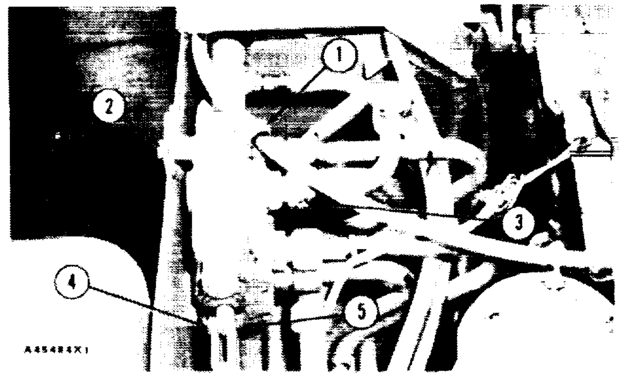
a) install crankcase guard*

*This operation is in the Engine Disassembly and Assembly.

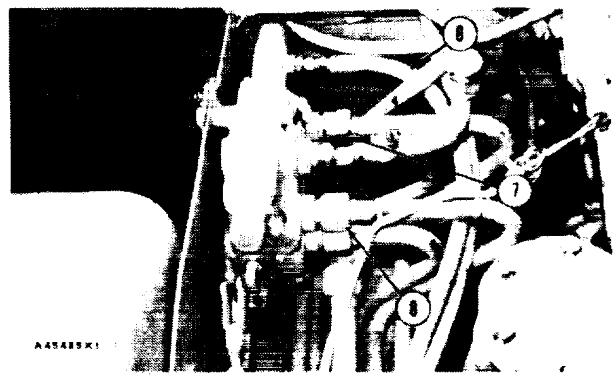
BOWL AND EJECTOR CONTROL VALVE

REMOVE BOWL AND EJECTOR CONTROL VALVE

1. Remove the nut from bolt (2). Remove battery cable clamp ( ) from the bolt. Move battery cable out of the way.

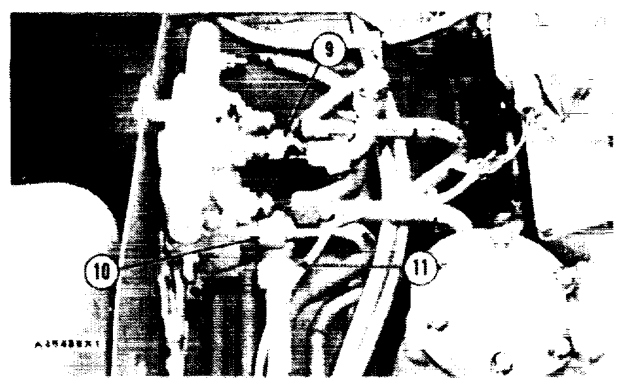


2. Disconnect tube (3) from the valve.



3. Remove cotter pins (5) and pins (4) from the two control cables.

4. Disconnect hose (6) from the valve. Disconnect tubes (7) and (8) from the valve.



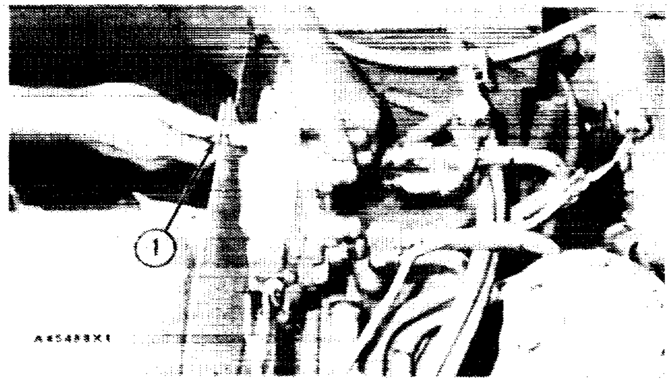
5. Disconnect tubes (9), (10) and (11) from the valve.

6. Remove nuts and bolts (2). Remove the valve.

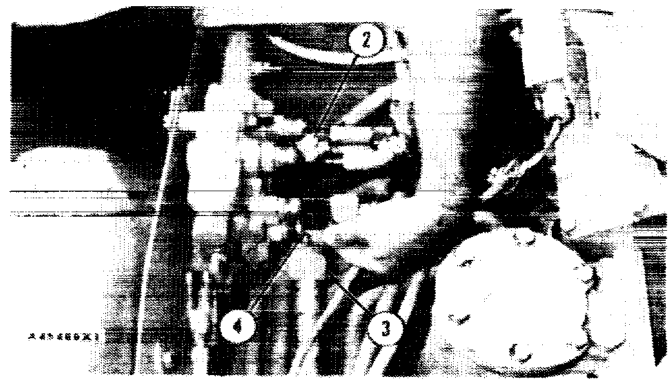
BOWL AND -EJECTOR CONTROL VALVE

INSTALL BOWL AND EJECTOR CONTROL VALVE

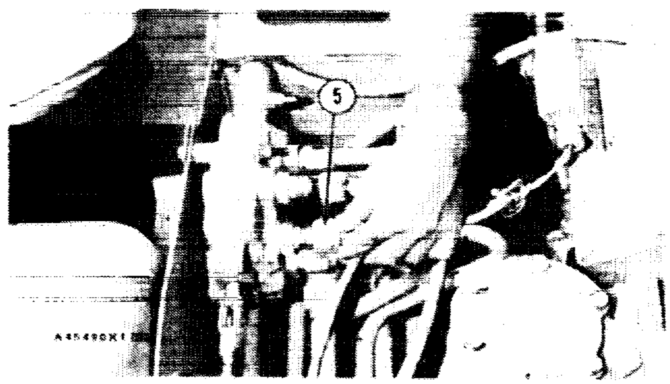
1. Install the valve and bolts (1).



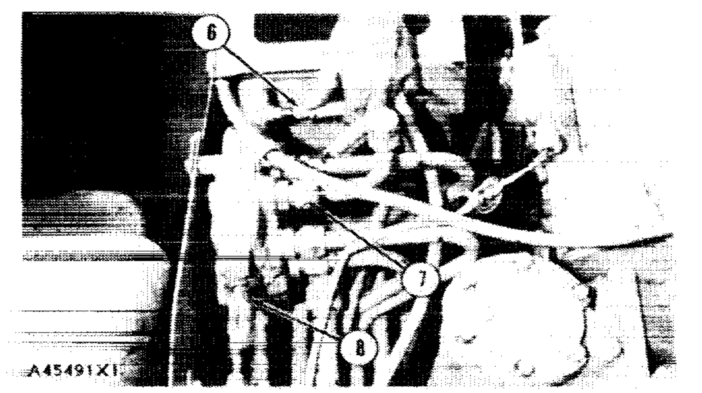
2. Connect tubes (2), (3) and (4) to the valve.



3. Connect tube (5) to the valve.



4. Connect tube (7) and hose (6) to the valve. To connect the two cables to the valve, install pin and cotter pin (8).



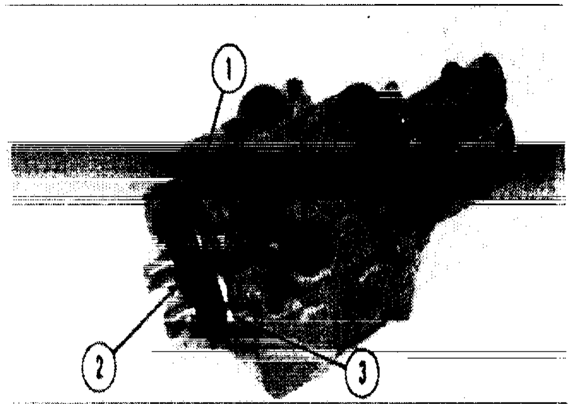
BOWL AND EJECTOR CONTROL VALVE

DISASSEMBLE BOWL AND EJECTOR CONTROL VALVE

	Tools Needed	A	B
1P1857	Snap Ring Pliers	1	
1P1856	Snap Ring Pliers	1	

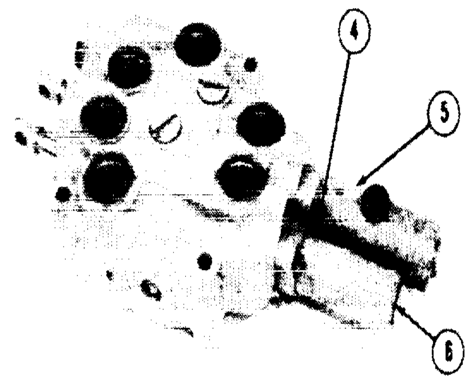
start by:
a) remove bowl and ejector control valve

1. Remove four screws (1), retainers (3), rubber seals (2) and the washers from the valve spools.



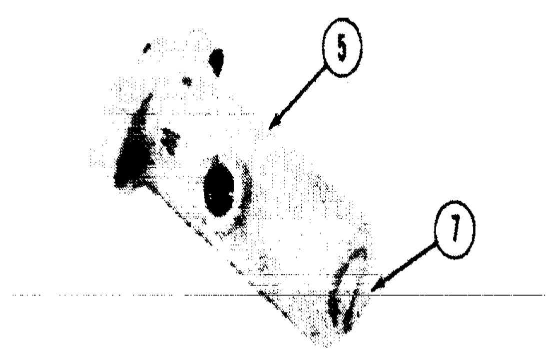
A49085X1

2. Remove four bolts (4). Remove caps (5) and (6) from the body. Remove cap (6) carefully because of the three balls on the valve spool.



A49086X1

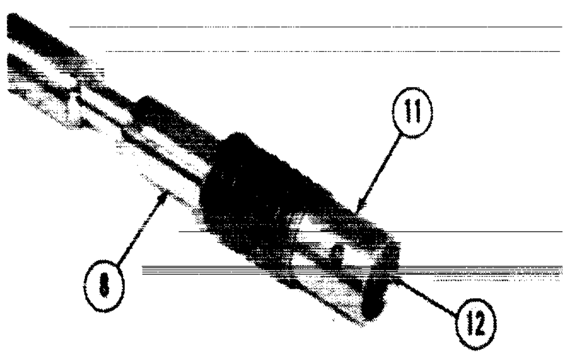
3. Remove the O-ring seal from the front of cap (5). Remove plug assembly (7), the spring and the ring from cap (5).



A49087X1

4. Remove sliding door cylinder valve spool (8) and bowl lift spool (9) from the body. Remove sleeve (10) from spool (8). Remove the two O-ring seals from inside the body. Check the condition of the seals. If the seals have damage, use new parts for replacement.

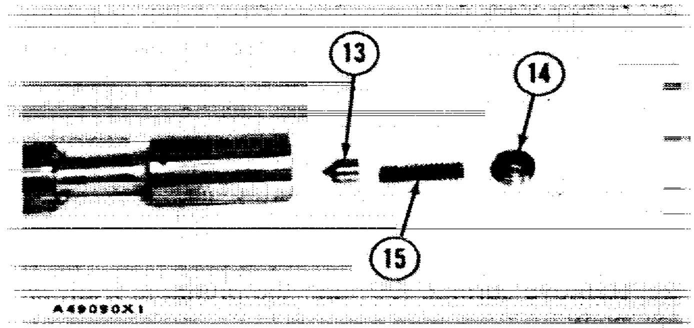
5. Remove snap ring (12) with tool (A). Remove the washer, the spring and the plunger from inside valve spool (8). Turn retainer (1 I) off valve spool (8). Remove the piston assembly, the spring and the two washers from the spool.



A49089X1

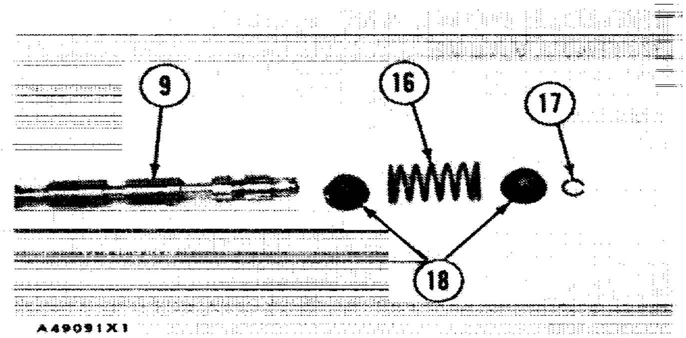
BOWL AND EJECTOR CONTROL VALVE

6. Remove screw (14), spring (15) and poppet (13) from the inside of the valve spool.

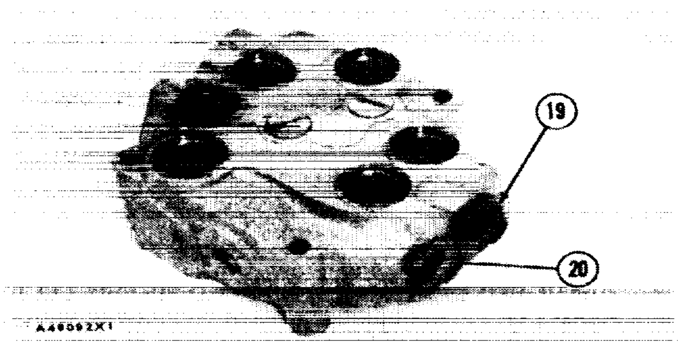


7. Remove snap ring (17) from valve spool (9) with tool (B). Remove washers (18) and spring (16) from the valve spool.

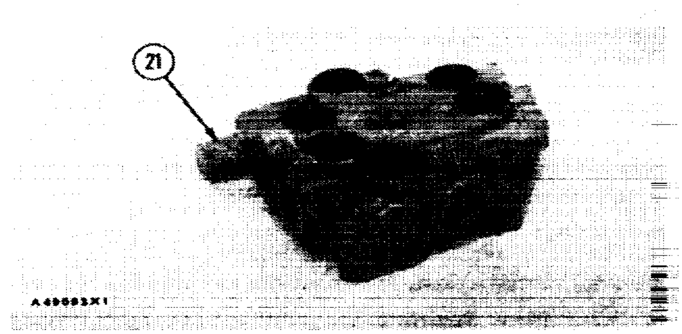
WARNING: Retainer is under tension from the spring that is behind it.



8. Remove retainers(l9) and (20) and the O-ring seals. Check the condition of the O-ring seals. If the seals have damage, use new parts for replacement.

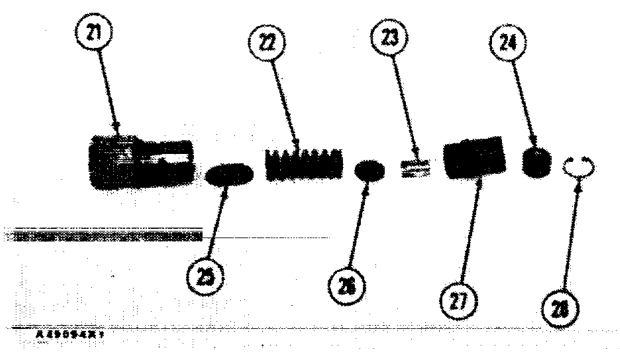


9. Remove relief valve assembly (21) from the body. Remove the washer and the seal from inside the body.



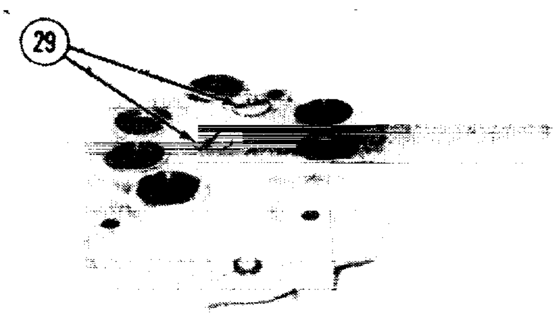
10. Remove snap ring (28) with tool (A). Remove sleeve (24) and the ball from housing (27). Turn housing (27) counterclockwise off the valve body (21) and remove piston (23), washer (26), spring (22) and washers (shims) (25). Check the condition of the O-ring seals. If the seals have damage, use new parts for replacement.

NOTE: Keep the washers (shims) together for installation purpose.



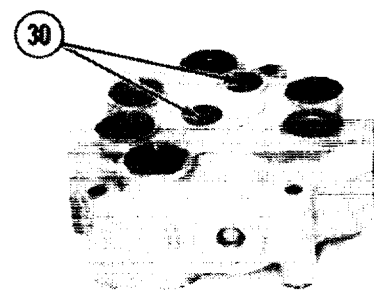
BOWL AND EJECTOR CONTROL VALVE

11. Remove plugs (29) from the body. Remove the O-ring seals from the plugs. Check the condition of the O-ring seals. If the seals have damage, use new parts for replacement.



A49095X1

12. Remove springs (30) and the plungers from the body.

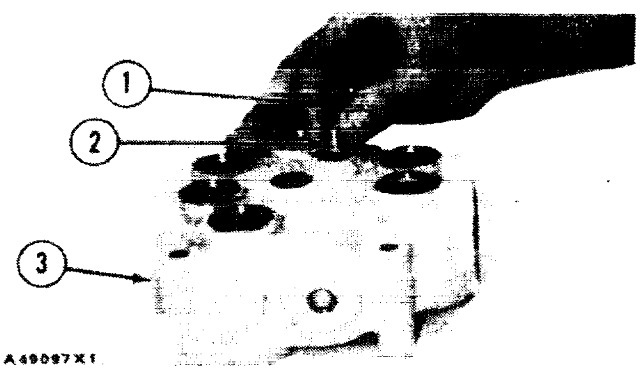


A49096X1

ASSEMBLE BOWL AND EJECTOR CONTROL VALVE

	Tools Needed	A	B
1P1857	Snap Ring Pliers	1	
1P1856	Snap Ring Pliers		1

1. Make sure all of the parts are clean and free of dirt and foreign material. Put clean hydraulic oil on all of the parts of the valve.



A49097X1

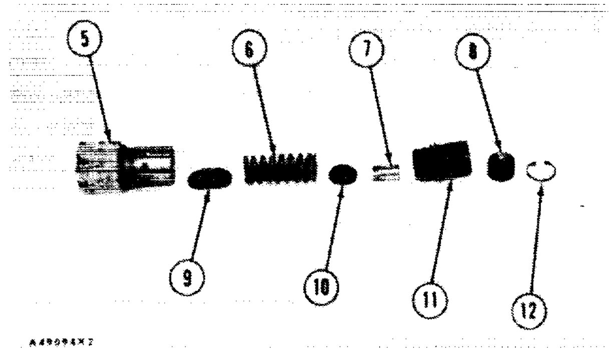
2. Install two plungers (2) and two springs (1) in body (3).

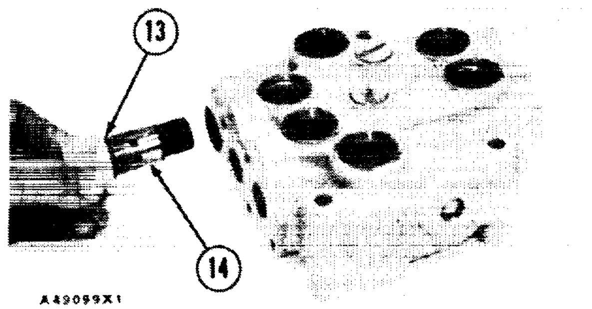
A49098X1

3. Install the O-ring seals on plugs (4). Install plugs (4) in the body.

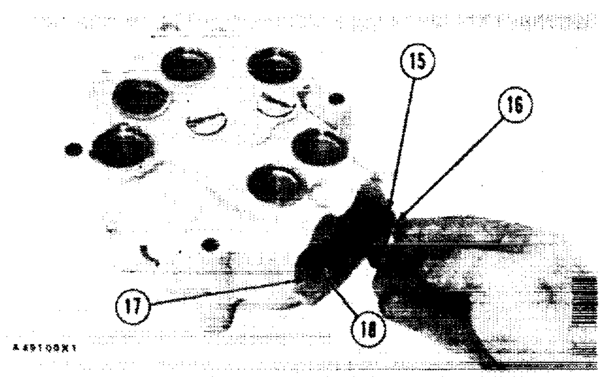
BOWL AND EJECTOR CONTROL VALVE

4. Install washers (shims) (9), spring (6), washer (10) and piston (7) in valve body (5). Put the O-ring seal on housing (11) and install the housing in valve body (5). Install the ball and sleeve (8) in the housing. Install snap ring (12) in the housing with tool (A). See TESTING AND ADJUSTING for correct adjustment.

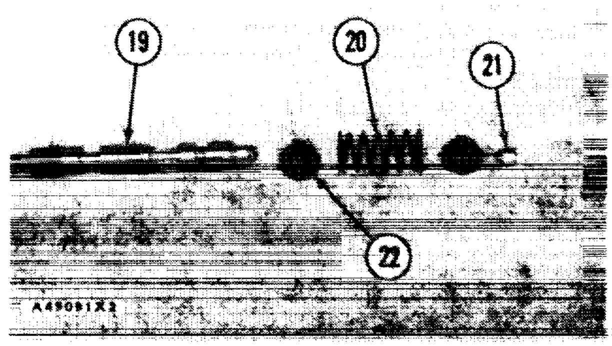




5. Install the seal and the washer in the inside of the body. Put O-ring seal (13) on relief valve assembly (14) and install it in the body.



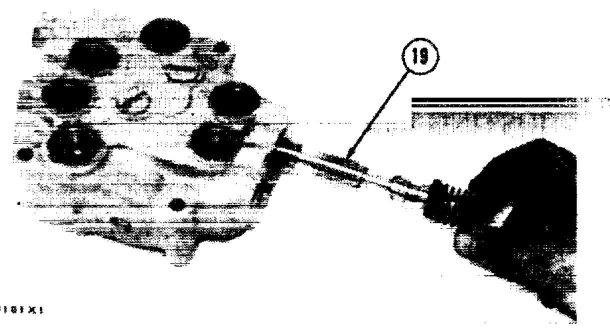
6. Install O-ring seal (18) and retainer (17) in the body. Put O-ring seal (15) in retainer (16) and install the retainer in the body.



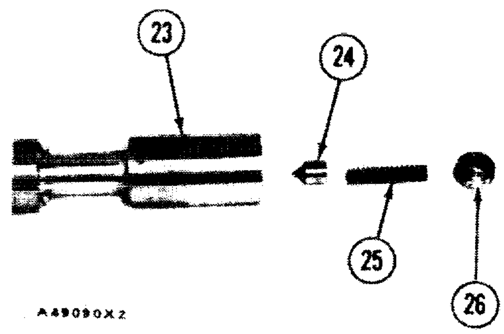
7. Put retainer (22), spring (20) and retainer on valve spool (19). Install snap ring (21) on the valve spool with tool (B).

BOWL AND EJECTOR CONTROL VALVE

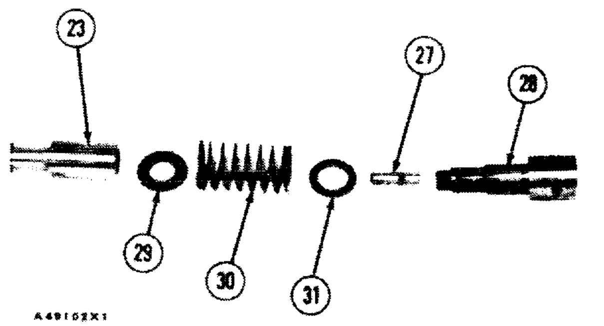
8. Install the two O-ring seals in the body. Install valve spool (19) in the body.



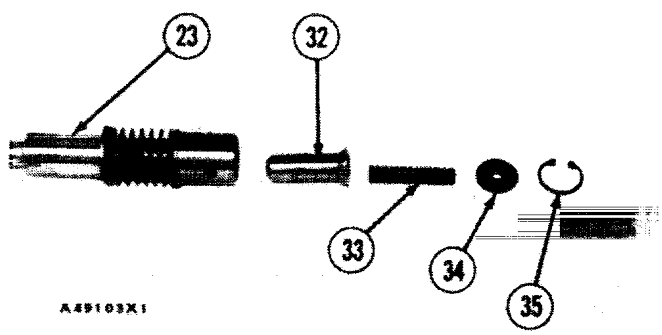
9. Put poppet (24), spring (25) and screw (26) inside valve spool (23) and tighten the screw.



10. Install O-ring seals on piston assembly (27) and retainer (28). Put washer (29), spring (30), washer (3 1) and piston assembly (27) on retainer (28). Install retainer (28) on valve spool (23) and tighten to a torque of 5 to 8 lb.ft. (7 to 11 N.m).



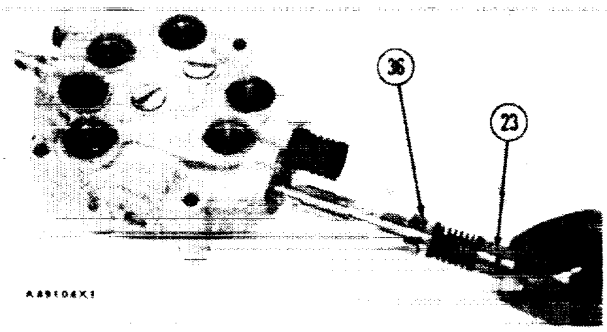
11. Put plunger (32), spring (33) and washer (34) inside valve spool (23) and install snap ring (35) in the valve spool with tool (A).



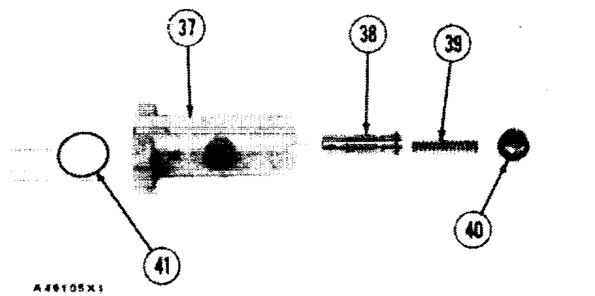
NOTE: See TESTING AND ADJUSTING for correct pressure to open poppet valve.

BOWL AND EJECTOR CONTROL VALVE

12. Install sleeve (36) on valve spool (23). Install the valve spool in the body.

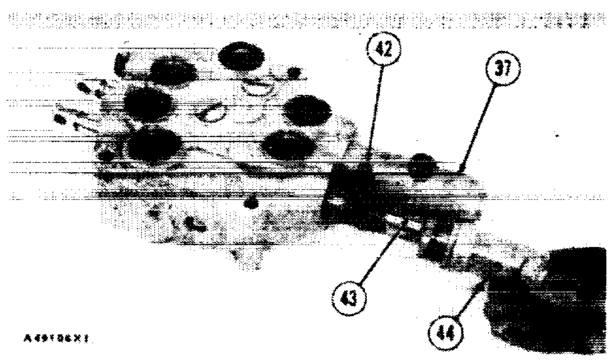


13. Install 0-ring seal (41) in cap (37). Put the seals on valve spool (38) and plug (40). Install valve spool (38), spring (39) and plug (40) in cap (37).

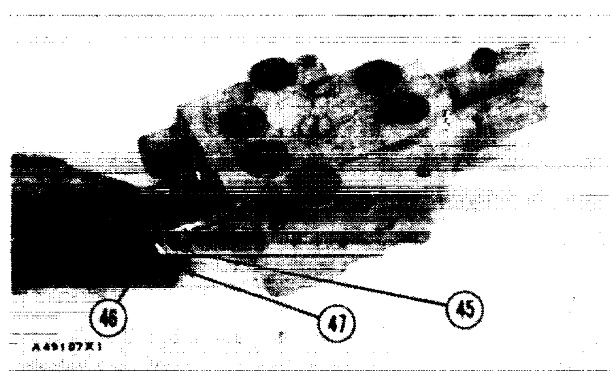


NOTE: Put 4L7464 Silicone Grease on the ends of the valve spools before the installation of the caps.

14. Install cap (37) and two bolts (42). Install the seal in cap (44) and three balls (43) on the valve spool. Install cap (44) on the valve spool and install two bolts to hold it. Tighten the four bolts to a torque of 10 to 13 lb.ft. (14 to 18 N.m).



NOTE: Put 4L7464 Silicone Grease on the ends of the valve spools before the installation of the rubber seals.

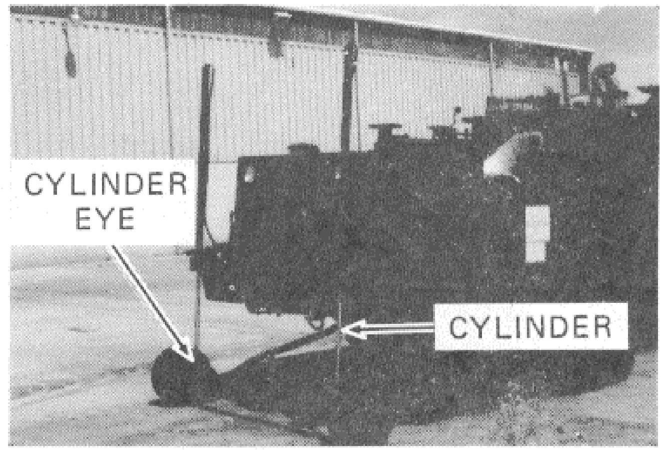


15. Install washers (45), retainers (47) and rubber seals (46) on the valve spools. Install the four screws that hold the retainers.
end by:
a) install bowl and ejector control valve

LOAD TRANSFER CYLINDER

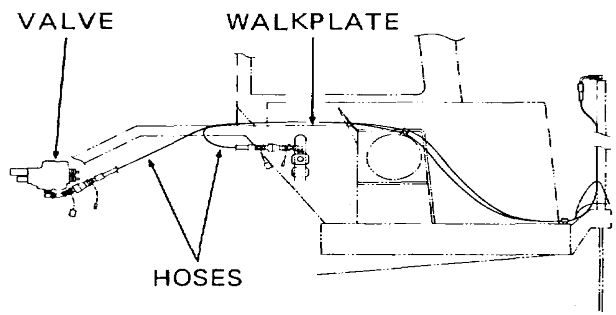
REMOVE LOAD TRANSFER CYLINDER

1. Start the engine, and lower the load transfer axle. Stop the engine.

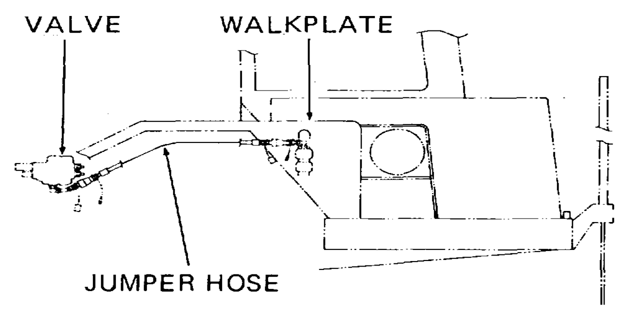


2. Disconnect the load transfer axle cylinder eyes from the lugs on the axle. Start the engine, retract the cylinders, and stop the engine.

3. Disconnect two hoses; one from the dump and lift valve, and one from the fitting under the walkplate near the right front fender.

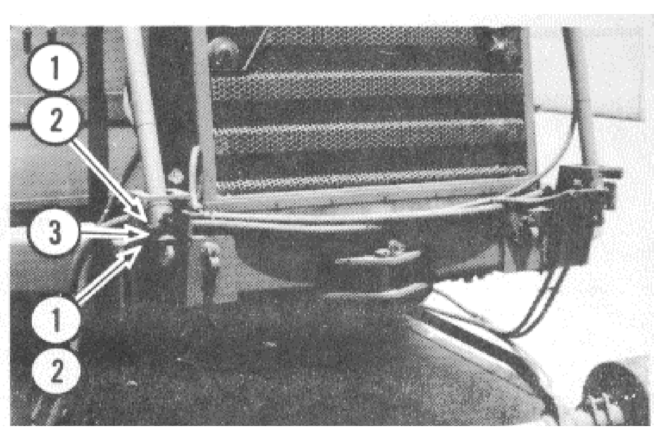


4. Attach jumper hose to fitting under walkway and to dump and lift salve.



NOTE: Attach hoist to cylinder before removing bolts (1), washers (2) and cap (3).

5. Remove four bolts (1), washers (2), cap (3) and bearings. Remove cylinder.

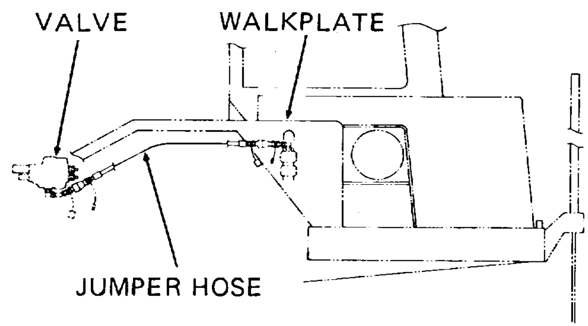


INSTALL LOAD TRANSFER CYLINDER

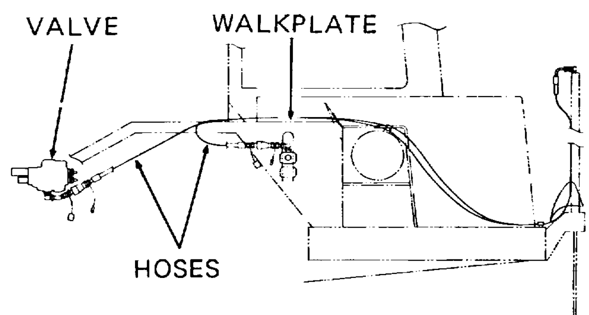
NOTE: Attach hoist to cylinder before installing bolts (1), washers (2) and cap (3).

1. Replace bearings and hoist cylinder into position. Replace cap (3), four washers (2) and bolts (1). Tighten bolts and remove hoist.

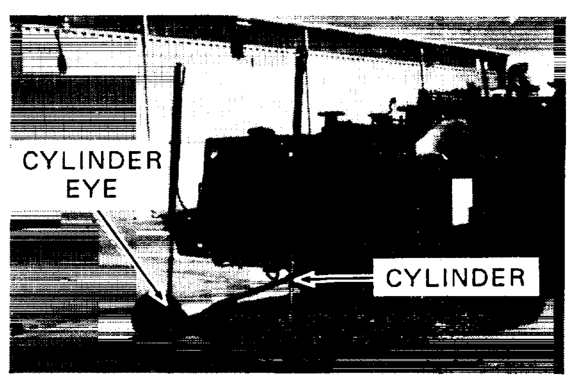
2. Remove jumper hose from fitting under walkway and from dump and lift valve.



3. Connect two hoses; one to the dump and lift valve, and one to the fitting under the walk plate near the right front fender.



4. Start the engine, extend the cylinders, and stop the engine. Connect the load transfer axle cylinder eyes to the lugs on the axle.

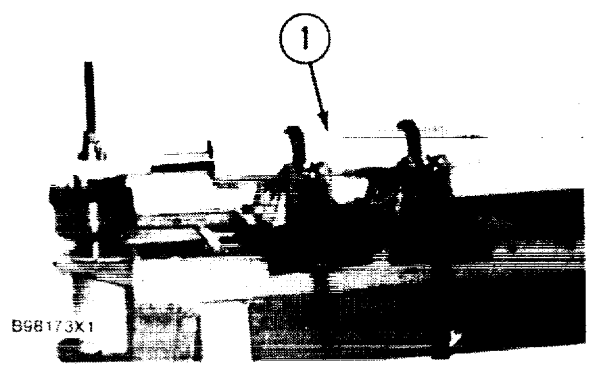


LOAD TRANSFER CYLINDER

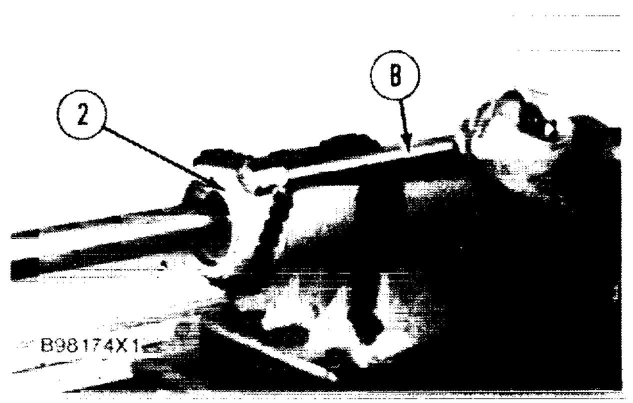
DISASSEMBLE LOAD TRANSFER CYLINDER

	Tools Needed	A	B	C	D
6V4947	Hydraulic Cylinder Repair	1			
	Stand				
3S6224	Hydraulic Pump Assembly	1			
3P1535	Chain Wrench Group		1		
1P850	Torque Multiplier			1	
5S6079	Socket			1	
1P851	Spline Adapter			1	
1P852	Male Adapter			1	
6V3160	Hydraulic Cylinder				1
IP1832	Bearing Pulling Adapter				1
1P543	Nut				1
9S5559	Stud				1
	Sleeve [2 1/2" (64 mm) I.D.				1
	x 6" (152 mm)]				
5P8250	Washer				1
6V9061	Hand Pump (or electric)				1

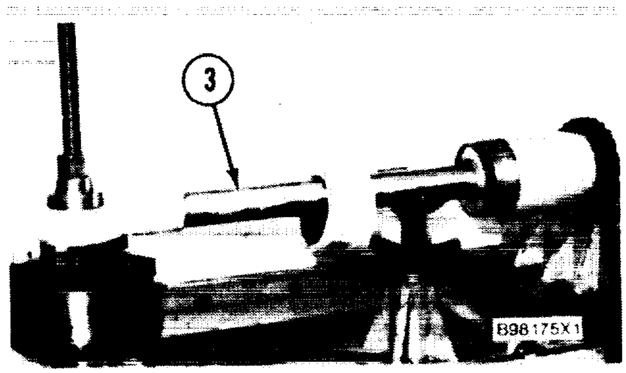
1. Install cylinder (1) on tooling (A).



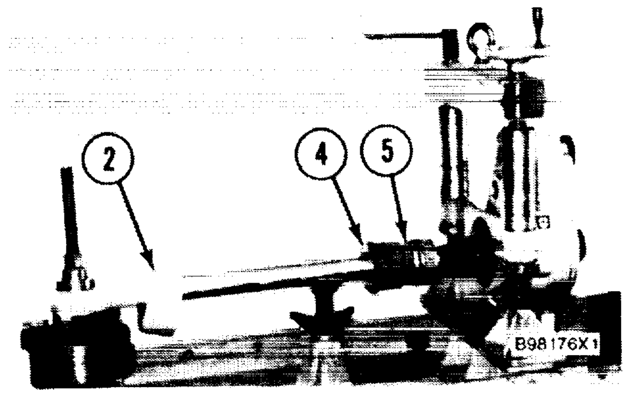
2. Remove crown (2) from cylinder (1) with tool (B)



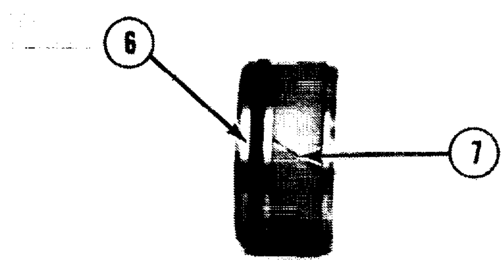
3. Put the support under rod assembly (3), and remove it from the cylinder assembly



4. Use tooling (C) to remove the bolt and washer that hold piston (5) on the rod. Remove piston (5), head (4) and crown (2) from the rod.



5. Remove seal assembly (6) and wear ring (7) from the piston.



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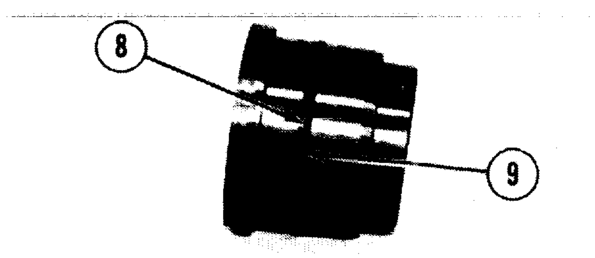
6. Remove back-up ring (8) and O-ring seal (9) from the head.



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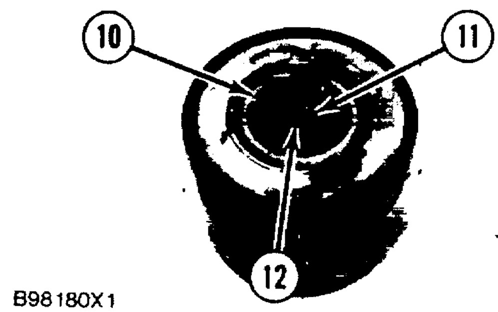
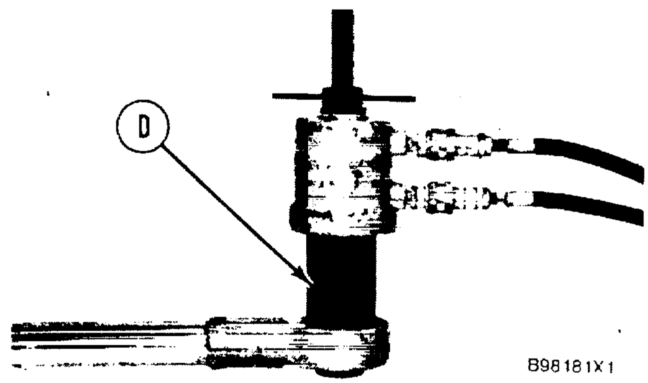
7. Remove seals (10), (11) and (12) from the Inside of the head

Group							



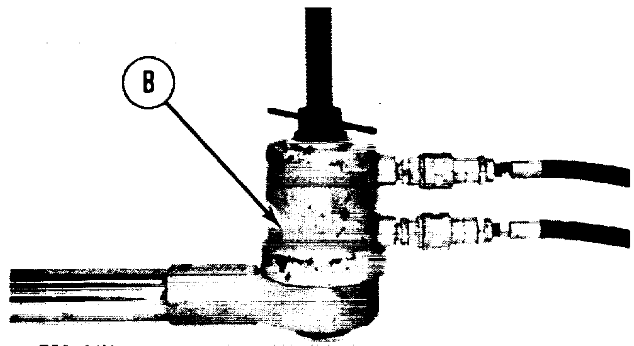
8. Remove bearing from the rod end of the cylinder with tooling (D)



Assemble Hydraulic Cylinders 5303, 4303, 5305, 5309-016

	Tools Needed	A	B	C	D	E	F	G
6V4947	Hydraulic	1						
	Cylinder Repair							
	Stand							
3S6224	Hydraulic Pump	1						
	Assembly							
6V3 160	Hydraulic		1					
	Cylinder							
1P1832	Bearing Pulling		1					
	Adapter							
1P543	Nut		1					
9S5559	Stud		1					
5P8250	Washer		1					
6V9061	Hand Pump (or		1					
	electric)							
9S0289	Compressor			1				
	Assembly							
1P510	Driver Group				1			
4S9181	Expander Assembly					1		
1P850	Torque Multiplier						1	
556079	Socket						1	
1P851	Spline Adapter						1	
1P852	Male Adapter						1	
3P1535	Chain Wrench							1

1. Install bearing in the rod end and head end of the cylinders with tooling (B).

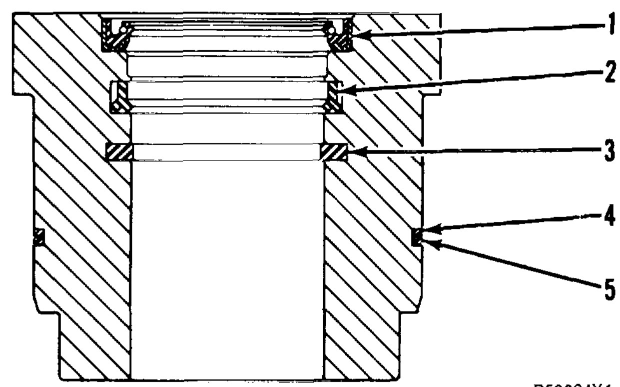


2. Use tool (C). If necessary, to install seals (2) and (3) in the head Install seal (2) with the lip in as shown

3. Use tooling (D) to Install lip-type seal (1) In the head Install the seal with the lip out as shown

4. Install back-up ring (4) and O-ring seal (5) on the outside diameter of the head

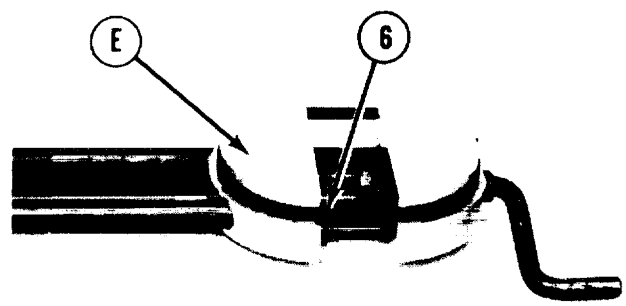
NOTE: Put clean oil on the edge of each seal.



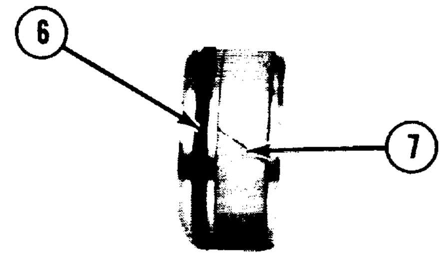
NOTICE

Seal (6) must be made larger (stretched) evenly about its circumference. Do not make the seal any larger than necessary.

5. Put seal assembly (6) in position on tool (E). Make the seal larger; then release the tension on the seal assembly Reposition the seal assembly on tool (E) Again make the seal assembly larger, then release the tension on the seal assembly. Make the seal just large enough to be installed on the piston. Numbers on the guide bar on the expander assembly correspond with the piston diameter, and give the correct indication of the needed size on the moveable block after the tension is released on the seal assembly



6. Install seal assembly (6) and wear ring (7) on the piston

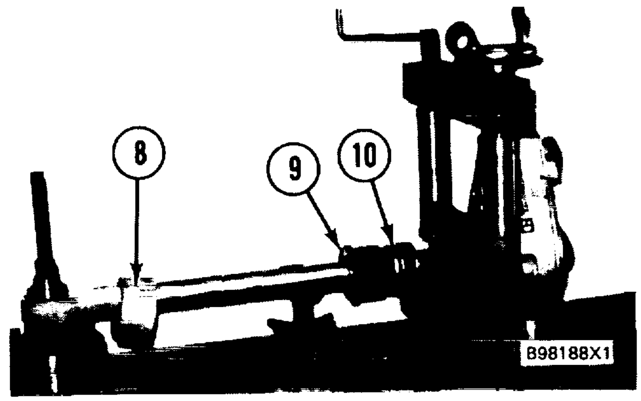


B05709X5

7. Put crown (8), head (9) and piston (10) on the cylinder rod

8. Put 2P2506 Thread Lubricant on the threads of the bolt that hold piston (10) in position on the rod Install the bolt and washer that hold the piston in position.

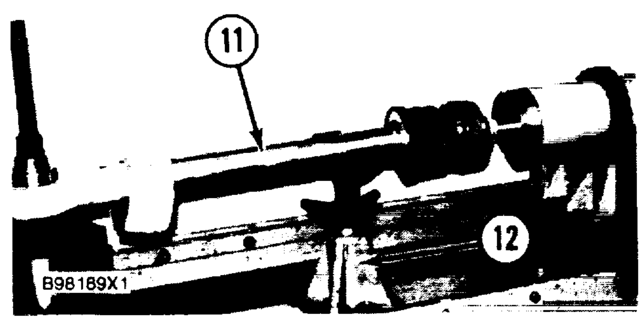
9. Put tooling (F) in position Use tooling (F) to tighten the bolt for the ejector and steering cylinders to a torque of 1080 ± 108 N. m (800 1-80 lb. ft) Tighten the bowl lift cylinder bolts to a torque of 1125 ± 100 Nom (830 ± 75 lb. ft) Tighten the floor cylinder bolt to a torque of 2580 ± 258 Nom (1910 ± 190 lb. ft).



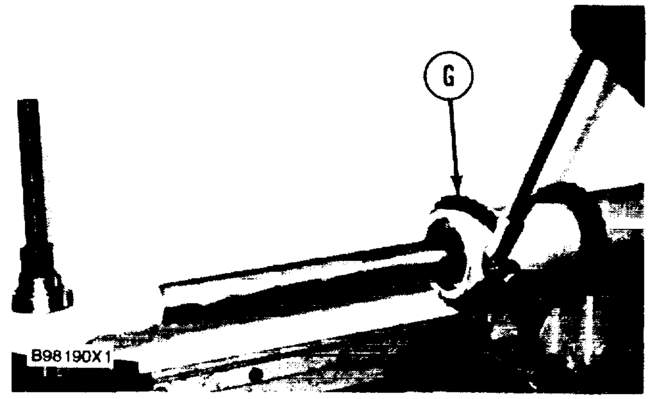
10. Remove tooling (F).

11. Install rod assembly (11) in the cylinder. Remove support (12) from under the cylinder rod

12. Put clean grease on the threads on the outside diameter of the cylinder and on the threads on the inside diameter of crown (8).



13. Install the crown on the cylinder Use tool (G) to tighten the crown to the correct torque Use the following formula to determine the correct amount of force (in lbs.) to use to get the correct torque.



$$X = \frac{Y}{Z}$$

"X" is the amount of force (In pounds) needed to get the correct torque on the crown.

"Y" is the torque that is needed.

"Z" is the distance (In feet) from the centerline of the cylinder to the position of the hand on the handle of the chain wrench group (or extension if needed)

NOTE: Tighten the crown with the rod fully extended This will keep cylinder, piston and head in better alignment

14. Tighten the crown for all the cylinders to a torque of 475 + 270 - 0 Nom (350 + 200 - 0 lb. ft)

15. Fasten a hoist to the cylinder, and remove it from tooling (A).

SECTION 4
RECONDITIONING PROCEDURES
4.5" BORE, V8 DIRECT INJECTION ENGINE

GENERAL INFORMATION

The 4.5" bore, V8 (Direct Injection) Engine can be reconditioned to provide performance characteristics comparable to a new engine. The reconditioned engine will operate satisfactorily if certain reconditioning precautions are observed.

Performance and oil control comparable to a new engine can be obtained only if the necessary machining is done to the required Specifications. Cylinder block reconditioning requires an automatic honing machine to control size, surface finish, and crosshatch pattern of the cylinder bores. A manually operated hone does not give satisfactory results and is not recommended.

To facilitate reconditioning, pistons and rings are available .020 in. (0.51 mm) and .040 in. (1.02 mm) oversize.

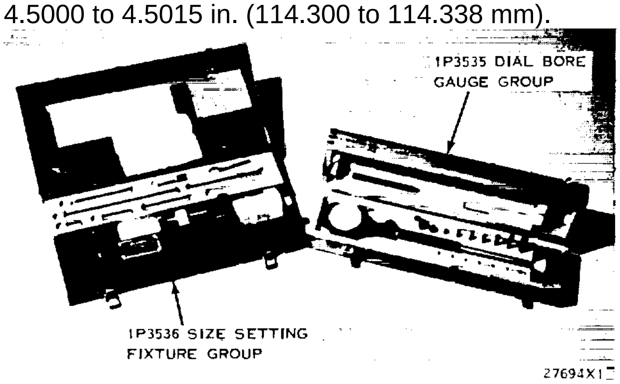
Connecting rod and main bearings are available .010 in. (0.25 mm), .020 in. (0.51 mm) and .050 in. (1.27 mm) undersize.

Main bearings are available with a .010 in. (0.25 mm) oversize outside diameter. These bearings are for cylinder blocks that have had the bore for the main bearings bored oversize.

CYLINDER BLOCK HONING

The following preliminary check is essential to determine if honing is necessary, and if so, the size to hone.

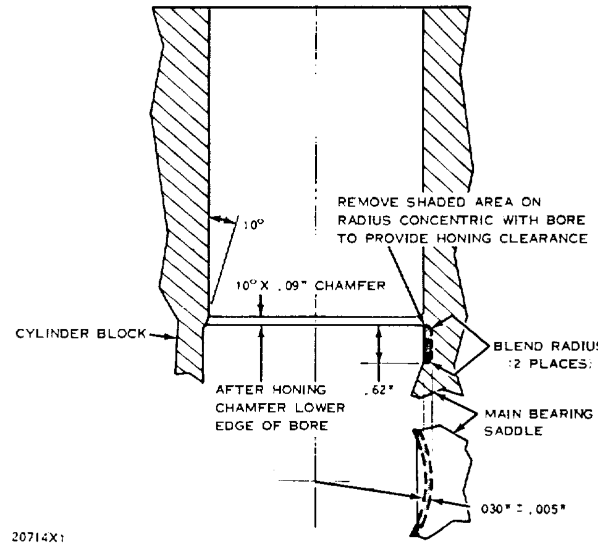
Measure all cylinder bores during disassembly using the IP3537 Bore Gauging Group. This group includes a IP3535 Dial Bore Gauge Group and a IP3536 Size Setting Fixture Group. The bore gauging group provides more accurate measurements than other methods, such as inside micrometers. When setting the gauge, always be sure the gauge pin has sufficient travel to measure the points of maximum wear in the bore. In a cylinder bore, maximum wear is usually across the diameter perpendicular to the crankshaft centerline, either at the top or bottom of ring travel. Normal wear usually will not exceed .020 in. (0.51 mm); however, if bore wear is greater than .020 in. (0.51 mm), hone the block .040 in. (1.02 mm) oversize. The fact that the block can be honed both .020 in. (0.51 mm) and .040 in. (1.02 mm) oversize will allow a block to be reconditioned twice under normal wear conditions. The standard bore size is 4.5000 to 4.5015 in. (114.300 to 114.338 mm).



1P3537 BORE GAUGING GROUP

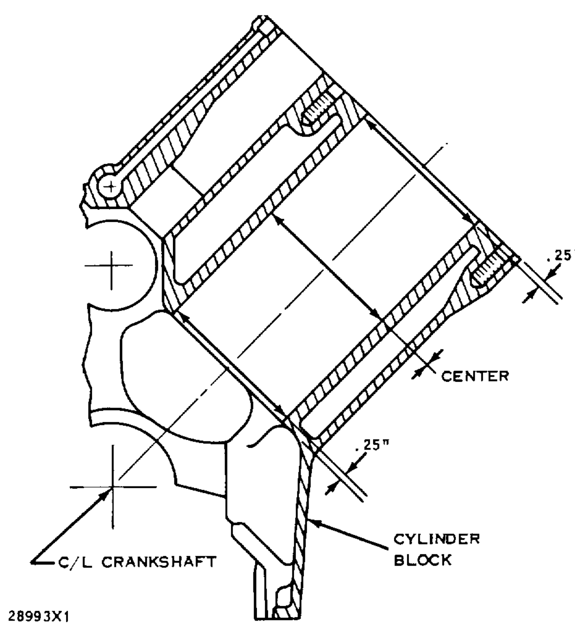
When reconditioning an engine, the bore size is the determining factor as to the necessity of honing the bores. If bores are worn .006 in. (0.15 mm) more than the standard size, the block should be honed. However, additional service may be obtained without honing if wear does not exceed the maximum wear limit of .0085 in. (0.216 mm)

Before honing, inspect the bottom of each cylinder bore adjacent to the main bearing saddle or web. Some of the saddles may overlap the edge of cylinder bores enough to interfere with honing. Where overlap exists, machine a relief in the saddle to provide clearance for the honing tool. The radius of the relief must be concentric with the cylinder bore and .030 + .005 in. (0.76 + 0.13 mm) larger than the bore radius. The relief extends .62 in. (15.7 mm) beyond the bottom of the bore, as shown. This provides adequate clearance for honing.



RELIEF IN SADDLES and CHAMFER AFTER HONING

When honing, check bore size at several locations in the length of the bore and around the circumference. Specifically measure at points perpendicular to the crankshaft centerline at locations .25 in. (6.4 mm) from each end and at center of bore. These three specific locations are primary gauge points during and after honing.



PRIMARY GAUGING POINTS

BASIC BLOCK

When honing cylinder blocks, maintain the specific dimensional surface finish and cross hatch tolerances to obtain safisfactory oil control. The tolerances specified are virtually the same as those used for original bore finish at the factory, and can be obtained with an automatic honing machine such as the Sunnen CK-I0. This machine has been evaluated and found to give satisfactory results.

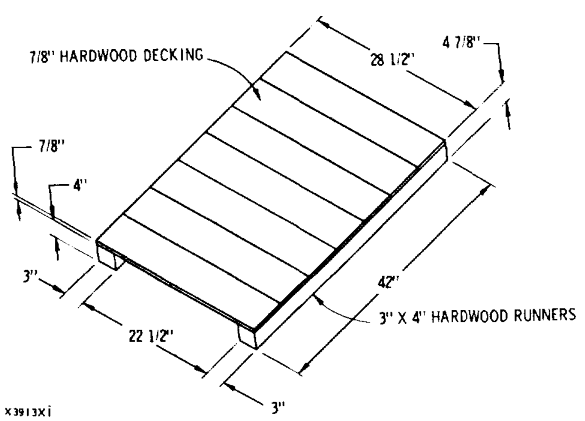
Due to the cost of suitable honing equipment, it may be more expedient to have the honing done by a shop equipped with a Sunnen CK-!O or equivalent.

TRANSIT PREPARATION

The following Steps can prevent damage to the block in transit to a shop.

1. Completely disassemble, but do not clean block. The residual oil on the surface will prevent rust.

2. Enclose the block in an industrial plastic bag and position it with the oil pan surface on a suitable wood pallet or equivalent. Dimension of a suitable wood pallet are shown.



TRANSPORTING PALLET

3. Cover the block with 1/2 in. (12.7 mm) thick plywood or equivalent, and band block to the pallet.

4. Follow similar instructions when block is returned. To prevent rust, the block should not be cleaned after honing, the film of honing oil provides ample protection from rusting.

NOTE: If blocks are to be stored for any length of time, clean and anti-rust after honing.

CLEANING PROCEDURE

After honing is completed, and before assembling the engine, the cylinder block must be cleaned and prepared according to the following instructions.

1. If not previously removed, the camshaft bearings must be removed to permit thorough cleaning of the oil passages. To remove the bearings, see the topic CAMSHAFT BEARINGS REMOVAL AND INSTALLATION.

2. Use 1P3565 Chamfering Group, remove the sharp corner at the bottom of the cylinder bores as shown. This is essential to prevent scuffing the piston skirts. The chamfer should be approximately 10° x .09 in. (10° x 2.3 mm).

CHAMFERING BORE

CAUTION

Avoid damage to the cylinder bore surface or any other parts.

3. Using the 1P5580 Brush Group and a strong detergent and water solution, clean the following areas of the block.

   A. Main oil gallery and supply passage. Use the IP5572 or IP5573 Brush and stroke several times while rotating the brush.

   B. Camshaft bearing oil passages. Use the 1P5571 Brush and stroke several times while rotating the brush.

   C. Cylinder bores. Use the 1P5574 Brush and stroke each bore for one minute while rotating the brush at 1000 rpm.

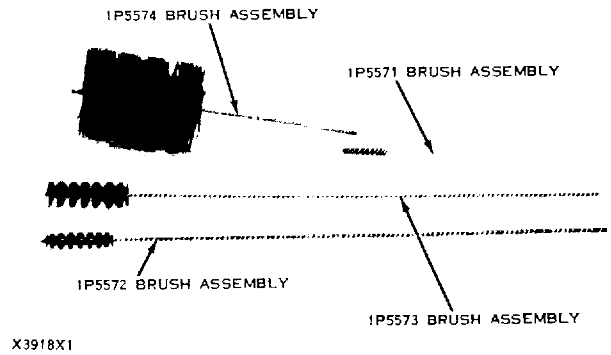
BASIC BLOCK

CAUTION

Incomplete cleaning will result in piston seizure or rapid wear of cylinder bores, pistons and rings. Only thorough rotary brushing with a strong detergent and water solution satisfactorily removes abrasive particles.

4. Thoroughly clean the cylinder block in an agitator-type cleaning tank. This type of cleaning should follow the brushing of the cylinder bores but is not sufficient by itself for cleaning.

5. Coat all machined surfaces immediatley after cleaning with engine oil (SAE 30). Keep the block covered to exclude dirt until assembled.



1P5580 BRUSH GROUP

SUNNEN CK-10 MACHINING DATA			
ITEM	**ROUGH**	**SEMIFINISH**	**FINISH**
.020 In. (0.51 mm)	4.5155 ± .001 in.	4.5185 ± .0005 in.	4.5205 ± .0005 in.
oversize bore	(114.694 ± 0.03 mm)	(114.770 ± 0.013 mm)	(114.821 ± 0.013mm)
.040 in. (1.02 mm)	4.5355 ± .001 In.	4.5385 ± .0005 in.	4.5405 ± .0005 in.
oversize bore	(115.202 ± 0.03 mm)	(115.278 ± 0.013 mm)	(115.329 ± 0.013mm)
Cylinder length	8 in. (203.2 mm)	8 in. (203.2 mm)	8 in.(203.2 mm)
Hone Head	CK-3000	CK-3000	CK-3000
Stroke	2.75 in. (69.9 mm)	2.75 in. (69.9 mm)	2.75 in. (69.9 mm)
Stroke length setting	8 in. (203.2 mm)	8 in. (203.2 mm)	8 in. (203.2 mm)
Rotation speed (rpm)	125	125	125
Strokes per minutes	49	49	37
Feed ratchet	14	14	14
Top over stroke	.375 in. (9.53 mm)	.375 in. (9.53 mm)	.375 in. (9.53 mm)
Stone	EHU-123	EHU-525	JHU-820
Load meter	85	75	40
Stock removal rate	.005 in.	.0025 in.	.0006 in.
Per minute	(0.13 mm)	(0.064 mm)	(0.015 mm)
Honing-per each .001 in. (0.03 mm)	.001 in.	.003 in.	.012 in.
stock removal, advance feed	(0.03 mm)	(0.08 mm)	(0.30 mm)
Surface finish (micro-inches)	-	-	5 to 15
NOTE: Mount cylinder block on .675" riser plates. Use 42" long bar, move clamps and riser blocks to extreme ends of carriage.			

BASIC BLOCK

SPECIFICATIONS AND TOLERANCES			
Dimension Location	**Standard Size**	**.020" (0.51 mm) Oversize**	**.040" (1.02 mm) Oversize**
Cylinder bore-finished	4.5000 to 4.5015 in. (114.300 to114.338mm)	4 5205 ± .0005 in. (114.821 ± 0.013 mm)	4.5405 ± 0005 In (115329 ± 0.013mm)
**Allowable wear limit	4.506 in. (114.45 mm)	4.526 in. (114.96 mm)	-
Maximum wear limit	4.509 in. (114.53 mm)	4.529 in. (115.03 mm)	4.549 in. (115.54 mm)
Surface finish (micro-inches)	5 to 15	5 to 15	5 to 15
Crosshatch included angle	140 to 150	138 to 150	138 to 150
Rough hone	-	4.5155 ± .001 in. (114.694 ± 0.03 mm)	4.5355 ± .001 in. (115.202 ± 0.03 mm)
Semifinish hone	-	4.5185 ± .0005 in. (114 770 ± 0.013 mm)	4.5385 ± .0005 in. (115.278 ± 0.013 mm)
**Top ring gap new	.0225 ± .0075 in. (0.572 ± 0.190 mm)	.0225 ± .0075 in. (0.572 ± 0.190 mm)	.0225 + .0075 in. (0.572 ± 0.190 mm)
**Allowable wear limit	.045 in. (1.14 mm)	.045 in. (1.14 mm)	.045 in. (1.14 mm)
Maximum wear limit	.055 in (1.40 mm)	.055 in. (1.40 mm)	.055 in. (1.40 mm)
***Oil ring gap-new	.0200 ± .0100 in. (0.508 ± 0.254 mm)	.0200 ± .0100 in. (0.508 ± 0.254 mm)	.0200 ± .0100 in. (0.508 ± 0.254 mm)
**Allowable wear limit	.038 in. (0.97 mm)	.038 in. (0.97 mm)	.038 in. (0.97 mm)
Maximum wear limit	.045 in. (1.14 mm)	.045 in. (1.14 mm)	.045 in. (1.14 mm)
Top ring vertical clearance in groove-new	.0030 to .0055 in. (0.076 to 0.140 mm)	.0030 to .0055 in. (0.076 to 0.140 mm)	.0030 to .0055 in. (0.076 to 0.140 mm)
**Allowable wear limit	.011 in. (0.28 mm)	.011 in. (0.28 mm)	.011 in. (0.28 mm)
Maximum wear limit	.014 in. (0.36 mm)	.014 in. (0.36 mm)	.014 in. (0.36 mm)
Oil ring vertical clearance in groove-new	.0010 to .0030 in. (0.025 to 0.076 mm)	.0010 to .0030 in. (0.025 to 0.076 mm)	.0010 to .0030 in. (0.025 to 0.076 mm)
**Allowable wear limit	.006 in. (0.15 mm)	.006 in. (0.15 mm)	.006 in. (0.15 mm)
Maximum wear limit	.008 in. (0.20 mm)	.008 in. (0.20 mm)	.008 in. (0.20 mm)

*Tolerance includes out-of-round, taper and any other irregularities. Take final measurements with blocks stablized to room temperature. Finished bore must clean up to 100%.

**Allowable wear limit is the suggested wear limit for a general overhaul. However, additional service may be obtained without honing the block if wear does not exceed maximum wear limits. (Cylinder bore wear is measured at the top and bottom of ring travel.)

***To be measured in unworn area of bore.

BASIC BLOCK

TIGHTENING PROCEDURE FOR THE BOLTS FOR MAIN BEARING CAPS		
3208		1. Put engine oil on bolt threads and washer face. 2. Tighten to 30 ’ 3 lb. ft (40 ± 4 N-m). 3. Put a mark on each bolt and cap. 4. Tighten bolts from mark an added 120 °± 5°.

MAIN BEARING BORES

With the main bearing caps installed and tightened to the torque given in the chart TIGHTENING PROCEDLIRE FOR THE BOLTS FOR NIAIN BEARING CAPS. Check main bearing bore size using the 1 P3537 Gauging Group. If the main bearing bore is not x, within 3.7075 + .0015 in. (94. 171 + 0.038 mm), replace the main bearing cap. It is necessary to line bore the replacement service caps. See the topic LINE BORING MAIN BEARING CAP.

When installing main bearing caps on a reconditioned engine, use new bearing cap bolts and washers.

MAIN BEARING CAP GUIDE WIDTH

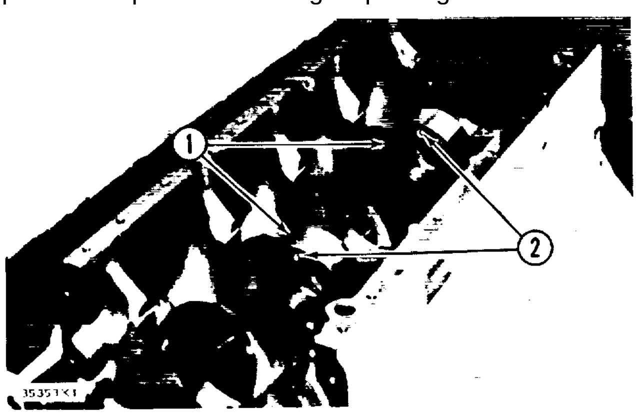
Check the width of the main bearing cap guide. The guide width of a new cap is 6.5600 + .0007 in. (166.624 $^{+}$ 0.018 mm). Replace main bearing caps that are less than the minimum width of 6.5580 in. (166.573 mm). It is necessary to line bore the replacement service caps. See the topic LINE BORING MAIN BEARING CAP.

When installing main bearing caps on a reconditioned engine, use new main bearing cap bolts and washers.

LINE BORING MAIN BEARING CAPS

When reconditioning a block, and one main bearing cap is replaced, line bore the replaced cap. If it is necessary to replace more than one cap, it is recommended that all of the main bearing bores be line bored. See the topic LINE BORING MAIN BEARING BORES.

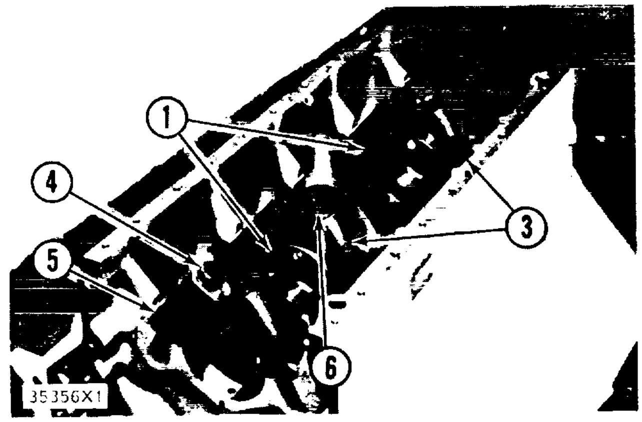
Clean bearing caps and saddles. Remove all nicks from pan rail. Plug oil holes in block with grease to prevent chips from entering oil passages.



CENTERING RINGS IN BLOCK
1. Centering rings. 2. Oiler

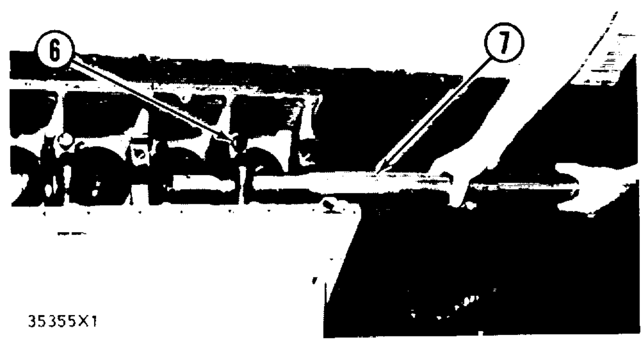
Place 1P2344 Centering Rings (1), with oiler (2) up, on each side of the cap being replaced. For an end cap, place 1P2344 Centering Rings (1) in the second and fourth main bearing bores.

Mark new cap to correspond with number on saddle and install the new unbored cap (5). Mark cap and saddle "OS" for oversize next to location number. Tighten the unbored cap bolts (4) to the torque shown in the chart TIGHTENING PROCEDURE FOR THE BOLTS FOR NIAIN BEARING CAPS. Place the original bearing caps (3) over the centering rings (1). Tighten the original bearing cap bolts (6) hand tight.



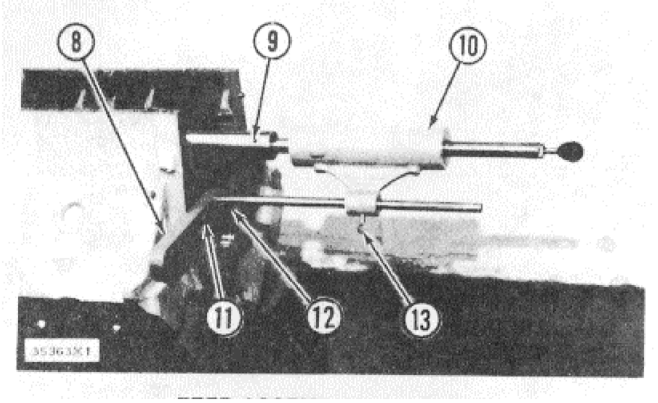
CENTERING RINGS INSTALLED
1. 1P2344 Centering Rings. 3. Original bearing caps. 4.
Bolts (two). 5. Unbored cap. 6. Bolts (four).

Oil boring bar (7) and insert it through centering rings (1). Tighten bolts (6) to a minimum of 20 lb. ft. (25 N m) and a maximum of 50 lb. ft. (70 N. m) while spinning boring bar (7) to check for binding. Centering rings (1) must be seated in bearing saddles after tightening.



INSTALLING BORING BAR
6. Bolts (four). 7. 1P2352 Boring Bar.

Bolt torsion bar assembly (8) loosely to opposite end of block from which boring bar will be driven. Install feed assembly (10) into boring bar and tighten setscrew (9). Slide feed assembly (10) onto torsion bar assembly (8) and tighten bolt (I 1). Tighten bolt (12) finger tight. Boring bar must slide in and out freely after these tightening operations. Tighten thumbscrew (13).



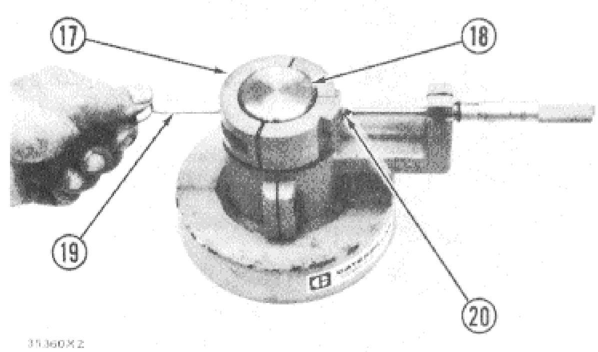
FEED ASSEMBLY INSTALLED
8. 1 P2369 Torsion Bar Assembly. 9. Setscrew. 10. 1 P2365Feed Assembly. 11. Bolt. 12. Bolt. 13. Thumbscrew.

To set tool in tool holder. Set micrometer (15) to 3. 7075 in. (94. 171 mm). Place centering ring (I) on IP2370 Micrometer Bracket Assembly. Move micrometer (15) until spindle (14) contacts centering ring (1). Tighten bolt (16). Back off micrometer thimble and recheck micrometer setting. Repeat above steps until micrometer setting is accurate.

SETTING MICROMETER
1. 1P2344 Centering Ring. 14. Micrometer spindle. 15. Micrometer. 16. Bolt.

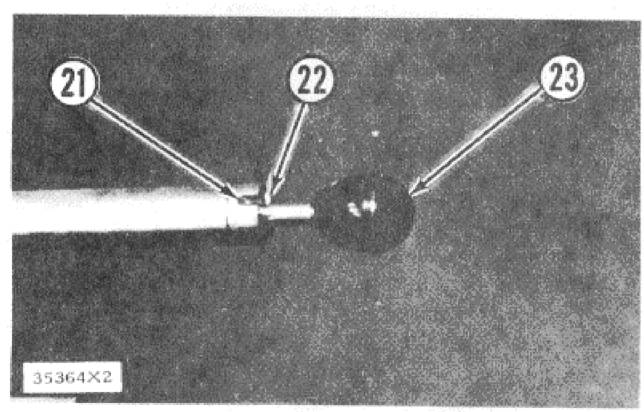
Place tool holder (17) on the 1P2370 Micrometer Bracket Assembly. Align mark on tool holder (17) with hole in shaft (18). Place tool bit (20) in tool holder (17) and set the micrometer . 070 in. (1. 78 mm) less than the finish bore diameter of 3. 7175 + . 0005 in. (94. 425 + 0. 013 mm). Turn the bracket assembly arm until micrometer spindle aligns with tool bit (20). Adjust tool bit (20) by pushing it with the 9S8521 Rod (19) until tip of tool bit (20) touches micrometer spindle.

CAUTION
Do not sweep micrometer spindle across tool bit.



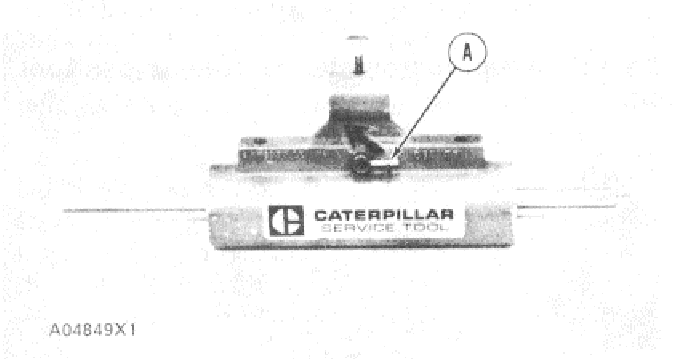
SETTING TOOL BIT
17. 1P2366 Tool Holder Assembly. 18. Shaft. 19. 9S8521Rod. 20. Tool bit.

Use a maximum of . 025 in. (0. 64 mm) rough cuts and . 010 in. (0. 25 mm) finish cuts. Wipe boring bar and tool holder clean. Place tool holder on the boring bar, with tool bit cutting edge facing the direction of rotation. Assemble the tool holder by placing lower half over the bolts, slide into slot and tighten bolts. Slide boring bar in until tool is approximately . 12 in. (3. 0 mm) from the bore. Compare tool cutting tip with bore surface while turning bore bar by hand, to insure correct tool setting. Set feed mechanism into feed by turning knob (23) until pin (22) drops into slot (21).



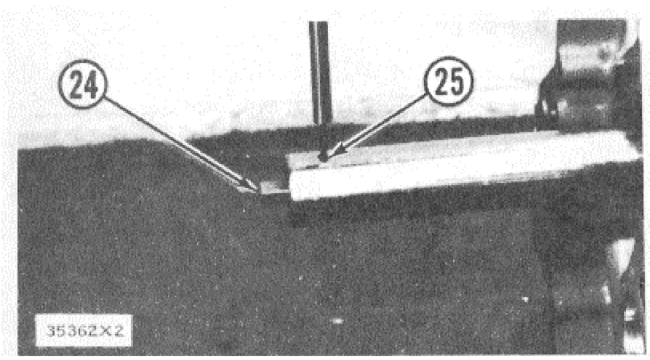
FEED ENGAGED
21. Slot. 22. Pin. 23. Knob.

NOTE: To set the feed mechanism into feed on later units, turn lever (A) up (the direction of arrow).



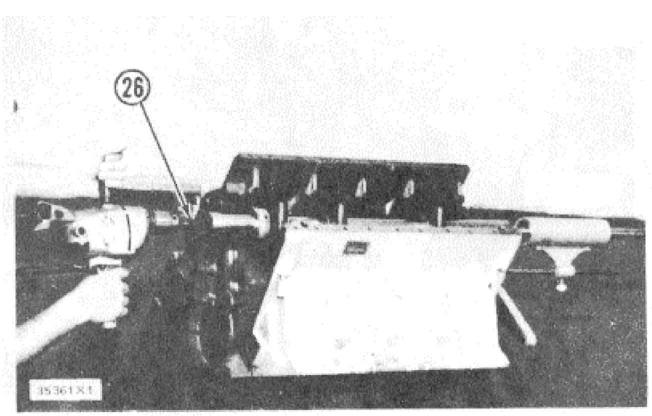
LATER FEED MECHANISM
A. Lever.

Place adapter (24) into boring bar and tightening setscrew (25).



ADAPTER INSTALLED
24. 1P2364 Adapter. 25. Setscrew.

Apply layout bluing to the bearing cap and bearing bore. Oil the centering rings. Do not use lubricant on the cutter. Use a one-half inch electric drill with universal joint (26) to feed tool through the bore. Service main bearings with . 010 in. (0. 25 mm) oversize outside diameter are available to permit the bore to be bored oversize. Bore the bore to 3. 7175 ± . 0005

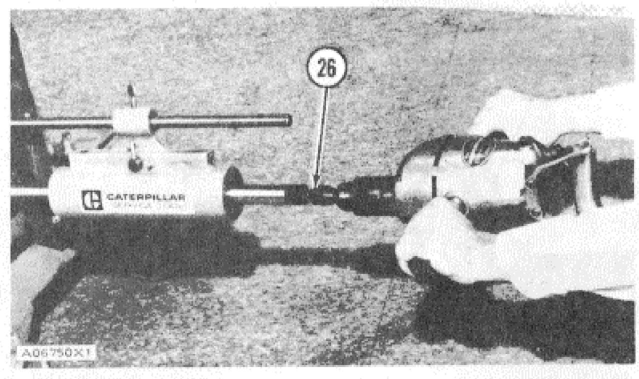


in. (94. 425 ± 0. 013 mm).

BORING BEARING BORE

26. 1P2363 Universal

NOTE: If you use the later feed mechanism, the tool can be driven either the boring bar or the feed mechanism.

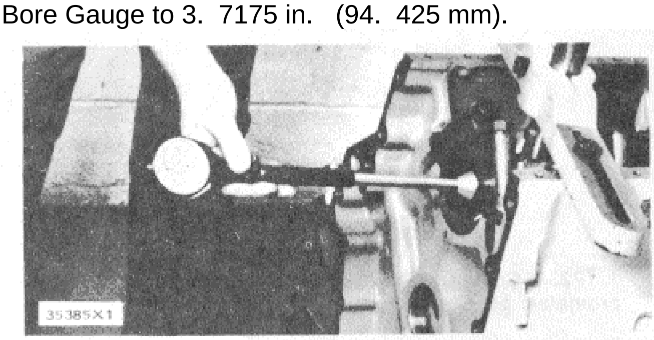


DRIVING THROUGH FEED MECHANISM
(Typical Example)
26. 1P2363 Universal.

The bluing applied to the bearing bore indicates the condition of the bore at the correct bore size. If bluing shows an out of round condition, check the largest diameter (indicated by remaining bluing) in relation to the smallest diameter (indicated by lack of bluing). The difference of the two must not exceed . 0010 in. (0. 025 mm).

If bluing indicates a step in the joint face, measure the diameter at the step in relation to the smallest diameter. A step of . 0005 in. (0. 013 mm) on one or both sides is permissible. A maximum of . 0010 in. (0. 025 mm) over the nominal finish bore diameter is permissible if within the described limits.

To check the bore diameter, set the IP3535 Dial Bore Gauge to 3. 7175 in. (94. 425 mm).



CHECKING BORE
(Typical Example)

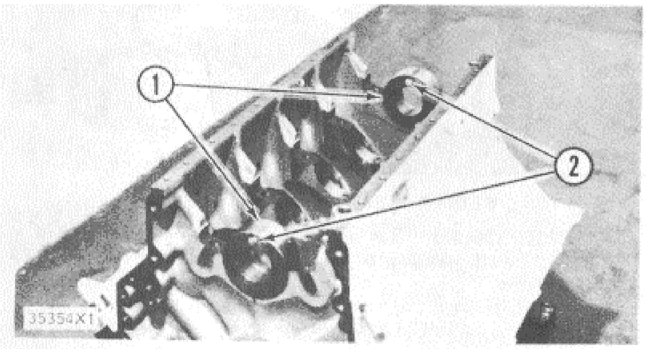
LINE BORING MAIN BEARING BORES -

Line bore all main bearing bores if bearing caps or saddles are distorted.

Clean bearing caps and saddles. Remove all nicks from pan rail. Plug oil holes in block with grease to prevent chips from entering oil passages.

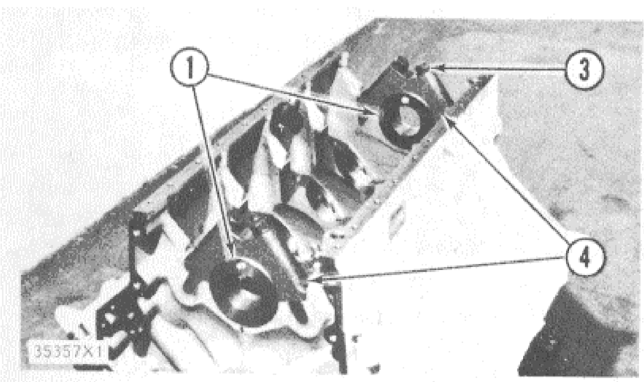
Place I P2344 Centering Rings (1), with oiler (2) up, at each end of' block. If an end bore is distorted, use the next good bore.

NOTE: There must be two good bores for locating centering rings.

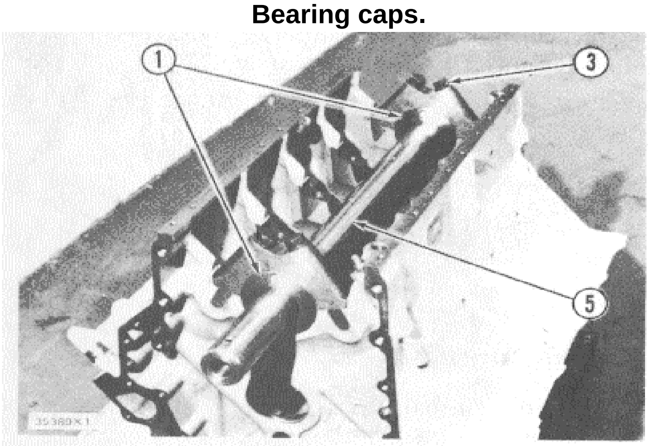


CENTERING RINGS IN BLOCK
1. 1P2344 Centering Rings. 2. Oiler.

Place original bearing caps (4) over the centering rings (1). Tighten bolts (3) hand tight.



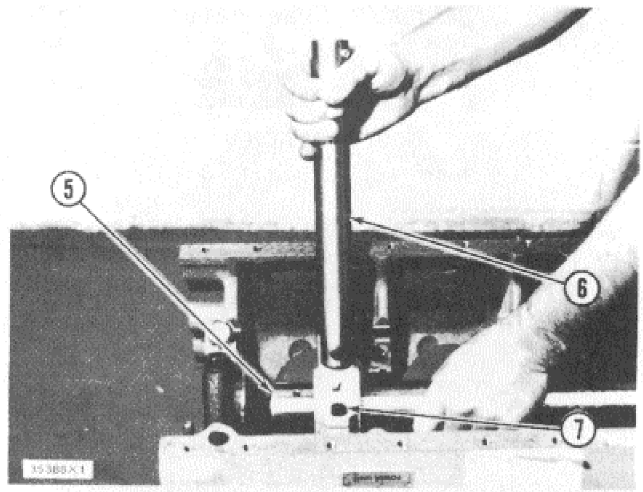
CENTERING RINGS INSTALLED
1. 1P2344 Centering Rings. 3. Bolts (four). 4. Bearing caps.



BORING BAR INSTALLED
1. 1 P2344 Centering Rings. 3. Bolts (four). 5. 1P2352 Boring Bar.

Oil boring bar (5) and insert it through centering rings (1). Tighten bolts (3) to a minimum of 20 lb. ft. (25 N. m) and a maximum of 50 lb. ft. (70 N. m) while spinning bearing bar (5) to check for binding. Centering rings (I) must be seated in boring saddles after tightening.

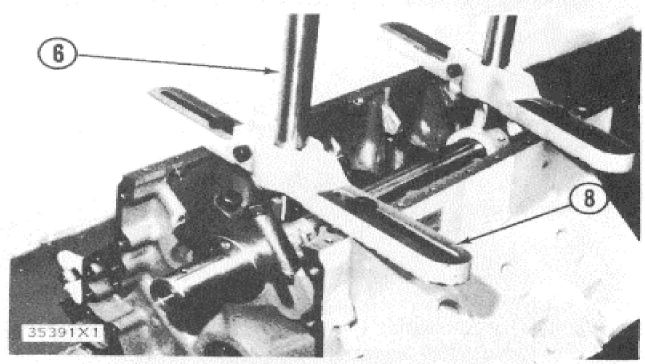
Slide boring bar (5) out of one end of block and install bearing assemblies (6) on boring bar (5). Slide boring bar (5) back through centering ring. Adjust bearing by tightening bolt (7) until bar begins to bind, then back off until boring bar (5) spins easily.



INSTALLING BEARING ASSEMBLIES
5. 1P2352 Boring Bar. 6. 1P2373 Bearing assembly (two). 7. Bolt.

Install bridge assemblies (8) over bearing assemblies (6). Position bridge assemblies (8) on block as shown with thicker portion up.

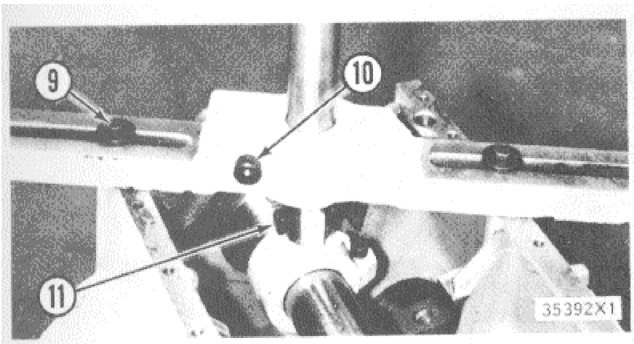
NOTE: Bridge assemblies must be on block as shown for tool holder clearance at each bore.



BRIDGE ASSEMBLIES INSTALLED
6. 1P2373 Bearing Assembly (two). 8. 1P2343 Bridge Assembly (two)

BASIC BLOCK

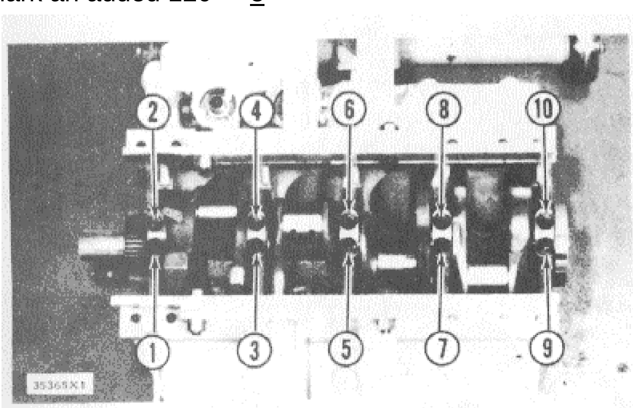
Tighten bolts (9) finger tight. Tighten bolt (10) lightly. Tighten bolt (11). Loosen, then tighten bolts (9) and bolt (10). Spin boring bar (5) during all tightening operations. Repeat abode procedure if boring bar (5) binds.



BOLT LOCATION
9. Bolts (two). 10. Bolt. 11. Bolt.

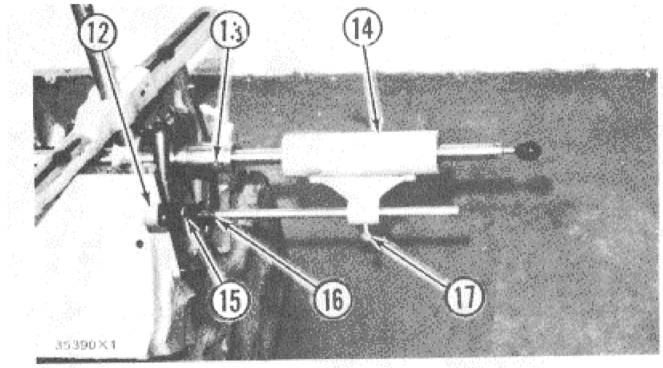
Remove original bearing caps and centering rings. Mark news caps to correspond with numbers on saddle and install new service caps. Mark caps and saddles "OS" for oversize ne\fs14 t to location number.

Be sure to install new bolts. Put engine oil on bolt threads and washer face. Tighten bolts in number sequence to 30 + 3 lb. ft. (40 + 4 N. m). put a mark on
each bolt and cap. Tighten all bolts by number from mark an added 120 + 5°.



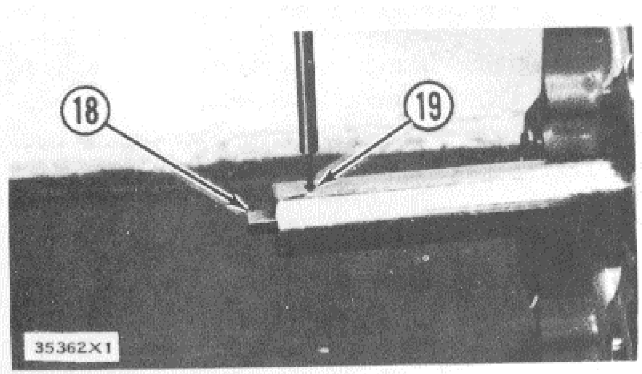
BOLT TIGHTENING SEQUENCE
(Typical Example)

Bolt torsion bar assembly (12) loosely to opposite end of block from which boring bar will be driven. Install feed assembly (14) into boring bar and tighten setscrew (13). Slide feed assembly (14) onto torsion bar assembly (12) and tighten bolt (15). Tighten bolt (16) finger tight. Boring bar must slide in and out freely after these tightening operations. Tighten thumbscrew (17).



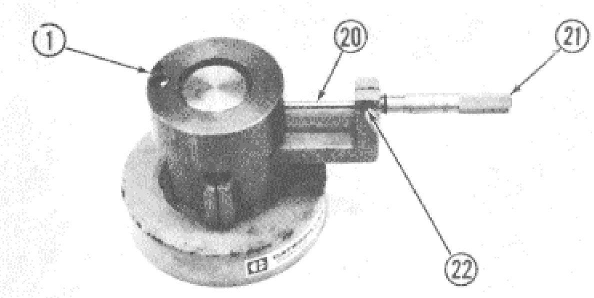
FEED ASSEMBLY INSTALLED
12. 1P2369 Torsion Bar Assembly. 13. Setscrew. 14.
1P2365 Feed Assembly. 15. Bolt. 16. Bolt. 17. Thumbscrew.

Place adapter (18) into boring bar and tighten setscrew (19).



ADAPTER INSTALLED
18. 1P2364 Adapter. 19. Setscrew.

To set tool in tool holder. Set micrometer (21) to 3. 7075 in. (94. 171 mm). Place centering ring (I) on the 1P2370 Micrometer Bracket Assembly. Move micrometer (2 1) until spindle (20) contacts centering ring (1). Tighten bolt (22). Back off micrometer thimble and recheck micrometer setting. Repeat above steps until micrometer setting is accurate.

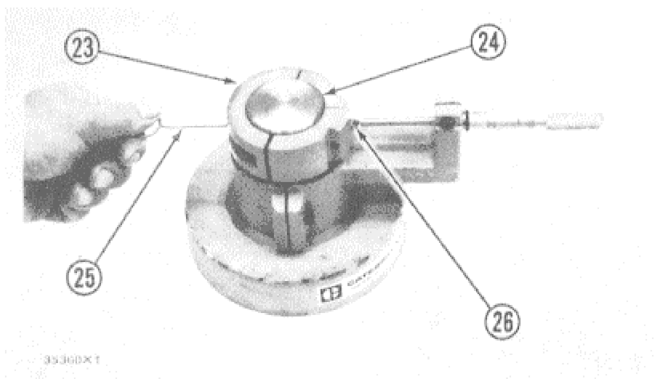


SETTING MICROMETER
1. 1 P2344 Centering Ring. 20. Micrometer spindle.
21. Micrometer. 22. Bolt.

Place tool holder (23) on the IP2370 Micrometer Bracket Assembly. Align mark on tool holder (23) with hole in shaft (24). Place tool hit (26) in tool holder (23) and set the micrometer . 070 in. (1. 78 mm) less than the finish bore diameter o(f 3. 7175 _+ . 0005 in. (94. 425 ± 0. 013 1r1m1). Turn the bracket adjustment arm until micrometer spindle aligns with tool bit (26). Adjust tool hit (26) by) pushing it with the 9S8521 Rod (25) until tip of tool hit (26) touches micrometer spindle.

CAUTION

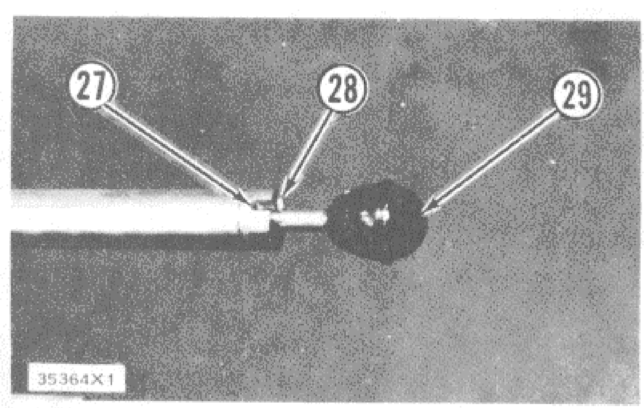
Do not sweep micrometer spindle across tool bit.



SETTING TOOL BIT

23. 1P2366 Tool Holder Assembly. 24. Shaft. 25. 9S8521 Rod. 26. Tool bit.

Use a maximum of . 025 in. (0. 64 mm) for rough cuts and . 010 in. (0. 25 mm) for finish cuts. Wipe the boring bar and tool holder clean. Place tool holder on the boring bar, with tool bit cutting edge facing the direction of rotation. Assemble the tool holder by placing lower half over the bolts, slide into slot and tighten bolts. Slide boring bar in until tool is approximately . 12 in. (3. 0 mm) from the bore. Compare tool cutting tip with bore surface while turning boring bar by hand, to insure correct tool setting.

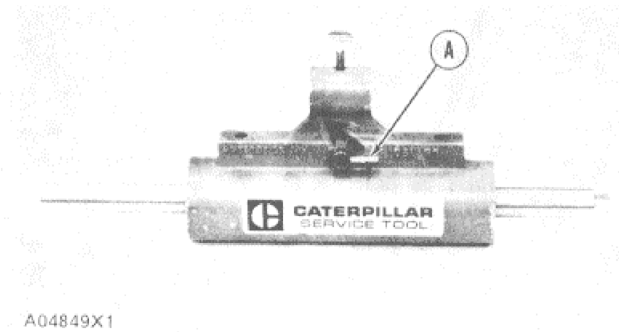


FEED ENGAGED

27. Slot. 28. Pin. 29. Knob.

Set feed mechanism into feed by turning knob (29) until pin (28) drops into slot (27).

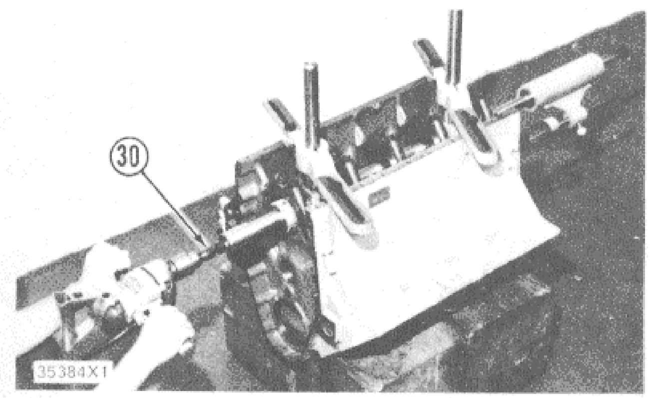
NOTE: To set the feed mechanism into feed on later unit, turn lever (A) up (the direction of arrow).



LATER FEED MECHANISM

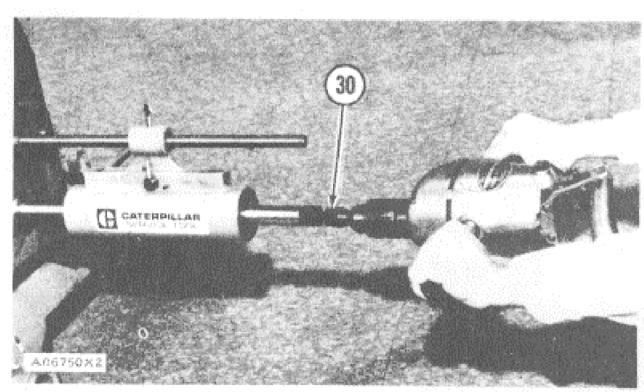
A. Lever.

Oil the bearing assemblies. Do not use lubricant on the cutter. Use one-half inch electric drill ,with universal joint (30) to feed the tool through the bores. Service main bearings with . 010 in. (0. 25 mm) oversize outside diameter are available to permit bores to be bored oversize. Bore block to 3. 7175 ± . 0005 in. (94. 425 +0. 013 mm).



BORING BLOCK

30. 1P2363 Universal.

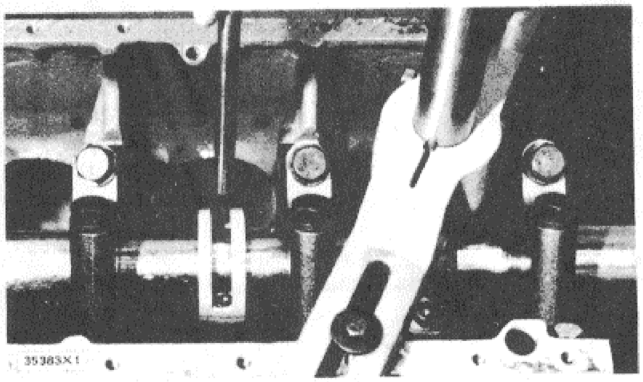


DRIVING THROUGH FEED MECHANISM

(Typical Example)

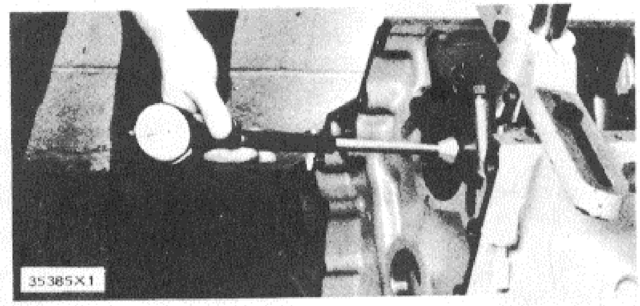
30. 1p2363 Universal.

NOTE: If you use the later feed mechanism the tool can be driven from either the boring bar or the feed mechanism.



POSITIONING TOOL HOLDER

When boring, if bearing assemblies interfere or tool does not reach next bore, reposition tool holder on boring bar.



CHECKING BORE

To check bores, set the IP3535 Dial Bore Gauge to 3. 7175 in. (94. 425 mm).

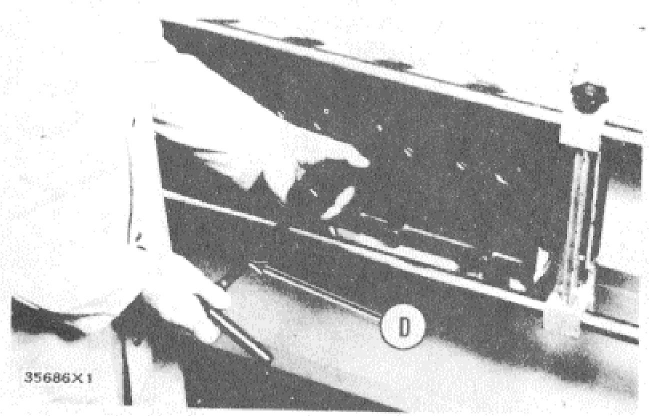
CYLINDER HEAD AND VALVE COMPONENTS

Check cylinder head for cracks before reconditioning.

Flatness of the cylinder head should be within .006 in. (0.15 mm) total, and a maximum of .003 in. (0.08 mm) for any 6 in. (152.4 mm) span. A maximum stock removal of .010 in. (0.25 mm) is permissible when resurfacing the head. Always check the thickness of a cylinder head before resurfacing. The cylinder head may have been resurfaced before and would not have enough stock to be resurfaced again.

To check the thickness of a cylinder head, measure through the fuel injection nozzle holes at each end of the cylinder head. For the correct thickness of the cylinder head, see the topic CYLINDER HEAD in the SPECIFICATIONS.

The exhaust valve seats have replaceable inserts. To remove, use the 8S7170 Valve Seat Insert Puller Group.



REMOVING EXHAUST VALVE SEAT INSERT

Freeze the exhaust salve seat inserts or use the 8S7170 Valve Seat Insert Puller Group to install inserts into head. Be sure bores are clean, free of burrs, and the insert has a good press fit into the bore.

After inserts are installed, grind the seat face of the insert to be sure it is flat, has the correct angle, and is in alignment with the bore in the valve guide. For specifications, see VALVE GRINDING SPECIFICATIONS CHART.

NOTE: Replace exhaust valve seat inserts when valve seat width or valve head-to-cylinder head face can not be machined to the correct specification. For specifications, see VALVE GRINDING SPECIFICATIONS CHART.

A 2N8943 Valve Seat Insert for the intake valve is available. This insert can be used in the repair of cylinder heads which have an intake valve seat with damage. Before, damage to an intake valve seat made replacement of the cylinder head assembly necessary.

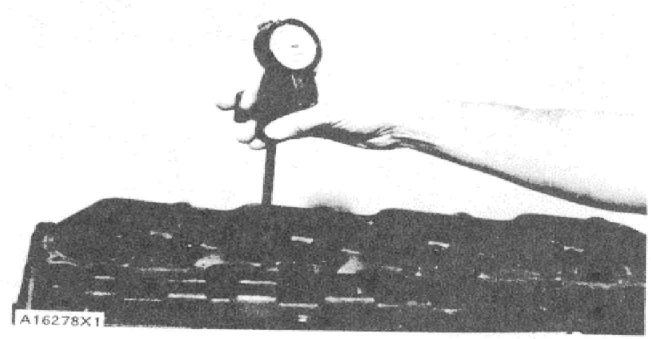
To use a 2N8943 Valve Seat Insert, the inlet port of the cylinder head must be machined to a diameter of 2.1470 $\pm$ .0005 in. (54.534 $\pm$ 0.013 mm) and to a depth of .442 + .002 in. (11.23 + 0.05 mm).

To install a 2N8943 Valve Seat Insert into the cylinder head, freeze the insert or use a 2P2343 Extractor with the 8S7170 Valve Seat Insert Puller Group. After an insert is installed, grind the seat face of the insert to be sure it is flat, has the correct angle, and is in alignment with the bore in the valve guide. For specifications, see VALVE GRINDING SPECIFICATIONS CHART.

Clean valve guides of all carbon and oil, using the 5P5176 Brush and a solvent.

The guides are cast in the cylinder heads. Check each salve guide bore size 3/4 in. (19.1 mm) deep from each end. The bore size is .3745 + .0005 in. (9.512 $\pm$ 0.013 mm) and the maximum size worn is .3760 in. (9.550 mm). Valve guides worn more than the maximum wear size, can be restored to original tolerances through knurling.

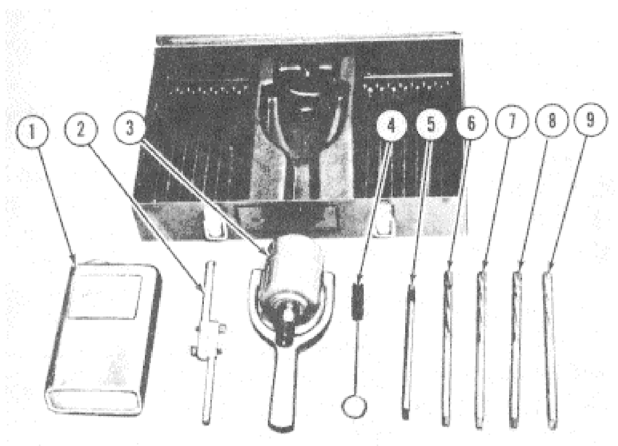
Use the 5P3536 Valve Guide Gauge Group to check the bore of the valve guides. Special Instructions GMG02562 gives complete and detailed instructions for use of the 5P3536 Valve Guide Gauge Group.



USING 5P3536 VALVE GUIDE GAUGE GROUP

NOTE: If valve guide bore is larger than .381 in. (9.68 mm), knurling may not restore the guide to original tolerances.

The following procedure can be used to knurl valve guide bores using the 5P5170 Knurling Group:



5P5170 KNURLING GROUP
1. 5P5178 Lubricant. 2. 5P5187 Tap Wrench. 3. 5P5177 Speed Reducer(7to 1). 4. 5P5176 Brush. 5. 5P5175 Knurling Arbor. 6. 5P5171 Reamer (. 371 in.). 7. 5P5172 Reamer (. 372 in.). 8. 5P5173 Reamer (. 373 in.). 9. 5P5174 Reamer (. 374 in.).

1. Clean and buff head, guides and valves. Check valve stem diameter. The intake valve stem diameter is . 3725 $\pm$. 0005 in. (9. 462 $\pm$ 0. 013 mm) and the minimum size worn is . 3710 (9. 423 mm). The tapered stem exhaust a stem diameter of . 3715 $\pm$. 0005 in. (9. 436 $^{+}$0. 013 mm) at the keeper end of the stem, and . 3705 + . 0005 in. (9. 411 - 0. 013 mm) at the head end of the stem. The minimum size worn is . 3690 in. (9. 373 mm).

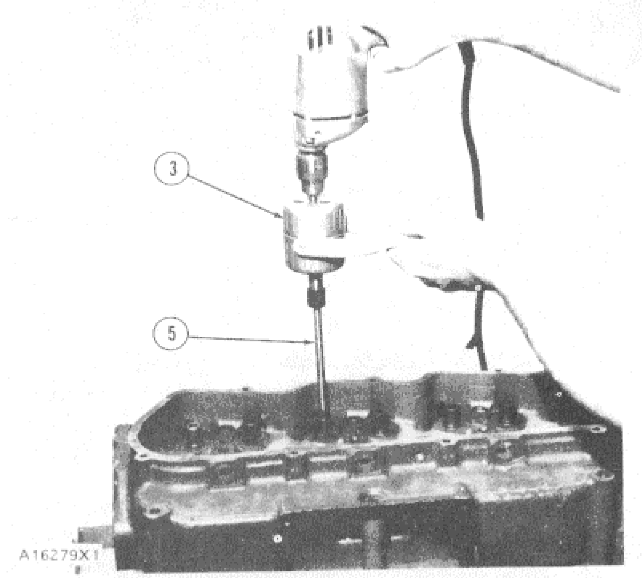
2 Place head on the FTS36 Cqylinder Head Bench or 8S6691 Cylinder Head Stand, ith rocker arm side toward you.

NOTE: Use FT967 Adapter Plates to mount head on FT806 Cylinder Head Bench.

3. Dill the 5P5176 Brush (4) into the 5P5178 Lubricant (1) and nin the brush through the guide.

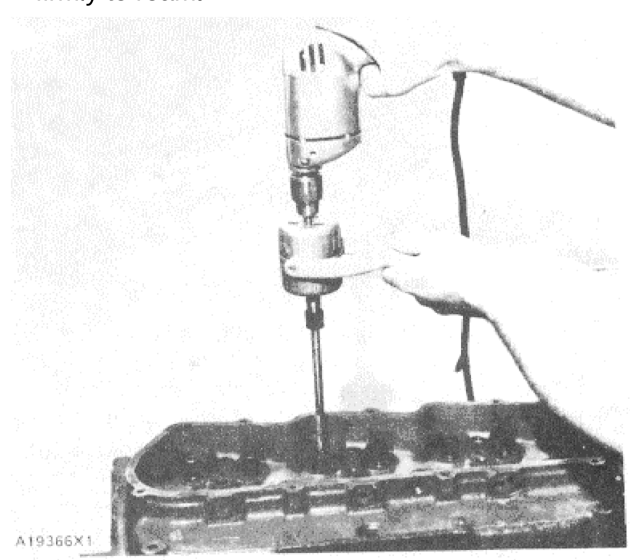
NOTE: The 5P5178 Lubricant is specially formulated for knurling cast iron guides and will prolong arbor life. If not a, use only Black Sulfur cutting oil or parafin base oil.

4. Dip the 5P5175 Knurling Arbor (5) into the 5P5178 Lubricant just prior to knurling. Use the 5P5177 Speed Reducer (3) and a 1/4 inch electric drill (1200 to 1600 rpm recommended) to drive the arbor. Hold the speed reducer and drill firmly during knurling. Do not push or guide arbor during knurling.



KNURLING GUIDE
3. 5P5177 Speed Reducer. 5. 5P5175 Knurling Arbor.

5. Select the reamer that is closest to the size of the stem that is to be used and ream the guide using the speed reducer and 1/4 inch electric drill. Push firmly to ream.



REAMING GUIDE
NOTE: It is not necessary to use lubricant for reaming.

6. Clean the valve guides with brmsh and solvent.

7. Install the valve. It is permissible to use a maximum force of 6 lbs. (27 N) with no oil to install the valve. Should valve not fit, use next size larger reamer and ream as in Step 5.

8. Thoroughly clean the valve guide bores after knurling.

CYLINDER HEAD AND VALVE COMPONENTS

The following procedure may be used to knurl valve guide bores using the United Tool Process:

1. Clean and buff head, guides, and . Check valve stem diameter. The intake stem diameter is . 3725 $^{+}$. 0005 in. (9. 462 + 0. 013 mm) and the minimum size worn is . 3710 in. (9. 423 mm). The tapered stem exhaust ale has a stem diame ter of . 3715 $^{+}$. 0005 in. (9. 436 +- 0. 013 mm) at the keeper end of the stem, and . 3705 + . 0005 in. (9. 411 + 0. 013 mm) at the head end of the stem. The minimum size worn is . 3690 in. (9. 373 mm).

2. Place head on the FT806 Cylinder Head Bench or 8S6691 Cylinder Head Stand with spring end of value guides toward you.

NOTE: Use FT967 Adapter Plates to mount head on FT806 Cylinder Head Bench.

3. Select the drill jig that corresponds in size to the valke guide. Use the 3/16 in. drill and stop in a slow speed drill. Drill an offset hole in guide 1/8 in. to 3/16 in. (3. 2 to 4. 8 mm) deep (hole to be drilled on exhaust manifold side of guide).

4. Using the proper size knurling tool and wheel, insert tool into guide and place wheel edge in offset notch. Place one drop of lubricant in each offset notch before knurling, and one drop on wheel after installing wheel in knurling tool. Use straight hex blade pronvided to match knurling tool and adapter in speed reducer. Hold outer sheel of reducer from turning and start drill. Follow, the rotating tool with slight pressure through the guide.

CAUTION

Use the mechanical speed reducer for all knurling and reaming as excessive speed and torque destroys tools. If possible, use a drill with a no load speed of 600 rpm.

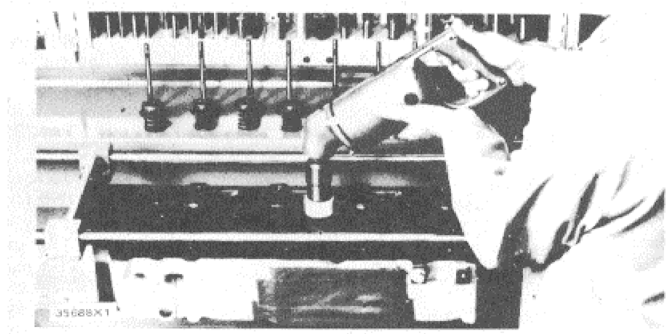
5. After knurling all guides, and before reaming, try valves in each end of guides. They should not fit nto guides. If valves will go in either end of guides, the guides must be knurled again using the next size wheel. Ream the guides with a . 374 in. reamer before knurling. Repeat knurling and reaming process until valves will not fit into guides.

6. Ream valve guide bores to . 3745 + . 0005 in. (9. 512 + 0. 013 mm). To ream valve guide bore use a . 374 in. reamer. The reamer will ream the bore . 0005 to . 0008 in. (0. 013 to 0. 020 mm) over the size marked on the reamer.

7. After reaming, clean guides thoroughly before checking valguide bore size.

8. Before installing, clean salve guide bores with the IP5571 Brush and a strong detergent. Stroke each bore several times with the brush rotating to remove all dirt and loose chips.

After the guides are knurled, the valves land valve seats must be ground to provide proper sealing. For valve grinding specifications, see VALVE GRINDING SPECIFICATIONS CHART.



GRINDING VALVE SEATS

VALVE GRINDING SPECIFICATIONS

Item	Exhaust	Intake
Seat Angle	45 1/2° ± ½°	30 1/2° ± ½°
Seat Width (Maximum)	105 in. 2. 67 mm	. 120 in. 3. 05 mm
Seat Outside Diameter (new)	1. 735 ± . 005 in. (44 07 ± 0. 13 mm)	2. 045 ± . 005 in. (52. 23 ± 0. 13 mm)
Seat Outside Diameter(Maximum)	1. 760 in. (44. 70 mm)	2. 065 in. (52. 45 mm)
Angle to Grind Insert to Reduce Seat Maximum Diameter	15°	Heads with inserts installed 15°
Depth of Bore to Reduce Seat Maximum Diameter	-	Heads without inserts . 170 in. (4. 32 mm)
Valve Face angle	45°± 1/4°	30°±¼
Valve Lip Thickness (new)	. 063 In.	. 091 in. (2. 31 mm)
Valve Lip Thickness (Minimum)	. 044 in. (1. 12 mm)	. 070 in. (1. 78 mm)
Valve Head Diameter	1. 804 ± . 005 in. (45. 82 ± 0. 13 mm)	2. 094. 005 in. 53. 19 ± 0. 13 mm)
Maximum Distance Valve Head to Cylinder Head Face (Closed Valve)	. 085 in. (2. 16 mm)	. 068 in. (1. 73 mm)
Minimum Distance Valve Head to Cylinder Head Face (Closed Valve)	. 050 in. (1. 27 mm)	. 036 in. (0. 91 mm)

CYLINDER HEAD AND VALVE COMPONENTS

VALVE SPRINGS

Check valve springs with the 8S2263 Valve Spring Tester. Springs not meeting Specifications should be replaced.

VALVE SPRING SPECIFICATIONS			
Item	**9N3617 Spring**	**9L9190 Spring**	**9L9172Spring**
Length under test force	1. 655 in. (42. 04 mm)	1. 715 in. (43. 56 mm)	1. 715 in. (43. 56 mm)
Test force	50 ± 5 lb. . (220 ± 22 N)	35 ± 5 lb. 155 ± 22 N)	16 5 ± 4 lb. (73 5 ± 18 N)
Use again minimum load at length under test force	35 lb. (155 N)	29 lb. (130 N)	12 lb. (53 N)
Length of spring at valve open position	1. 167 in. (29 64 mm)	1. 215 in. (30 86 mm)	1. 215 in. (30 86 mm)
Use again minimum load at valve open position	(687 N) 154 5 lb.	146 lb. (650 N)	65 lb. (290 N)
Free length after test	1. 855 in. (47 12 mm)	1 85 in. (471 mm)	1. 85 in. (471 mm)
Outside diameter	1. 440 in. (36 58 mm)	1. 440 in. (36 58 mm)	. 998 in. (25 35 mm)
Spring must not be bent more than	. 065 in. (1 65 mm)	065 in. (1 65 mm)	065 in (1 65 mm)

CONNECTING RODS

PISTON PIN BEARING REMOVAL AND INSTALLATION

The 5P8639 Press Group and the 5P9705 Tool Group are used to remove and install the piston pin bearings in the connecting rods. Use the procedure that follows to remove and install the piston pin bearing from the connecting rod.

Remove the crankshaft bearing from the large end of the connecting rod and install the cap on the rod. Put the connecting rod in an oxen and get the temperature of the rod to 400F (204°C).

Put the 5P9704 Spacer in the counterbore of the base plate Be sure the spacer is in the bore straight and is against the bottom of the counterbore. Put the connecting rod, with the Part Number up, on the base plate so that the pot assembly is in the center of the piston pin bearing.

Install the pin for the large end of the connecting rod In the center oft' the bearing bore. Put the 5P8653 Adapter over the post assembly and into the piston pin bearing. Make sure the alignment hole in the adapter is in line with the hole in the base plate. Install the 5P8641 Clamp Bar and the clamp pin on the large end of the connecting rod.

Put a new piston pin bearing on the 5P8653 Adapter. The hearing joint must be in alignment with the hole in the adapter. Put the 5P8645 Push adapter, with the tapered side down, on the post assembly and on top of the 5P8653 Adapter. Make sure the alignment hole in the push adapter is in alignment with the bearing joint and the holes in the 5P8653 Adapter and the base plate.

Put the pusher on the 5P8645 Push Adapter and use the press to push the old bearing out and the new bearing in. Use the press until the push adapter makes full contact with the connecting rod. Remove the tools and the connecting rod from the press group.

NOTE. The piston pin bearing must be bored (machined to size) before the connecting rod can be used.

CHECK FOR CONNECTING ROD DISTORTION

The 5P2050 Connecting Rod Checking Fixture is used to check for bearing bore center-to-center distance and for piston pin bearing bore to crankshaft bearing bore alignment. The checking fixture can be used to check connecting rods with or without the piston pin bearing installed.

To check connecting rods that are to be reconditioned, the fixture must first be adjusted to the correct bearing bore center-to-center distance. Use a connecting rod of known length (master rod) for adjustment.. Remove the connecting rod bearing and install the cap on the connecting rod and tighten the nuts as shown in the SPECIFICATIONS. Remove the piston pin bearing from the connecting rod.

Put the 5P2041 Pin Mandrel in the piston pin end of the master rod. Install the 5P2013 Plunger Extension on the plunger of the 5P2053 Crank Mandrel. Install the 5P2051 Position Arm on the end of the crank mandrel. Put the crank mandrel in the crankshaft bearing bore of the master rod. Move the position arm so it is in alignment with the centerline of the pin mandrel. Turn the actuator knob on the end of the crank mandrel and tighten the mandrel in the rod.

Put the master connecting rod on the checking fixture. Move the dial indicator holder until both indicators show approximately . 010 in. less than one complete revolution. Turn the dial face of each indicator until the hand is on zero.

Remove the connecting rod from the fixture; turn the rod 180" horizontally and put the rod on the fixture again. If the dial indicators read zero, the fixture is adjusted correctly. If there is a different reading on the dial indicators, move the dial face one-half the distance between zero and the reading. Remove the master rod from the fixture and remove mandrels from the master rod.

The checking fixture is now adjusted to check connecting rods for reconditioning.

Use the procedure that follows to inspect connecting rods to check if they are acceptable for reconditioning.

Remove the connecting rod bearing and install the cap on the connecting rod and tighten the nuts as shown in the SPECIFICATIONS. Remove the piston pin bearing from the connecting rod.

Put the 5P2041 Pin Mandrel in the piston pin bearing bore. Put the 5P2053 Crank Mandrel with 5P2013 Plunger Extension and 5P2501 Position Arm in the crankshaft bearing bore. Move the position arm in alignment with the centerline of the pin mandrel. Turn the actuator knob on the crank mandrel and tighten the mandrel in the rod.

Put the connecting rod on the checking fixture. Make a record of the readings on each of the dial indicators. Add the two readings and divide by two. The result is the average difference from the master connecting rod bearing bore center-to-center distance. The allowable difference for rods that are acceptable for reconditioning is + . 004 in
.

CONNECTING RODS

Leave the connecting rod in the checking fixture and check for both bores parallel. Make a record of the readings for both dial indicators. The total difference between indicator readings is the bores parallel dimension. The maximum allow-able dimension is . 006 in. for rods that are acceptable for reconditioning.

A check can also be made to check for connecting rod twist. Push one end of the pin mandrel against the locating surface behind it. Use a thickness gauge on the opposite end to check the clearance between the mandrel and the locating surface. Check both ends of the mandrel in this way for clearance. The amount of clearance is the twist in the rod. The maximum allowable twist is . 012 in. for rods that are acceptable for reconditioning.

BORING PISTON PIN BEARING

After new piston pin bearings are installed in the connecting rods, use the 5P3550 Connecting Rod Boring Machine to bore the piston pin bearings to the correct size.

Install the cap on the connecting rod (do not install the bearings). Tighten the nuts as shown in the SPECIFICATIONS.

Put the 5P2010 Mandrel on the spindle. In, tall nut and actuator, and tighten to hold mandrel in position. Install 5P2013 Plunger Extension on the plunger. The plunger must be in the up position within + 3:. Loosen the spindle carrier, and use the handle on top to adjust the bearing bore center-to-center dimension. Move the carrier until the vernier scale reads 7. 6867 ±. 0010 in. This is the correct scale dimension to get a bearing bore center-to-center dimension of 7. 9000 ± . 0010 in. Tighten the carrier in this position.

Put the connecting rod in position on the mandrel, with the boss on the pin end of the rod towards the left. Turn the actuator until the connecting rod is tight on the mandrel.

Install 5P3552 Bushing in the front bracket. Push the locating arbor through the front bushing. Put 5P3541 Locating Bushing, with the large dimension of the diamond shape horizontal, on the locating arbor. Slide the locating arbor through the connecting rod and into the rear bushing. Slide the locating bushing into the rod. Push the locating rods until they are against the connecting rod, and tighten the rods firmly). Remove the locating arbor end bushing.

Fasten the 5P2023 Tool Bit Setting Gauge to the boring bar. Be sure the contact point of the indicator is against the boring bar. Adjust the indicator so the resolution counter and the hand are at zero. Move the tool bit setting gauge so that the contact point is against the cutting edge of the tool bit. Fasten the gauge in this position. Loosen the screw that holds the tool bit. Make an adjustment to the tool bit until the indicator reads . 1881 in. Tighten the screw that holds the tool bit and recheck the setting.

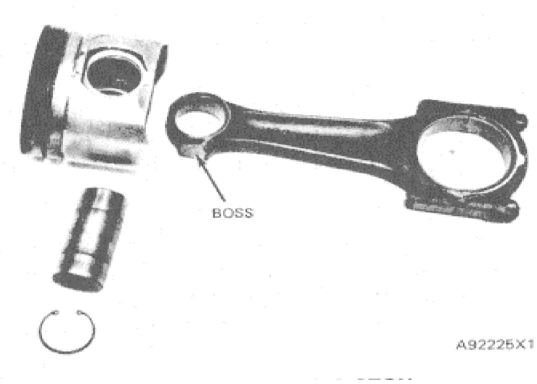
Put the boring bar through the connecting rod and into the rear bushing. Install the front bushing over the boring bar and into the bracket. Install 5P4777 Torsion Bracket on the rear of the boring machine. Put 5P4778 Feed Cylinder so the shaft goes through the rear bushing and into the boring bar. Tighten the setscrew in the boring bar to hold the feed cylinder shaft. Adjust torsion bracket and feed cylinder so the boring bar moves smoothly in rear bushing.

NOTE: Put the feed lever on the feed cylinder in the OPEN position before moving the boring bar.

With the feed lever in the OPEN position, move the boring bar until the tool bit is . 125 in. (3. 2 mm) from the bearing in the connecting rod. Put the feed lever the CLOSED position and tighten the thumbscrew on the cylinder against the torsion bracket shaft. Install 5P2055 Flexible Adapter in the front of the boring bar and fasten an electric drill to the adapter. Put oil on the boring bar at the front and rear bushings. Start the drill and let the feed cylinder)pull the boring bar through the bearing. Use a slows feed rate and do not push on the drill.

Check the bearing bore with a new piston pin. If the fit is too tight, do the boring operation again with the SAME tool bit setting.

Install the connecting rod into the piston with the boss on the rod on the same side as the crater in the piston.



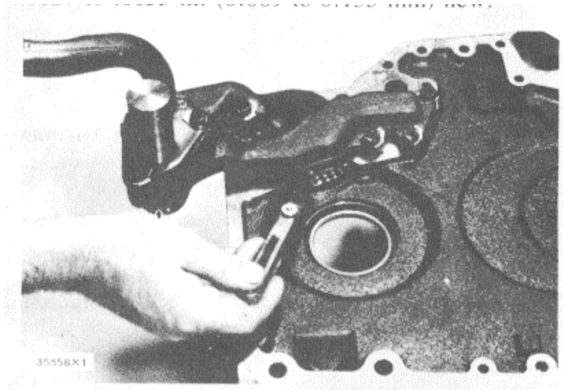
CONNECTING ROD AND PISTON

When the connecting rod and piston assembly is installed, use new connecting rod bolt nuts.

TM 5-3805-260-24

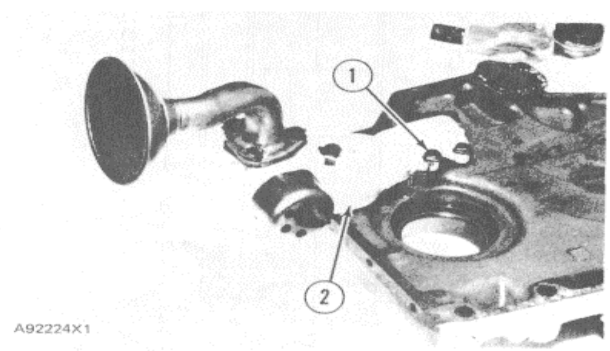
OIL PUMP

Check oil pump end clearance End clearance is .0027 to .0053 in. (0.069 to 0.135 mm) new.

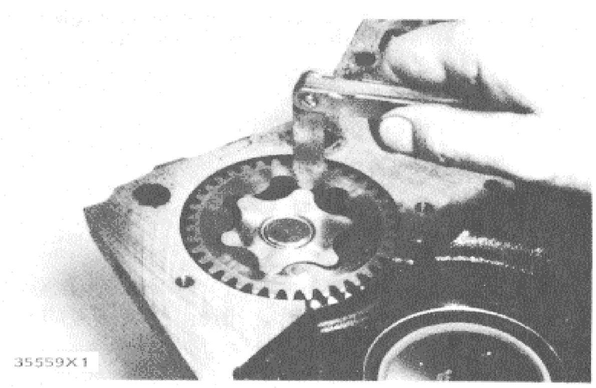


CHECKING END CLEARANCE
(Oil pump with plunger bypass shown)

Remove oil pump cover mounting bolts (1). Remove oil pump corer (2).

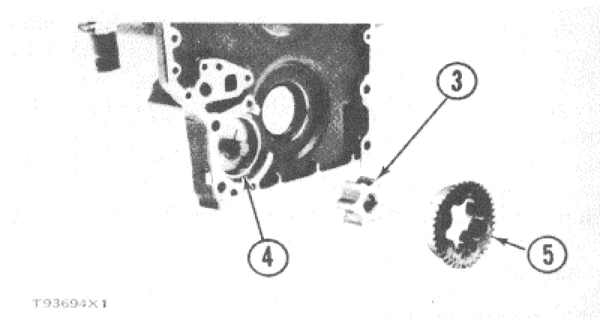


OIL PUMP
(Oil pump with belleville washer bypass shown)
1. Bolts (four). 2. Oil pump cover.

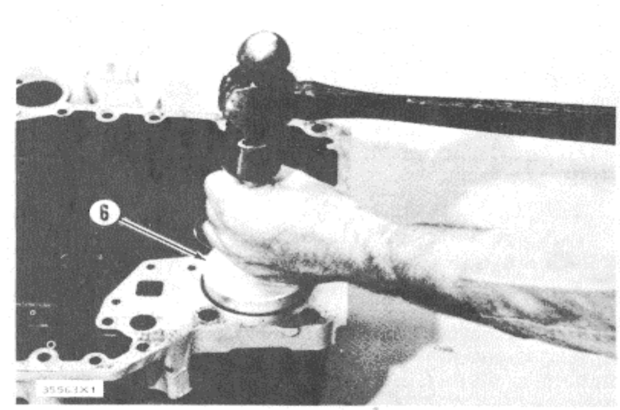


Check oil pump rotor tip clearance. Rotor tip clearance is .004 ± .002 in. (0.10 ± 0.05 mm). Maximum rotor tip clearance is .009 in. (0.23 mm).

Remove outer rotor (5) and inner rotor (3). Check size of bearing (4). Size of bearing (4) is 2.8041 ± .0022 in. (71.224 ± 0.056 mm). Replace bearing if necessary. Use an 8S2285 Driver (6) to install the bearing. For the correct location of bearing junction, see the topic OIL PUMP in the SPECIFICATIONS.



ROTORS REMOVED
3. Inner rotor. 4. Bearing. 5. Outer rotor.



INSTALLING BEARING
6. 8S2285 Driver.

Clean all parts thoroughly before installing. Oil all component parts before installing. Install inner rotor (3), outer rotor (5), cover (2), mounting bolts (1) and locks. Tighten bolts to 18 ± 5 lb. ft. (24 ± 7 N•m) and secure with locks.

CHECKING ROTOR TIP CLEARANCE

CRANKSHAFT

Reconditioning of the crankshaft can be done by grinding the "journals" (bearing surface on the crankshaft for the connecting rod bearings and main bearings) .010 in. (0.25 mm), .020 in. (0.51 mm) or .050 in. (1.27 mm) ’undersize" (smaller than the original size).

The diameter of the "journals’ for the connecting rod bearings is 2.7496 ± .0006 in. (69.840 ± 0.015 mm). The diameter of the "journals" for the main bearings is 3.4995 ± .0006 in. (88.887 ± 0.015 mm). The minimum permissible diameter of the "journals" for the connecting rod is 2.7486 in. (69.814 mm). The minimum permissible diameter of the "journals" for the main bearings is 3.4985 in. (88.862 mm). Measure each "journal" in several places around the diameter to find the maximum wear point. If the diameter of any "journal" is smaller than the minimum permissible diameter, grind all of the "journals." Before grinding a crankshaft, check the crankshaft for being straight. To check a crankshaft for being straight, support each end main bearing "journal" in V-blocks. Using a dial indicator, position the indicator at the zero reading then measure the total indicator reading at the other three main bearing "journals." The maximum total indicator reading is .008 in. (0.20 mm) at the center main bearing "journal" and .004 in. (0.10 mm) at the other two main bearing "journals." If total indicator reading is more than that given but less than .030 in. (0.76 mm) the crankshaft can be "straightened" (made straight). Before "straightening" (making straight) a crankshaft get temperature of the crankshaft to 400°F (204°C). For the specifications for grinding a crankshaft, see the topic CRANKSHAFT GRINDING SPECIFICATIONS.

With the crankshaft installed in the cylinder block, check the end play for the crankshaft. End play for the crankshaft is .003 to .010 in. (0.08 to 0.25 mm). Maximum permissible end play for the crankshaft is .014 in. (0.36 mm).

NOTE: If end play for the crankshaft is more than the maximum permissible end play, check the crankshaft thrust bearing.

CRANKSHAFT GRINDING SPECIFICATIONS

The dimensions and finish for grinding crankshafts are as follows:

Diameter (A) for connecting rod bearing journals is;

.010 in. (0.25 mm)
Undersize .... 2.7396 + .0006 in.
(69.586 + 0.015 mm)

.020 in. (0.51 mm)
Undersize .... 2.7296 ± .0006 in.
(69.332 ± 0.015 mm)

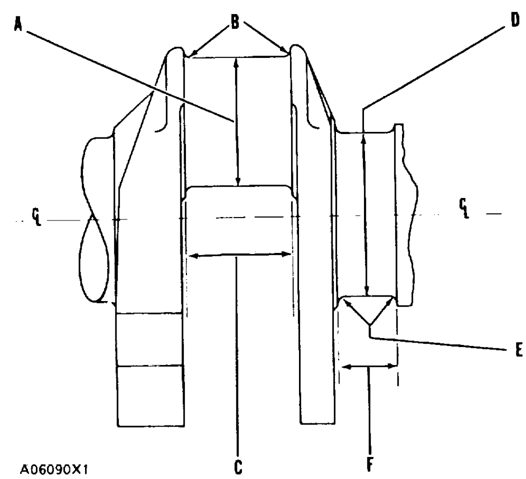
.050 in. (1.27 mm)
Undersize .... 2.6996 ± .0006 in.
(68.570 $^{+}$ 0.015 mm)

Surface finish must be 10 micro inches (0.25 micrometers) or less.

Radius (B) must be . 100 ± .010 in. (2.54 ± 0.25 mm).

Surface finish must be 63 micro inches (1.6 micrometers) or less.

The radius must blend smoothly with the newly machined journals.



DIMENSIONS FOR GRINDING
A. Diameter of connecting rod bearing journals. B. Radius on connecting rod bearing journals. C. Width to grind journals for the connecting rods. D. Diameter of main bearing journals. E. Radius on main bearing journals. F. Width to grind journals for the main bearings.

Width (C) is 2.314 ± .003 in. (58.77 ± 0.08 mm)

Diameter (D) for main bearing journals is:

.010 in. (0.25 mm)
Undersize .... 3.4895 ± .0006 in.
(88.633 ± 0.015 mm)

.020 in. (0.51 mm)
Undersize .... 3.4795 ± .0006 in.
(88.379 ± 0.015 mm)

.050 in. (1.27 mm)
Undersize .... 3.4495 ± .0006 in.
(87.617 ± 0.015 mm)

CRANKSHAFT

Surface finish must be 10 micro inches (0.25 micrometers) or less.

Radius (E) must be .095 ± .010 in. (2.41 ± 0.25 mm)

Surface finish must be 63 micro inches (1.6 micrometers) or less.

The radius must blend smoothly with the newly machined journals.

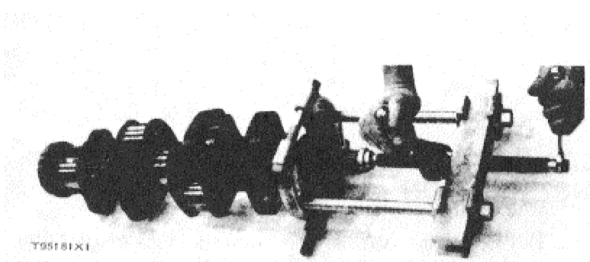
Width (F) is 1.258 ± .002 in. (31.95 ± 0.05 mm) for number 4 main bearing journal. Surface finish on the thrust faces of the number 4 main must be 18 micro inches (0.45 micrometers) or less. Width (F) is 1.268 + .020 - .010 in. (32.21 + 0.51 - 0.25 mm) for number 2, 3, and 5 main bearing journals.

There is no width (F) for number 1 main bearing journal.

When grinding a crankshaft, no material can be removed from the crankshaft webs or counterweights.

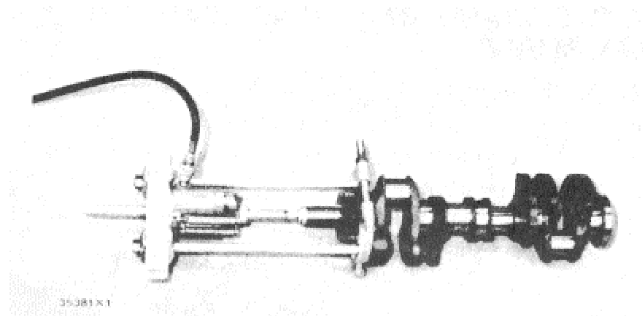
CRANKSHAFT GEAR REMOVAL

Remove the gear using an 8B7548 Push Puller, 8B7551 Bearing Pulling Attachment, 8B75621 Step Plate, and 8H684 Ratchet Box Wrench.


PULLING CRANKSHAFT GEAR

PULLING CRANKSHAFT GEAR

The IP820 Hydraulic Puller Group can also be used to pull gear from crankshaft. Tools required are IP820 Hydraulic Puller Group, 8B7551 Bearing Pulling Attachment, 8B7549 Puller legs (two), 8B7561 Step Plate, 3H465 Plate (four), IB4207 Nut (two), and 5P3100 Pump Group.


USING HYDRAULIC PULLER

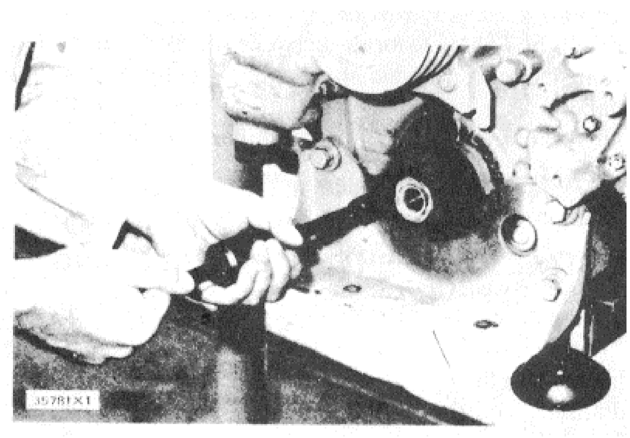
USING HYDRAULIC PULLER

CRANKSHAFT GEAR INSTALLATION

1. Install the key in keyway of crankshaft. Remove all burrs from key and keyway inside of crankshaft gear.
2. Heat gear to 500°F (260°C) maximum.
3. Install gear on crankshaft with timing mark on gear facing front of crankshaft.

CRANKSHAFT FRONT OIL SEAL REMOVAL

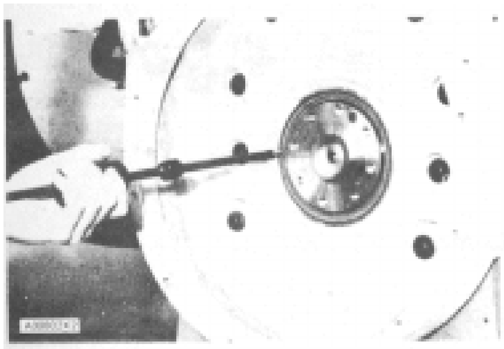
Remote the crankshaft front pulley. Use the 1P3075 Puller Group to remove the crankshaft front oil seal.



REMOVING FRONT OIL SEAL
(Typical Example)

REMOVE CRANKSHAFT REAR SEAL AND WEAR SLEEVE

Remove the crankshaft rear oil seal with the 1P3075 Puller Group.



REMOVING REAR OIL SEAL

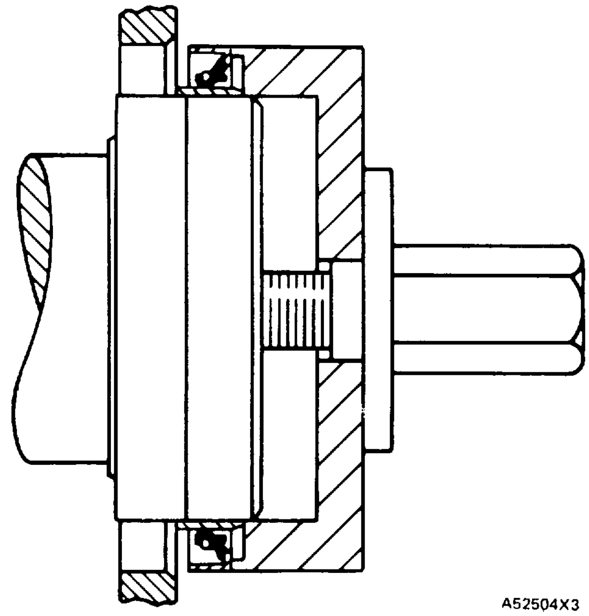
Install a 5P7338 Distorter Ring from the 5P7318 Wear Sleee Distorter Group, in the rear seal bore.

REMOVING REAR WEAR SLEEVE (Typical Example)

Install 5P7312 Distorter between distorter ring and wear sleeve. Turn the distorter until the edge of the tool makes a flat place (crease) in the wear sleeve. Do this in two or more places until the wear sleeve is loose. Remove the tools and wear sleeve.

INSTALL CRANKSHAFT REAR SEAL AND WEAR SLEEVE

The crankshaft rear seal and wear sleeve must be installed at the same time. Clean the wear sleeve inside diameter and the crankshaft outside diameter and put 6 Quick Cure Primer on the surfaces. Put 9S3265 Retaining Compound on the outside diameter of the crankshaft and the inside diameter of the w-car sleeve. Install 5P290 locater on the rear of the crankshaft. Put a sealer on the outer metal case of the seal. Put the wear sleeve and seal in position on the locater. with the outside diameter bevel of the , wear sleeve away from the crankshaft. Be sure the lip of the seal is toward the engine. Put 5P7293 Installer in position on the locator. Put clean engine oil on the face of the nut and install it on the locator. Tighten the nut until the installer will no longer move.



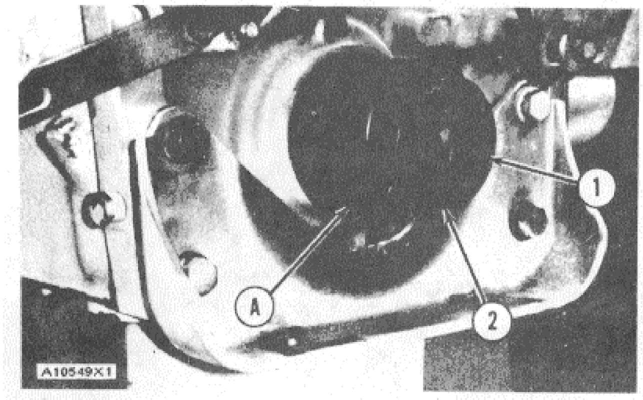
INSTALLING CRANKSHAFT REAR SEAL AND WEAR SLEEVE

CRANKSHAFT FRONT OIL SEAL INSTALLATION

1. Put the seal over the short end of 5P4194 Installer Assembly (A). Put a sealer on the outer diameter of the seal metal shell. The lip of the seal must be toward the Inside of the engine.

2. Put the seal and Installer assembly (A) in position on the end of' the crankshaft. Install bolt (1) and washer (2) that hold the crankshaft pulley in place. Tighten bolt (1) Tighten the installer assembly (A) makes contact with the crankshaft gear.

NOTE. If a new wear surface for the front seal is needed, put the 5P4230 Spacer between the seal and flange of the installer assembly)



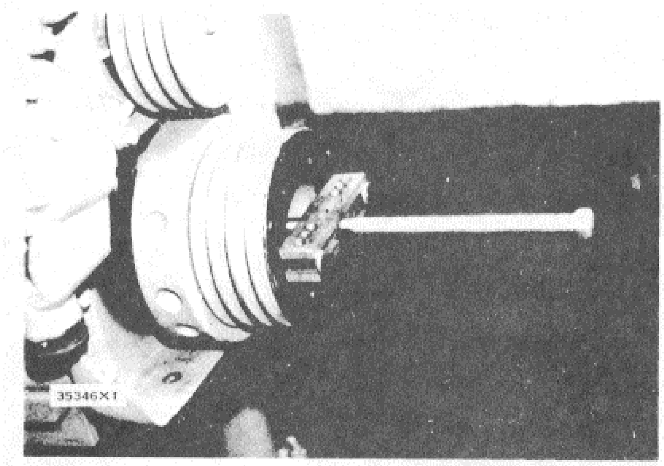
INSTALLING FRONT OIL SEAL
1. Bolt. 2. Washer. A. 5P4194 Installer Assembly.

3. Put engine oil on the lip of the s, cal bcI)ore installing the pulley.

CRANKSHAFT PULLEY REMOVAL

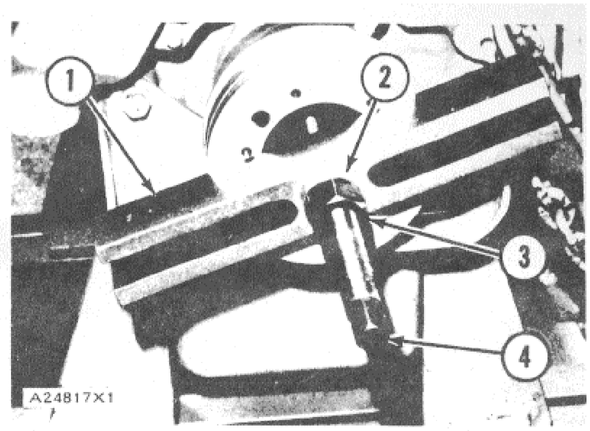
1. Remove pulley retaining bolt and washer.

2. Remove the pulley using a 5F7465 Puller A.ssembly, XB7560 Step Plate, two 5M2894 Washers, and two S1571 Bolts.



PULLEY REMOVAL
(Typical Example)

CRANKSHAFT PULLEY INSTALLATION



INSTALLING PULLEY
1. Crossbar 2. Washer. 3. Nut. 4. Screw.

1. Lubricate lip of crankshaft front oil seal and the sealing surface of crankshaft pulley with engine oil (SAE 30).

2. To install pulley, start pulley on crankshaft. Put screw (4) from the 8B7548 Push Puller into the crankshaft until it bottoms out. Put crossbar (I) from the 8B7548 Push Puller onto screw (4). Install washer (2) and nut (3) to on screw (4). Hold screw (4) and turn nut (3) to press pulley onto crankshaft. When installed, the pulley hub will contact the crankshaft gear.

3. Remove the tool setup. Install the pulley retaining bolt and washer. Tighten the pulley retaining bolt to 460 - - 60 lb. ft. (624 + 80XO N•m).

CAMSHAFT

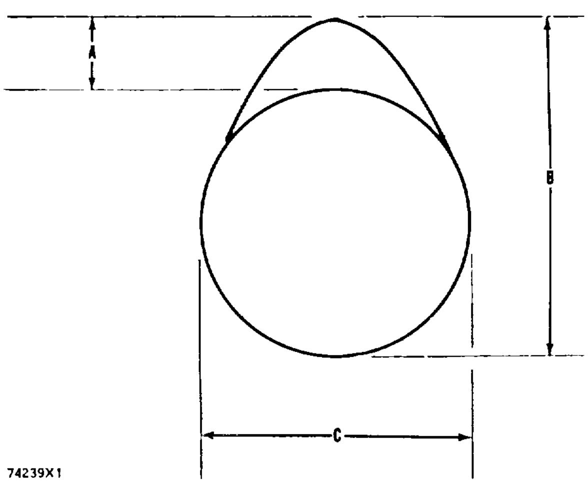
CAMSHAFT

When reconditioning an engine, check the diameter of the camshaft bearing journals and the camshaft lobe height.

Camshaft bearing journals have a diameter of 2.5000 ± .0005 in. (63.500 ± 0.013 mm) and the minimum diameter worn is 2.4970 in. (63.424 mm).

To find lobe lift (A) of camshaft, use the following procedure:

1. Measure lobe height (B) of one exhaust and one intake lobe.
2. Measure base circle (C) of one exhaust and one intake lobe.
3. Subtract base circle (C) dimension (STEP 2) from lobe height (B) dimension (STEP I). The difference is actual lobe lift (A).
4. The specified (new) lobe lift (A) is:
   (a) Exhaust lobe .3071 in. (7.800 mm)
   (b) Intake lobe .3077 in. (7.816 mm)
5. The maximum permissible difference between actual lobe lift (STEP 3) and specified lobe lift (STEP 4) is .025 in. (0.64 mm).

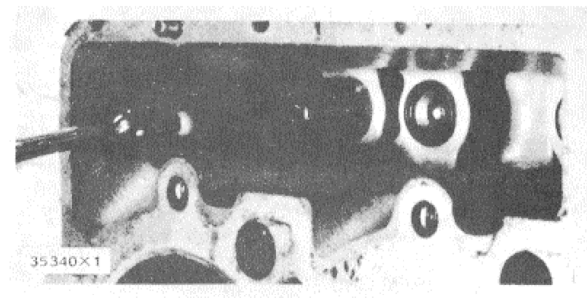


CAMSHAFT LOBE
A. Lobe lift. B. Lobe height. C. Base circle.

With camshaft' installed in the cylinder block, check end play. End play with new components should be .007 + .003 in. (0.18 - 0.08 mm). The maximum permissible end play is .020 in. (0.51 mm).

CAMSHAFT FOLLOWERS

Use an 8S2293 Magnet to remove the cam followers



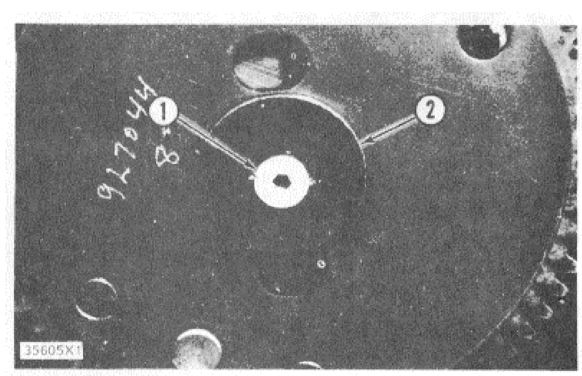
REMOVING CAM FOLLOWERS

Cam followers establish a wear pattern with the camshaft lobes. Identify and reinstall the followers removed. Dishing or circular wear pattern is allowed on the cam follower face, providing the wear face keeps a polished appearance. Replace the follower if the wear face is rough or shows signs of scuffing. A new follower can be used with an old camshaft, providing the lobe is in good condition. Put engine oil on the cam followers and the camshaft lobes before installing the cam followers.

NOTE: Use new cam followers with a new camshaft.

CAMSHAFT GEARS

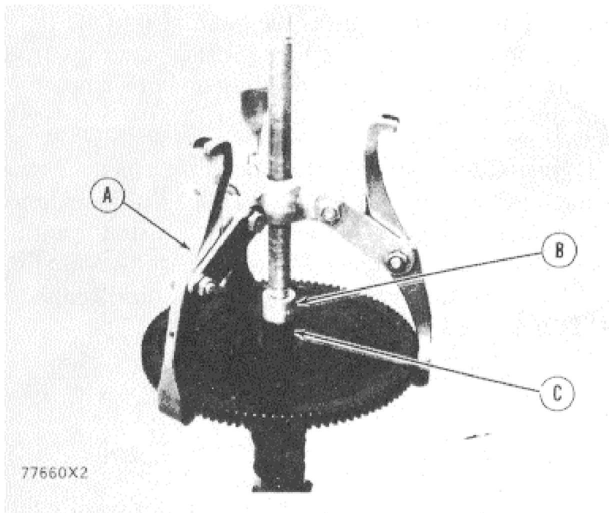
1. Remove screw (I) and washer (2) from Lnd of camshaft.



REMOVING TIMING ADVANCE RETAINING SCREW
1. Screw. 2. Washer.

2. Remove timing advance unit from the camshaft.
3. Install puller (A), with spacer (C) over the shaft in the camshaft spacer (B) on spacer (C) as shown and remove the gear from the camshaft.

CAMSHAFT



REMOVING GEAR
(Typical Example)
A. 1P2321 Puller. B. 8S5579 Spacer. C. 9S9155 Spacer.

To install the gear use the following procedure:

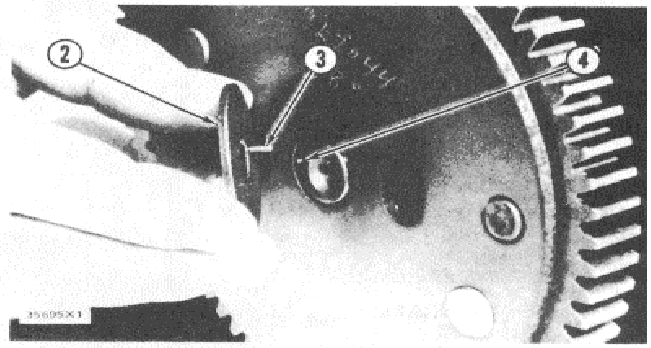
1. Heat the gear to a temperature of approximately 400°F (2041C) before installing on the camshaft.

CAUTION
Do not heat the gear with a torch. Do not heat the gear to a temperature of more than 600°F (315°C). Heating the gear with a torch or to a temperature of more than 600F (3150C) may cause the two drive dowels for the automatic timing advance to loosen and come out of the gear.

2. Align slot in gear hub with the pin in the camshaft. Install the gear on the camshaft with timing mark on gear aligned with timing mark on crankshaft gear. Be sure the gear is completly seated against the shoulder of the camshaft.

CAUTION
Do not drive the gear on the camshaft.

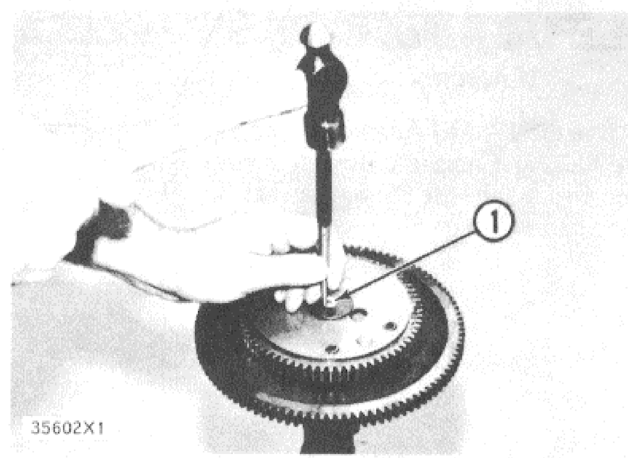
3. Align holes in weights with dowels in gear and install the automatic timing advance.
4. Align pin (3) in washer with hole (4) in camshaft and install washer (2).
5. Install screw (1) and tighten to 72 + 5 lb. in. (8.2 ± 0.6 N m). Stake screw in two places.



INSTALLING WASHER
2. Washer. 3. Pin. 4. Hole.

CAUTION
Stake screw (1) carefully. Heavy blows on washer or screw can force the shaft extension too far into the camshaft and eliminate all end clearance.

6. After screw (I) is staked, the gear and weight assembly requires end clearance to prevent binding against the washer, camshaft end or camshaft gear. The required end clearance is .003 to .037 in. (0.08 to 0.84 mm).

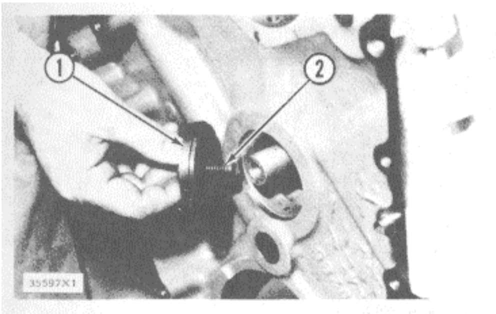


STAKING SCREW
1. Screw.

CAMSHAFT BEARINGS REMOVAL AND INSTALLATION

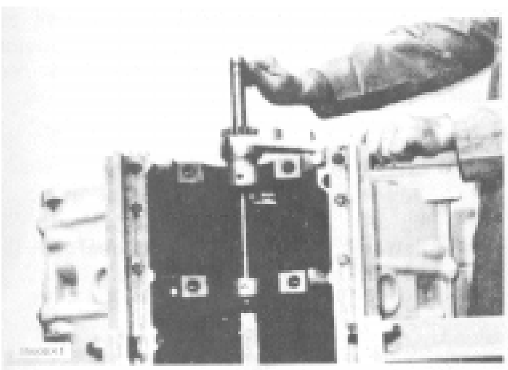
Remove camshaft bearings using the IP5544 Washer (1) and S509 Bolt (2), from the IP5545 Adapter Group, in conjunction with the 8S2241 Camshaft Bearing Removal and Installation Group, and the 8H684 Ratchet Box Wrench.

CAMSHAFT



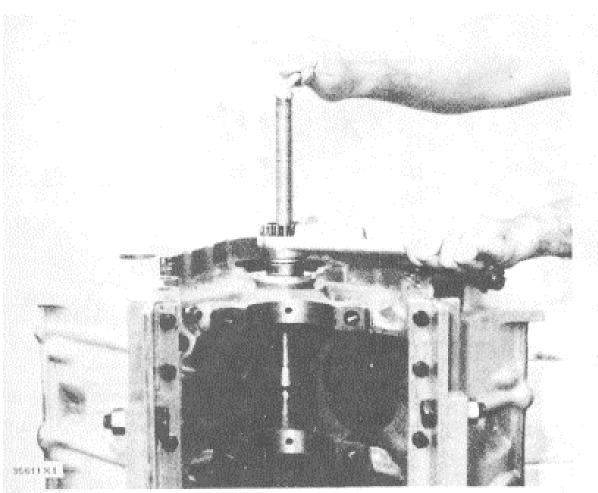
INSTALLING WASHER
1. 1P5544 Washer. 2. S509 Bolt.

With removal tools installed on cylinder block, remove bearings.



REMOVING CAMSHAFT BEARINGS

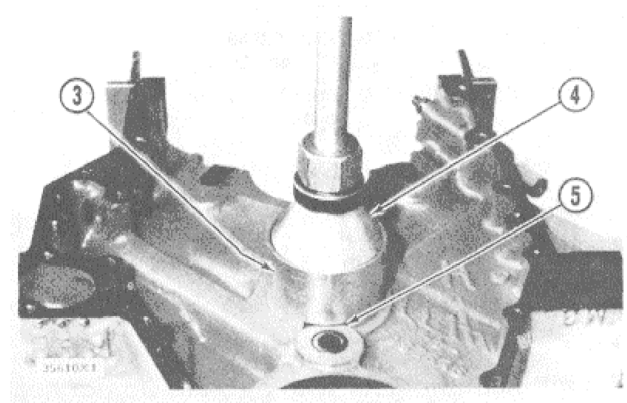
Use the IP5545 Adapter Group in conjunction with the 8S2241 Camsihaft Bearing Removal and Installation Group, and the 8S684 Ratchet Box Wrench install camshaft bearing



INSTALLING CAMSHAFT BEARINGS.

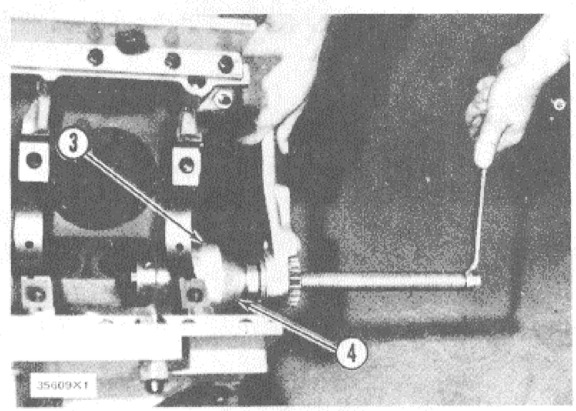
The IP5545 Adapter Group pilots in the camshaft bearing bore and also pilots the bearing into the bore. This insures bearing alignment. Install bearings from chamfered side of the bore and align oil hole in hearings with oil holes in the cylinder block.

To install the camshaft front bearing, it is necessary to machine a notch in the 8S8289 Tube (3) for clearance of' the boss that projects above the camshaft bearing bore. Machine the notch 1 1/2 in. (38.1 1mm) wide, 3/8 in. (9.5 1m1) deep, with a I/8 in. (3.2 mm) radius or chamfer in the corners and on the edges.



NOTCH IN TUBE
3. 8S8289 Tube. 4. 8S8288 Cone. 5. Notch.

Invert the 8S8288 Cone (4) and in, tall it In the 8S8289 Tube (3) for installation of the camshaft front bearing.



INSTALLING CAMSHAFT FRONT BEARING
3. 8S8289 Tube. 4. 8S8288 Cone.

ENGINE TEST PROCEDURE

LUBRICATION FOR A REBUILT ENGINE

It is very important for a rebuilt engine to have "adequate" (needed) lubrication during the first seconds of operation. A "dry start" (without needed lubrication) on a rebuilt engine can cause bearing damage.

When an engine is rebuilt with new parts, oil is put on each part as it is installed This is generally enough lubrication for engine start-up. However, this lubrication may not be enough or may be lost if the rebuilt engine is place in storage for any length of time.

When a factory assembled short block assembly is installed, the oil used at the factory has, to give this needed lubrication. However, the factory oil application can flow off the parts in a short block during storage or shipment. As a result the parts in a rebuilt engine will not have "adequate" lubrication start-up.

To prevent the possibility of a "dry start" and bearing damage during the first seconds of running, use the 1P540, Flow Checking Tool Group, and Shop air pressure to pressure lubricate (fill the main oil passage with oil under pressure) all rebuilt engines.

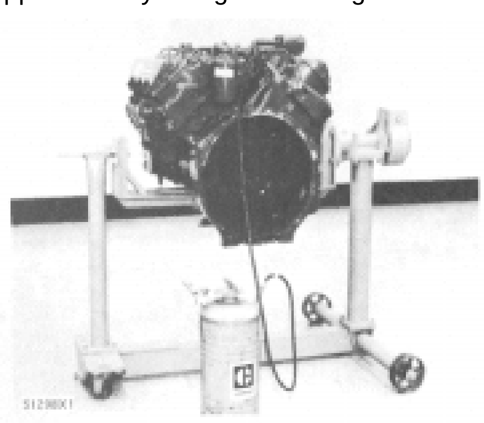
Procedure for Pressure Lubrication

1. Clean the tank of the IP540 Flow Checking Tool Group thoroughly, and set the pressure regulator to 35 ± 5 psi (240 $^{\pm}$35 kPa).

WARNING

Air pressure should not be more than 50 psi (345 kPa) at any time.

2. Put approximately one gallon of engine oil In the tank.



PRESSURE LUBRICATION
(Using the 1 P540 Flow Checking Tool Group)

3. Connect the tools to the engine as shown. The tap shown is connected to the main oil passage.

4. Add air pressure to the tank, with the regulator set at 35 + 5 psi (240 $^{+}$ 35 kPa). Although the tank does haxve a hand pump, it is difficult to get enough air pressure to do the job with the hand pump. Therefore, use of shop air is recommended.

5. Let the one gallon of engine oil flow into the oil passage under pressure.

When filling the crankcase, put in one gallon of oil less than the recommendation in the Lubrication and Maintenance Guides, if engine has received this pressure lubrication application. Also if the engine is not going to be used for a long time, do the above procedure again before the first starting.

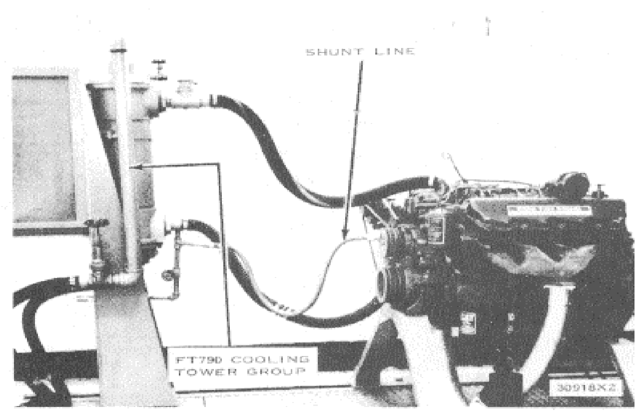
If shop air is not available for charging the tank, the hand pump may be used to get the minimum required pressure.

CAUTION

Do not use the same 1 P540 Flow Checking Tool Group for both "pressure lubrication application" and for checking fuel flow. Incorrect cleaning is probable if the tool is used for both fuel and lube oil. Even a minute amount of dirt in the fuel system can cause fuel nozzle failure.

DYNAMOMETER TEST PRECAUTION

To avoid possible engine damage while testing on a dynamometer, the thermostats must be installed and the shunt line connected as shown.



SHUNT LINE CONNECTED TO ENGINE

ENGINE TEST PROCEDURE

INITIAL OPERATION AFTER ENGINE RECONDITIONING

The quality of oil control components used in Cater pillar engines is such that, following engine reconditioning (with Caterpillar Service Parts), only an initial operational check is necessary before continued operation in normal service.

The purpose of this initial operational check is to: insure that the engine has been assembled properly; determine if proper pressures and temperatures are maintained in the lubrication, cooling and fuel systems; correct any leaks; perform necessary adjustments (such as valve clearance, governor high and low idle speeds, etc.); check the power setting of the engine.

To provide a safe, uniform initial operational check, the following procedure is recommended:

1. Motor engine at cranking speed until oil pressure is observed.

2. Operate engine for 10 minutes at low idle.

3. Operate engine for 15 minutes at half-load and ¾ rated speed.

4. Operate engine for 30 minutes at rated load and speed.

CHAPTER 4
SCRAPER MAINTENANCE

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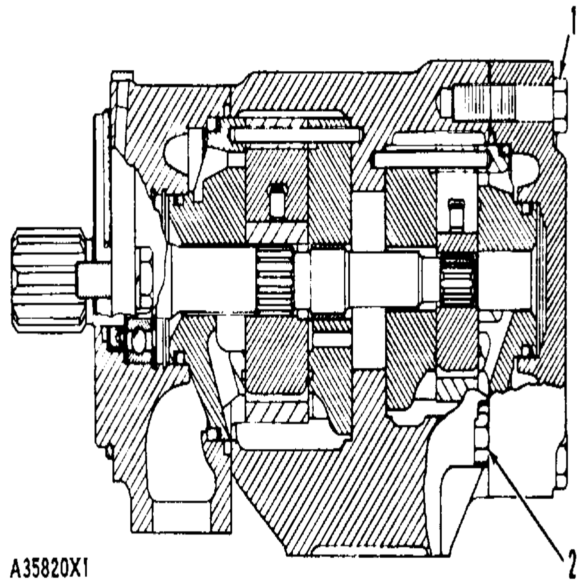
SECTION 1
SPECIFICATIONS

HYDRAULIC PUMP
(9J5061)



Rotation is counterclockwise when seen from drive end

Type of pump: Vane

For test, use SAE 10W oil at 150°F (65°C).

LARGE SECTION OF PUMP (Drive end) (Steering)

Test at Full Speed

Output .... 23 0 U S gpm (87.1 litre/min)
at a pressure of .... 100 psi (7.0 kg/cm^2) (690 kPa)
with pump at .... 2000 rpm
with engine at .... 2000 rpm
Output........................ .20 4 U S. gpm (77 2 litre/min)
at a pressure of .. 1000 psi (70 0 kg/cm^2) (6900 kPa)
with pump at .... 2000 rpm
with engine at .... 2000 rpm

Test at Half Speed

Output .... 11.3 U.S. gpm (42.8 litre/min)
at a pressure of .... 100 psi (70 kg/cm^2) (690 kPa)
with pump at .... 1000 rpm
with engine at .... 1000 rpm
Output .... 10 0 U S gpm (37 9 litre/min)
at a pressure of .. 1000 psi (70 0 kg/cm^2) (6900 kPa)
with pump at .... 1000 rpm
with engine at .... 1000 rpm

SMALL SECTION OF PUMP (Cover end) (Implement)

Test at Full Speed.

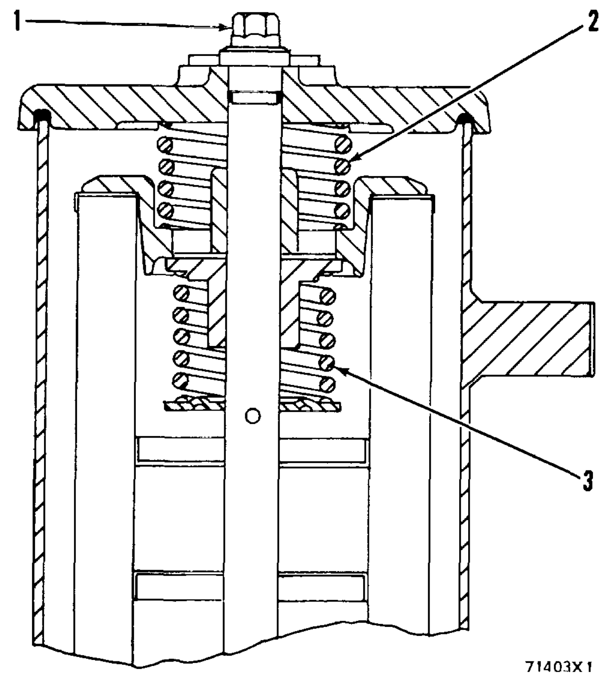
Output .... 23 7 U.S gpm (89 7 litre/min)
at a pressure of .... 100 psi (7.0 kg/cm^2) (690 kPa)
with pump at .... 2000 rpm
with engine at. .... 2000 rpm
Output .... 23.0 U S gpm (87.1 litre/mln)
at a pressure of .. 1000 psi (70 0 kg/cm^2) (6900 kPa)
with pump at .... 2000 rpm
with engine at .... 2000 rpm

Test at Half Speed.

Output .... 11 7 U S gpm (44.3 litre/mn)
at a pressure .... 100 psi (7 0 kg/cm^2) (690 kPa)
with pump at .... 1000 rpm
with engine at .... 1000 rpm
Output .... 10 8 U S gpm (40 9 litre/min)
at a pressure of .. 1000 psi (70 0 kg/cm^2) (6900 kPa)
with pump at .... 1000 rpm
with engine at .... 1000 rpm

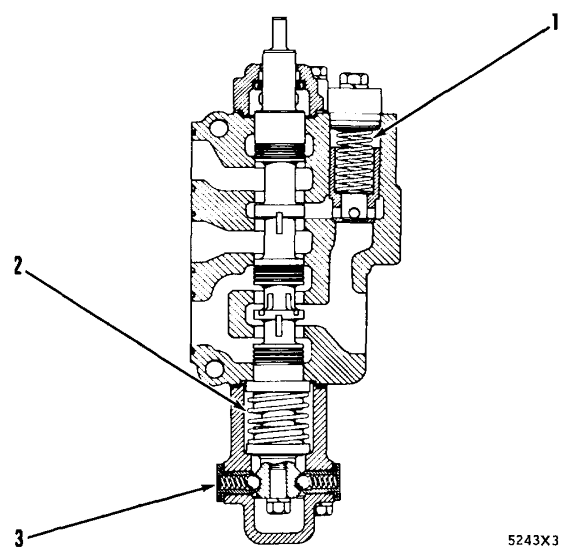
(1) Torque for four bolts .... 45 ± 5 lb ft. (61 ± 7 N m)
(2) Torque for four bolts................ 70 ± 5 lb ft (95 ± 7 N m)

OIL FILTER
(8J4423)



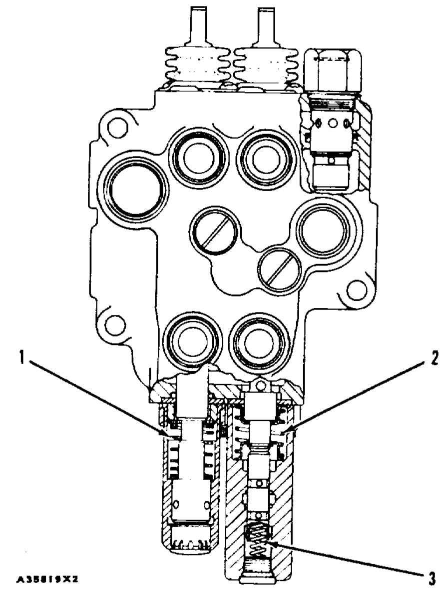
(1) Torque for bolt .... 60±5 lb.ft. (81±7 N.m)
(2) 6J2236 Spring:
Length under test force .... 1.38 in. (35.1 mm)
Test force .... 124.6 ± 7.4 lb (544.5 ± 32 9 N)
Free length after test .... 3.44 in (87.4 mm)
Outside diameter .... 2 80 in (20 3 mm)
(3) 5J2926 Spring for bypass valve:
Length under test force .... 2.98 in 75.7 mm)
Test force .... 60 6 ± 4 3 lb (269.7 ± 19 1 N)
Free length after test .... 5.40 in. (137.2 mm)
Outside diameter .... 1.94 in (49.3 mm)

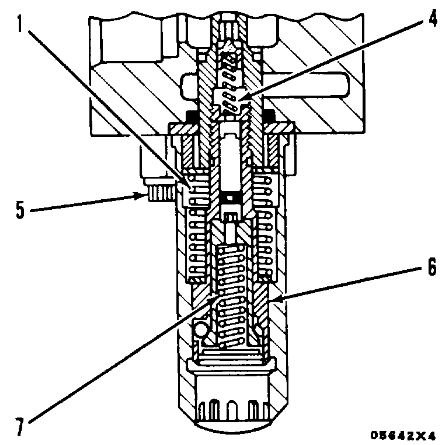
ELEVATOR CONTROL VALVE
(7J2451)



(1) 2J5845 Spring for check valve:
Length under test force 2.50 in (63 5 mm)
Test force .... 6 21 to 7 29 lb. (27.6 to 32.4 N)
Free length after test .... 4.19 in (106.4 mm)
Outside diameter .... 1.12 in. (28.4 mm)
(2) 4J3840 Spring for centering spool:
Length under test force1.73 in. (43.9 mm)
Test force .... 28.5 to 31 5 lb. (126.8 to 140.2 N)
Free length after test .... 3.21 in. (81 5 mm)
Outside diameter .... 1.81 in (46.0 mm)
(3) Torque for four plugs .... 42 ± 4 lb.ft. (57 ± 5 N.m)

BOWL AND EJECTOR CONTROL VALVE
(5R6141)





9J1072 Relief valve, pressure
setting .... 2525 + 25 or - 0 psi (177 5 + 1.8 or 0 kg/cm2)
(17425 + 172 or - O kPa)
At a flow of .... 15 U.S. gpm (56.8 litre/min)
Pressure to open poppet
valve 1900 ± 100 psi (133.6 ± 7.0 kg/cm2) (13110 ± 690 kPa)

(1) 7J5979 Spring for ejector spool:
Length under test force .... 1.19 in (30.2 mm)
Test force .... 30.5± 3.5 lb. (135.7 ± 15.6 N)
Free length after test .... 1 78 in (45 2 mm)
Outside diameter .... 1 01 in. (25.6 mm)

(2) 7J6449 Spring for bowl spool:
Length under test force .... 1.12 n. (28.4 mm)
Test force 20 .... 1 lb. (89.0± 4.5 N)
Free length after test .... 1.83 In. (46.5 mm)
Outside diameter .... 1.13 in. (28 7 mm)

(3) 3G1597 Spring.

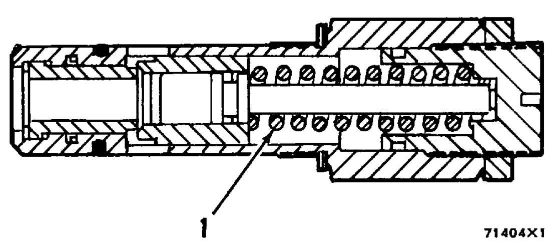
(4) 7J6578 Spring for poppet valve:
Length under test force .... 70 in. (17.8 mm)
Test force .... 7.45 ± .37 lb. (33.1 ± 1 7 N)
Free length after test .... 84 in (21.3 mm)
Outside diameter .... 19 in. (4.8 mm)

(5) Torque for four bolts ...... 10 to 13 lb.ft. (14 to 18 N.m)

(6) Torque for retainer .... 5 to 8 lb.ft. (7 to 11 N.m)

(7) 7J6577 Spring for plunger:
Length under test force .... 1 31 in (33.3 mm)
Test force .... 17 lb. (75 6 N)
Free length after test .... 1.50 in. (38.1 mm)
Outside diameter .... 31 in. (7.9 mm)

ELEVATOR RELIEF VALVE
(7J6521)



Pressure to open relief
valve 2500 ± 50 psi (175.8 ± 3.5 kg/cm2) (17 250 ± 345 kPa)

(1) 7J7434 Spring:
Free length .... 2.32 in. (58.9 mm)
Outside diameter .... 77 in. (19.6 mm)

CYLINDERS

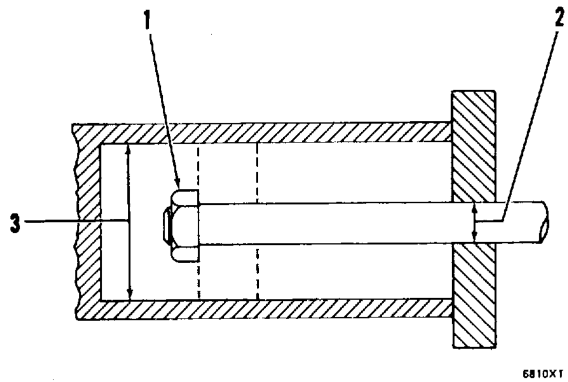
7J6058 Bowl Cylinders:

(1) Torque for nut with lubricant on threads .... 1200 ± 120 lb,ft. (1630 ± 160 N.m)

(2) Bore in new head .... 2.003± 001 in. (50.88± 0.02 mm)

Diameter of new rod ....1.9980 ± ,0015 in. (50.75 ± 0.04 mm)

(3) Bore in new cylinder ....3.9950 ± .0015 in. (101.47 ± + 0.04 mm)



7J5528 Door Cylinder:

(1) Torque for nut with lubricant on threads .... 1600± 160 lb.ft. (2170 ± 215 N.m)

(2) Bore in new head ....2.503 ± .001 in. (63.58 ± 0.02 mm)

Diameter of new rod ....2.4980 ± .0015 in. (63.45 ± 0.04 mm)

(3) Bore in new cylinder ..5.000 ± .005 or - 000 in (127.0 ± 0.13 or - 0.00mm)

8J6418 Ejector Cylinder:

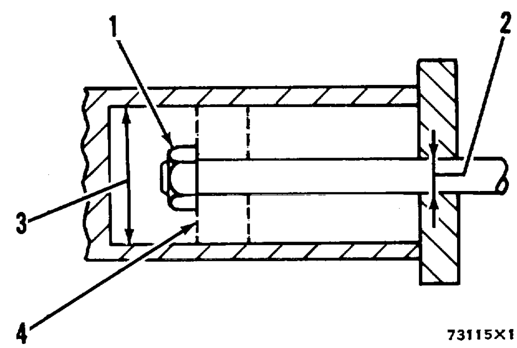
(1) Torque for nut with lubricant on threads.............................. 1000± 120 lb.ft. (1360 ± 160 N.m)

(2) Bore in new head ....2.003 to 2.008 in. (50.88 to 41.00 mm)

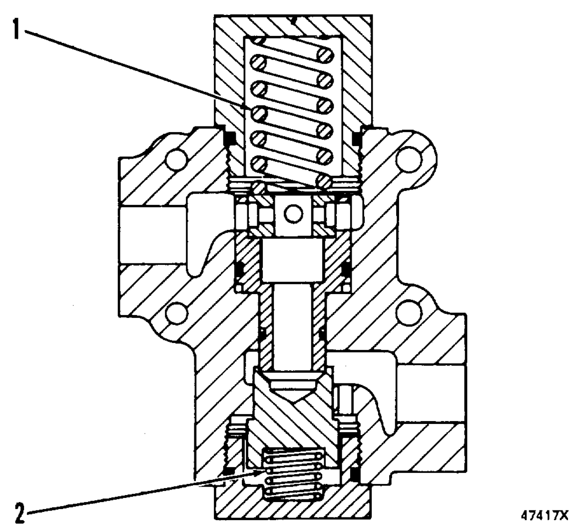
Diameter of new rod ....1.997 to 2.000 in. (50.2 to 50.80 mm)

(3) Bore In new cylinder ....3.5035 ± .0025 in. (88.99 ± 0.06 mm)

(4) Torque for piston with lubricant on threads .... 500 lb.ft. (680 N.m)



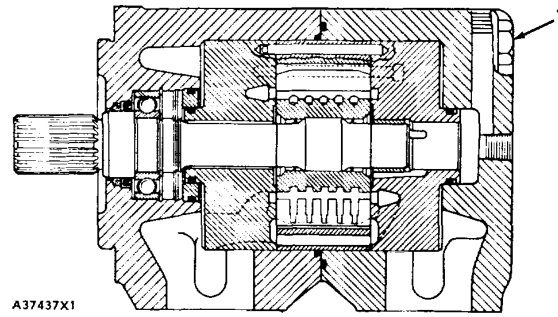
DOOR CHECK VALVE (3G4806)



(1) 8J3123 Spring for check valve:
Free length......................................2.22 in. (56.4 mm)
Outside diameter.............................1.12 in. (28.4 mm)

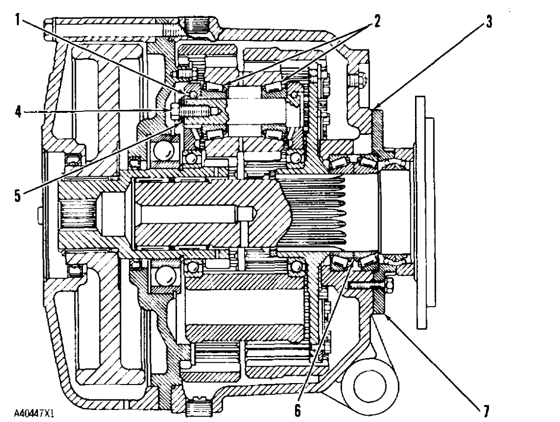
(2) 7J6896 Spring for seat:
Free length ....88 in.(22.4 mm)
Outside diameter ....62 in. (15.7 mm)

HYDRAULIC MOTOR
(7J4458)



(1) Torque for bolts 200 ± 10 lb.ft. (270 ± 14 N m)

PLANETARY ASSEMBLY
(1U36)



(1)7J6545 Shim (thickness) 002 in. (0.05 mm)
7J6546 Shim (thickness) 003 in. (0.08 mm)
7J6547 Shim (thickness) 005 in. (0 13 mm)
7J6548 Shim (thickness) 010 in. (0.25 mm)

Bearings (2) Adjustment:

1.Install bolt (4) and washer (5) without shims (1). Tighten bolt (4) until gear does not turn freely.
2.Measure the gap under the washer to get the thickness for shims (1).
3.Remove bolt (4) and washer (5).
4.Install the thickness of shims (1) measured in Step 2 and install washer (5), plate (lock) and bolt (4) Tighten the bolt to a torque of
50 ± 10 lb ft. (75 ± 15 N m)

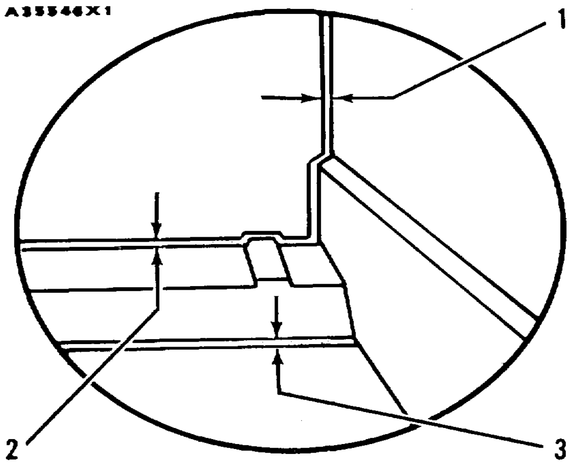
NOTE Gear must turn freely with no end play, 000 to 002 in. (.00 to 0.05 mm) tight.

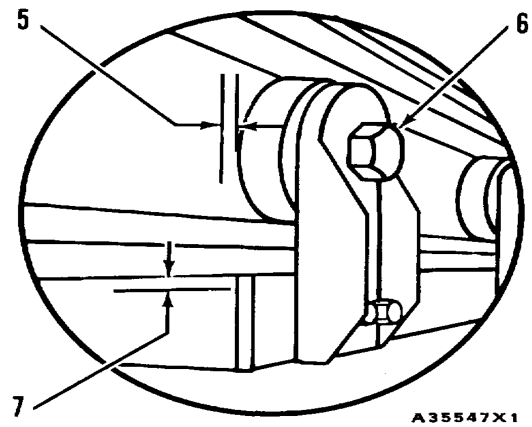
(3)9J248 Shim (thickness)002 in. (0.05 mm)
9J249 Shim (thickness) 003 in (O 08 mm)
9J258 Shim (thickness) 005 in. (0.13 mm)
9J259 Shim (thickness) 010 in (25 mm)

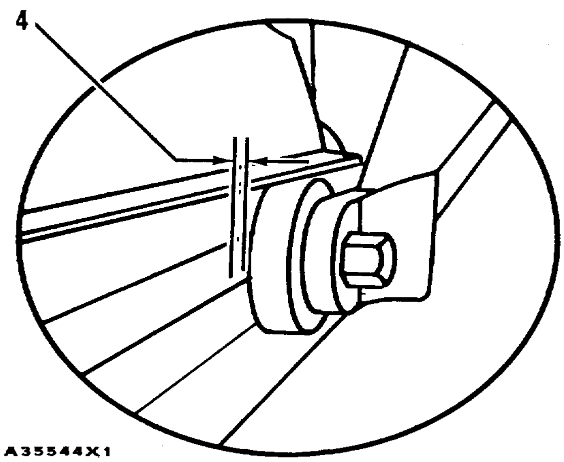
Bearings (6) Adjustment:

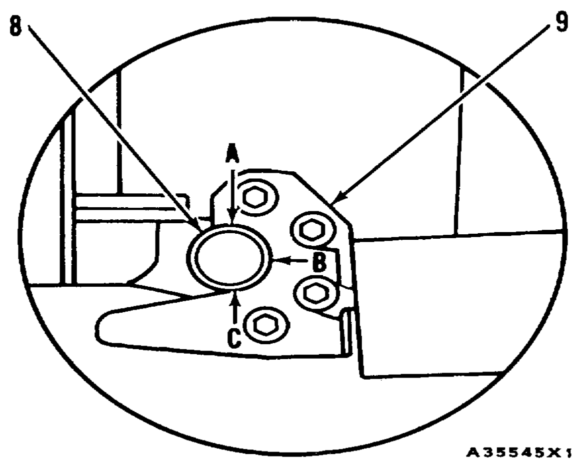
1.Install plate (7) without shims (3). Tighten bolts
2.Measure the gap under plate (7).
to a torque of 15 lb.ft. (20 N-m).
3.Remove the bolts and plate (7).
4.Install a thickness of shims (3) .001 to .005 in. (0 03 to 00 13 mm) less than the gap measured in Step 2. Install plate (7) and the bolts and lockwashers Tighten bolts to a torque of 32 ± 5 lb.ft. (45 ± 7 N-m)

NOTE: With the housing level, fill housing with SAE 80 oil to the fill level" plug opening (on side of the housing). DO NOT OVER FILL Install plug and give oil time to drain down into housing Remove "fill level" plug and let all extra oil drain out. Install plug.









(1) Clearance between ejector and side of bowl.................. 12 to .75 in. (3 O to 19.1 mm)
NOTE: When one side has .75 in (19.1 mm) clearance, the other side must not have more than .50 in. (12.7 mm).

(2) Clearance between ejector and floor .... 03 to .25 in. (0.8 to 6.4 mm)

(3) Clearance between door and floor.........................26 to .76 in. (66 to 19.3 mm)
and floor.........................26 to .76 in. (66 to 19.3 mm)

(4) Clearance between ejector rear rollers to guide ....03 to .19 in. (0.8 to 4.8 mm)
NOTE: When one side has .19 in. (4.8 mm) clearance, the other side must not have more than .12 in. (3.0 mm).

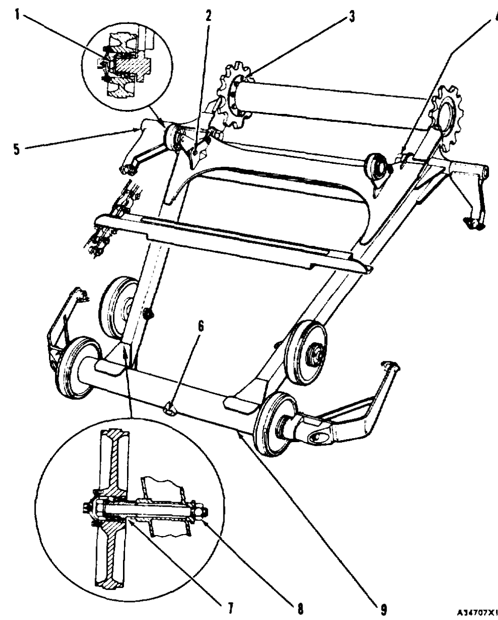
(5) Clearance between door roller and bowl sides .... .06 to 18 in (1 5 to 4 6 mm)
NOTE: When one side has .18 in. (4.6 mm) clearance, the other side must not have more than 13 in (3.3 mm).

(6) Torque for nut.... 450±70 Ib.ft. (610 ± 95 N.m)

(7) Clearance between door and bottom of bowl side .... .07 to .25 in. (1.8 to 6.4 mm)

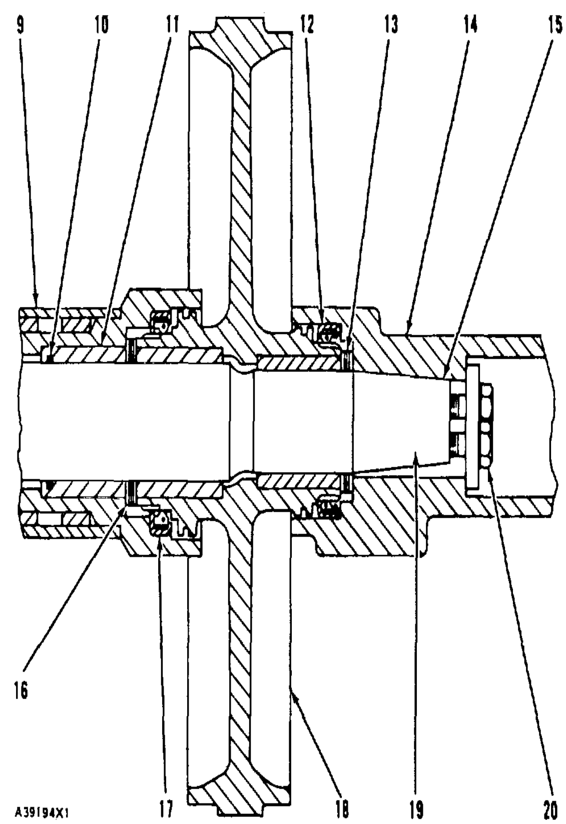
(8) Clearance at A, B and C between door insert and guide (9) when door Is closed .... 00 in. (0 0 mm)

ELEVATOR
(9J119)



(1) Torque for two nuts ....240 to 260 lb.ft. (325 to 350 N.m)
(2) Torque for four nuts ....300 to 315 lb ft. (410 to 425 N m)
(3) Torque for 16 nuts.................90 to 100 lb.ft. (125 to 150 N.m)
(4) Torque for two bolts ....500 lb.ft. (680 N m)
(5) Installation of right support arm:
  1. Install link assembly.
  2 Slowly tighten bolt to torque of ....500 lb.ft (680 N m)
  3 Install driver on end of link.
  4. Hit driver with a 10 lb (5 kg) hammer (taper must fit).
  5 Slowly tighten bolt to torque of .... 500 lb.ft. (680 N m)
  6 Install left support arm.
(6) Torque for lockscrew 200 ± 10 lb.ft. (270 ± 15 N m)
(7) 15334 Shims. Use shims needed to put right idler in center of chain links Same for left idler.
(8) Torque for two nuts .... 640 + 80 lb.ft (875 + 100 N m)
(9) Lower tube

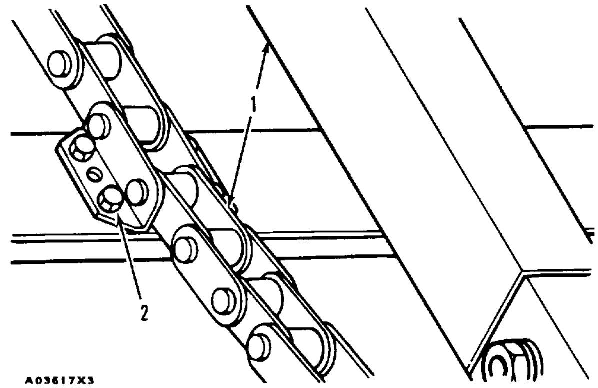
Roller and Shaft Installation:



1. Put seals (10) in bearings (11) and install the bearings in each end of lower tube (9).
2. Install shaft (15) in tube (9).
3. Put rollers (18), with no washers (16), on each end of shaft (15).
4. With each roller (18) against tube (9), measure the distance between the center lines of the rollers. To get the total thickness of washers (16), subtract the measurement from 47 in. (1194 mm).
5. Remove rollers (18). Install seals (17) in each end of tube (9).
6. Install one half (1/2) the total thickness of washers (16) in each end of tube (9).
7. Install rollers (18) and hubs (14), with no washers (13), on the ends of shaft (15).
8 Measure the end play of rollers (18) and shaft (15). To get the total thickness of washers (13), subtract .00 to .06 in. (0.0 to 1.5 mm) from the end play measurement.
9. Remove hubs (14).
10. Install key (19) in shaft (15) and seals (12) in hubs (14).
11. Install one half (1/2) the total thickness of washers(13) against rollers (18) and install hubs (14). With lubricant on the threads, tighten bolts (20) into shaft (15) to a torque of 100 to 110 lb.ft. (136 to 149 N.m)
12. Hit hubs (14) with a 10 lb. (5 kg) hammer and again tighten bolts (20) to a
torque of ....100 to 110 lb.ft. (136 to 149 N.m)

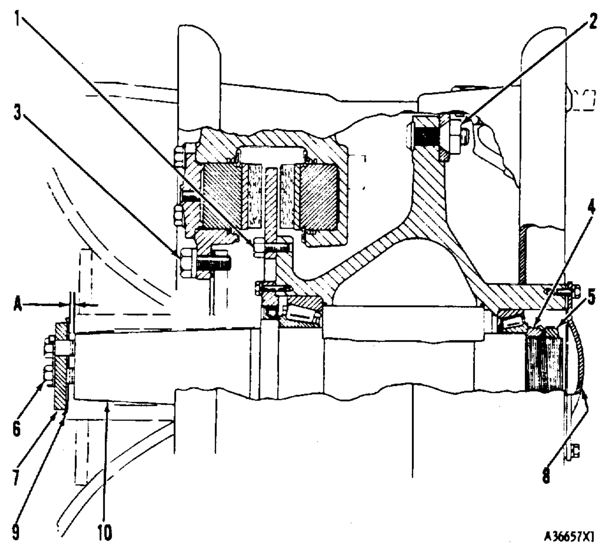
When bolts (20) do not loosen after hubs (14) are hit with the hammer, the rollers and shaft are installed.

ADJUSTMENT OF ELEVATOR CHAIN



(1) Distance from bottom of elevator frame to top of chain (chain slack, measured half way between sprocket and lower roller at loop) .... 7.50 - 1.50 in. (190.5 - 38.1 mm)
(2) Torque for nuts on bolts through flight and chain link assembly .... 100 to 125 Ib.ft. (136 to 170 N.m)

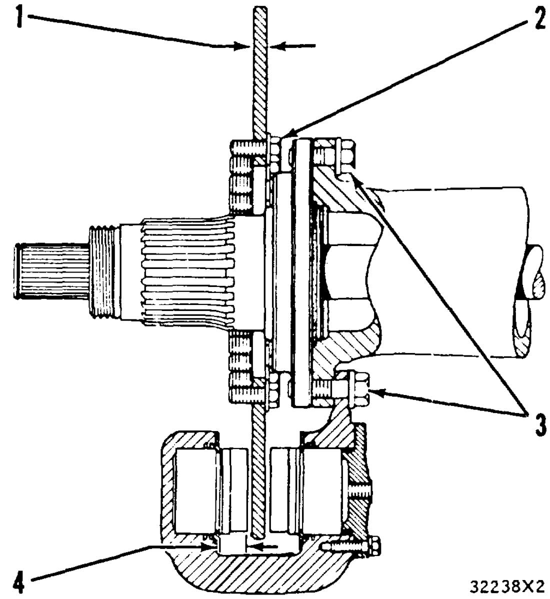
WHEEL GROUP

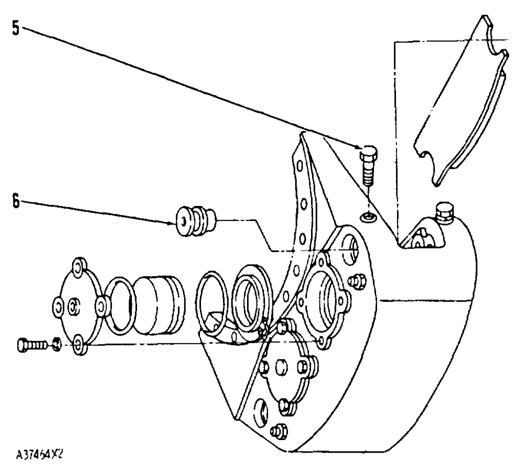


Adjustment Procedure for Wheel Bearings:

1. Fasten a rope to the studs for nuts (2) with at least two full wraps around the outside circumference.
2. Fasten a spring scale to the free end of the rope.
3. While the wheel is turned, tighten nut (4) until a pull of 5 lbs. (2.3 kg) is the indication on the scale.
4. Install the lock, and outer nut (5).
5. While cover (8) is removed, hit the end of shaft (10) with a hammer until bolts (6) cannot be tightened to more than 200 to 220 lb. ft. (272 to 299 N m)
6. Install shims (9) to have dimension (A) of .125 in. (3.17 mm) minimum between plate (7) and end of shaft (10).

WHEEL BRAKE ASSEMBLY





(1) Thickness of disc-
New.. 50 in (12 7 mm)
Minimum permissible thickness (worn) (in area where pad and disc make contact) .... 44 in (11 2 mm)

(2) Torque for bolts with lubricant on threads. 195 - 20 lb ft (265 ± 25 N-m)

(3) Torque for bolts with lubricant on threads ..159 to 175 lb ft (217 to 240 N-m)

(4) Thickness of lining assembly (including plate).
New .... 88 In (22 4 mm)
Minimum permissible thickness (worn) .... 38 In (9 6 mm)
(Measure the lining at both ends because it can wear more at one end than the other)

(5) (6) Clearance between pin (6) and brake disc must not be less than 010 in (O 25 mm) If clearance is less than 010 in (O 25 mm), turn bolt (5) counterclockwise one turn slide pin (6) to get 010 in (O 25 mm) clearance and tighten bolt (5) again

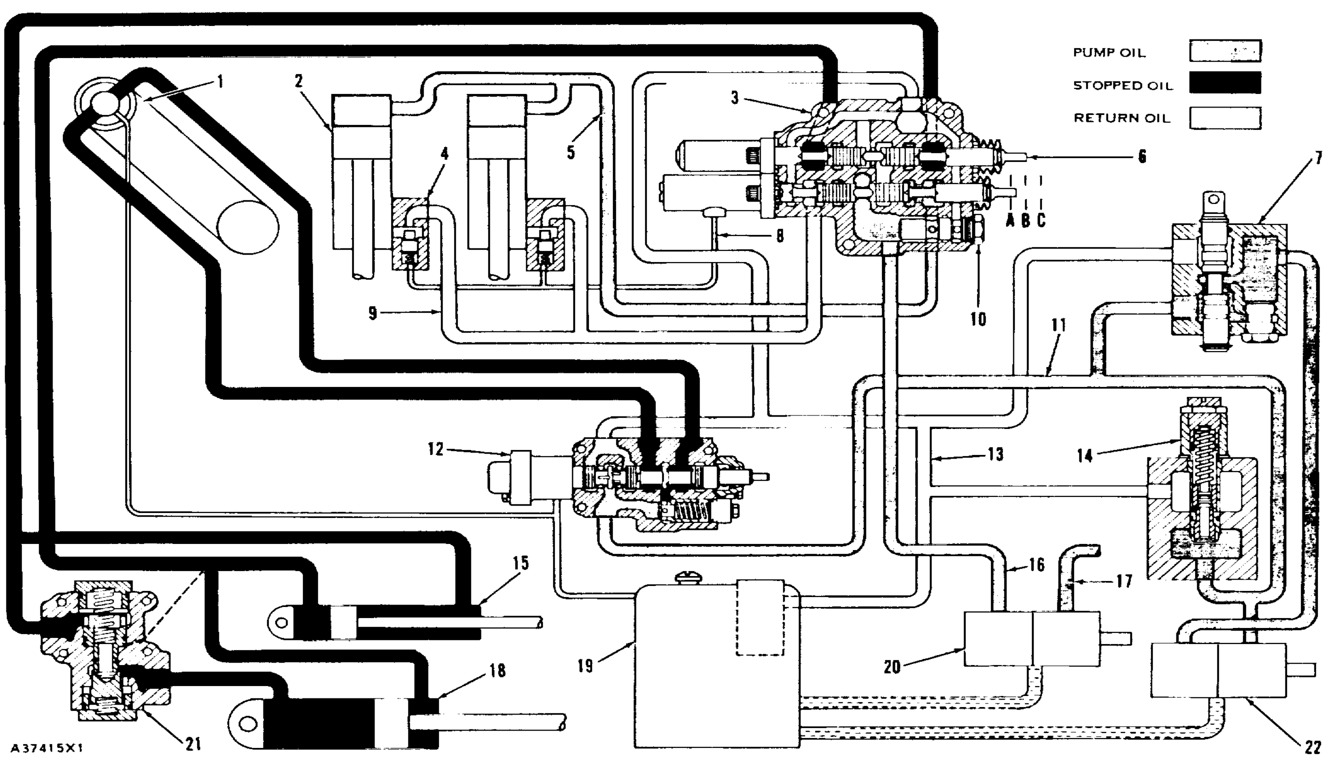
SECTION 2
SYSTEMS OPERATION, TESTING, AND ADJUSTING

The scraper hydraulic system has two hydraulic pumps. The pumps are on the housing for the torque converter, between the transmission and engine near the left side of the tractor. Each of the pumps have two sections and both are vane-type pumps. One of the pumps is for the hydraulic motor that runs the elevator. The oil from both sections of this pump is used to run the elevator at HIGH speed. When the elevator is in LOW speed, the oil from only one of the pump sections is used. The other two-section pump is for the steering and the cylinders for the bowl and ejector.

The control levers for the elevator, bowl and ejector are at the right side of the seat for the operator. Flexible cables (with covers) are used to connect the control levers to the valve spools in the hydraulic control valves. When the control levers are in HOLD position, with the engine running, all of the oil from the hydraulic pumps goes through the control valves and back to the filter in the hydraulic tank. The oil goes through the filter and then into the tank.

The oil filter has a bypass valve. If the filter element gets too much dirt and the oil can not easily go through the element, there is an increase in the pressure of the oil to the filter. High oil pressure opens the bypass valve and the oil goes through the open bypass valve into the tank. Cold hydraulic oil can not easily go through the filter element. The increased pressure of the cold hydraulic oil keeps the bypass valve open until the oil gets warm which decreases the oil pressure and the bypass valve closes.

BOWL CIRCUIT



SCHEMATIC OF HYDRAULIC SYSTEM FOR BOWL DOWN

1. Elevator hydraulic motor.
2. Bowl cylinder (two).
3. Bowl control valve.
4. Carry check valve (two).
5. Oil line (for head ends of bowl cylinders).
6. Ejector valve spool.
7. Elevator speed valve.
8. Vent line (for carry check valves).
9. Oil line (for rod ends of bowl cylinders).
10. Relief valve (bowl oil circuit).
11. Oil line (to elevator control valve).
12. Elevator control valve(in HOLD position).
13. Return oil line.
14. Relief valve (elevator circuit).
15. Ejector cylinder.
16. Oil line.
17. Oil line (for steering).
18. Door cylinder.
19. Filter and tank.
20. Pump (bowl and steering).
21. Door check valve.
22. Pump (elevator).
A. DOWN position.
B. HOLD position.
C. UP position.

Bowl Down

When the bowl valve spool in control valve (3) is held in DOWN position (A), the oil from pump (20) in line (16) goes out of the control valve through line (5) into the head ends of bowl cylinders (2). The DOWN position of the bowl valve spool also opens a passage for the oil in vent line (8) to go through the control valve to the tank. The pump oil in the head ends of cylinders (2) moves the pistons and rods, connected to the bowl, down and lowers the bowl. The pistons push the oil from the rod ends of the bowl cylinders and opens carry check valves (4). The check valves open because the oil in vent line (8) can go to the tank. The rod end oil, pushed through valves (4), goes through line (9), through control valve (3), through return oil line (13) into the filter and tank (19).

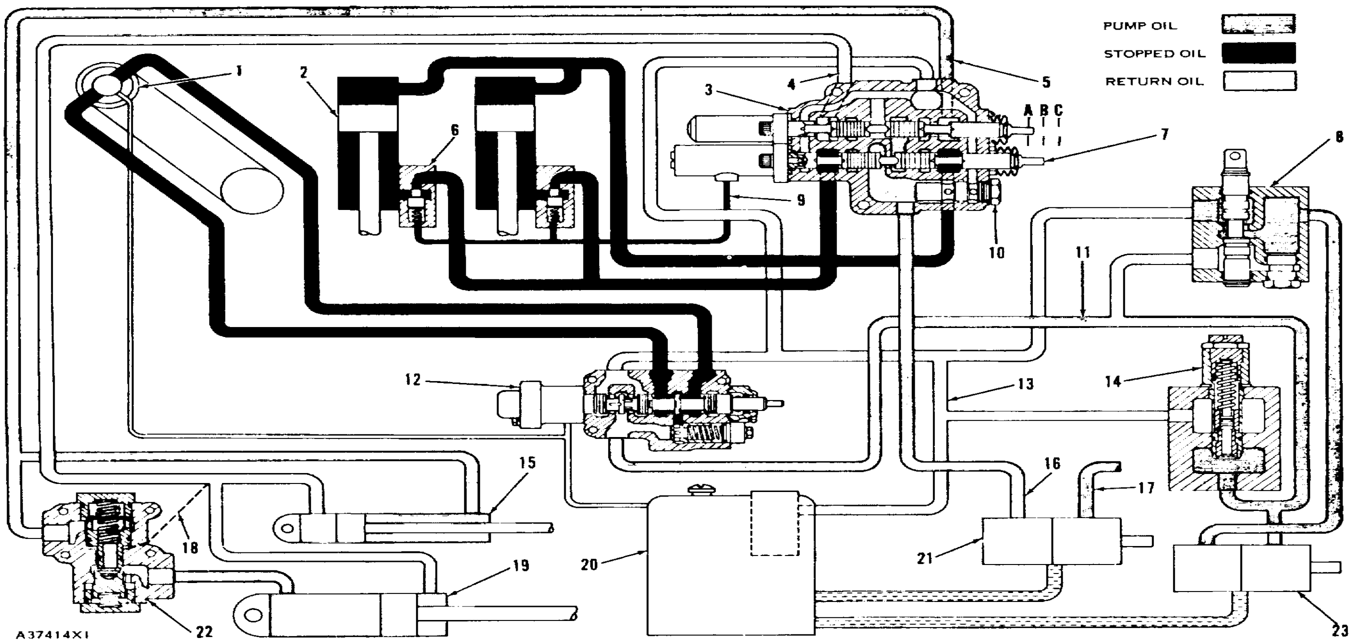
Relief valve (10) in control valve (3) prevents high oil pressure damage to the parts in the oil circuit of pump (20). If pump oil pressure increases to approximately 2525 psi (177 kg/cm2) (17 425 kPa) the pressure opens the relief valve and the pressure can not increase any farther.

Release the control lever and a spring on the bowl valve spool moves it to HOLD position (B). Now, the pump oil goes to the filter and tank and the passage for the oil in vent line (8) is closed. The stopped oil in vent line (8) keeps the carry check valves closed. The bowl can not go down because the pistons, in the bowl cylinders, can not push oil through the closed carry check valves.

Bowl Up (No Illustration)

Hold the control lever in the UP position and it keeps the bowl valve spool in UP position (C), in control valve (3). The UP position of the bowl valve spool opens a passage to the tank for the oil in vent line (8) and also lets the pump oil, in the control valve, go through line (9) to carry check valves (4). With vent line (8) open to the tank, the pump oil in line (9) goes through carry check valves (4) into the rod ends of bowl cylinders (2). The pump oil moves the pistons and rods, connected to the bowl, up to lift the bowl. The pistons push the oil out of the head ends, of the bowl cylinders, through line (5) to control valve (3). The oil goes through the control valve and through return oil line (13) into the filter and tank (19).

Release the control lever and the spring on the bowl valve spool moves it to HOLD position (B). The HOLD position of the bowl valve spool closes the passage to the tank for the oil in vent line (8) and carry check valves (4) close. The movement of the bowl stops when the check valves close and the bowl control lever must be moved to either lower or lift the bowl.



SCHEMATIC OF HYDRAULIC SYSTEM FOR EJECTOR RETURN

1. Elevator hydraulic motor.
2. Bowl cylinder (two).
3. Control valve.
4. 5. Oil lines (for ejector and door cylinders).
6. Carry check valve (two).
7. Bowl valve spool.
8. Elevator speed valve.
9. Vent line (for carry check valves).
10. Relief valve.
11. Oil line (for elevator control valve).
12. Elevator control valve.
13. Return oil line.
14. Relief valve (elevator).
15. Ejector cylinder.
16. Oil line.
17. Oil line (for steering).
18. Pilot oil line.
19. Door cylinder.
20. Filter and tank.
21. Pump (bowl and steering).
22. Door check valve.
23. Pump (elevator).
A RETURN (close) position.
B. HOLD position.
C. EJECT (open) position.

Ejector Return (Close)

The ejector control lever is held in the RETURN position by the detent balls on the ejector spool When it is in RETURN position (A). The oil from pump (21) in line (16) goes out of control valve (3), through line (5) into the rod end of ejector cylinder (15) and through door check valve (22) into the head end of door cylinder (19).

The area of the piston in the door cylinder is more than the area of the piston in the ejector cylinder so the door cylinder piston moves first. The pump oil in the head end of the door cylinder pushes the piston and rod, connected to the door of the bowl, and the door closes. Now, the pump oil in the rod ends of the ejector cylinder pushes the piston and rod, connected to the ejector, and the ejector is pulled to the back of the bowl. When the ejector cylinder cannot move the ejector any farther and the guide near the front *of the bowl stops the movement of the door, the pressure of the pump oil increases in the cylinders, lines and control valve (3). When the pressure of the pump oil gets to approximately 1900 psi (134 kg/cm2) (13 110 kPa), the hydraulic ejector kickout, in the valve spool housing on control valve (3), moves the ejector valve spool to HOLD position (B).

The HOLD position (B), of the ejector valve spool, stops the oil in lines (4) and (5) and the ejector and door can not move until the ejector control lever is moved.

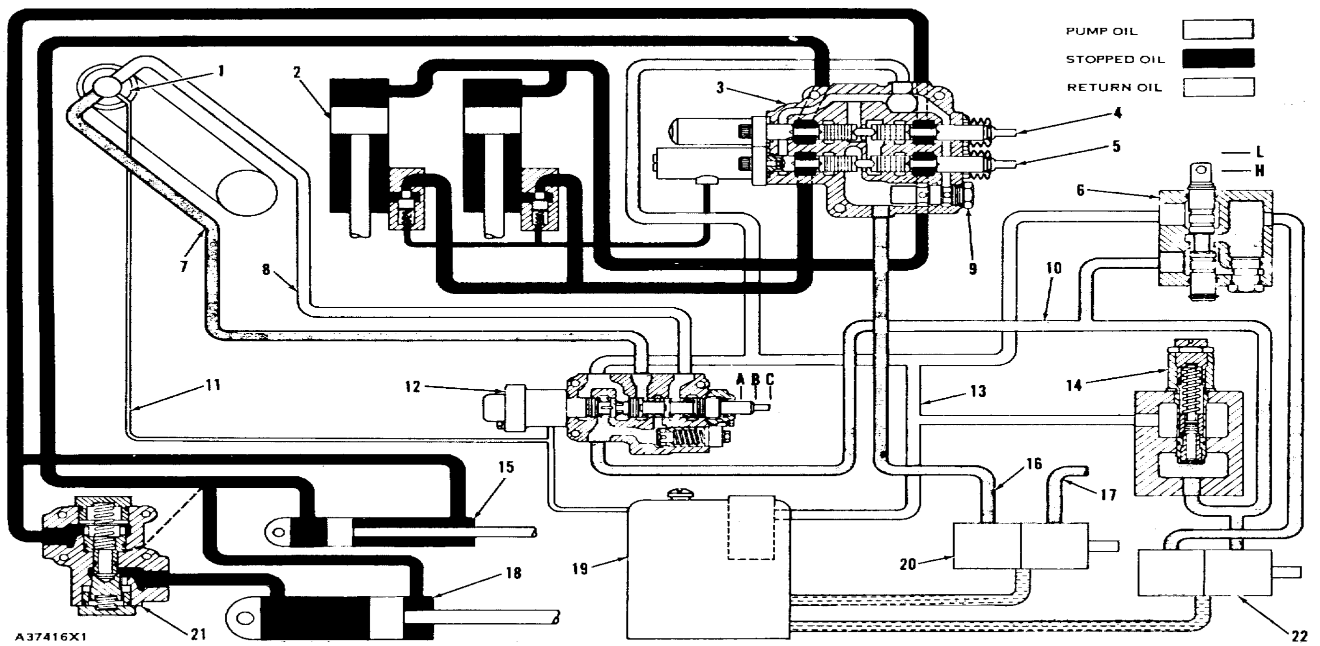
Eject (Open) (No Illustration)

Hold the control lever in EJECT position and it keeps the ejector valve spool in EJECT position (C) in control valve (3). The oil from pump (21) in control valve (3) goes through line (4) into the head end of ejector cylinder (1 5) and into the rod end of door cylinder (19). The pump oil in the rod end of cylinder (19) cannot move the piston because door check valve (22) stops the oil from the head end of cylinder (19). When the piston can not be moved, the pump oil pressure increases and this increase in pressure through pilot oil line (18) opens door check valve (22). The pump oil in the rod end of door cylinder (19) now pushes the piston and rod, connected to the door, to open the door. After the door opens, the pump oil in the head end of ejector cylinder (15) moves the piston and rod, connected to the ejector, and the ejector moves the load out of the bowl.

The oil pushed, by the pistons, from the rod end of ejector cylinder (15) and from the head end of door cylinder (19) goes through line (5), through control valve (3) and through return oil line (13) into the filter and tank (20).

Release the ejector control lever and a spring on the ejector valve spool moves the valve spool to HOLD position (B). The HOLD position stops the oil in lines (4) and (5) and neither the ejector or door can move until the ejector control lever is moved.

ELEVATOR CIRCUIT



SCHEMATIC OF HYDRAULIC SYSTEM FOR ELEVATOR FAST FORWARD

1. Elevator hydraulic motor.
2. Bowl cylinders (two).
3. Control valve.
4. Ejector valve spool.
5. Bowl valve spool.
6. Elevator speed valve.
7. 8. Oil lines (for hydraulic motor).
9. Relief valve (bowl circuit).
10. Oil line (to elevator control valve).
11. Oil drain line.
12. Elevator control valve.
13. Return oil line.
14. Relief valve (elevator).
15. Ejector cylinder.
16. Oil line (bowl circuit).
17. Oil line (for steering).
18. Door cylinder.
19. Filter and tank.
20. Pump (bowl and steering).
21. Door check valve.
22. Pump (elevator).
A. REVERSE position.
B. HOLD position.
C. FORWARD position.
H. HIGH SPEED position.
L. LOW SPEED position.

Elevator Forward

The elevator control lever is held in FORWARD position by the detent balls, in elevator control valve (12), that keep the elevator valve spool in FORWARD position (C). With the speed control lever in HI position, the valve spool in elevator speed valve (6) is in HIGH SPEED position (H).

The oil from both sections of pump (22) goes to elevator control valve (12). The oil from the drive end section goes through line (10) to valve (12). Elevator relief valve (14), with a pressure setting of approximately 2500 psi (176 kg/cm2) (17 250 kPa), prevents high oil pressure damage to the parts in the oil circuit from pump (22). The oil from the cover section of pump (22) goes through elevator speed valve (6) and adds to the pump oil in line (10) to elevator control valve (12). With the engine running at high rpm and the valve spool in control valve (12) in FORWARD position (C), the oil from pump (22) goes through line (7) to run elevator hydraulic motor (1) forward at high speed. The oil from the elevator motor goes through line (8), control valve (12) and through return oil line (13) into filter and tank (19).

Move the elevator speed lever to the LOW position and the valve spool in elevator speed valve (6) moves to LOW SPEED position (L). Now, the oil from the cover end of pump (22) goes through speed valve (6) and goes into return oil line (13) to the tank. With only oil from one section of pump (22) to elevator motor (1), the elevator runs at a slow speed.

The elevator control lever must be moved to the HOLD position to move the elevator valve spool to HOLD position (B). With the valve spool in HOLD position, the oil from pump (22) goes through control valve (12), through return oil line (13) into filter and tank (19).

Elevator Reverse (No Illustration)

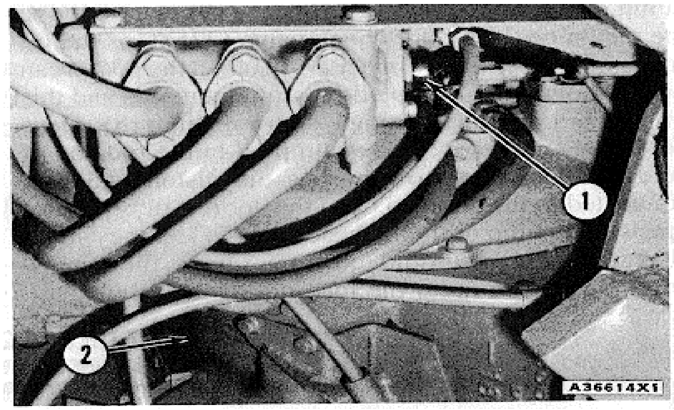
The elevator control lever is held in the REVERSE position by the detent balls in elevator control valve (12). With the valve spool in REVERSE position (A), the oil from pump (22) goes through control valve (12) and through line (8) to elevator motor (1) to run the elevator in reverse. The oil from the elevator goes through line (7), through control valve (12) and through return oil line (13) into the filter and tank (19). The reverse speed of the elevator is controlled by the rpm of the engine and the position of the elevator speed lever connected to the valve spool in elevator speed valve (6). HIGH SPEED position (H) lets the oil from the cover end section of pump (22) add to the oil from the drive end section of the pump in line (10) to the elevator motor. The speed valve stem in LOW SPEED position (L) lets the oil from the cover end section of pump (22) go through return oil line (13) to the tank. Now, only the oil from the drive end section of the pump goes through line (10) and to the elevator motor.

Move the control lever to the HOLD position. This moves the elevator valve spool to HOLD position (B) and stops the elevator.

ELEVATOR VALVES

Control Valve

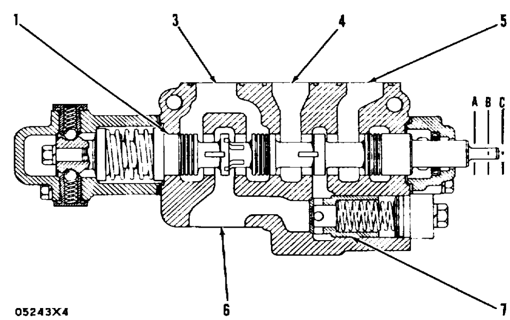
The location of the elevator control valve is just in front of transmission (2), near the left side of the machine. The flexible cable from the control lever goes under the scraper hitch and is connected to valve spool (I) in the elevator control valve.



ELEVATOR CONTROL VALVE

1. Valve spool (in control valve). 2. Transmission.

Detent balls, in the control valve, keep valve spool (1) in any of the three positions for the valve spool. When the valve spool is held in FORWARD position (C), the oil from the pump goes in through inlet (6), opens check valve (7),- goes through the check valve and through outlet (4) that connects with an oil line to the elevator hydraulic motor.

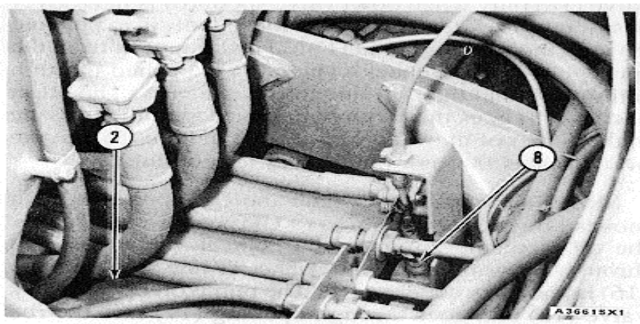


ELEVATOR CONTROL VALVE (HOLD POSITION)
1. Valve stem. 3. Outlet to tank. 4. Outlet to motor (for reverse). 5. Outlet to motor (for forward). 6. Inlet from pump. 7. Check valve. A. REVERSE position. B. HOLD position. C. FORWARD position.

With valve spool (1) in HOLD position (B), the pump oil through inlet (6) does not get any pressure to open check valve (7) because the oil goes out through outlet (3) and to the tank. The spring in check valve (7) keeps it closed, when there is no pump oil pressure in the control valve, and the oil in the lines to the elevator motor is stopped. The hydraulic motor can not be turned when oil is stopped in the lines to the motor.

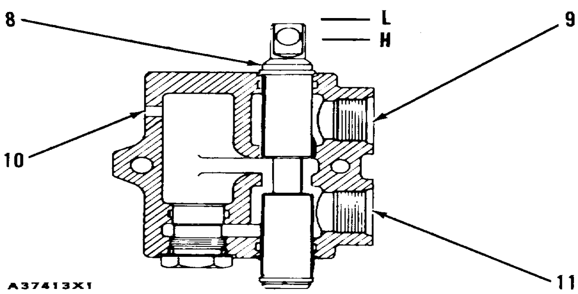
With valve spool (1) in REVERSE position (A), the pump oil through inlet (6) opens check valve (7) and then goes through outlet (5) that connects with an oil line to the elevator motor.

ELEVATOR SPEED VALVE



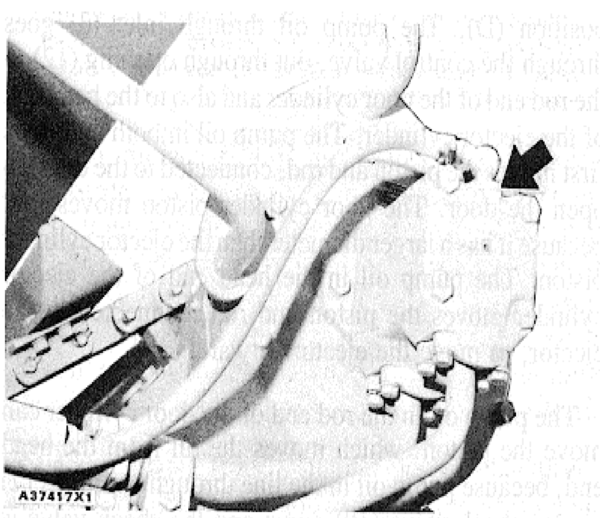
2. Transmission. 8. Valve spool (in LOW SPEED position).

The elevator speed valve is beside transmission (2) on the right side of the machine. The flexible cable from the elevator speed lever is connected to valve spool (8) in the speed control valve.



ELEVATOR SPEED VALVE

8. Valve spool. 9. Outlet (to the tank). 10. Inlet from pump. 11. Outlet (to hydraulic motor). H. HIGH SPEED position. L. LOW SPEED position.

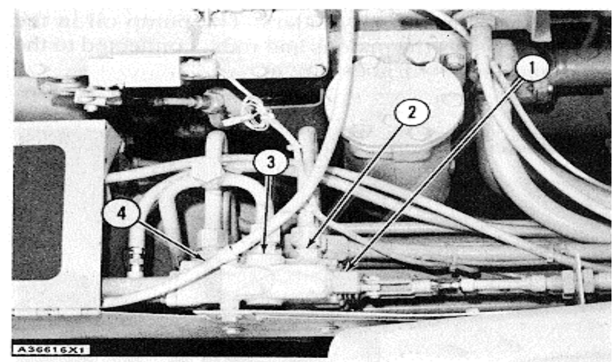


Hydraulic elevator motor

Oil from the pump goes through inlet (10) and through outlet (9) to the tank when valve spool (8) is in LOW SPEED position (L). When the elevator speed lever is moved to the HI position as shown, the flexible cable moves valve spool (8) to HIGH SPEED position (H). Now, the pump oil through inlet (10) goes through outlet (11) and to an oil line from the other pump section. The oil from both pump sections goes to the elevator motor and runs the elevator at high rpm.

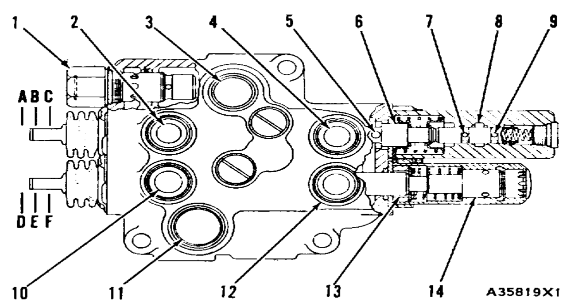
SCRAPER VALVES
Control Valve (Lift Circuit)

The scraper control valve is beside the transmission near the right side of the machine.



SCRAPER CONTROL VALVE

1. Relief valve. 2. Line (to head ends of bowl cylinders. 3. Inlet (pump). 4. Line (to rod ends of bowl cylinders).



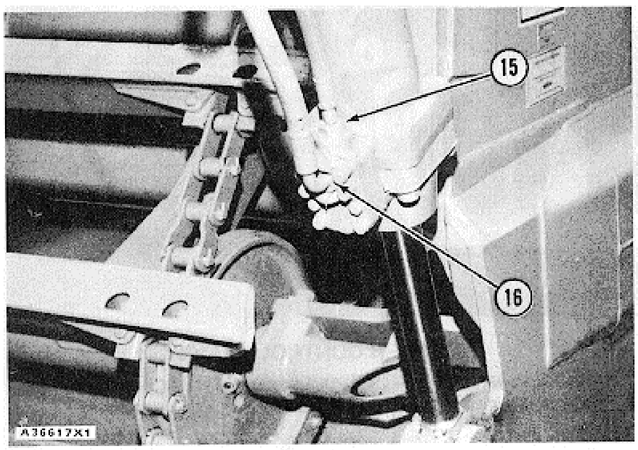
SCRAPER CONTROL VALVE

1. Relief valve. 2. Opening (to head ends of bowl cylinders). 3. Inlet (from pump). 4. Opening (to rod ends of bowl cylinders). 5. Hole (to passage in valve stem). 6. Bowl valve spool. 7. Hole (to passage In valve stem). 8. Passage (from vent line for carry check valves). 9. Hole (to passage In valve stem). 10. Opening (to ejector and door cylinder). 11. Outlet (to tank). 12. Opening (to ejector and door cylinder). 13. Ejector valve spool. 14. Ejector kick-out valve. A. UP position. B.HOLD position. C. DOWN position. D. EJECT (Open) position. E. HOLD position. F. RETURN (Close) position.

The flexible cables from the control levers, for bowl DOWN or UP, for ejector RETURN or EJECT, connect to the valve spools in the control valve. Relief valve (I), in the control valve, is in the oil circuit from the pump to either the bowl I or the ejector and door cylinders.

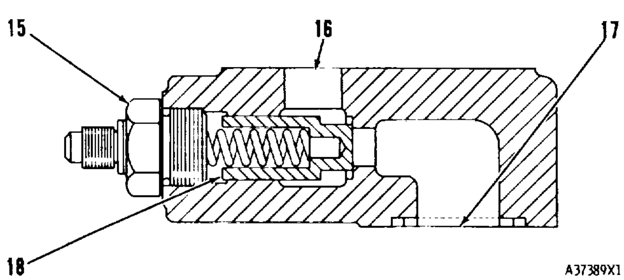
When the bowl lift lever is in the HOLD position, bowl valve spool (6) is in HOLD position (B). The oil from the pump goes through the control valve, through outlet (12) and to the tank.

Move the lift lever to the DOWN position and it moves bowl valve spool (6) to DOWN position (C). Now, the oil from the pump goes out opening (2) to the head ends of the bowl cylinders. The pump oil in the head ends pushes the pistons and rods, connected to the bowl, and the bowl goes down.



CARRY CHECK VALVE
15. Fitting (for vent line to control valve). 16. Oil line opening In valve body.

As the pistons in the bowl cylinders go down, they push the oil from the rod ends through opening (17). The oil pushes check valve (18) open and then goes through opening (16) and the oil line to the control valve opening (4). The rod end oil goes. through the control valve and through outlet (I1) to the tank.



15. Fitting (for vent line to control valve). 16. Oil line opening. 17. Opening (to the rod end of the cylinder). 18. Check valve.

The rod end oil from the bowl cylinder opens check valve (18) only when bowl valve spool (6) is in DOWN position (C). Hole (7), in the valve spool, is in passage (8) with the valve spool in HOLD position. Oil from the spring chamber in check valve (18) is pushed through fitting (15) and the oil line into passage (8). The oil in passage (8) goes through hole (7), through the passage in the center of the valve spool and out hole (5) into the oil that goes through outlet (I) to the tank.

Move the bowl lift lever to the UP position and it moves bowl valve spool (6) to UP position (A). Now, the oil from the pump in the control valve goes out through opening (4), through the oil line into opening (16) in the carry check valve. The pump oil opens check valve (18) and goes through opening (17) into the rod ends of the bowl cylinders. The pump oil in the rod ends pushes the pistons and rods, connected to the bowl, and the bowl goes up.

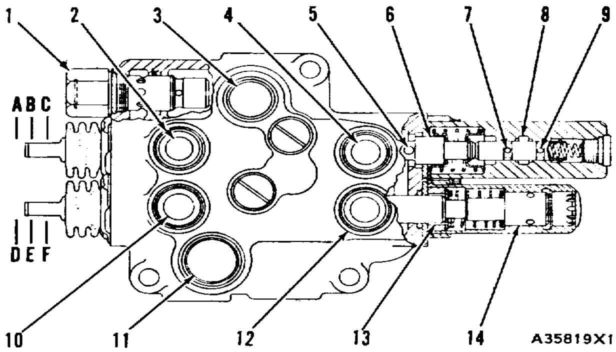
The pump oil through opening (16) pushes on the step surface of check valve (18) to open the valve. The pump oil opens the check valve because, when bowl valve spool (6) is in UP position (A), hole (9) is then in passage (8) and the oil in the spring chamber of check valve (18) goes through fitting (15), the oil line and into passage (8). The oil in passage (8) goes through hole (9) out of hole (5) and into the oil that goes through outlet (11) to the tank.

The HOLD position (B) for valve spool (6) stops the oil in passage (8), in the oil line and fitting (15) and in the spring chamber of check valve (18). The oil from the rod ends of the bowl cylinders in opening (16), of the carry check valves, can not open the check valves and this keeps the bowl up until the bowl lift lever is moved.

Control Valve (Ejector Circuit)

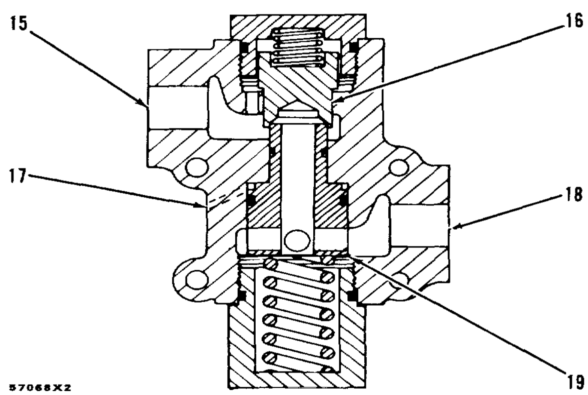
Hold the ejector-floor lever in the OPEN-EJECT position and it moves ejector valve spool (13) to EJECT position (D). The pump oil through inlet (3) goes through the control valve, out through opening (12) to the rod end of the door cylinder and also to the head end of the ejector cylinder. The pump oil in both cylinders first moves the piston and rod, connected to the door, to open the door. The door cylinder piston moves first because it has a larger diameter than the ejector cylinder piston. The pump oil in the head end of the ejector cylinder moves the piston and rod, connected to the ejector, to move the ejector forward.

The pump oil in the rod end of the door cylinder can move the piston, which moves the oil from the head end, because pump oil in the line through opening (17) moves check valve (19) down and the check valve is open. With the check valve open, the oil pushed from the head end of the door cylinder goes through the line to opening (15), through check valve (19) and out the line from opening (18) to the control valve (tank).



SCRAPER CONTROL VALVE

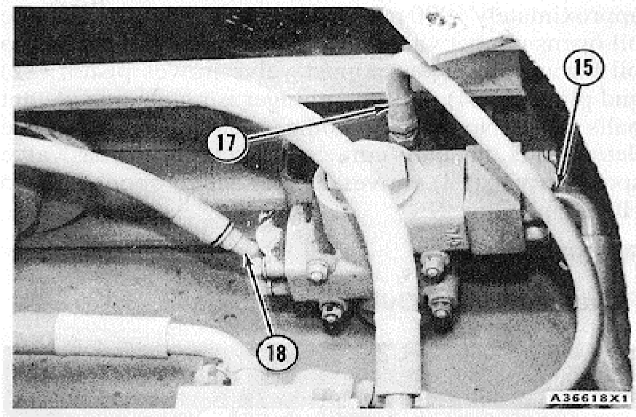
1. Relief valve. 2. Opening (to bowl cylinders). 3. Inlet (pump). 4. Opening (to bowl cylinders). 5. Hole. 6. Bowl valve spool. 7. Hole. 8. Passage (from carry check valves). 9. Hole. 10. Opening (for rod end of ejector and head end of door cylinder). 11. Outlet (to tank). 12. Opening (for head end of ejector and rod end of door cylinder). 13. Ejector valve spool. 14. Ejector kickout valve. A. UP position. B. HOLD position. C. DOWN position. D. EJECT (open) position. E. HOLD position. F. RETURN (close) position.



DOOR CHECK VALVE

15. Opening (for head end of door cylinder). 16. Seat. 17. Opening (from rod end of door cylinder and head end of ejector cylinder). 18. Opening (to control valve and rod end of ejector cylinder). 19. Check valve.

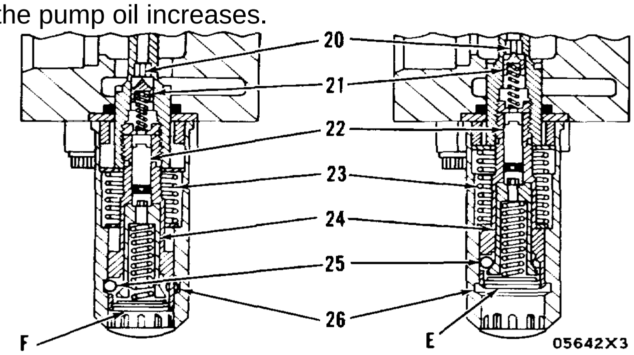
When ejector valve spool (13) is in RETURN position (F), detent balls in ejector kickout valve (14) keep the valve spool and the control lever in the RETURN position. The pump oil in the control valve goes out through opening (10) to the rod end o, the ejector cylinder and through the door check valve to the head end of the door cylinder.



DOOR CHECK VALVE

15. Opening (for head end of door cylinder). 17. Oil line from rod end of door cylinder and head end of ejector cylinder. 18. Opening (for oil line to control valve and rod end of ejector cylinder).

The pump oil through the line to opening (I 8), in the door check valve, goes through the passage in check valve (19), pushes seat (16) open and then goes through opening (15) and the line to the head end of the door cylinder. The pump oil in the head end of the door cylinder moves the piston and rod, connected to the door, to close the door. The pump oil in the rod end of the ejector cylinder now moves the piston and rod, connected to the ejector, to move the ejector to the rear of the scraper. When the piston can not move the ejector any farther, because it is against a stop, the pressure of the pump oil increases.



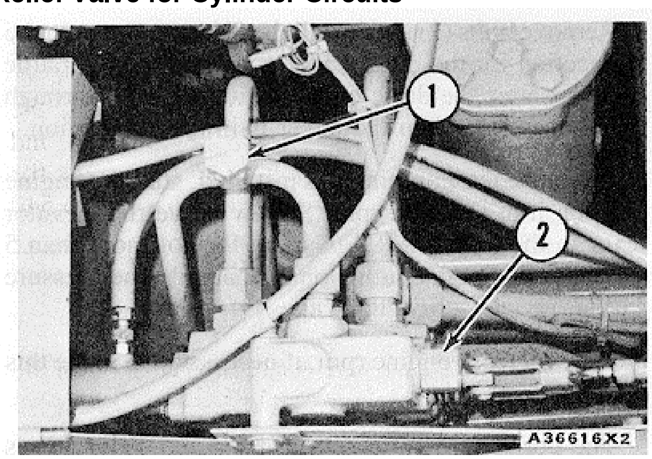
EJECTOR KICKOUT VALVE

20. Orifice (in valve spool). 21. Poppet valve. 22. Piston. 23. Spring (for valve spool). 24. Plunger. 25. Detent ball (three). 26. Detent (in housing). E. HOLD position of valve spool. F. RETURN position of valve spool.

The pump oil is also in a passage, in ejector valve spool (13), through orifice (20) against poppet valve (21) when the valve spool is in RETURN position (F). When the pressure of the pump oil in the rod end of the ejector cylinder, the head end of the door cylinder and through orifice (20) in valve spool (13) increases to approximately 1900 psi (134 kg/cm2) (13 1 10 kPa), the oil opens poppet valve (21). The pressure of the pump oil through the open poppet valve moves piston (22) and plunger (24) until the plunger is not against detent balls (25). Now, with plunger (24) away from the detent balls, the balls come out of detents (26) as valve spool spring (23) moves ejector valve spool (13) to HOLD position (E).

RELIEF VALVES

Relief Valve for Cylinder Circuits



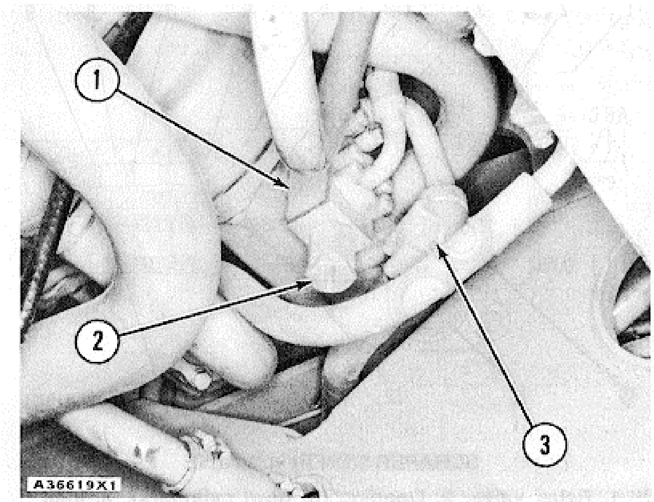
SCRAPER CONTROL VALVE
1. Oil line (from the pump). 2. Relief valve.

The relief valve (2) in the circuits for the bowl cylinders, ejector cylinder and door cylinder is in the control valve for the scraper. When the engine is running, oil from the pump goes through line (1), with the Tee test plug, and into the passage in the control valve with relief valve (2).

The pressure setting of the relief valve can be adjusted. The relief valve must be removed and disassembled to change the amount of shims in the valve.

Add shims for an increase or remove shims for a decrease in the pressure setting of relief valve (2).

Relief Valve for Elevator Circuit



RELIEF VALVE FOR ELEVATOR
1. Housing. 2. Adjustment screw for relief valve. 3. Pump oil line.

The housing (1), with the relief valve, is under the machine and is near the left side of the frame. Housing (1) is on the oil outlet of the drive end section of the elevator hydraulic pump. When the engine is running, the oil from the drive end section of the pump goes through housing (I) and through line (3) to the elevator control valve. The oil from the cover end section of the elevator hydraulic pump is in the circuit with the relief valve when the elevator speed lever is in both the HI and LOW position.

Turn adjustment screw (2) to change the pressure setting for the relief valve. Turn the screw clockwise to increase or counterclockwise to decrease the pressure setting of the relief valve.

The 5S5123 Hydraulic Testing Group is used to make the pressure test of the hydraulic system. Before any tests are made, visually inspect the complete hydraulic system for leakage of oil and for parts that have damage. For some of the tests, a timer and a measuring rule (either for inches or for millimeters) are usable tools.

⚠ WARNING: When testing and adjusting the hydraulic system, move the machine to a smooth horizontal location. Move away from machines that are at work and any personnel. There must be only one operator. Keep all other personnel either away from the machine or where the operator can see the other personnel.

VISUAL CHECKS

A visual inspection of the hydraulic system and its components is the first step when a diagnosis of a problem is made. Stop the engine, lower the bowl to the ground and when the oil is cool so any pressure in the tank will be at a minimum, make the inspections that follow:

1. Measure the oil level. Slowly turn the filler cap until it is loose to let the tank pressure lower before the filler cap is removed. Look for air in the oil in the tank.

2. Remove the filter element and look for particles removed from the oil by the filter element. A magnet will separate ferrous particles from non-ferrous particles (piston rings, O-ring seals, etc.).

3. Check all oil lines and connections for damage or leaks.

OPERATION CHECKS

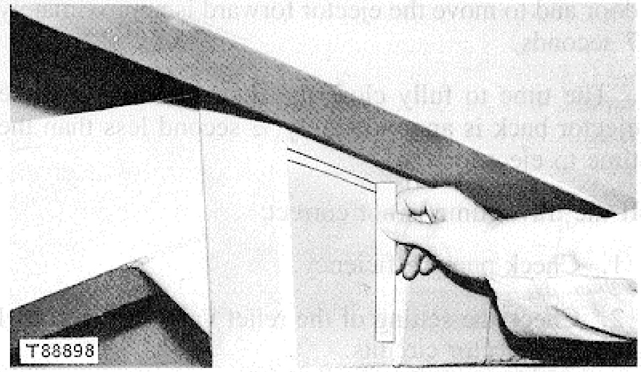
Checks of scraper operation can be used to find the source of oil leakage in the hydraulic system. The oil in the hydraulic system must be at an operating temperature of 100° to 1200F (380 to 400C).

Drift of Bowl Cylinders

Check the drift of the bowl cylinders. Lift the bowl 6 to 10 in. (152 to 254 mm), then move the control lever to the HOLD position. After three minutes, put a mark on the side of the bowl at the bottom of the draft arm 6 in. (152 mm) from the front of the bowl side. After five minutes, make the measurement for drift. Drift on a new machine is not more than .31 in. (7.9 mm).

If the drift is too much:

1. Check the carry check valves.
2. Check the piston seals in the bowl cylinders.



MEASURING DRIFT UOF BOWL CYLINPUEHR (Typical Example)

Travel Time of Bowl Cylinders

Lower the bowl to the ground. Run the engine at high idle rpm. Use a stop watch to find the time needed to fully lift the bowl.

The time to lift the bowl from the ground to maximum height is approximately 2 seconds.

If the travel time is not correct:

1. Check pump efficiency.
2. Check the settings of the relief valve for the bowl and ejector circuits.
3. Check the operation of the bowl valve spool in the control valve for the scraper.
4. Check the piston seals in the bowl cylinders.

Drift of Door Cylinder

The check valve for the door lets oil go to the ejector cylinder and the door cylinder while the ejector moves. The check valve keeps the door closed at the time the bowl is loaded.

If the door opens during the load operation:

1. Check for dirt under the check valve.
2. Check for a broken valve spring in the check valve.
3. Make sure valve moves freely in the valve body.

Travel Time of Ejector and Door

Lift the bowl approximately 6 in. (152 mm). Make sure the door is closed. Run the engine at high idle. Hold the ejector control lever in the FORWARD position. Use a stop watch to find the time to fully open the door and to move the ejector forward.

When the bowl is empty, the time to fully open the door and to move the ejector forward is approximately 7 seconds.

The time to fully close the door and to move the ejector back is approximately ½/2 second less than the time to eject forward.

If the travel time is not correct:

1. Check pump efficiency.
2. Check the setting of the relief valve for the bowl and ejector circuits.
3. Check the operation of the ejector valve spool in the control valve for the scraper.
4. Check the piston seals in the ejector and door cylinders.
5. Check the door check valve.

Operating Speeds of the Elevator

Put a mark on one flight of the chain. Operate the engine at high idle rpm. Use a stop watch to make a record of the number of revolutions per minute.

OPERATING	SPEEDS OF	ELEVATOR
Speed	**Chain**	**Seconds Per**
Range	**rpm**	**Chain Rev.**
LOW	6.5 to 7	8 5 to 9 5
HIGH	10 to 11	5.3 to 5.8

If the operating speeds are not correct:

1. Check pump efficiency.
2. Check the setting of the relief valve for the elevator circuit.
3. Check the operation of the control valve for the elevator.
4. Check the operation of the elevator valve spool in the control valve for the scraper.
5. Check the hydraulic motor.
6. Check adjustment of elevator chain.

CHECKING PUMP EFFICIENCY

For any pump test at a given rpm, the pump flow (gpm) at 100 psi (7.0 kg/cm^2) (690 kPa) will be larger than the pump flow (gpm) at 1000 psi (70.0 kg/cm^2) (6900 kPa).

The difference between the pump flow of two operating pressures is the flow loss.

Method of finding flow loss...

Pump flow at 100 psi	57.5 gpm (litre/min)*
Pump flow at 1000 psi	-52.0 gpm (litre/min)*
Flow loss	5.5 gpm (litre/min)*

Flow loss when expressed as a percent of flow loss is used as a measure of pump performance.

If the percent of flow' loss is more than 10% for test on the machine or 15% for test on the bench, pump performance is not good enough.

Example of finding percent of flow loss........

$$\frac{\text{gpm flow loss}}{\text{Pump flow @ 100 psi}} \times 100 = \text{Percent of flow loss}$$

or

$$\frac{*5.5}{*57.5} \times 100 = 9.5\%$$

*Numbers in examples are for illustration and not values for any specific pump or pump condition. See the SPECIFICATIONS FOR 613B SCRAPER HYDRAULIC SYSTEM for pump flow of a new pump at 100 psi and 1000 psi.

Test On The Machine

Install a 9S2000 Flow Meter. Run the engine at 2000 rpm. Measure the pump flow at 100 psi (7.0 kg/cm2) (690 kPa) and at 1000 psi (70.0 kg/cm^2) (6900 kPa). Use these values in Formula I.

Formula I:

$$\frac{\text{gpm @ 100 psi - gpm @ 1000 psi}}{\text{gpm C 100 psi}} \times 100 \quad \text{Percent of flow loss}$$

Test on the Bench

If the test bench can be run at 1000 psi and at full pump rpm, find percent of flow loss using Formula I.

If the test bench can not be run at 1000 psi at full pump rpm, run the pump shaft at 1000 rpm. Measure the pump flow at 100 psi (7.0 kg/cm2) (690 kPa) and at 1000 psi (70.0 kg/cm2) (6900 kPa). Use these values in the top part of Formula II. For the bottom part of the formula, run the pump shaft at 2000 rpm. Measure the pump flow at 100 psi.

Formula II:

$$\frac{\text{gpm @ 100 psi—gpm @ 1000 psi}}{\text{gpm @ 100 psi @ pump rpm}} \times 100 \quad \text{Percent of flow loss}$$

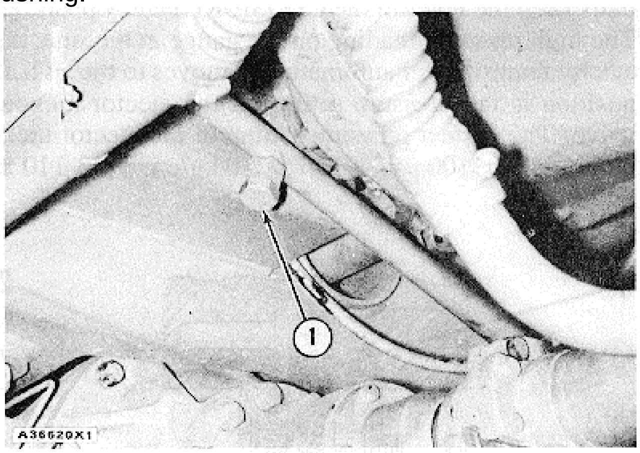
RELIEF VALVES

A 2P8421 Adapter and parts from the 5S5 123 Hydraulic Test Group are needed to test the pressure setting of the relief valves.

Relief Valve for the Elevator

The engine must be stopped before the test gauge and the cover for the oil line are installed.

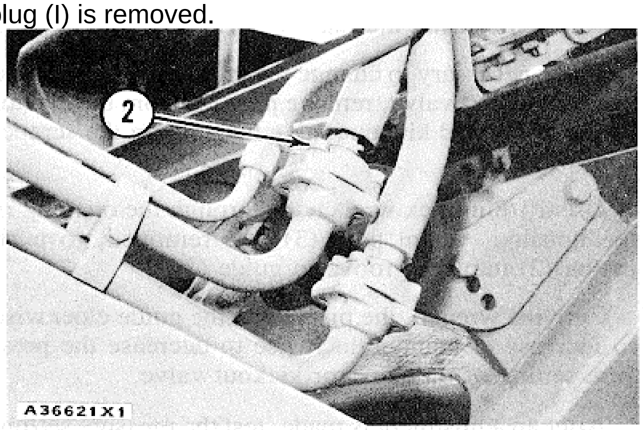
Install the 4M5317 Reducing Bushing in the 5P3501 Adapter, then install both in the 2P8421 Adapter. Install the 7S8714 Pressure Gauge (0-4000 psi) on the 4S4648 Hose Assembly, then install the hose in the reducing bushing.



PRESSURE TEST LOCATION
(Under the Machine)
1. Plug.

The plug (I) in the line from the pump is under the front of the transmission and is near the left side of the frame.

Hydraulic oil will run out when plug (1) is removed so immediately install the hose and gauge assembly when plug (I) is removed.



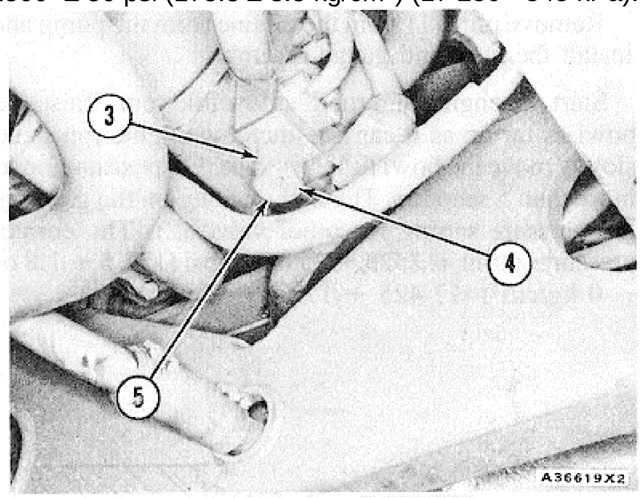
CONNECTIONS IN LINES TO ELEVATOR MOTOR
2. Bolt (four in the connection of the oil line for elevator forward).

Remove bolts (2) and install the 5H4020 Cover in the connection for the oil line that goes into the hydraulic motor nearest the drive end. Use longer bolts through the connection when the cover is in the connection.

When the test equipment is installed, start the engine and run it at low idle rpm. Slowly move the elevator lever to the FORWARD position for not more than 5 seconds. The high reading on the gauge is the pressure setting for elevator relief valve (3).

NOTE: Increase engine rpm, if necessary, to make this pressure test.

The correct pressure setting for relief valve (3) is 2500 -± 50 psi (175.8 ± 3.5 kg/cm^2) (17 250 - 345 kPa).



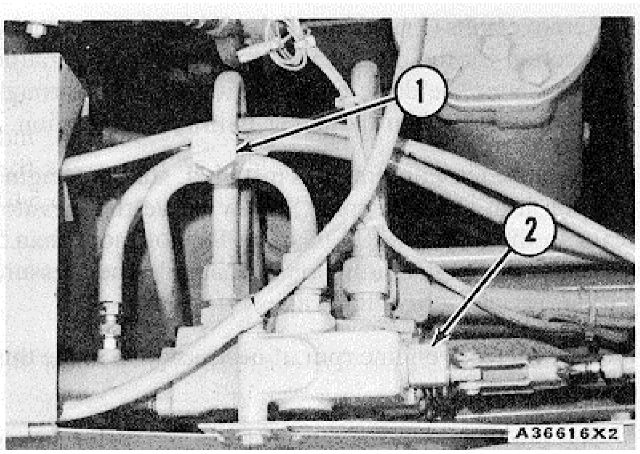
ELEVATOR RELIEF VALVE
(Under the Machine)
3. Relief valve. 4. Locknut. 5. Adjustment screw.

The elevator relief valve (3) is under the machine in front of the drive axle and near the left side of the frame. To adjust, loosen locknut (4) and turn adjustment screw (5) only a few degrees; clockwise to increase or counterclockwise to decrease the pressure setting. Tighten locknut (4) and then make another elevator relief valve test.

When the pressure setting adjustment for the elevator relief valve is correct, stop the engine and remove the test equipment.

Relief Valve in the Control Valve

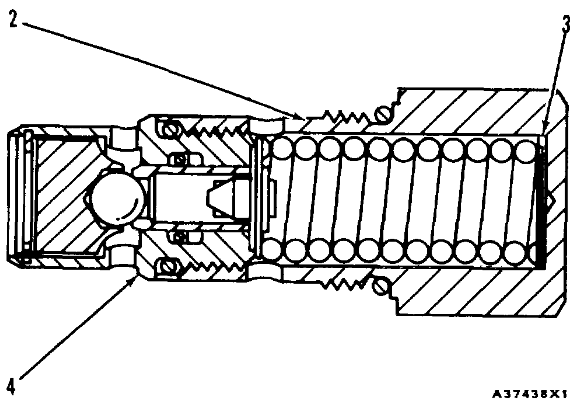
The engine must be stopped before the test gauge is installed. Install the 4M5317 Reducing Bushing in the 5P3501 Adapter, then install both in the 2P8421 Adapter. Install the 7S8714 Pressure Gauge (0-4000 psi) on the 4S4648 Hose Assembly, then install the hose in the reducing bushing.



SCRAPER CONTROL VALVE
1. Plug in line from the pump. 2. Relief valve.

Remove plug (1) from the oil line from the pump and install the hose and gauge assembly.

Start the engine and run it at low idle rpm. Raise the bowl as far up as it can go. Increase engine rpm, and slowly move the bowl lift lever to the UP position for no more than 5 seconds. The high reading on the gauge is the pressure setting for relief valve (2). The correct pressure setting is 2525 + 25 or -0 psi (177.5 + 1.8 or - 0 kg/cm^2) (17 425 + 172 or - 0 kPa).



RELIEF VALVE
2. Relief valve. 3. Shims. 4. Valve body.

If the pressure setting of relief valve (2) was not correct, stop the engine. Remove relief valve (2) from the scraper control valve and install a new relief valve.

If a new relief valve is not available, remove valve body (4) from valve (2) and either add shims (3) to increase or remove shims to decrease the pressure setting of the relief valve.

After a shim is either removed or added and valve body (4) is installed on valve (2), install the relief valve in the scraper control valve. Start the engine and make another relief valve test.

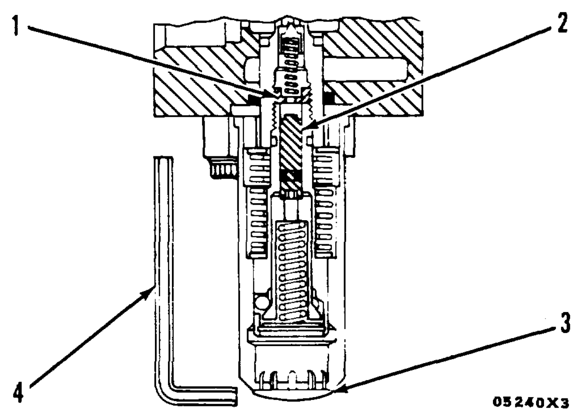
Do not remove the test gauge if the ejector kickout valve is to be tested.

EJECTOR KICKOUT VALVE

Install the 7S8714 Pressure Gauge and hose in the oil line from the pump to the scraper control valve. See RELIEF VALVE IN THE CONTROL VALVE for test gauge installation.

Start the engine and hold the ejector control lever in the OPEN-EJECT position until the floor is almost open.

Run the engine at high idle rpm and move the ejector control lever to the CLOSE-RETURN position. Detent balls keep the lever in the CLOSE-RETURN position. The high pressure reading on the gauge at the time the ejector control lever automatically moves to the HOLD position is the pressure setting of the ejector kickout valve. The correct pressure setting of the ejector kick-out is 1900 + 100 psi (133.6 + 7.0 kg/cm^2) (13 110 ± 690 kPa).



EJECTOR KICKOUT VALVE
1. Guide (with groove). 2. Piston (will fit in groove). 3. Plug. 4.1/8 in. hex wrench.

If it is necessary to change the pressure setting of the ejector kickout valve, remove plug (3) from the ejector spool spring and kickout valve housing on the scraper control valve.

Use a 1/8 in. hex wrench (4) through the opening in the housing, where plug (3) was removed, to push piston (2) into the groove in guide (1).

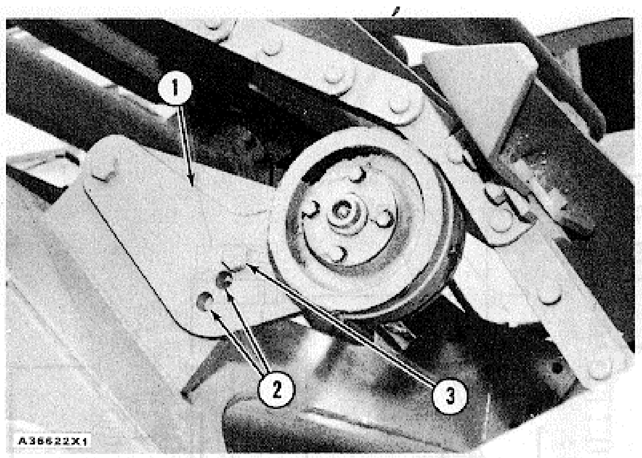
Turn the wrench, the piston and the guide clockwise to increase or counterclockwise to decrease the pressure setting of the elevator kickout valve.

After an adjustment is made, test the pressure setting of the elevator valve. When the pressure setting is correct, install plug (3). Stop the engine and remove the test equipment.

ELEVATOR

The position of arm (1), with one elevator carrier roller, can be moved to another position to tighten the elevator chain when it is too loose.

The elevator chain is too loose when the distance measured between the bottom of the elevator frame, half way between the sprocket and the lower roller, and the chain is more than 10 in. (254 mm). The correct distance is 6 to 10 in. (152 to 254 mm).



ELEVATOR CARRIER ROLLER
1. Arm. 2. Holes. 3. Bolt.

To tighten a chain, remove bolt (3) and move arm (1 toward the chain at the top and install the bolt in one of holes (2). The torque for the nut on bolt (3) is 300 to 31 lb. ft. (410 to 430 N m).

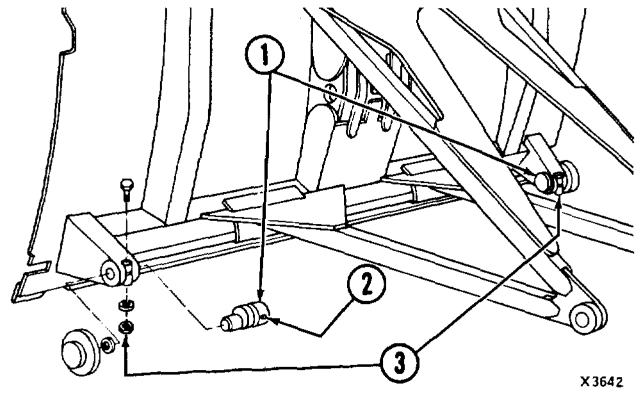
If the chain is too loose after arm (1) is moved as far as it can be moved, remove a link from the chain. One link changes the length of the chain approximately 3 in (75 mm).

When an adjustment is made for the chain on one side, the chain on the other side of the elevator track must have the same adjustment.

The sprockets must be in alignment with the rollers or the chains will come off the sprockets. When sprocket alignment is necessary, loosen the four bolts in the carrier assembly, for the sprocket on the right side, and move it to correct the alignment. The torque for the carrier assembly bolts is 375 to 400 lb. ft. (510 to 540 N m).

EJECTOR

The correct clearance between the bottom edge of the ejector and the scraper floor is .03 to .25 in. (0.8 to 6.4 mm).

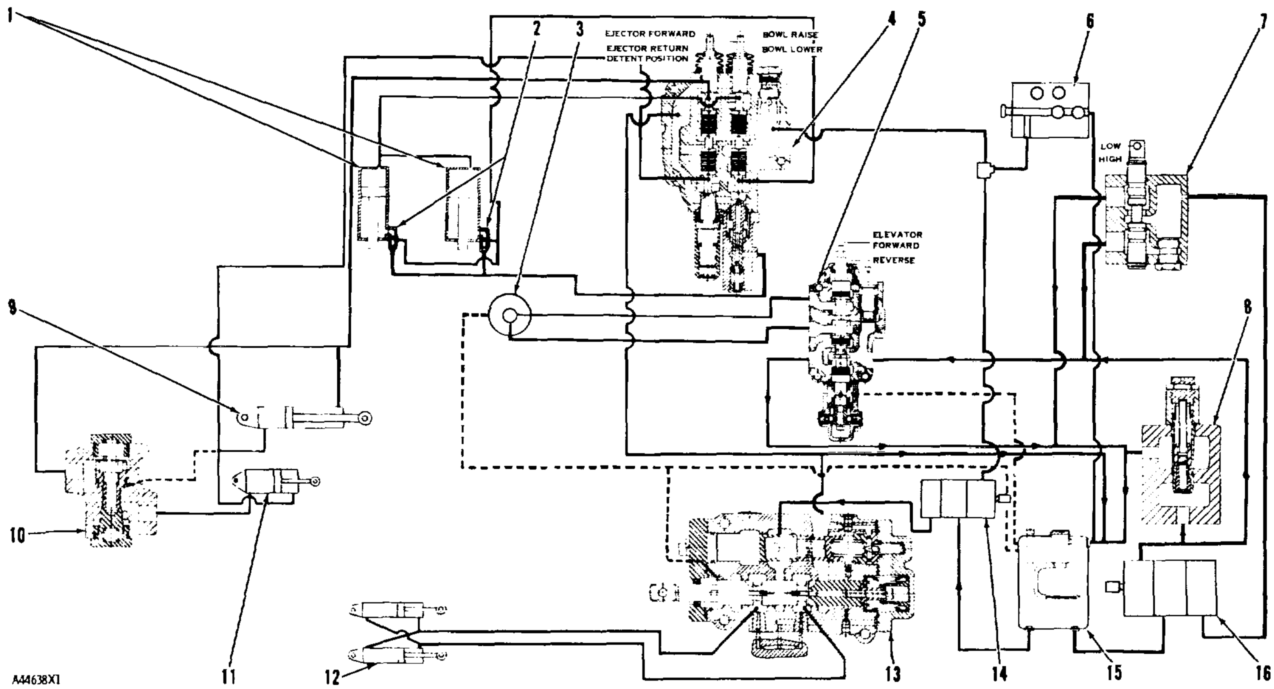


EJECTOR
1. Roller shafts. 2. Holes (in shafts). 3. Locknuts.

If the clearance is not correct, loosen locknuts (3), then use a rod in the .44 in. (I 1.1 mm) diameter holes and turn roller shafts (1) to get the correct clearance. Tighten locknuts (3).

NOTE: The center of the shaft diameter for the roller is not in alignment with the center of the shaft diameter for roller adjustment. When roller shaft (I) is turned, the roller moves up and down the same distance the centers of the shaft are out of alignment.

FLOW METER TEE TEST PROCEDURE-X



SCHEMATIC OF HYDRAULIC SYSTEM WITH FLOW METER INSTALLED

1. Bowl cylinders.
2. Bowl check valve.
3. Elevator motor.
4. Scraper valve.
5. Elevator control valve.
6. 9S2000 Flow Meter.
7. Elevator speed control valve.
8. Elevator relief valve.
9. Ejector cylinder.
10. Ejector check valve.
11. Floor cylinder.
12. Steering cylinders.
13. Steering valve.
14. Steering and implement pump.
15. Tank and filter group.
16. Elevator pump.

INTRODUCTION

The Tee Test is a method of testing a hydraulic system under conditions as close as possible to those existing when the system is in operation. When used correctly, the Tee Test will find the cause of a problem. When used as part of a preventive- maintenance program, it will give an indication of a problem that can cause a failure.

When an analysis is made of the hydraulic system, a standard procedure must be used to check it. The method used to check the system will follow these steps in order:

1. Visual Checks
2. Performance Tests
3. Instruments Tests

The procedures to follow for each of these steps are given in the Testing and Adjusting section of the Service Manual for each machine.

EQUIPMENT INSTALLATION
(Ejector and Bowl System)

1. With the engine stopped, slowly remove the cap on the hydraulic tank to release any pressure and then tighten. Start the engine and move the ejector to the full forward position. This will cause a vacuum in the tank to keep oil leakage at a minimum. Stop the engine.

WARNING: Do not install the adapter for the supply line for the pump or the return line assembly with the engine ON (running). Injury to personnel can be the result.

2. Remove the plug for the tee test from the supply line elbow.

3. Install a supply line adapter in the supply line elbow.

NOTE: Install the adapter as rapidly as possible to keep the oil loss at a minimum.

4. Remove the plug for the tee test from the filter cover assembly.

5. Install the return line adapter.

6. Connect the return line hoses and the supply line hose to the flow meter.

7. Connect the return line hose to the return line adapter.

8. Connect the supply line to the supply line adapter.

WARNING: A plain coupler will not open the valve in the adapter for the pump supply line. Use a valved coupler against a valved nipple when hoses are connected.

9. Install the tachometer generator with the correct drive.

10. Install the cable between the tachometer generator and the input connection for the tachometer (rpm) on the flow meter.

PREPARATION OF SYSTEM FOR TEST

1. Open the manual load valve fully (turn counterclockwise).

2. Start the diesel engine.

3. Move the ejector control lever to the FOR-WARD or OPEN POSITION.

4. With the engine at test rpm, slowly turn the manual load valve clockwise until the pressure goes upl) to 1000 psi.

5. Look at the oil temperature gauge.

6. When the oil temperature is 100° F, turn the manual load valve clockwise until the pressure is 1500 psi.

7. When the oil temperature is 1600 F, move all control levers several times to get full cylinder movement of all cylinders.

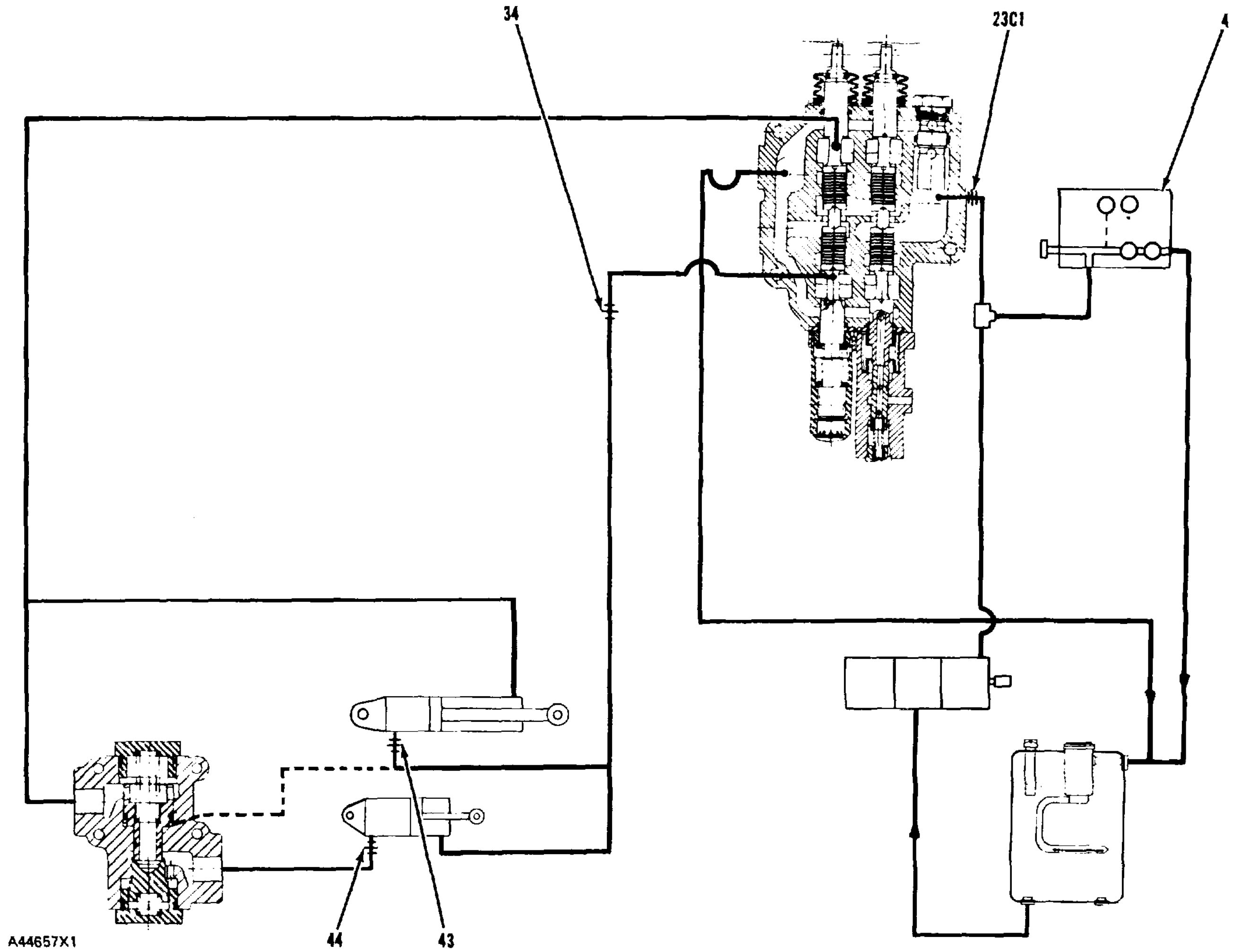
8. Move the cylinders and run the elevator as long as needed to get the desired oil temperature of 1500 F all through the system.

9. Put a chain around the elevator to prevent movement.

SCRAPER EJECTOR AND BOWL SYSTEM TEST (CHART A)

Write Down the Basic Test Data

NOTE: Conditions in the hydraulic system must be constant before you write down the test data. The control levers must be held in the exact position desired. Best results are found when oil temperature is 150 ± 5° F.



TEST	COMPONENTS IN EACH TEST WITH CONTROL VALVE IN FORWARD POSITION	DESIRED FLOW
4	System Test, EJECTOR Circuit	21 U. S. gpm
23 (Chart Cl)	Pump (Scraper and Steering, Large Section)	22. 5 U. S. gpm
34	Pump (Scraper and Steering, Large Section) and Scraper Valve	22 U. S. gpm
43	Pump (Scraper and Steering, Large Section), Scraper Valve, and Ejector Cylinder	21. 5 U. S. gpm
44	Pump (Scraper and Steering, Large Section), Scraper Valve, Floor Cylinder, and Floor Cylinder Check Valve	21. 5 U. S. gpm

Test 1: Maximum Pressure Relief Valve Setting

1. Open the manual load valve fully.

2. Move the ejector control lever to FORWARD position. When the ejector cylinder is at the end of its stroke, keep the control lever in FORWARD position.

3. With the engine at test rpm, slowly close the manual load valve until oil flow through the flow meter stops (0 gpm).

NOTE: The test rpm is given on the Procedure Data Sheet, CHART A (Page 4-36).

4. Write down the pressure.

5. The setting for the relief valve for maximum pressure must be according to the Service Manual.

CAUTION: When the pressures are higher than 1000 psi, slowly open manual load valve before releasing the control lever. This will prevent possible damage to the pressure gauge.

Test 2: System Oil Temperature

1. Open the manual load valve fully.

2. Move the ejector control lever to FORWARD position.

3. Write down the oil temperature. Oil temperature must be 150 ± 5° F.

Test 3: System Base Flow Rate

1. Open the manual load valve fully.

2. Move the ejector control lever to the FOR- WARD position. - When the ejector cylinder is at the end of its stroke, keep the control lever in FORWARD position.

3. Get the engine to test rpm.

4. Check pressure to make sure it is at a minimum value of approximately 100 psi.

5. Write down the flow rate (gpm).

The base flow rate of the system will be the same as the low pressure flow of the hydraulic pump. Because there will be minimum leakage in the control valves, lines and cylinder seals at low pressure, the base flow rate can be used to find the flow differential in Tests 4 through 7.

Tests 4 through 7: Leakage Rates

These five tests are similar. Each test is done as follows:

1. Move the control lever to the respective OPERATE position. When the respective cylinder is at the end of its stroke, keep the control lever in position.

2. Get the engine to test rpm.

3. Make an adjustment to the manual load valve to get 1000 psi pressure.

4. Then make the system constant with these conditions.

5. Write down the flow rate (gpm) for each test.

The flow differential for each test (4 through 7) is found by:

Subtract the flow rate (gpm) for each test from the base flow rate (Test 3).

The percent of flow loss for each test (4 through 7) is found by:

Divide the flow differential for each test by the base flow rate (Test 3) and multiply by 100.

Test 9: System Oil Temperature

1. Open the manual load valve fully.

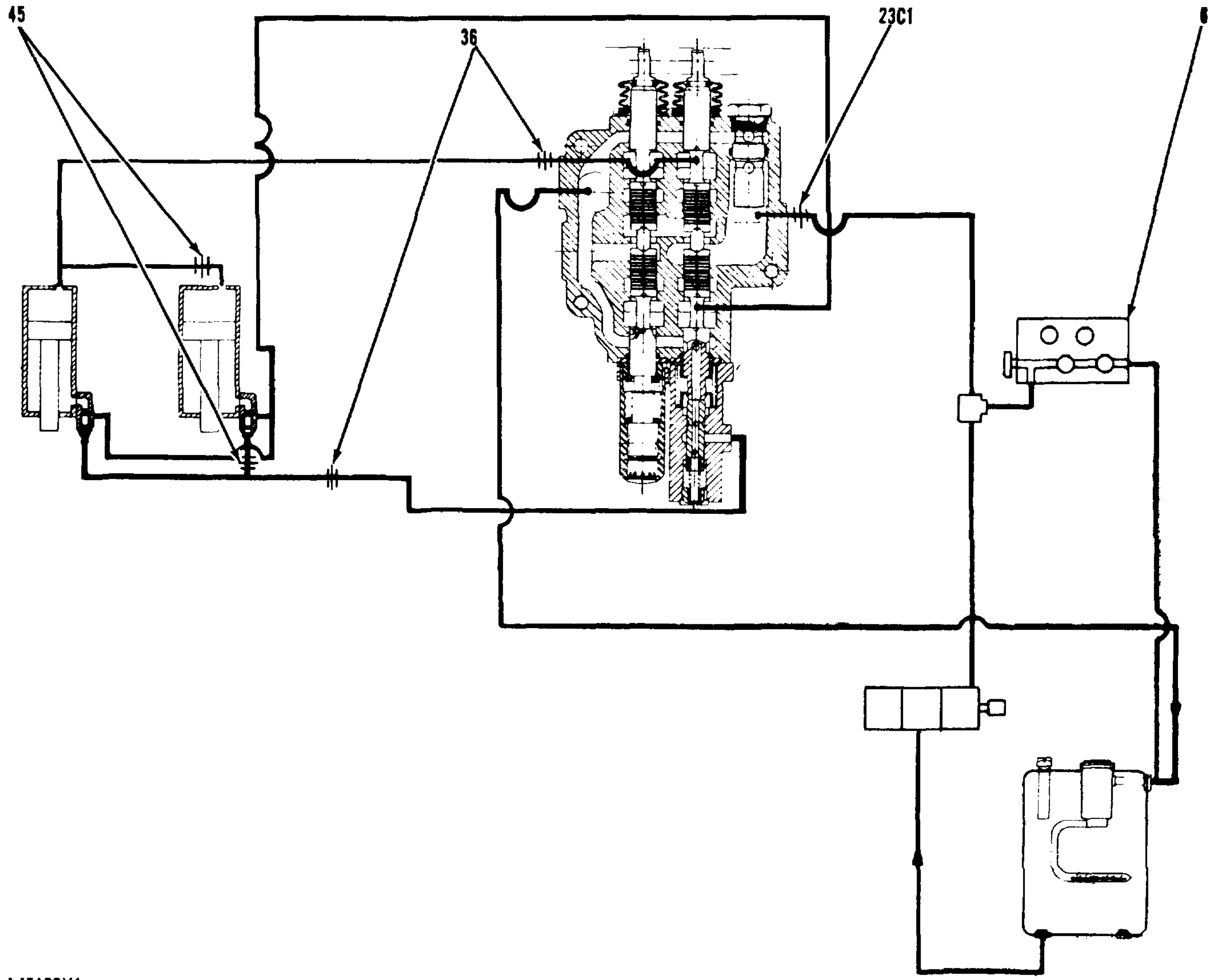
2. Move the ejector control lever to the FOR-WARD position.

3. Write down the oil temperature.

Make a comparison of the oil temperature from Test 2 and 9. Test 2 must be 150 ± 5°F and Test 9 must be inside of (within) 10° F of Test 2. For each 10° F higher difference, subtract . 5 gallon per pump cartridge from the leakage rate. For each 100 F lower difference, add . 5 gallon per pump cartridge to the leakage rate.

EQUIPMENT INSTALLATION (Elevator System)

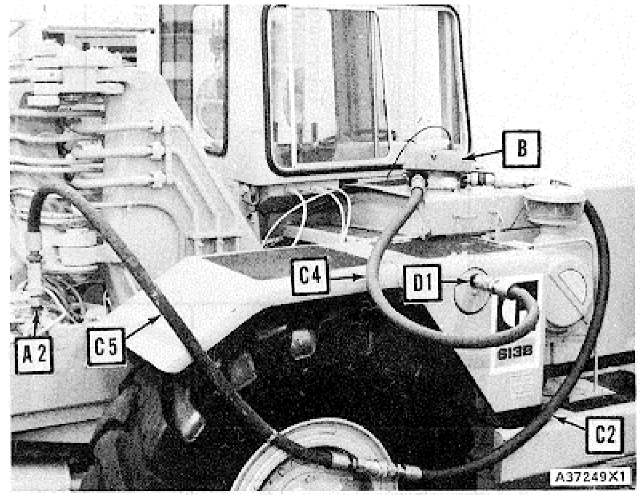
Tee locations for the elevator systems are different from the tee location for the ejector and bowl systems. A supply line tee block A9 and/or adapter must be installed in the specified location for correct test results. See the illustrations and schematics for the specific machine.



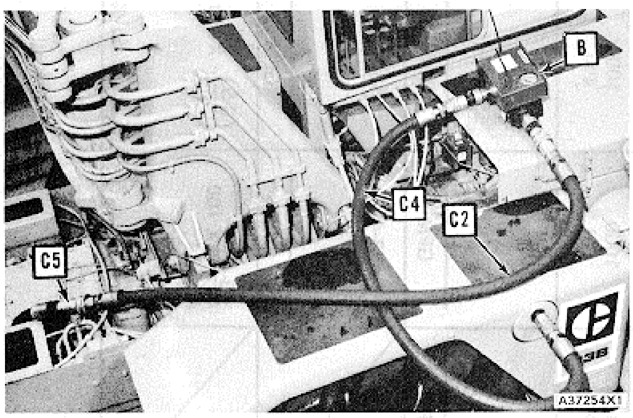
TESTING BOWL CIRCUIT

TEST	COMPONENTS IN EACH TEST WITH CONTROL VALVE IN RAISE POSITION	DESIRED FLOW
6	System Test, BOWL Circuit	21 U. S. gpm
23 (Chart C1)	Pump (Scraper and Steering, Large Section)	22. 5 U. S. gpm
36	Pump (Scraper and Steering, Large Section) and Scraper Valve	22 U. S. gpm
45	Pump (Scraper and Steering, Large Section), Scraper Valve, and Right Cylinder Circuit	21. 5 U. S. gpm

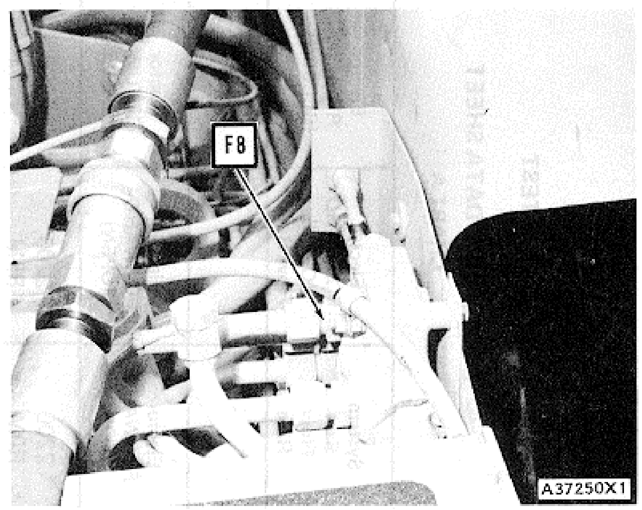
TOOLS NEEDED		
Assembly Number	Description	Quantity
A2	Pump Supply Line Adapter	1
B	Flow Meter Assembly	1
C2	Connecting Hose Assembly	1
C4	Connecting Hose Assembly	1
C5	Connecting Hose Assembly	1
D1	Return Line Assembly	1
F3	Blocking Plate Assembly	1
F4	Blocking Plate Assembly	2
F5	Blocking Plate Assembly	1
F8	Blocking Plate Assembly	2
F14	9S5518 Plug a7/16"-20Thread)	1
F14	9L8493 Cap (7/16"-20 Thread)	1



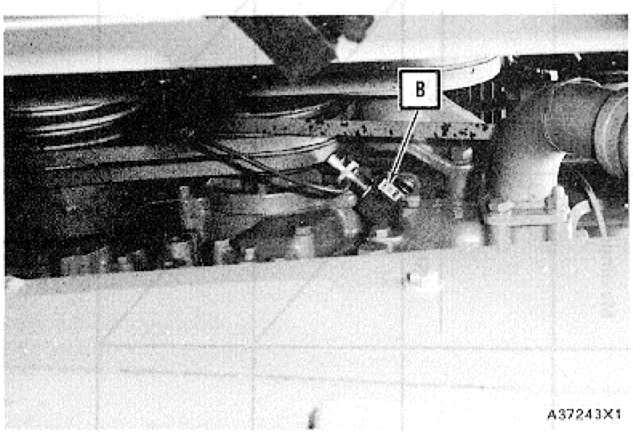
FLOW METER INSTALLED IN BOWL & EJECTOR CIRCUIT
(See Tee Test Tooling Chart for parts reference)



FLOW METER INSTALLED IN ELEVATOR CIRCUIT
(See Tee Test Tooling Chart for parts reference)



BLOCKING LOCATION FOR TEST OF THE PUMP (SCRAPER AND STEERING, LARGE SECTION)
(Test Chart C1)
(See Tee Test Tooling Chart for parts reference)



TACHOMETER DRIVE INSTALLED
(See Tee Test Tooling Chart for parts reference)

1. With the engine stopped, remove the pressure in the hydraulic system. Slowly remove the cap on the hydraulic tank to release any pressure. Then tighten the cap.

2. Remove the plug for the tee test from the supply line.

3. Install a supply line adapter in the supply line elbow.

613B:

SCRAPER EJECTOR AND BOWL SYSTEM TEST

TEE – TEST

PROCEDURE DATA SHEET

CHART A

DATE ____________

MACHINE SERIAL NUMBER ____________

SERVICE METER READING ____________

Test Name	Maximum Pressure Relief Valve Setting	System Oil Temperature (Start)	System Base Flow Rate	Ejector FORWARD (OPEN) Flow Rate	Ejector RETURN (CLOSED) Flow Rate	Bowl RAISE Flow Rate	Bowl LOWER Flow Rate		System Oil Temperature (End)
Test Number	1	2	3	4	5	6	7		9
Control Lever Position	Ejector FORWARD (OPEN)	Ejector FORWARD (OPEN)	Ejector FORWARD (OPEN)	Ejector FORWARD (OPEN)	Ejector RETURN (CLOSED)	Bowl RAISE	Bowl LOWER		Ejector FORWARD (OPEN)
Engine Speed	2200 RPM	Any Speed	2200 RPM	2200 RPM	2200 RPM	2200 RPM	2200 RPM		Any Speed
System Test Pressure	Maximum	0-100 PSI	100 PSI	1000 PSI	1000 PSI	1000 PSI	1000 PSI		0-100 PSI
Test Data	____ PSI	____ °F	____ GPM	____ GPM	____ GPM	____ GPM	____ GPM		____ °F
Flow Differential				(3-4) ____ GPM	(3-5) ____ GPM	(3-6) ____ GPM	(3-7) ____ GPM		
Percent Flow Loss				$\left(\frac{3-4}{3}\right) \times 100$ ____ %	$\left(\frac{3-5}{3}\right) \times 100$ ____ %	$\left(\frac{3-6}{3}\right) \times 100$ ____ %	$\left(\frac{3-7}{3}\right) \times 100$ ____ %		

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NOTE: Install the adapter as rapidly as possible to keep the oil loss at a minimum.

4. Connect the supply line from the flow meter to the supply line adapter.

WARNING: Do not install the adapter for the supply line for the pump or the return line assembly with the engine ON (running). Injury to personnel can be the result.

PREPARATION OF SYSTEM FOR TEST

1. Open the manual load valve fully (turn counterclockwise).

2. Start the diesel engine.

3. Move the elevator control lever to the FORWARD SLOW position.

4. With the engine at 2000 rpm, slowly turn the manual load valve clockwise until the pressure goes up to 1000 psi.

5. Look at the oil temperature gauge.

6. When the oil temperature is 100° F, turn the manual load valve clockwise until the pressure is 1500 psi.

7. When the oil temperature is 160° F, run the elevator FORWARD and REVERSE, SLOW and FAST.

8. Run the elevator as long as needed to get the desired oil temperatures of 150° F all through the system.

9. Put a chain around the elevator so it will not move.

SCRAPER ELEVATOR SYSTEM TEST (CHART B)

Write Down the Basic Test Data

NOTE: Conditions in the hydraulic system must be constant before you write down the test data. The control levers must be held in the exact position desired. Best results are found when oil temperature is 150 ± 5° F.

Test 10: Maximum Pressure Relief Valve Setting

1. Open the manual load valve fully.

2. Move the elevator control lever to FORWARD SLOW position.

3. With the engine throttle at test rpm, slowly close the manual load valve until oil flow through the flow meter stops (0 gpm).

NOTE: The test rpm is given on the Procedure Data Sheet, CHART B (Page 4-39).

4. Write down the pressure and engine rpm.

5. The setting for the relief valve for maximum pressure must be according to the Service Manual.

CAUTION: When the pressures are higher than 1000 psi, slowly open manual load valve then release the control lever. This will prevent possible damage to the pressure gauge.

Test 11: System Oil Temperature

1. Open the manual load valve fully.

2. Move the ejector control lever to FORWARD SLOW position.

3. Write down the oil temperature. Oil temperature must be 150 ± 5° F.

Tests 12, 13 and 14: System Base Flow Rate

These three tests are similar. Each test is done as follows:

1. Move the control levers to the respective OPERATE position.

2. Get the engine to test rpm.

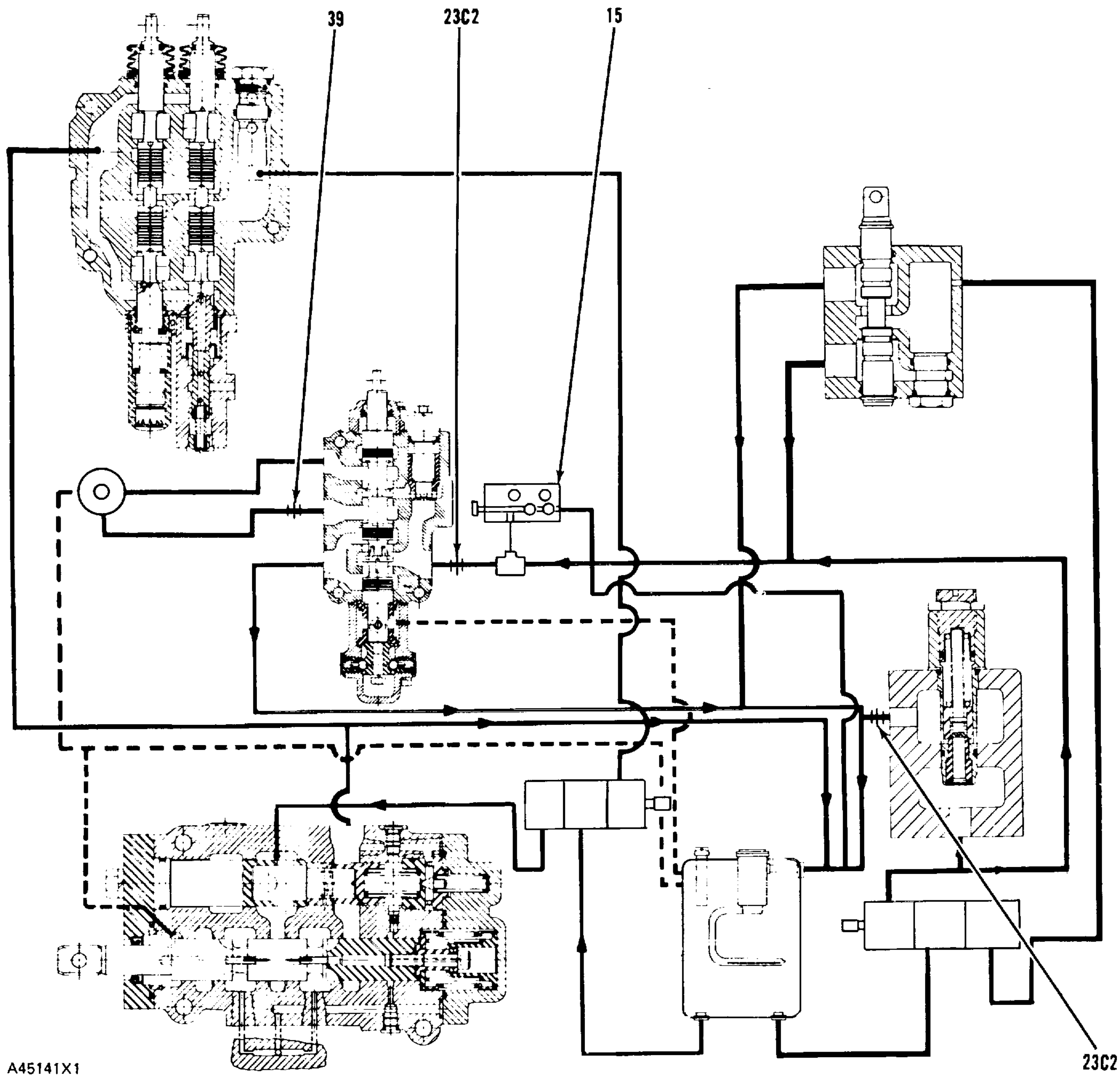
3. Make an adjustment to the manual load valve to get a pressure of approximately 100 psi.

4. Keep the system constant with these conditions.

5. Write down the flow rate (gpm) for each test.

Tests 15, 16 and 17: Leakage Rates

These three tests are similar. Each test is done as follows:



TESTING SLOW SPEED CIRCUIT OF ELEVATOR

TEST	COMPONENTS IN EACH TEST WITH CONTROL VALVE IN FORWARD SLOW OR NEUTRAL POSITION	DESIRED FLOW
15	Systems Test, Slow Speed Circuit of ELEVATOR	27 U S. gpm
23 (Chart C2)	Pump (Elevator, Large Section)	32. 4 U S. gpm
39	Pump (Elevator, Large Section) Elevator Relief Valve, and Scraper Valve	31 U. S. gpm

613B:
SCRAPER ELEVATOR
SYSTEM TEST

TEE – TEST

PROCEDURE DATA SHEET

CHART B

MACHINE SERIAL NUMBER ____________

SERVICE METER READING ____________

DATE ____________

Test Name	Maximum Pressure Relief Valve Setting	System Oil Temperature (Start)	Elevator Base Flow Rate	Elevator Base Flow Rate	Elevator Base Flow Rate	Elevator Flow Rate	Elevator Flow Rate	Elevator Flow Rate	System Oil Temperature (End)	Bowl Circuit Drift Comparison
Test Number	10	11	12	13	14	15	16	17	20	21
Control Lever Position	Elevator FORWARD Slow	Elevator FORWARD Slow	Elevator FORWARD Slow	Elevator REVERSE Slow	Elevator FORWARD Fast	Elevator FORWARD Slow	Elevator REVERSE Slow	Elevator FORWARD Fast	Elevator FORWARD	Bowl 1. HOLD 2. RAISE
Engine Speed	2200 RPM	Any Speed	2200 RPM	2200 RPM	2200 RPM	2200 RPM	2200 RPM	2200 RPM	Any Speed	Engine Stopped
System Test Pressure	Maximum	0 - 100 PSI	100 PSI	100 PSI	100 PSI	1000 PSI	1000 PSI	1000 PSI	0 - 100 PSI	0 PSI
Test Data	____ PSI	____ °F	____ GPM	____ GPM	____ GPM	____ GPM	____ GPM	____ GPM	____ °F	Hold / Drift; M / S; Than RAISE Drift Rate
Flow Differential						(12 - 15) ____ GPM	(13 - 16) ____ GPM	(14 - 17) ____ GPM		
Percent Flow Loss						$\left(\frac{12-15}{12}\right) \times 100$ ____ %	$\left(\frac{13-16}{13}\right) \times 100$ ____ %	$\left(\frac{14-17}{14}\right) \times 100$ ____ %		

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1 Move the control lever to the respective OPERATE position.

2. Get the engine to test rpm.

3. Make an adjustment to the manual load valve to get 1000 psi pressure.

4. Keep the system constant with these conditions.

5. Write down the flow rate (gpm) for each test.

The flow differential for each test (15, 16, and 17) is found by:

Subtract the flow rate (gpm) for each test from its respective base flow rate (12 minus 15, 13 minus 16, and 14 minus 17).

The percent of flow loss for each test 15, 16, and 17 is found by:

Divide the flow differential by its respective base flow rate and multiply by 100.

Test 20: System Oil Temperature

1. Open the manual load valve fully.

2. Move the elevator control lever to the FORWARD SLOW position.

3. Write down the oil temperature.

Make a comparison of the oil temperature from Test 11 and 20. Test 11 must be 150 ± 5° F and Test 20 must be inside of (within) 10° F of Test 11. For each 10° F higher difference, subtract . 5 gallon per pump cartridge from the leakage rate. For each 10° F lower difference, add . 5 gallon per pump cartridge to the leakage rate.

Test 21: Bowl Circuit Drift Comparison

Test 21 is a comparison of visual drift rates for the bowl circuit. This test is used to check the condition of the carry check valves. Raise the bowl approximately one foot off the ground. Turn the manual load valve all the way out for minimum restriction. Stop the engine.

With the bowl control lever in the HOLD position, look for a down drift (movement) in the bowl. Then move the control lever to the RAISE position. Look for down drift again. If the drift in the RAISE position is more than the drift in the HOLD position, put a circle around the M in the Test Data box. If the drift in the RAISE position is the same or less than the drift in the HOLD position, put a circle around the S in the Test Data box.

"Is It Necessary to Make More Tests? If So, Which Circuit(s)?"

Make a comparison of the test data on Charts A and B for the specific machine under test. The percent of flow loss on Charts A and B is the maximum for best performance.

Components that are worn, or do not work correctly, are found by their flow differential and percent of flow loss or lower system efficiency. System values for new and rebuilt machines must not be more than the percent of flow loss in the system tests shown on Chart A or B for the specific machine. The permissible flow differential is a function of machine application. If the flow loss is acceptable, the Tee Test is complete.

If the flow loss is not acceptable in one or more systems, the tests for the pump and/or the blocked circuits must be done.

If the flow loss is not acceptable in only one of the circuits, do the tests for that circuit as shown on the insert pages. The leakage rate of any component in a circuit is found by:

Subtract the test information with the component in the circuit from the test information with the component out of the circuit.

Troubleshooting

The examples that follow are a list of problems and probable reasons. They will give aid to find the location of the components that are worn, or do not work correctly. Not all probable reasons have an application to all machines.

PROBLEM: Setting for the main relief valve is higher or lower than given in Test 1. Percent of flow loss for Tests 4 through 7 is 15% to 50%.

PROBABLE REASON:

Setting for main relief valve is not correct and leakage is too high.

RECOMMENDATION FOR ACTION:

Make adjustments to the main relief valve to get the correct pressure. Make a test for leakage in the problems that follow.

PROBLEM: Percent of flow loss for Tests 4 through 7 is more than the percent shown on Chart A.

PROBABLE REASON:

A. Bad pump.

B. Leakage in the relief valve.

C. Wear or damage in the valve body and/or valve spools.

RECOMMENDATION FOR ACTION:

A. Do the Scraper Pump Tests, Chart C1.

B. If the extra percent of flow loss is not caused by a bad pump, problem is in the control valves or relief valve.

PROBLEM: Percent of flow loss for Tests 4 and/or 5 is more than 15%; for Tests 6 and 7, percent of flow loss is less than the percent shown in Chart A.

PROBABLE REASON:

A. Leakage in the ejector cylinder piston seals.
B. Leakage in the ejector check valve.
C. Leakage in the floor cylinder.
D. Leakage in the floor check valve.
E. Wear or damage in the control valve body and/or valve spool.

RECOMMENDATION FOR ACTION:

Do the Blocked Circuit Tests 34 and 35 for the ejector circuit. If leakage is still too high, the problem is in the ejector control valve. Inspect its components.
PROBLEM: Percent of flow loss for Tests 6 and 7 is more than the percent shown in Chart A; for Tests 4 and 5, it is less than the percent shown in Chart A.

PROBABLE REASON:

A. Leakage in one or both of the piston seals for the bowl cylinders.

B. Wear or damage in the valve body or spool in the bowl circuit.

RECOMMENDATION FOR ACTION:

Do the Blocked Circuit Tests 36 and 37 for the bowl circuit. If leakage is still too high, the problem is in the bowl control valve. Inspect its components.

PROBLEM: Down drift of bowl in Test 21 is more in the RAISE position than in the HOLD position.

PROBABLE REASON:

Leakage in the scraper control valve.

RECOMMENDATION FOR ACTION:

Do Blocked Circuit Test 36 for the bowl circuit. If leakage rate for the control valve is too high, check the bowl control valve.

PROBLEM: Down drift of bowl in Test 21 is the same in the RAISE position as in the HOLD position but more than the amount permitted in the Service Manual for the machine under test.

PROBABLE REASON:

A. Leakage in the carry check valves.
B. Leakage in the pistons seals in the bowl cylinders.
C. Leakage in the scraper control valve.

RECOMMENDATION FOR ACTION:

Do Blocked Circuit Tests 36 and 37 for bowl circuit. If leakage is not found in control valve, do Blocked Components Tests 45 and 46. If leakage is still not found in bowl cylinders, the problem is in the carry check valves. Remove and inspect them for damage or wear. Replace parts as needed.

PROBLEM: Percent of flow loss for Test 17 is more than the percent shown in Chart B; for Tests 15 and 16, it is less than or the same as the percent shown on Chart B.

PROBABLE REASON:

A. Bad small pump, Chart C3.
B. Excessive leakage in speed control valve.

RECOMMENDATION FOR ACTION:

Do the Pump Test, Chart C3. If the larger amount of flow loss is not caused by the small pump, do the Speed Control Valve Leakage Test 55.

PROBLEM: Setting for the main relief valve is higher or lower than given in Test 10. Percent of flow loss for Tests 15 through 17 is 20% to 50%.

PROBABLE REASON:

Setting for main relief is not correct and leakage is too high.

RECOMMENDATION FOR ACTION:

Make adjustments to the main relief valve to get correct pressure. Make a test for leakage in the problems that follow.

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PROBLEM: Percent of flow loss for Tests 15 through 17 is more than the percent shown in Chart B.

PROBABLE REASON:

A. Bad large pump, Chart C2.

B. Leakage in elevator motor.

C. Leakage in elevator control valve.

D. Leakage in relief valve.

E. Leakage in speed control valve.

RECOMMENDATION FOR ACTION:

Do the Elevator Large Pump Test, Chart C2. If the extra flow loss is not caused by a bad pump, do the Blocked Elevator Motor Tests 38, 39, and 40. If the extra flow loss is not caused by large amount of leakage, do the leakage Tests 40, 54, 55, and 56. Repair or replace parts as necessary.

PUMP TEST (Charts C1, C2, C3)

These tests are used to find the efficiency of the hydraulic pumps. The tests are the same for all pumps and/or pump sections. Analysis of the system data (Charts A and B) will give an indication of which pumps or pump sections must be tested. See the respective schematic or illustration in the Tee Test Insert for the correct tee and blocking locations. The locations are as follows:

Chart C1: Scraper and Steering Pump (Large Section).

Tee location: The plug on the supply line near the implement control valve.

Blocking location: Between the supply line and the implement control valve.

Chart C2: Elevator Pump (Large Section).

NOTE: Speed Control Valve must be in LOW SPEED position during this test.

Tee location: The plug on the supply line near the elevator control valve.

Blocking locations:

1. Between the supply line and elevator control valve.
2. Between the elevator relief valve and the hydraulic tank.

Chart C3: Elevator Pump (Large and Small Section).

WARNING: Speed control valve must be in HIGH SPEED position during this test.

Tee location: The plug on the supply line near the elevator control valve.

Blocking locations:

1. Between the elevator control valve and the supply line.
2. Between the elevator speed control valve and the hydraulic tank.
3. Between the elevator relief valve and the hydraulic tank.

WARNING: Installation of the Blocking Plate Assemblies keeps oil from going through the system. All pump flow goes through the flow meter. Open the manual load valve fully, then start the diesel engine. The main relief valve is not part of the circuit for the pump test. If the pressure gets too high, it is possible to cause injury to personnel or damage to equipment.

Test 22: Pump Flow at Low Pressure (Test rpm)

1. Open the manual load valve fully.
2. Start the diesel engine.
3. Run the engine at test rpm.
4. Slowly close the manual load valve to get 100 psi pressure.
5. Write down the oil temperature and the flow rate (gpm).

Test 23: Pump Flow at High Pressure (Test rpm)

1. Run the engine at test rpm.
2. Slowly close the load valve to get 1000 psi pressure.
3. Write down the oil temperature and flow rate (gpm).

Test 24: Pump Flow at Low Pressure (/2 Test rpm)

1. Run the engine at l/ Test rpm.

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TEE – TEST

SCRAPER PUMP TEST

PROCEDURE DATA SHEET

CHART C1

MACHINE SERIAL NUMBER (72M4268-UP)

DATE ____________

SERVICE METER READING ____________

	Full Speed Pump Flow		Half Speed Pump Flow		Pump Test for Aeration And/Or Cavitation				
	Low Pressure	High Pressure	Low Pressure	High Pressure	Varied Speeds - Constant Pressure				
Test Number	22	23	24	25	26	27	28	29	30
Engine Speed	2200 RPM	2200 RPM	1100 RPM	1100 RPM	1000 RPM	1300 RPM	1600 RPM	1900 RPM	2200 RPM
Pump Test Pressure	100 PSI	1000 PSI	100 PSI	1000 PSI	1000 PSI	1000 PSI	1000 PSI	1000 PSI	1000 PSI
Oil Temperature	____ °F	____ °F	____ °F	____ °F	____ °F	____ °F	____ °F	____ °F	____ °F
Test Data	____ GPM	____ GPM	____ GPM	____ GPM	____ GPM	____ GPM	____ GPM	____ GPM	____ GPM
Flow Differential		(22 - 23) ____ GPM		(24 - 25) ____ GPM	(27 - 26) ____ GPM	(28 - 27) ____ GPM	(29 - 28) ____ GPM	(30 - 29) ____ GPM	(31 - 30) ____ GPM
Percent Flow Loss		$\left(\frac{22-23}{22}\right) \times 100$ ____ %							

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613B:
SCRAPER PUMP TEST (Large Section)
ELEVATOR
DATE ____

TEE – TEST
PROCEDURE DATA SHEET
CHART C2

MACHINE SERIAL NUMBER ____
SERVICE METER READING ____

	Full Speed Pump Flow		Half Speed Pump Flow		Pump Test for Aeration And/Or Cavitation				
	Low Pressure	High Pressure	Low Pressure	High Pressure	Varied Speeds - Constant Pressure				
Test Number	22	23	24	25	26	27	28	29	30
Engine Speed	2200 RPM	2200 RPM	1100 RPM	1100 RPM	1000 RPM	1300 RPM	1600 RPM	1900 RPM	2200 RPM
Pump Test Pressure	100 PSI	1000 PSI	100 PSI	1000 PSI	1000 PSI	1000 PSI	1000 PSI	1000 PSI	1000 PSI
Oil Temperature	____ °F	____ °F	____ °F	____ °F	____ °F	____ °F	____ °F	____ °F	____ °F
Test Data	____ GPM	____ GPM	____ GPM	____ GPM	____ GPM	____ GPM	____ GPM	____ GPM	____ GPM
Flow Differential		(22 - 23) ____ GPM		(24 - 25) ____ GPM	(27 - 26) ____ GPM	(28 - 27) ____ GPM	(29 - 28) ____ GPM	(30 - 29) ____ GPM	(31 - 30) ____ GPM
Percent Flow Loss		$\left(\frac{22-23}{22}\right) \times 100$ ____ %							

The Elevator speed control lever must be in the low speed position during all tests on Chart C2.

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613B:
SCRAPER PUMP TEST (Large and Small Section)
ELEVATOR

DATE ____________________

TEE – TEST

PROCEDURE DATA SHEET

CHART C3

MACHINE SERIAL NUMBER ____________

SERVICE METER READING ____________

	Full Speed Pump Flow		Half Speed Pump Flow		Pump Test for Aeration And/Or Cavitation				
	Low Pressure	High Pressure	Low Pressure	High Pressure	Varied Speeds - Constant Pressure				
Test Number	22	23	24	25	26	27	28	29	30
Engine Speed	2200 RPM	2200 RPM	1100 RPM	1100 RPM	1000 RPM	1300 RPM	1600 RPM	1900 RPM	2200 RPM
Pump Test Pressure	100 PSI	1000 PSI	100 PSI	1000 PSI	1000 PSI	1000 PSI	1000 PSI	1000 PSI	1000 PSI
Oil Temperature	____ °F	____ °F	____ °F	____ °F	____ °F	____ °F	____ °F	____ °F	____ °F
Test Data	____ GPM	____ GPM	____ GPM	____ GPM	____ GPM	____ GPM	____ GPM	____ GPM	____ GPM
Flow Differential		(22 - 23) ____ GPM		(24 - 25) ____ GPM	(27 - 26) ____ GPM	(28 - 27) ____ GPM	(29 - 28) ____ GPM	(30 - 29) ____ GPM	(31 - 30) ____ GPM
Percent Flow Loss		$\left(\frac{22-23}{22}\right) \times 100$ ____ %							

WARNING: The Elevator speed control lever must be in the high speed position for all tests on Chart C3.

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2. Make an adjustment to the load valve to get 100 psi pressure.

3. Write down the oil temperature and the flow rate (gpm).

Test 25: Pump Flow at High Pressure (1/2 Test rpm)

1. Run the engine at ½ Test rpm.

2. Slowly close load valve to get 1000 psi pressure.

3. Write down the oil temperature and flow rate (gpm).

Make a comparison of the test data with the data on Charts C1, C2, C3 for specific pump under test. The information on Charts Cl, C2, C3 is for best pump performance.

Troubleshooting

PROBLEM: Percent of flow loss for Test 23 is 10% or more; for Test 4 through 7 it is more than the percent shown in Chart A.

PROBABLE REASON:

Pump has a problem and leakage is in the control valve, valve circuits and/or cylinders.

RECOMMENDATION FOR ACTION:

Find pump problem. Install a new or rebuilt pump, if necessary. Do the Blocked Circuit Tests to find leakage rate in the control valve, valve circuits and/or cylinders.

PROBLEM: Percent of flow loss for Test 23 is 0 to 10%; for Tests 4 through 7 it is more than the percent shown in Chart A.

PROBABLE REASON:

Pump is in good condition, but there is leakage in control valve, valve circuits and/or cylinders.

RECOMMENDATION FOR ACTION:

Do the Blocked Circuit Tests to find leakage rate in control valve, valve circuits and/or cylinders.

PROBLEM: Percent of flow loss for Test 23, Chart C2 is 15% or MORE; for Test 23, Chart C3, flow loss is 10% or less.

PROBABLE REASON:

A large amount of elevator speed control valve leakage.

RECOMMENDATION FOR ACTION:

Remove the speed control valve. Disassemble the control valve and inspect the parts. Repair or replace parts as necessary.

PROBLEM: Percent of flow loss for Test 23 is 10% or MORE. Flow differential for Test 23 is higher than the flow differential for Test 25 by 0 to 2 gpm.

PROBABLE REASON:

Pump is worn.

RECOMMENDATION FOR ACTION:

If flow loss is found to be too high for the machine application, install a new or rebuilt pump.

PROBLEM: Percent of flow loss for Test 23 is 10%o or MORE. Flow differential for Test 23 is higher than flow differential for Test 25 by 2 gpm or MORE.

PROBABLE REASON:

A. Oil aeration (low oil level, hydraulic oil that is not the correct type, air leak in the suction line for the pump, oil leaks in the tank such as failure of seals or loose connections).

B. Pump cavitation (restriction in the suction line for the pump, oil viscosity that is not correct).

RECOMMENDATION FOR ACTION:

Do Tests 26 through 30 to find if the reason is aeration or cavitation.

Pump Test for Aeration and Cavitation

Tests 26 through 30: Aeration and Cavitation Tests

These seven tests are similar. Do the tests as follows:

1. Open the manual load valve fully, then start the diesel engine.

2. Run the engine at the test rpm for Test 26.

3. Slowly close the manual load valve to get 1000 psi pressure.

4. Write down the flow rate (gpm) and the oil temperature.

5. Then run the engine at test rpm (for Tests 27, 28, 29 and 30).

6. Write down the flow rate (gpm) and oil temperature for each test.

CAUTION: Immediately after the diesel engine is stopped, remove the Blocking Plate Assembly from the pressure line for the pump to prevent any possible damage later.

Troubleshooting

PROBLEM: Percent of flow loss for Test 23 is 10% or MORE and flow differential for Test 23 is more than 2 gpm higher than the flow differential for Test 25. Tests 26 through 30 have the same flow differential.

PROBABLE REASON:

Oil aeration (low oil level, hydraulic oil that is not the correct type, air leak in the suction line for the pump, oil leaks in the tank such as failure of seals, loose connections or pump cartridge is not installed correctly in pump body).

RECOMMENDATION FOR ACTION:

A. Check oil level and type of hydraulic oil being used.

B. Check suction line for air leaks put foam (like shaving cream) on all connections. The foam will be pulled into the line at any point of leakage.

C. Remove the cover from the hydraulic tank and inspect for oil leaks (check above the oil level first).

D. Disassemble the pump and check for correct assembly and damage to seals.

PROBLEM: Flow differential between each of the Tests 26 through 30 suddenly becomes lower at one test and the flow rate is the same for the remainder of the tests at higher engine speed (rpm). Example: 8 gpm differential between Tests 26 and 27, 27 and 28, 28 and 29, but 1 gpm differential between 28 and 29 and flow rate for Test 30 is the same as 29.

PROBABLE REASON:

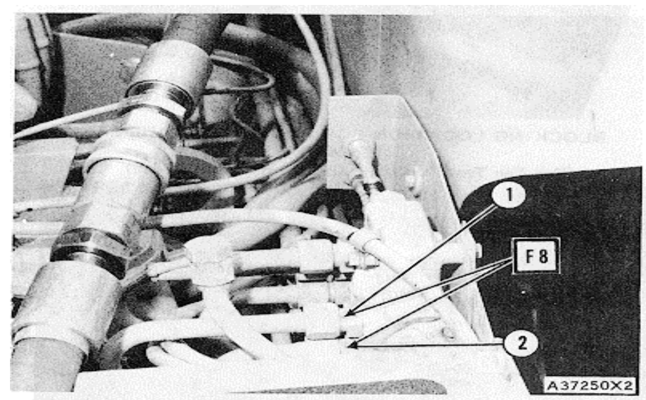
Pump cavitation (restriction in the suction line for the pump).

RECOMMENDATION FOR ACTION:

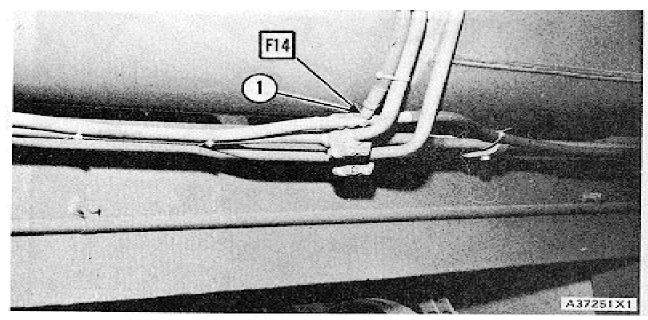
Inspect suction line and tank.

BLOCKED CIRCUIT TESTS (CHART D)

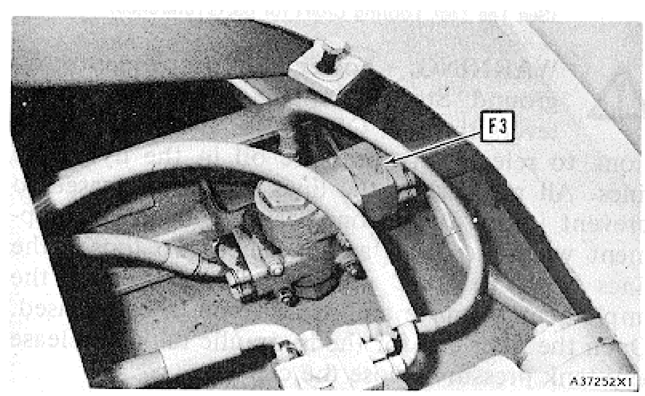
If the System Tests and Pump Tests give an indication of leakage in the control valves and/or cylinders that is not acceptable, do the Blocked Circuit Tests. Blocking Plate Assemblies can be put in each of the circuit lines. For best accuracy, do these tests with the oil temperature approximately 150°F (near the oil temperature for the System Tests and Pump Tests). For parts reference see pages 4-59 through 4-64.



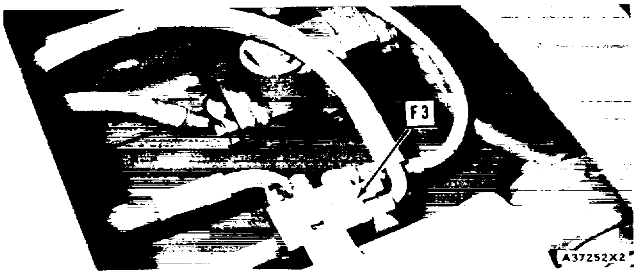
CIRCUIT BLOCKING LOCATIONS
(See Tee Test Tooling Chart for parts reference)
1. Bowl, Tests 36 & 37. 2. Ejector, Tests 34 & 35.



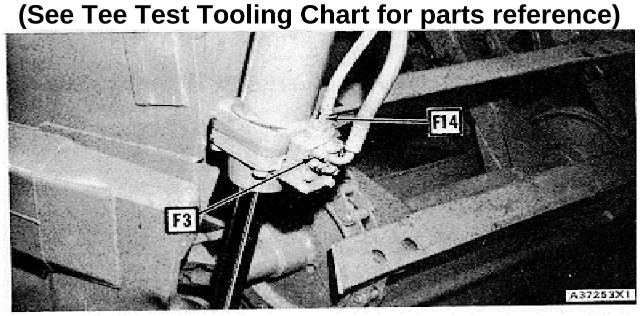
CIRCUIT BLOCKING LOCATIONS
(See Tee Test Tooling Chart for parts reference)
1. Bowl, Tests 36 & 37.



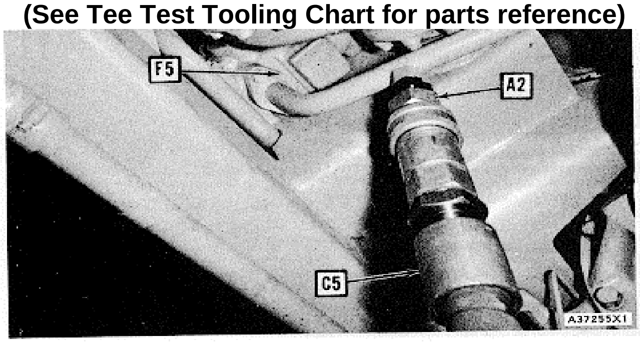
FLOOR CYLINDER BLOCKING LOCATION
(Test 44)
(See Tee Test Tooling Chart for parts reference)



BLOCKING LOCATION FOR EJECTOR CYLINDER
(Test 43)--
(See Tee Test Tooling Chart for parts reference)



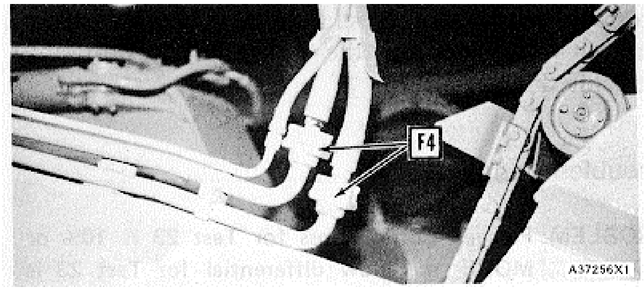
BLOCKING LOCATION FOR RIGHT BOWL CYLINDER
(Test 45 and 46)
(See Tee Test Tooling Chart for parts reference)



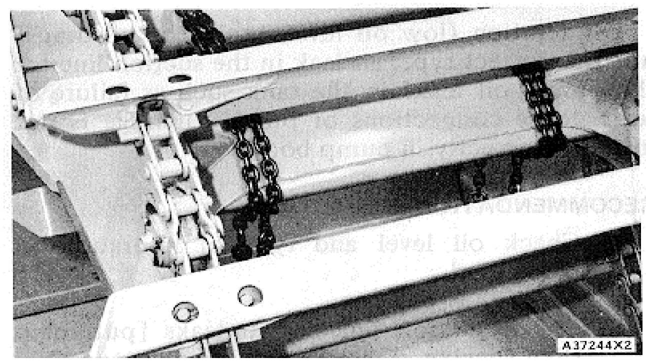
BLOCKING LOCATION FOR TESTS OF THE ELEVATOR PUMP
(LARGE SECTION)
(Tests 22 through 30, Chart C2)
(See Tee Test Tooling Chart for parts reference)

WARNING: Lower all implements to ground. Stop the engine. Move the control levers through OPERATE and HOLD positions to release any pressure oil in the hydraulic lines. All pressure in the lines must be released to prevent injury to personnel and damage to equipment when the lines are loosened. To loosen the lines with pressure oil in them can cause the implement to move and pressure oil to be released. Open the filler cap for the hydraulic tank to release any tank pressure. Close the cap.

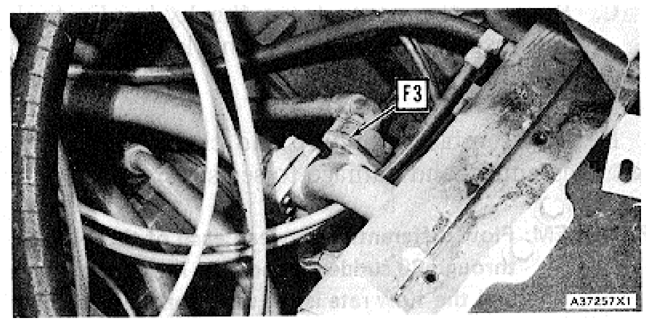
NOTE: Tests 34 through 40 are leakage rate tests for circuits.



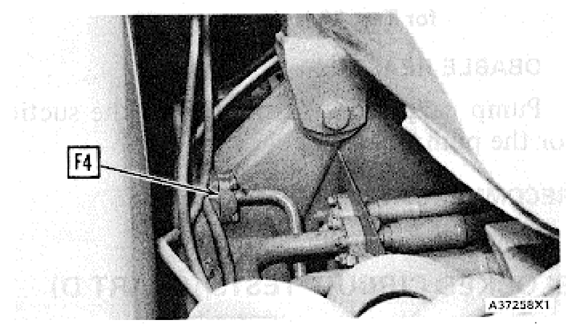
BLOCKING LOCATION FOR ELEVATOR ELEVATOR CIRCUIT TESTS
(See Tee Test Tooling Chart for parts reference)



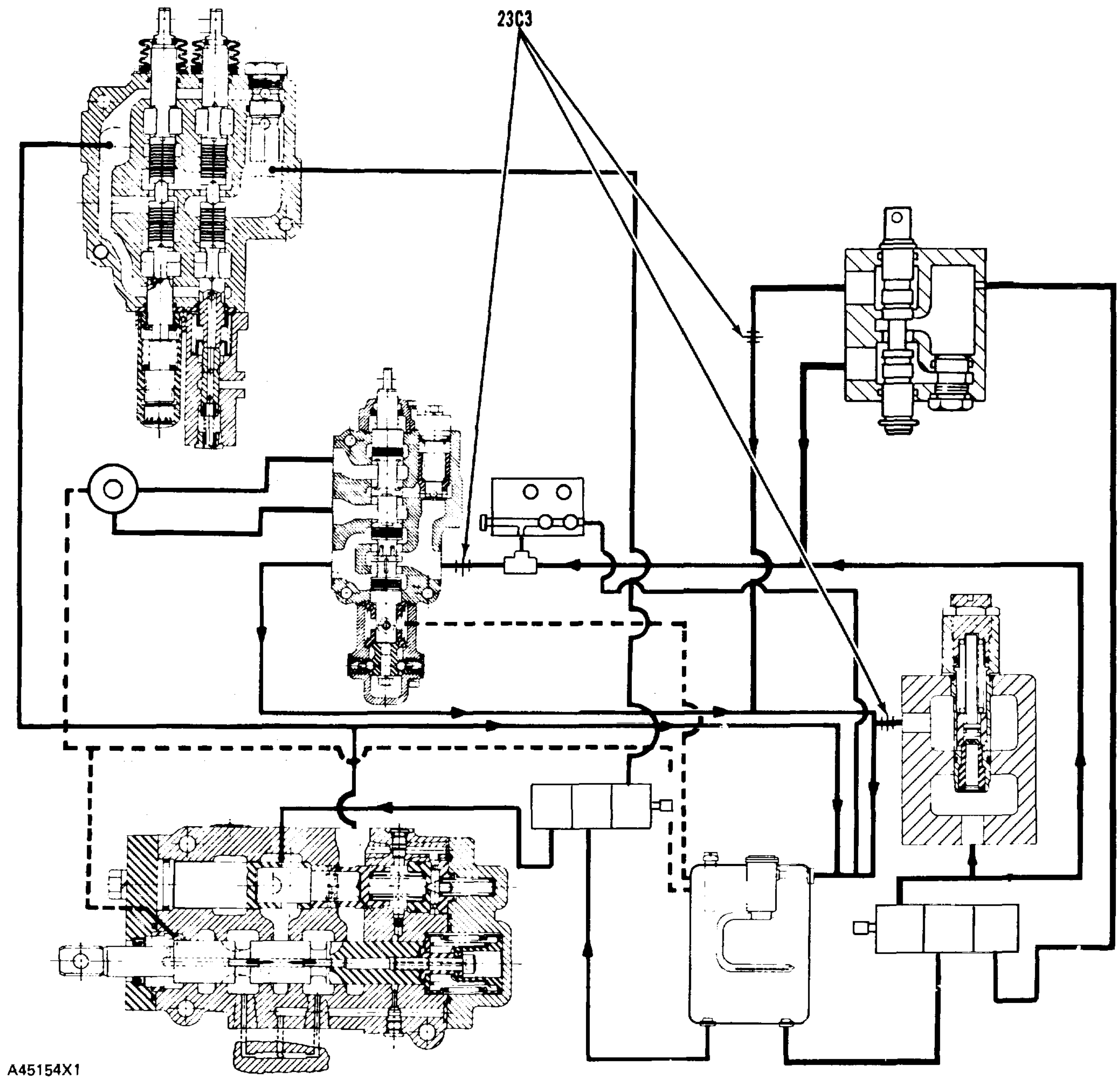
CHAIN TO PREVENT ELEVATOR FROM MOVING



BLOCKING LOCATION FOR RELIEF VALVE
(Test 56)
(See Tee Test Tooling Chart for parts reference)



BLOCKING LOCATION FOR SPEED CONTROL VALVE
(Test 55)
(See Tee Test Tooling Chart for parts reference)



TESTING FAST SPEED PUMP OF ELEVATOR

TEST	COMPONENTS IN EACH TEST WITH CONTROL VALVE IN NEUTRAL POSITION	DESIRED FLOW
23 (Chart C3)	Pump (Elevator, Large and Small Sections)	51 U S. Gpm

613B:

SCRAPER BLOCKED CIRCUIT TEST

TEE – TEST

PROCEDURE DATA SHEET

CHART D

DATE ____________

MACHINE SERIAL NUMBER ____________

SERVICE METER READING ____________

Test Name	System Oil Temperature (Start)	Ejector FORWARD (OPEN) Flow Rate	Ejector RETURN (CLOSED) Flow Rate	Bowl RAISE Flow Rate	Bowl LOWER Flow Rate	Elevator REVERSE Flow Rate	Elevator FORWARD Flow Rate Slow	Elevator FORWARD Flow Rate Fast	System Oil Temperature (End)
Test Number	33	34	35	36	37	38	39	40	41
Control Lever Position	Ejector FORWARD (OPEN)	Ejector FORWARD (OPEN)	Ejector RETURN (CLOSED)	Bowl RAISE	Bowl LOWER	Elevator REVERSE	NEUTRAL	NEUTRAL	Ejector FORWARD (OPEN)
Engine Speed	Any Speed	2200 RPM	2200 RPM	2200 RPM	2200 RPM	2200 RPM	2200 RPM	2200 RPM	Any Speed
System Test Pressure	0-100 PSI	1000 PSI	1000 PSI	1000 PSI	1000 PSI	1000 PSI	1000 PSI	1000 PSI	0-100 PSI
Test Data	°F	GPM	GPM	GPM	GPM	GPM	GPM	GPM	°F
Circuit Leakage Rate		(34-4) GPM	(35-5) GPM	(36-6) GPM	(37-7) GPM	(38-16) GPM	(39-15) GPM	(40-17) GPM	
Control Valve Group Leakage		(23-34)* GPM	(23-35)* GPM	(23-36)* GPM	(23-37)*			(54-40) GPM	

*Value of TEST 23 is from Chart C1

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Tee location for Tests 34 through 38 are at the plug on the supply line elbow at the scraper control valve or pump. Blocking locations are explained at the beginning for each test. See schematics and illustrations for the specific machine being tested.

NOTE: It is important that the tee block and blocking plate assemblies be installed in the exact position shown to get the correct test results. Remove all blocking plates not for the specific test being made.

For All Blocked Circuit Tests

1. Put control levers in HOLD position.
2. Open the manual load valve fully.
3. Start the diesel engine.

Blocked Circuit Test

Tee location for Tests 33 through 37 is the plug on the supply line near the scraper control valve.

Test 33: System Oil Temperature

1. Put the ejector control lever in the FOR- WARD position.
2. Run the engine at any rpm with the system pressure at 0 to 100 psi.
3. Write down the oil temperature.

Tests 34 through 37: Leakage Rate

1. Block the circuit line for the ejector and bowl circuits at the control valve.
2. With the manual load valve fully open, move the ejector control lever to the FORWARD (OPEN) position.
3. Run the engine at test rpm.
4. Slowly close the manual load valve to get 1000 psi pressure.
5. Write down the flow rate (gpm).
6. Do this procedure again for ejector return, bowl raise, and bowl lower.

Tests 38 through 40: Leakage Rate

Tee location: The plug on the supply line near the elevator control valve.

Blocking location: The circuit line for the elevator circuit at the control valve.

1. With the manual load valve fully open, move the elevator control lever to the FORWARD position.
2. Slowly close the manual load valve to get 1000 psi.
3. Write down the flow rate (gpm).
4. Repeat this procedure for elevator reverse and elevator fast forward.

Test 41: System Oil Temperature

1. Put the ejector control lever in FORWARD (OPEN) position.
2. Run the engine at any rpm with the system pressure at 0 to 100 psi.
3. Write down the oil temperature.

Find the leakage rate' of the circuit and the leakage rate of the control valves. Use the test information from the System Tests, Pump Test and Blocked Circuit Tests.

Example 1: Find the leakage rates of the ejector circuit in the FORWARD position.

Test 23; Chart C1: Flow rate of the pump only.

Test 34: Flow of pump and control valve.

Test 4: Flow rate of pump, control valve and circuit.

The system components tested in Tests 34 and 23, Chart C1 are the same except for the control valve. Then the difference in flow rates must be the leakage in the control valve in the circuit (take the test information for Test 34 away from the test information for Test 23, Chart C1).

The system components tested in Tests 34 and 4 are the same except for the cylinders, and floor cylinder check valve (ejector cylinder check valve). Then the difference in flow rates must be the leakage in the cylinders, and floor cylinder check valve (ejector cylinder check valve) (take the test information for Test 4 away from the test information for Test 34).

Example 2: Find the leakage rates of the elevator circuit in the FORWARD FAST position.

Test 40: Flow rate of pump and unloading valve.

Test 17: Flow rate of pump, control valve and unloading valve.

The components tested in Tests 40 and 17 are the same except for the control valve. The difference in the flow rates must be caused by leakage in the control valve.

Make a comparison of all the test data with the data on Chart D for the machine under test. The information on Chart D is for best circuit performance.

Troubleshooting

PROBLEM: Leakage rates for Tests 34, 35, 36, 37, and 38 are more than the rates shown in Chart D.

PROBABLE REASON:
Leakage in the pressure relief valve.

RECOMMENDATION FOR ACTION:
Inspect pressure relief valve.

PROBLEM: Tests 34 and 35 give an indication of leakage in the ejector circuit.

PROBABLE REASON:
A. Leakage in the ejector cylinders.

B. Leakage in the floor cylinder.

C. Leakage in the floor check valve (ejector check valve).

RECOMMENDATION FOR ACTION:
Do Tests 43 and 44 for the ejector circuit.

PROBLEM: Tests 36 and 37 give an indication of leakage in the bowl circuit.

PROBABLE REASON:
A. Leakage in only one of the cylinders and check valve.

B. Leakage in both cylinders and check valve.

RECOMMENDATION FOR ACTION:
Do Tests 45 and 46 for the bowl circuit.

PROBLEM: Motor leakage rate in Tests 38, 39 and 40 is more than shown in Chart D.

PROBABLE REASON:
Leakage in the motor.

RECOMMENDATION FOR ACTION:
Disassemble and inspect the elevator motor. Make a repair or install new parts as necessary.

PROBLEM: Leakage rate in Test 40 is more than shown in Chart D.

PROBABLE REASON:
Damage in the control valve.

RECOMMENDATION FOR ACTION:

Disassemble and inspect the control valve. Make a repair or install new parts as necessary.

PROBLEM: Leakage rate for Tests 34, 35, 36 and 37 are more than shown in Chart D.

PROBABLE REASON:
Leakage in the pressure relief valve.

RECOMMENDATION FOR ACTION:
Inspect pressure relief valve.

BLOCKED COMPONENT TESTS (CHART E)

If the Blocked Circuit Tests give an indication of leakage that is too high in cylinders, valves, or motor, do the Blocked Component Tests. For best accuracy, operate all controls through several cycles to get the temperature of oil in the cylinders the same as the temperature of the oil in the hydraulic tank. Make the temperature of the oil in the complete system 150° F.

WARNING: Lower all implements to the ground. Stop the engine. Move the control levers through OPERATE and HOLD positions to release any pressure oil in the hydraulic lines. All pressure in the lines must be released to prevent injury to personnel and damage to equipment when the lines are loosened. To loosen the lines with pressure oil in them can cause the implement to move and/or pressure oil to be released. Open the filler cap for the hydraulic tank to release any tank pressure. Close the cap.

Tee locations are not the same for all tests. At the beginning of each test, tee locations and blocking locations are explained. See the schematics and illustrations for the specific machine being tested.

NOTE: It is important that the tee block and blocking plate assemblies be installed in the exact position shown to get the correct test results. Remove all blocking plates not for the specific test being made.

Test 42: System Oil Temperature

Tee location: The plug on the supply line elbow at the scraper control valve, or at the pump.

Blocking location: None.

1. Open the manual load valve fully.

2. Start the diesel engine. Run the engine at any rpm with the system pressure at 0 to 100 psi.

3. Move the ejector control lever to FORWARD (OPEN) position.

4. Write down the oil temperature.

Test 43: Ejector FORWARD (OPEN) Flow Rate (Ejector Cylinder Blocked)

Tee location: The plug on the supply line elbow at the scraper control valve, or at the pump.

Blocking locations:

At the manifold, between the ejector cylinder head and the manifold.

1. Open the manual load valve fully.

2. Move the ejector control lever to FORWARD (OPEN) position.

3. Slowly close the load valve to get 1000 psi pressure.

4. Write down the flow rate (gpm).

Test 44: Ejector FORWARD Flow Rate (Floor Cylinder Check Valve Blocked)

Tee location: The plug on the supply line elbow at the scraper control valve, or at the pump.

Blocking location: At the inlet to the floor cylinder check valve, between the valve and the line from the head end of the floor cylinder.

1. Open the manual load valve fully.

2. Move the ejector control valve to FORWARD position.

3. Slowly close the load valve to get 1000 psi pressure.

4. Write down the flow rate (gpm).

Tests 45 and 46: Bowl RAISE and Bowl LOWER Flow Rates (Right Bowl Cylinder and Balance Line Blocked)

These two tests are similar. Do the tests as follows:

Tee location: The plug on the supply line elbow at the scraper control valve, or at the pump.

Blocking locations:
At the inlet to the head end of the right bowl cylinder AND at the outlet of the vent line to the right bowl cylinder.

1. Open the manual load valve fully, then start the engine.

2. Move the bowl control lever to RAISE posi- tion.

3. Run the engine at test rpm.

4. Slowly close the manual load valve to get 1000 psi pressure.

5. Write down the flow rate (gpm).

6. Do this procedure again for bowl LOWER.

Test 52: System Oil Temperature

1. Open the manual load valve fully.

2. Start the diesel engine. Run the engine at any rpm with the system pressure at 0 to 100 psi.

3. Move the ejector control lever to FORWARD, SLOW position.

4. Write down the oil temperature.

Find the leakage rate of the cylinders, valves, and hydraulic motor. Use the test information from the Systems Tests, Pump Tests, Blocked Circuit Tests, and Blocked Component Tests.

Example: Find the leakage of the right bowl cylinder in the bowl RAISE position.

Test 6: Flow rate of the bowl circuit.

613B:
SCRAPER BLOCKED COMPONENT TEST

TEE – TEST
PROCEDURE DATA SHEET
CHART E

DATE ____________

MACHINE SERIAL NUMBER ____________
SERVICE METER READING ____________

		Ejector Cylinder Blocked	Floor Cyl. Check Valve Blocked	Right Cylinder & Vent Line Blocked		Elevator Motor Blocked	Reversing Valve Blocked	
Test Name	System Oil Temperature (Start)	Ejector FORWARD (OPEN) Flow Rate	Ejector FORWARD Flow Rate	Bowl RAISE Flow Rate	Bowl LOWER Flow Rate			System Oil Temperature (End)
Test Number	42	43	44	45	46			52
Control Lever Position	Ejector FORWARD (OPEN)	Ejector FORWARD (OPEN)	Ejector FORWARD	Bowl RAISE	Bowl LOWER			Elevator FORWARD
Engine Speed	Any Speed	2200 RPM	2200 RPM	2200 RPM	2200 RPM			Any Speed
System Test Pressure	0 - 100 PSI	1000 PSI	1000 PSI	1000 PSI	1000 PSI			0 - 100 PSI
Test Data	°F	GPM	GPM	GPM	GPM			°F
Leakage Rate		Ejector Cylinder Leakage (43 - 4) GPM	Floor Cylinder Leakage (44 - 4) GPM	Right Bowl Cyl. Leakage (45 - 6) GPM	Right Bowl Cyl. Leakage (46 - 7) GPM			
Leakage Rate				Left Bowl Cyl. Leakage (36 - 45) GPM	Left Bowl Cyl. Leakage (37 - 46) GPM			

A04405X9

Test 36: Flow rate of the pump and control valve.

Test 45: Flow rate of the pump, control valve, and left cylinder and carry check valve.

The system components tested in Tests 6 and 45 are the same except for the right bowl cylinder. Then the difference in flow rates must be the leakage in the right bowl cylinder (take the test information for Test 4 away from the test information for Test 45).

The system components tested in Tests 36 and 45 are the same except for the left bowl cylinder and carry check valves. Then the difference in flow rates must be the leakage in the left bowl cylinder (take the test information for Test 45 away from the test information for Test 36).

Make a comparison of the test data with the data given on Chart E for the specific machine under test. The information on Chart E is for best component performance.

Troubleshooting

PROBLEM: Leakage rates for Tests 43, 44, 45 and 46 are more than the rates shown on Chart E.

PROBABLE REASON:
Pressure relief valve.

RECOMMENDATION FOR ACTION:
Inspect the relief valve.

PROBLEM: Leakage rate for Test 43 is more than the rate shown on Chart E.

PROBABLE REASON:
A. Leakage in the piston seal of the ejector cylinder.

B. Wear or damage in the ejector cylinder assembly.

RECOMMENDATION FOR ACTION:
Disassemble and make repairs to the cylinder.

PROBLEM: Leakage rate in Test 44 is more than the rate shown on Chart E.

PROBABLE REASON:
A. Leakage in the piston seal of the floor cylinder.

B. Wear or damage in the floor cylinder assembly.

RECOMMENDATION FOR ACTION:
Disassemble and make repairs to the floor cylinders.

PROBLEM: Leakage rates in Tests 45 and 46 are more than shown on Chart E.

PROBABLE REASON:
A. Leakage in the piston seals of the right or left bowl cylinders.
B. Wear or damage in the right or left bowl cylinder.
C. Loose nut on a piston.

RECOMMENDATION FOR ACTION:
Disassemble and make repairs to the right or left bowl cylinder.

Elevator Motor Control Circuit Test (Chart F)

Test 53: System Oil Temperature
Tee location: The plug on the supply line near the elevator control valve.

Blocking location: Between the elevator control valve and the pump supply line.

1. Put the speed control lever in the HIGH SPEED position.

2. Open the manual load valve fully.

3. Start the diesel engine.

4. Look at the oil temperature gauge.

5. Write down the oil temperature. Oil temperature must be 150 ± 5° F.

Test 54: System Flow Rate

Tee location: The plug on the supply line near the elevator control valve.

Blocking location: Between the elevator control valve and the pump supply line.

1. Put the speed control lever in the HIGH SPEED position.

2. Open the manual valve fully.

3. Get the engine to test rpm.

4. Make an adjustment to the manual load valve to get 1000 psi.

5. Check engine rpm and system pressure; pressure should be 1000 psi; engine speed should be 2200 rpm.

6. Write down the flow rate.

Test 55: Speed Control Valve Leakage

Tee location: The plug on the supply line near the elevator control valve.

Blocking location: Between the elevator control valve and the pump supply line.

WARNING: The speed control lever must be in the HIGH SPEED position during this test.

1. Put the speed control lever in the high speed position.

2. Open the manual load valve fully.

3. Get the engine to test rpm.

4. Make an adjustment to the manual load valve to get 1000 psi.

5. Check engine rpm and system pressure; pressure should be 1000 psi; engine speed should be 2200 rpm.

6. Write down the flow rate.

Test 56: Relief valve leakage

Tee location: The plug on the supply line near the elevator control valve.

Blocking location:

1. Between the elevator control valve and the pump supply line.

2. At the outlet of the relief valve, which blocks leakage return back to the hydraulic tank.

WARNING: The speed control lever must be in the HIGH SPEED position during this test.

Blocking location: Same as Test 56.

1. Put the speed control lever in the HIGH SPEED position.

2. Open the manual load valve fully.

3. Get the engine to test rpm.

4. Make an adjustment to the manual load valve to get 1000 psi.

5. Check engine rpm and system pressure; pressure should be 1000 psi; engine speed should be 2200 rpm.

6. Write down the flow rate.

Test 57: System Oil Temperature

Tee location: The plug on the supply line near the elevator control valve.

WARNING: The speed control valve must be in the HIGH SPEED position during this test.

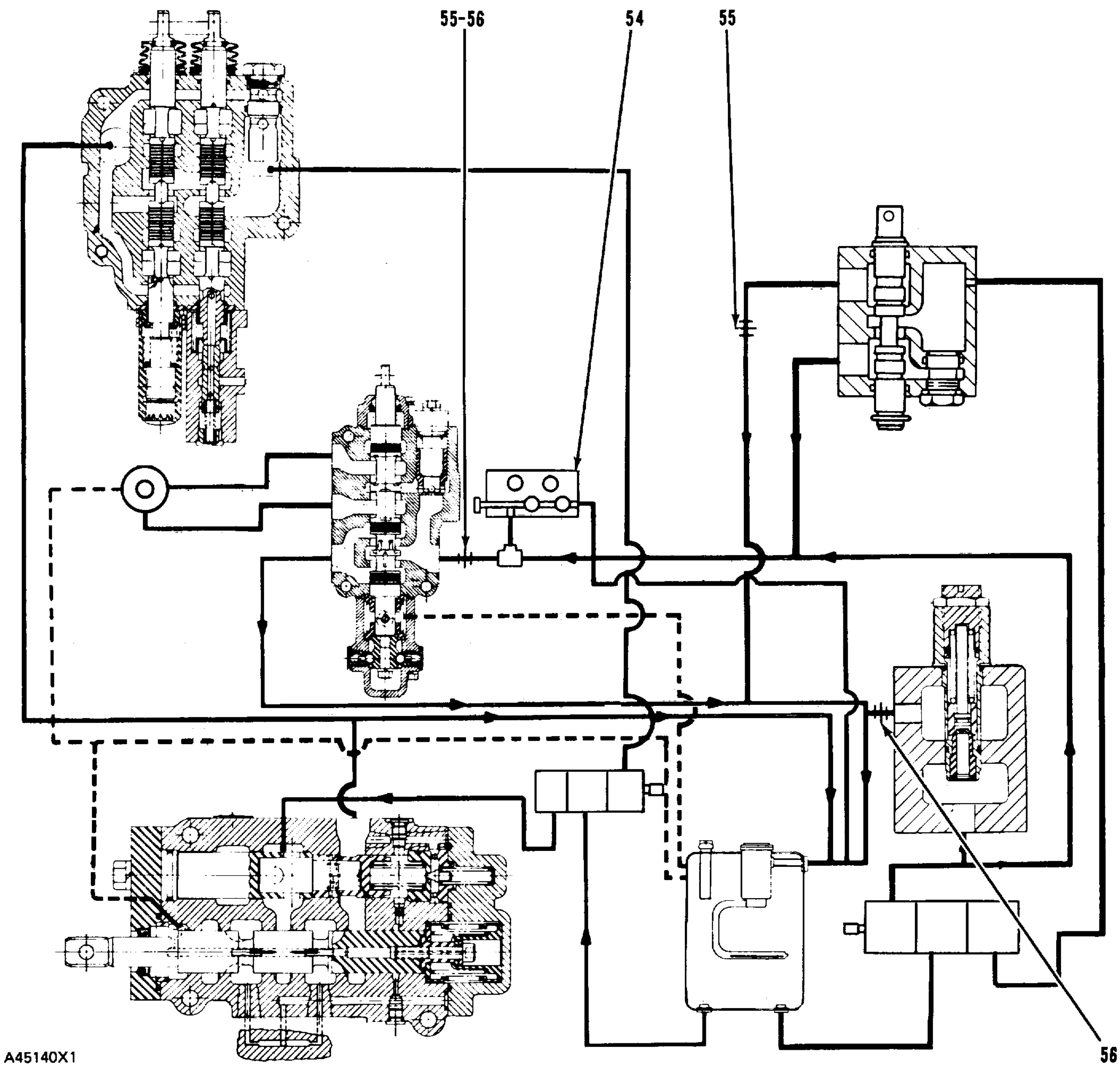
1. Put the speed control lever in the high speed position.

2. Open the manual load valve to obtain 0 psi.

3. Get the engine to test rpm.

4. Observe the temperature gauge.

5. Write down the oil temperature.



TESTING ELEVATOR MOTOR CONTROL CIRCUIT

TEST	COMPONENTS IN EACH TEST WITH CONTROL VALVE IN FORWARD FAST	DESIRED FLOW
54	Systems Test, Fast Speed of ELEVATOR Control Circuit	50 U. S. gpm
55	Pump (Elevator, Large and Small Sections), Elevator Speed Control Valve and Relief Valve	50. 5 U. S. gpm
56	Pump (Elevator, Large and Small Sections) and Elevator Speed Control Valve	51 U. S. gpm

TEE – TEST

PROCEDURE DATA SHEET

613B:
SCRAPER ELEVATOR MOTOR
CONTROL CIRCUIT TEST

MACHINE SERIAL NUMBER ______________

CHART F

DATE ______________

SERVICE METER READING ______________

Test Name	System Oil Temperature (Start)	System Flow	Speed Control Valve Leakage	Relief Valve Leakage	System Oil Temperature (End)
Test Number	53	54	55	56	57
Control Lever Position	FORWARD SLOW	FORWARD FAST	FORWARD FAST	FORWARD FAST	FORWARD FAST
Engine Speed	Any Speed	2200 RPM	2200 RPM	2200 RPM	2200 RPM
System Test Pressure	0-100 PSI	1000 PSI	1000 PSI	1000 PSI	0-100 PSI
Test Data	______ °F	______ GPM	______ GPM	______ GPM	______ °F
Flow Differential			(55-54) ______ GPM	(56-55) ______ GPM	
Percent Flow Loss			$\left(\frac{55-54}{55}\right) \times 100$ ______ %	$\left(\frac{56-55}{56}\right) \times 100$ ______ %	

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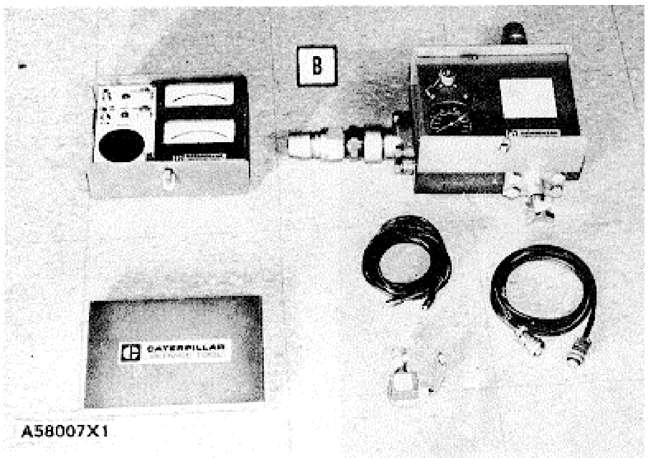
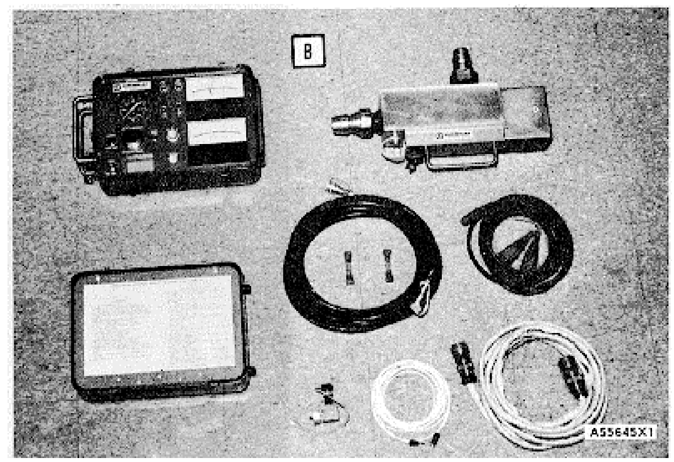
WARNING: The speed control valve must be in the high speed position for tests 55, 56, & 57.

TEE TEST TOOLS

WARNING: Tools that are not included in this book must not be used on machines with system pressures higher than 3000 psi (20 700 kPa).





9S2000 FLOW METER ASSEMBLY

B - 9S2000 Flow Meter Assembly

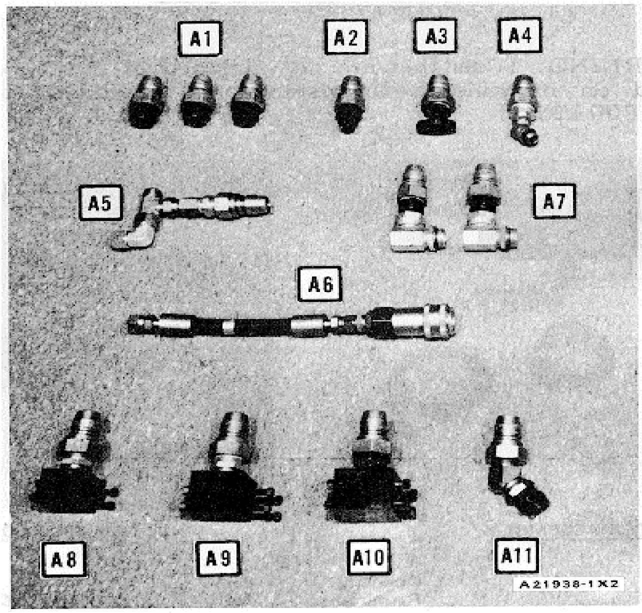
Part No.	Description	Quantity Required
9S2000	Flow Meter	1
5P7360	Tachometer Generator (Part of 9S2000)	a
2P5523	Cable Assembly (Part of 9S2000)	
9S3048	Cable Assembly (Part of 9S2000)	a
9S6341	Safety Disc (. 010" 4300 psi) (Part of 9S2000)	a
1P7411	Safety Disc (. 013" 6200 psi) (Part of 9S2000)	a
3H4330	Split Flange	4
S1587	Bolt 8	
3B4508	Lockwasher	8
8S9964	Flange Type Fitting	2
7F8267	O-Ring Seal	2
8S9965	Pipe Nipple	2
2P8334	Plain Nipple	2

5P3600 FLOW METER ASSEMBLY

B - 5P3600 Flow Meter Assembly

Part No.	Description	Quantity Required
5P3600	Flow Meter Group	1
5P7360	Tachometer Generator (Part of 5P3600)	
5P7362	Cable Assembly (Tachometer) (Part of 5P3600)	a
5P7365	Cable Assembly (Flow Block) (Part of 5P3600)	
5P7366	Cable Assembly (Power) (Part of 5P3600)	
5P7363	Hose Assembly (Pressure Gauge) (Part of 5P3600)	
9S6341	Safety Disc (. 010" - 4300 psi) (Part of 5P3600)	a
1P7411	Safety Disc (. 013" - 6200 psi) (Part of 5P3600)	a
7N4154	Lamp (No. 45) (Part of 5P3600)	a
7N4153	Lamp (No. 1408) (Part of 5P3600)	a
5P7372	Meter (RPM, Temp) (Part of 5P3600)	
5P7368	Meter (GPM) (Part of 5P3600)	
8S9967	Adapter	2
2P8334	Plain Nipple	2

a - Recommend spare parts be kept on hand.



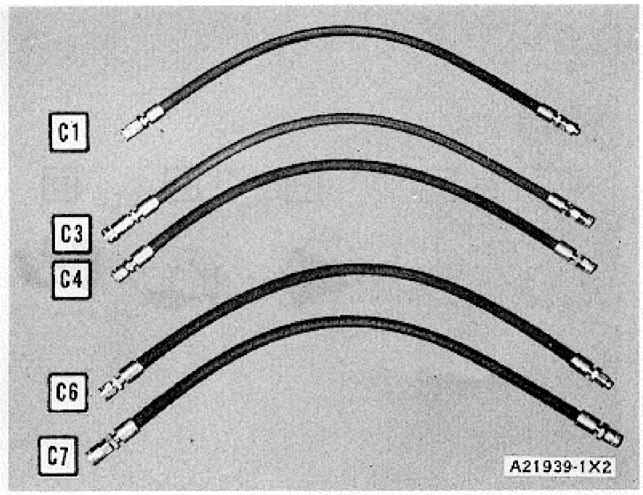
A - Pump Supply Line Adapter

Assembly No.	Part No.	Description	Quantity Required
	8S9967	Adapter	3
A1	2S4078	O-Ring Seal (Part of 8S9967)	a
	2P8336	Valved Nipple (1 ¼”)	3
	9S7336	Adapter	1
	3D2824	O-Ring Seal (Part of 9S7336)	a
A2	9S7337	Reducing Bushing	1
	2P8336	Valved Nipple (1 ¼”)	1
	2P8339	Quad Ring (Part of 2P8336)	a
A3	FT828	Filter Adapter	b
	2P8336	Valved Nipple (1 ¼”)	1
	1P5596	Pipe Nipple (3/4” x 1 ¼”)	1
A4	307976	Adapter-45° Union	1
	3D2824	O-Ring Seal	1
	5P2242	Tee	1
	5P2244	Union	
A5	1P5597	Pipe Nipple (1" x 1 ¼”)	c
	2P8336	Valved Nipple (1 ¼”)	c
	315744	Elbow-90°	1
	8S6646	Hose	1
	3B7257	Bushing	1
A6	43099	Fitting	1
	2P8337	Valved Coupler	1
	307980	Adapter-90°	2
A7	2S4078	O-Ring Seal	2
	1P5598	Pipe Nipple (1 ¼” x 1 ¼”)	2
	2P8336	Valved Nipple (1 ¼”')	2

A - Pump Supply Line Adapter

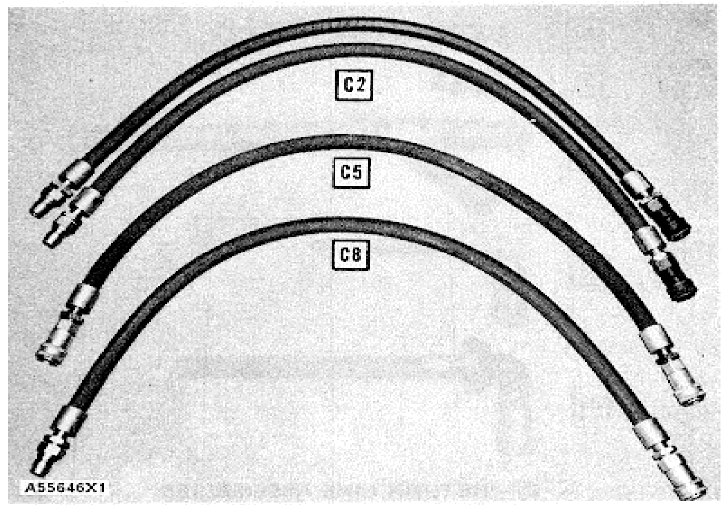
Assembly No.	Part No.	Description	Quantity Required
	5P3032	Adapter (1" Hose)	1
	1P5597	Pipe Nipple (1" x 1 ¼”")	1
A8	4F7391	O-Ring Seal	1
	2P8336	Valved Nipple (1 ¼”)	1
	8S9191	Bolt	4
	1D4717	Nut	4
	5P3033	Adapter (1 ¼” Hose)	1
	1P5597	Pipe Nipple (1” x 1 ¼”)	1
A9	4F7952	O-Ring Seal	1
	2P8336	Valved Nipple (1 ¼”)	1
	7H3472	Bolt	4
	1D4718	Nut	4
	5P3034	Adapter (1 ½” Hose)	1
	1P5598	Pipe Nipple (1 ¼” x 1 ¼”)	d
	7F8267	O-Ring Seal	1
A10	2P8336	Valved Nipple (1 ¼”)	d
	2H6488	Bolt	4
	1D4719	Nut	4
	44977	Elbow-45°	1
A11	2P8336	Valved Nipple (1 ¼”)	1
	8S9967	Adapter	1

a - Recommend spare parts be kept on hand.
b - Use from A8 assembly.
c - Use from A7 assembly.



C - CONNECTING HOSE ASSEMBLIES

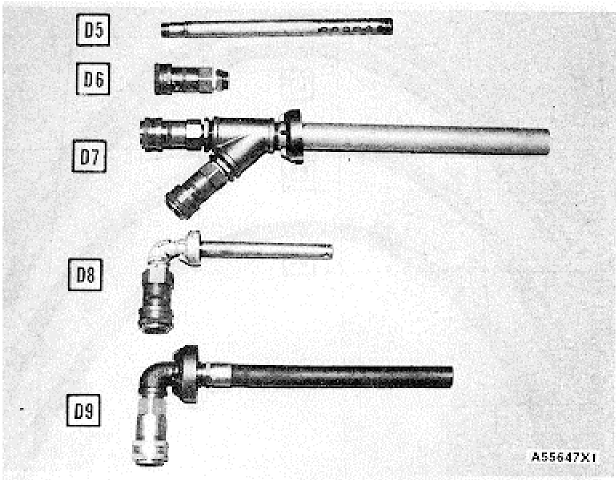
Assembly No.	Part No	Description	Quantity Required
C1	Use C2 on 9S2000 Flow Meter. Not used on 5P3600 Flow Meter.		
C2	2P2349	Hose Assembly	2
	2P8335	Plain Coupler	2
	2P8334	Plain Nipple	2
C3	Use C5 except on the 992. Use C8 on 992.		
C4	Use C2 on 9S2000 Flow Meter. Not used on 5P3600 Flow Meter.		
C5	2P2349	Hose Assembly	1
	2P8335	Plain Coupler	1
	2P8337	Valved Coupler	1



C - CONNECTING HOSE ASSEMBLIES

C - Connecting Hose Assembly

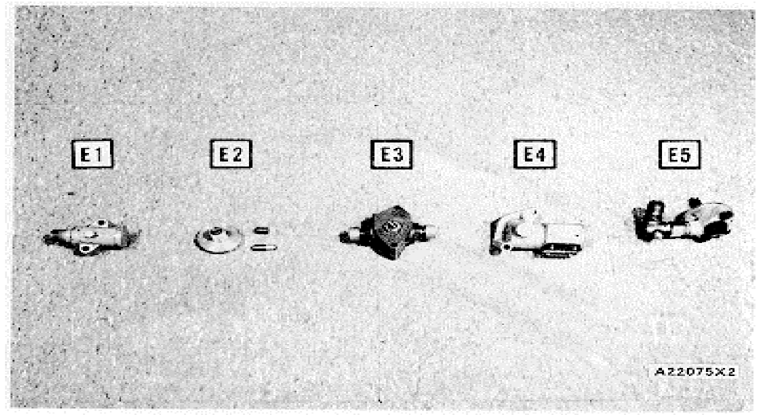
Assembly No.	Part No.	Description	Quantity Required
C6	Use Connecting Hose Assembly C2		
C7	Use C2 on 992 only		
C8	2P2349	Hose Assembly	1
	2P8337	Valved Coupler	1
	2P8336	Valved Nipple (1/")	1
	8S9976	Coupler Repair Kit (Part of 8S9972 & 8S9974I	



D - RETURN LINE ASSEMBLIES

Assembly No.	Part No	Description	Quantity Required
		D - Return Line Assembly	
D1		Use Return Line Assembly D6	
D2		Use Return Line Assembly D7	
D3		Use Return Line Assembly D8	
D4		Use Return Line Assembly D9	
D5	5P3517	Tube Assembly-Return	1
	8S9967	Adapter	1
D6	2P8335	Plain Coupler	1
	3B7750	Pipe Nipple	2
	4J3815	Gasket	1
D7	1P58	Filler Return Group	1
	2P8337	Valved Coupler	2
	3B6555	Street Ell	1
	3B7749	Nipple	1
D8	3B7257	Bushing	1
	9H6454	Gasket	1
	1 P757	Filler Return Group	1
	2P8337	Valved Coupler	1
D9	FT794	Return Line Cap Assembly	1

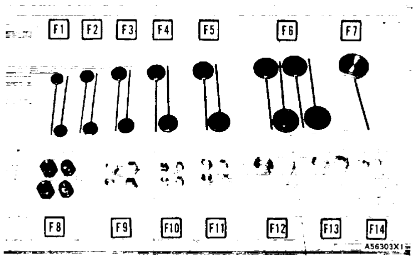
Use 2P8337 Valved Coupler instead of 8S9974.



E - TACHOMETER DRIVE ASSEMBLIES

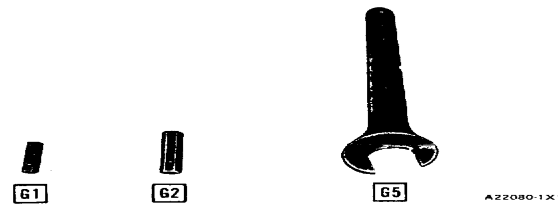
Assembly No.	Part No	Description	Quantity Required
		E - Tachometer Drive	
	1M5061	Tachometer Drive Group	1
E1	3B4505	Lockwasher	2
	5P1 759	Tachometer Adapter (9S5609)	1
	9N641	Adapter Group (Part of 5P1759)	
	4M8303	Seal (Part of 5P1759)	
E2	5P1758	Shaft Assembly (Part of P1759)	
	4N538	Coupling (Part of 5P1759)	
	9S211	Clamp	2
	9S3032	Clamp	2
	4L8393	Tachometer Drive Group (1.1) (Drill out holes to 11/32" Dia.)	1
	1B2714	Bolt (/"-20 x 2%")	2
E3	3B4504	Lockwasher (%")	2
	3B4505	Lockwasher (5/16")	2
	2S424	Service Meter Group	1
	2B2695	Bolt (5/16"-18 x 7/8")	1
E4	3B4505	Lockwasher (5/16")	2
	7M6006	Drive Group (Modified)	1
E5	5S6106	Adapter, 2.1 Drive	1
	1B7182	Bolts	2

_ Included in 5P8687 Tool Group



Assembly No.	Part No	Description	Quantity Required
		F - Blocking Plate Assemblies*	
	9S7358	Blocking Plate Assembly {1/2")	2
Fl	5F7054	O-RingSeal	2
	9S8894	Blocking Plate Assembly (5/8")	2
	F24J8996	O-Ring Seal	2
	9S7359	Blocking Plate Assembly (%")	2
F3	5F1678	O-Ring Seal	2
	9S8092	Blocking Plate Assembly (1")	2
F4	4F7391	O-Ring Seal	2
	9S8093	Blocking Plate Assembly (11/")	2
F5	4F7952	O-Ring Seal	2
	9S8094	Blocking Plate Assembly (11/")	4
F6	7F8267	O-Ring Seal	4
	9S8095	Blocking Plate Assembly (2")	1
F7	8F6711	O-Ring Seal	1
	9S8895	Plug (1 1/16"-12 Thread)	2
F8	9S8896	Cap (1 1/16"-12 Thread)	2
	2P9697	Plug (7/8"-14 Thread)	2
F9	8L6111	Cap(7/8"-14Thread)	2
	9S8927	Plug (9/16"-18 Thread)	2
F10	8S4950	Cap(9/16"-18 Thread)	2
	5P2909	Plug (3/4"-16 Thread)	2
F11	8S4951	Cap (3/4"-16 Thread)	2
	5P2299	Plug 1(5/16"-12 Thread)	1
F12	3R6789	Cap (1 5/16"-12 Thread)	1
	5P4299	Plug (1 3/16"-12 Thread)	1
F13	8L9137	Cap (1 3/16"-12 Thread)	1
	9S5518	Plug (7/16"-12 Thread)	1
F14	9L8493	Cap (7/16"-12 Thread)	1

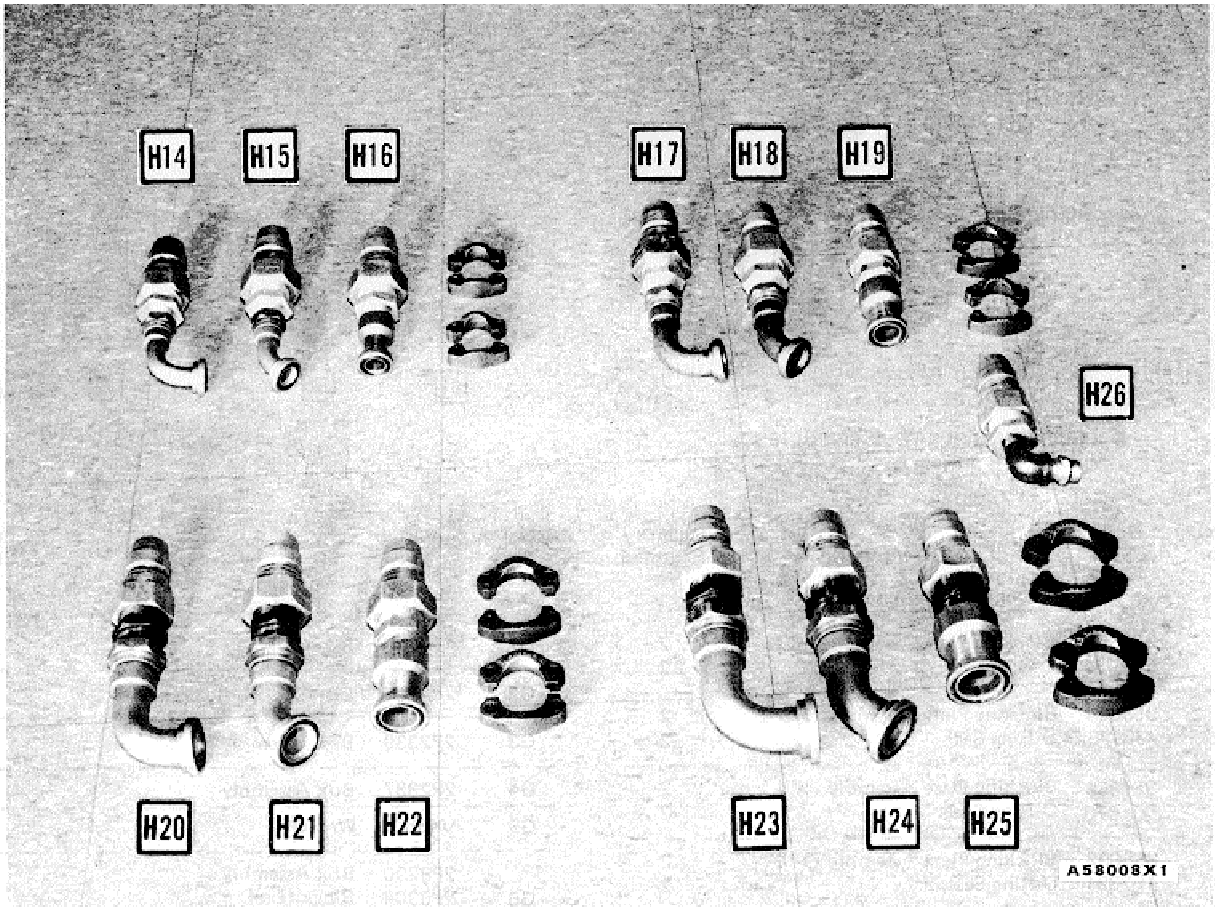
’All of the above assemblies are included in the 5P8687 Tool Group.



G — TOOLS

Assembly No.	Part No	Description	Quantity Required
G2	1 P3567	Bit-Tool (%")	1
G3	2P2339	Box Assembly	1
G4	2P2337	Box Assembly	1
G5	V455	Wrench 1	
	2P8290	Box Assembly	1
G6	2P8304	Block (Lid)	1
	5P8686	Block (Tool Holder)	1

- Included in 5P8687 Tool Group.
- Use only with 9S2000 Flow Meter.



Assembly No.	Part No	Description	Quantity Required

H - Pump Supply Line Adapter

H1 Use H14 Pump Supply Line Adapter

H2 Use H15 Pump Supply Line Adapter.

H3 Use H16 Pump Supply Line Adapter.

H4 Use H17 Pump Supply Line Adapter.

H5 Use H18 Pump Supply Line Adapter

H6 Use H19 Pump Supply Line Adapter.

H - Pump Supply Line Adapter

H7 use H20 Pump Supply Line Adapter.

HB Use H21 Pump Supply Line Adapter.

H9 Use H22 Pump Supply Line Adapter.

H10 Use H23 Pump Supply Line Adapter.

H11 Use H24 Pump Supply Line Adapter.

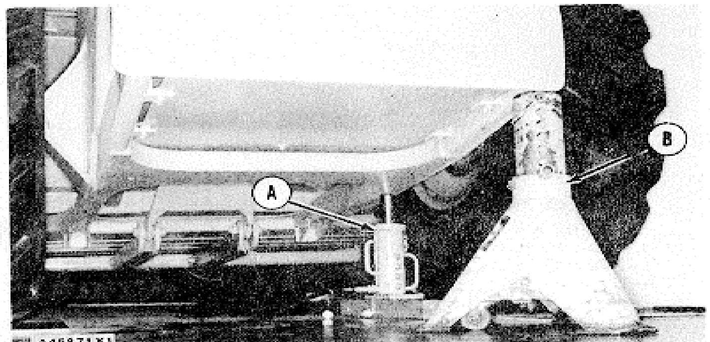
H12 Use H25 Pump Supply Line Adapter.

H13 Use H26 Pump Supply Line Adapter.

SECTION 3
SYSTEMS DISASSEMBLY AND ASSEMBLY

REMOVE AND INSTALL SCRAPER RIM AND TIRE

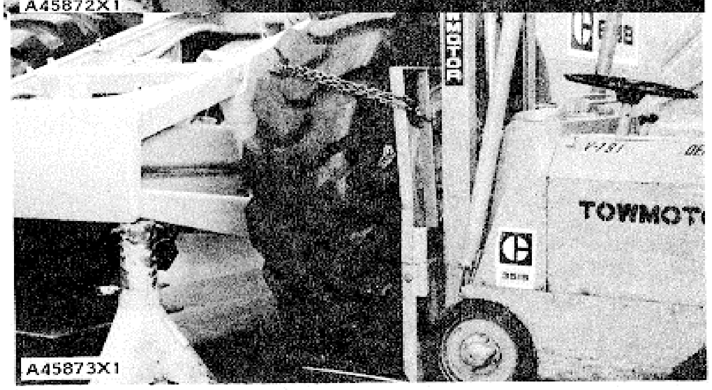
	Tools Needed	A	B
8S7610	Base Assembly		1
BS7650	Cylinder		1
5P3100	Pump Group		1
8S7640	Stand		
8S7611	Tube		
8S7615	Pin		



1. Lower the scraper and put blocks in front and behind the wheels.
2 Put tooling (A) in the position shown and lift the
3. Put tooling (B) under the scraper frame and lower the weight of the scraper on tooling (B).
4. Remove tooling (A).
5. Remove all but two of nuts (1) that hold the rim to the wheel assembly.

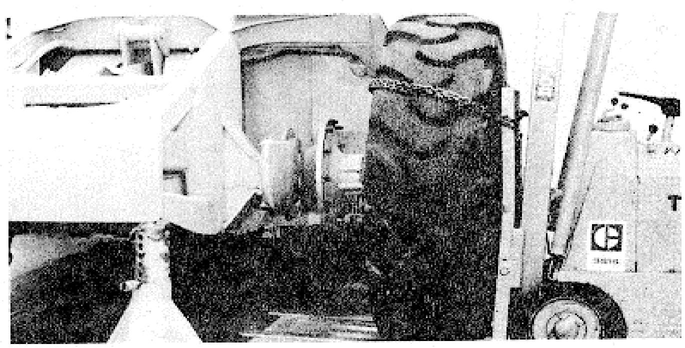
6. Loosen the last two nuts approximately .125 in. (3.1 8 mm).
7. Fasten the tire to a lift truck with a chain as shown.

WARNING: The tire can fall off of the lift truck. Make sure the tire is fastened to the lift truck.

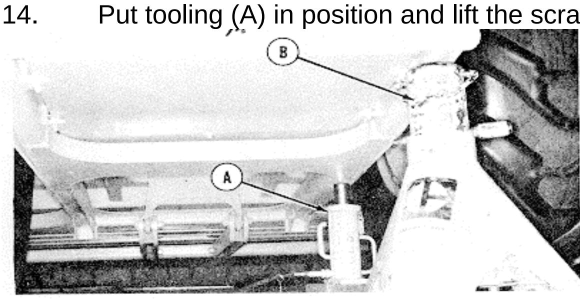


8. Remove the last two nuts that hold the rim and tire in position. Remove the rim and tire. Weight f the rim and tire is 925 lb. (421 kg).
9 Fasten the rim and tire to a lift truck as shown

WARNING: Make sure the tire is fastened to the lift truck.



10. Put the rim and tire in position on the wheel assembly.
11. Install the nuts that hold the rim and tire.
12. Remove the chain and lift truck.
13. Tighten nuts (I) to a torque of 375 ± 25lb. ft. (510 ± 35 N. m).
14. Put tooling (A) in position and lift the scraper.

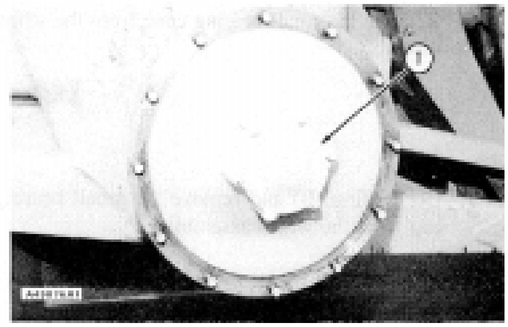


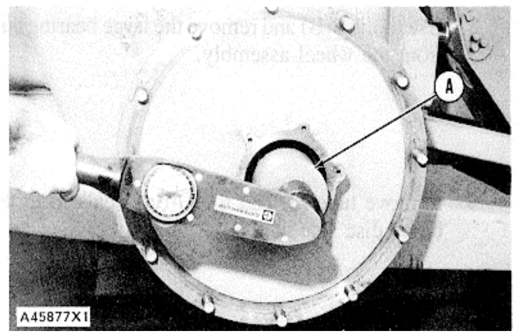
15. Remove tooling (B),lower the scraper to the ground and remove tooling (A).

REMOVE SCRAPER WHEEL ASSEMBLIES BEARING AND SEALS

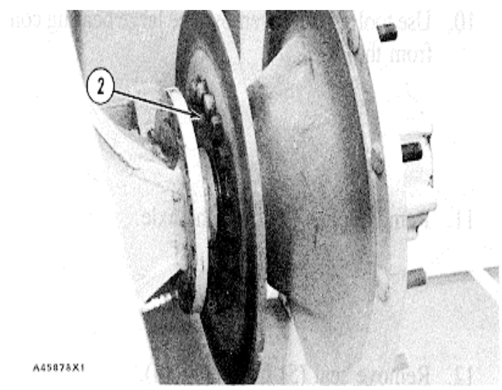
Tools Needed		A	B	C
5P6153	Spanner Wrench	1		
BB7548	Puller Assembly		1	1
8B7554	Bearing Cup Puller Attachment			
8H684	Ratchet Box Wrench		1	1
8B7551	Bearing Puller Attachment			
8B7549	Leg			2

start by:
a) remove scraper rim and tire
b) remove brake head assemblies



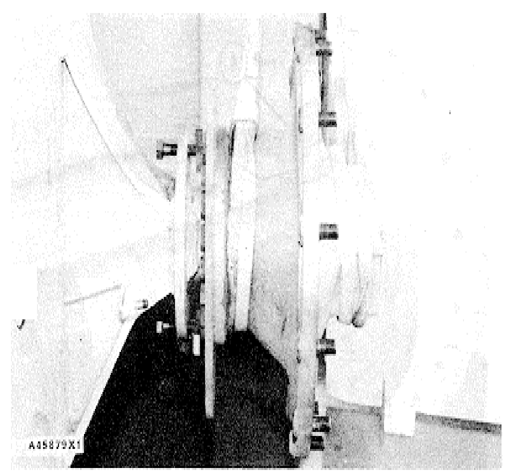


1. Remove cover (1) from the wheel assembly.



2. Bend the tab of the lock from the nut and use tool (A) to remove the two nuts and lock that hold the wheel assembly to the axle.

3. Remove the six bolts (2) and lockwashers that hold the plate to the hub assembly.



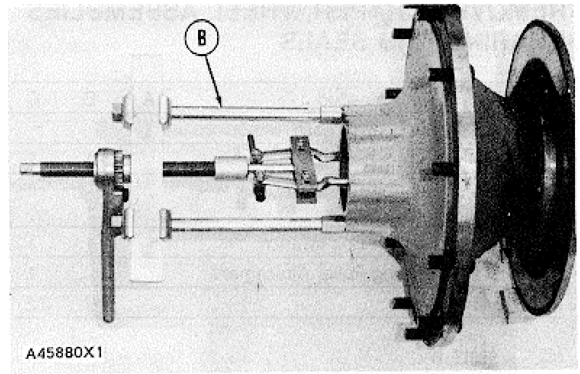
4. Fasten a hoist to the wheel assembly.

5. Use two 5/8"-11 NC forcing screws or bolts approximately 4 in. (101.6 mm) long and two spacers to push the wheel assembly from the axle. Remove the wheel assembly. The weight of the wheel assembly is 225 lb. (101 kg).

SCRAPER WHEEL ASSEMBLIES, BEARING AND SEALS

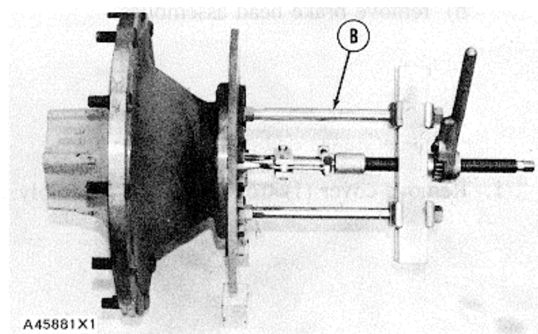
6. Remove the small bearing cone from the wheel assembly.

7. Use tooling (B) and remove the small bearing cup from the wheel assembly.



8. Use tooling (B) and remove the large bearing cup from the wheel assembly.

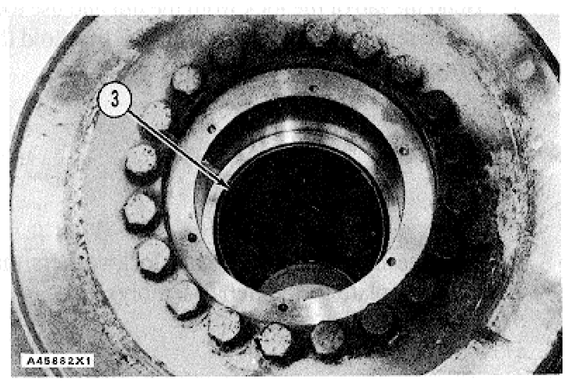
9. Remove tube (3) and the O-ring seals from the brake disc side of the wheel assembly.

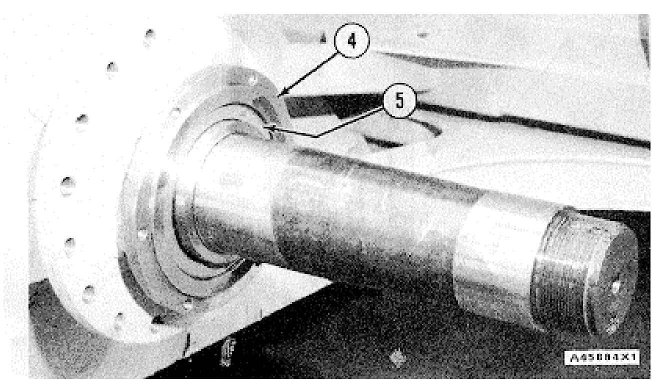


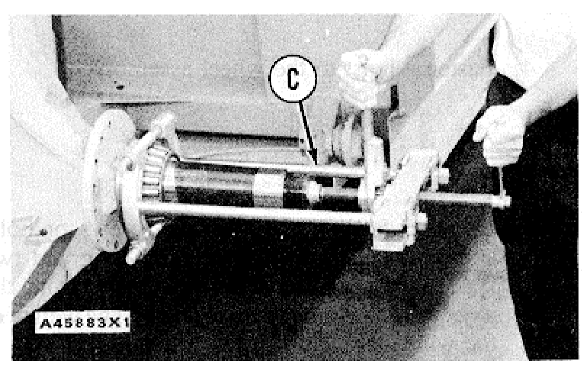
10. Use tooling (C) to remove the large bearing cone from the axle.

11. Remove plate (4) from the axle.

12. Remove seal (5) from plate (4).



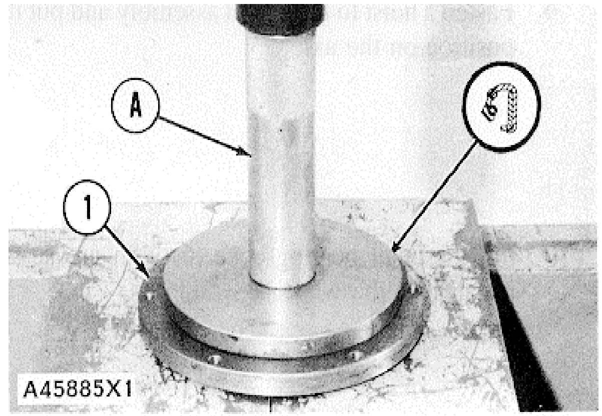




INSTALL SCRAPER WHEEL ASSEMBLIES, BEARINGS AND SEALS 2

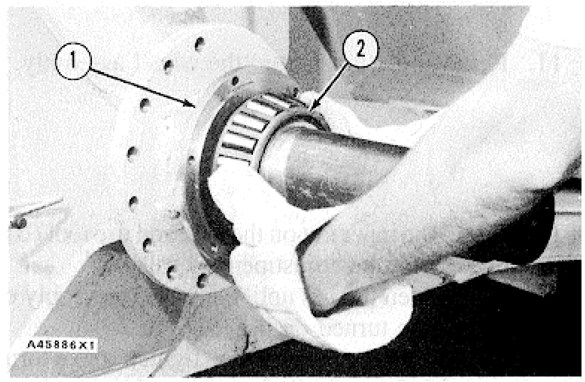
	Tools Needed	A	B
1 P520	Driver Group	1	
5P6153	Spanner Wrench		1

1 Use a press and tool group (A) to install the lip type seal in plate (I) from the machined side of the plate. Make sure the lip of the seal is toward the flat side of the plate and the case of the seal is even with the machined side of the plate.



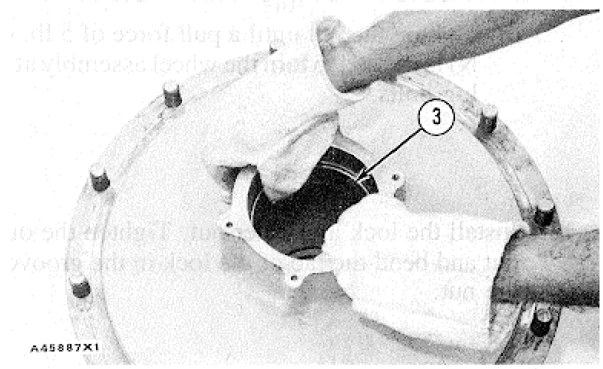
2. Put plate (I) and the seal in position on the sleeve of the axles with the lip of the seal toward the scraper frame.

3. Heat bearing cone (2) in oil to a maximum temperature of 275°F (135°C) and install it on the axle as shown.



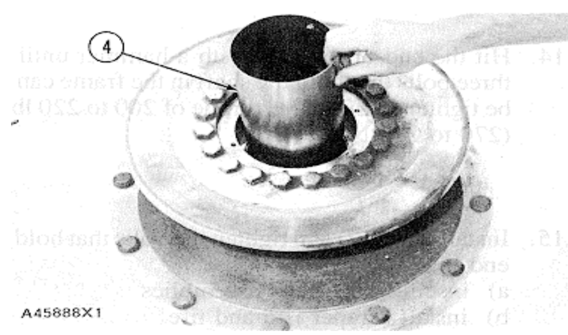
4. Fill bearing cone (2) with grease.

5. Lower the temperature of outer bearing cup (3) and install it in the wheel assembly as shown.

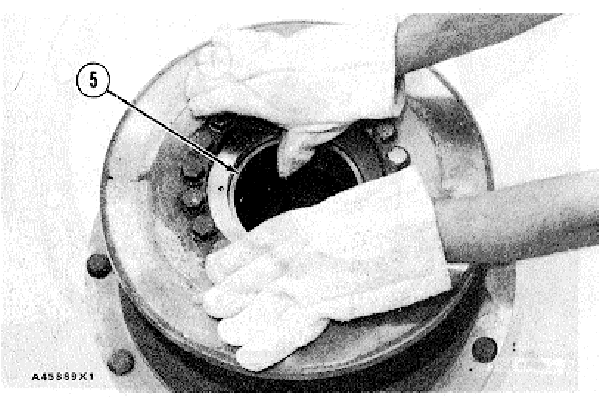


6. Install the two O-ring seals in the wheel assembly.

7. Install tube (4) in the wheel assembly from the brake disc side of the wheel assembly.

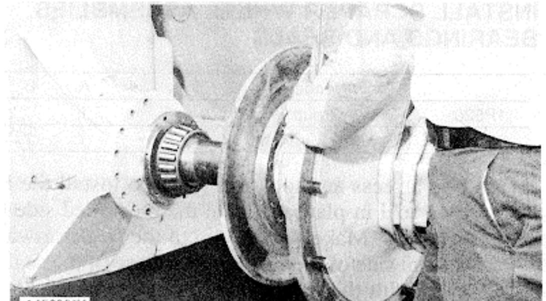


8. Lower the temperature of inner bearing cup (5)and install it in the wheel assembly.

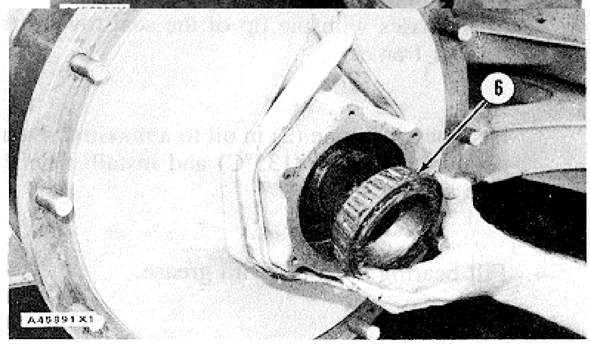


SCRAPER WHEEL ASSEMBLIES, BEARINGS AND SEALS

9. Fasten a hoist to the wheel assembly and put it in position on the axle.



10 Fill the outer bearing cone (6) with grease and install it in the %wheel assembly.

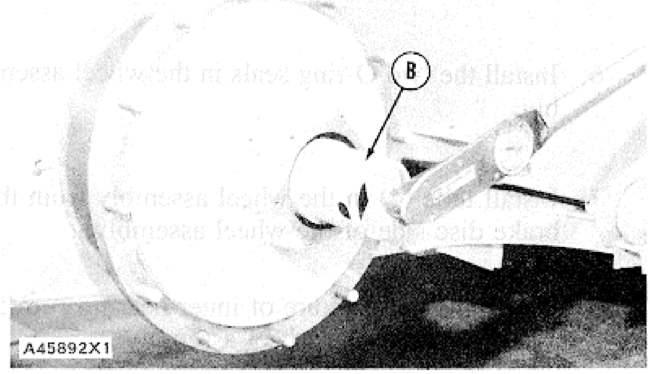


11. Remote the hoist from the Wheel assembly.

12. Install the inner nut on the axle and use tool (B) to make a torque adjustment as follows:
   a) Tighten the nut until the wheel assembly cannot be turned on the axle.
   b) Loosen the nut and then tighten it to a torque of 360 to 400 lb.ft. (484 to 540 N1m).

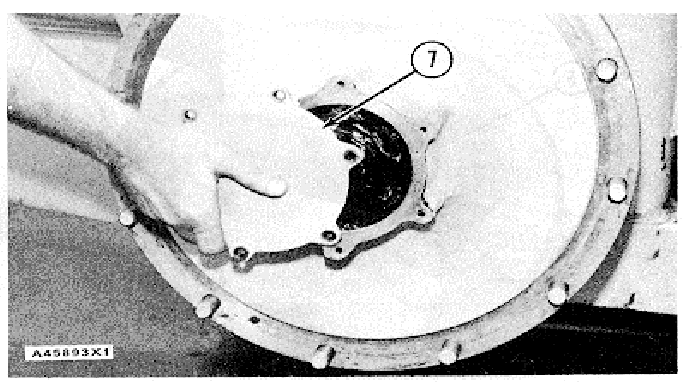
-or-

   c) Tighten the nut until a pull force of 5 lb. (22) is needed to turn the wx heel assembly at the lug bolts.



13. Install the lock and outer nut. Tighten the outer nut and bend the tab of the lock in the groove of the nut.

14. Hit the end of the axle with a hammer until the three bolts that hold the shaft in the frame can not be tightened more at a torque of 200 to 220 lb. ft. (270 to 295 N.m).



15. Install cover (7) and tighten the bolts that hold it. end by:
   a) install brake head assemblies
   b) install scraper rim and tire

SCRAPER AXLES

REMOVE SCRAPER AXLES

	Tools Needed	A
9S8900	Cylinder Group	1
FT959	Adapter	1
5F9888	Adapter	1
5F9892	Pin	1
955431	Sleeve Assembly	1
9S5433	Adapter	1
6H4158	Pin	1
7B2499	Ring	1
5P3100	Pump Group	1

start by:
a) remove scraper wheel assemblies, bearings and seals

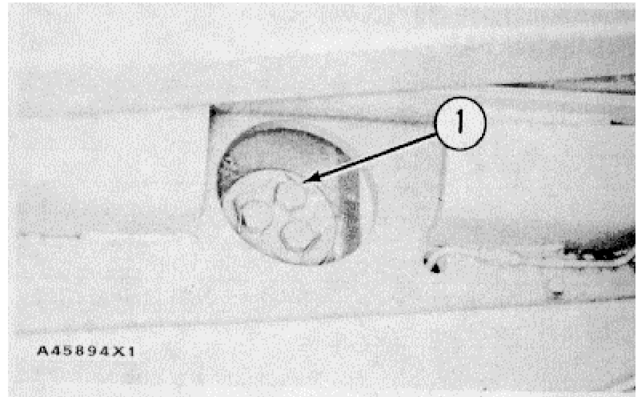
1. Bend the tabs of the plate (lock) from bolts (1) that hold the axle in the frame.
2. Loosen bolts (1) approximately .25 in. (6.4 mm). Do not remove these bolts.
3. Install tooling (A) and pull axle (2) loose.
4. Remove tooling (A), bolts (1), the plate (lock), plate and shims from inside the scraper frame.
5. Remove the axle from inside the scraper frame.
6. Remove the axle from the scraper frame. The weight of the axle is 50 lb. (23 kg).

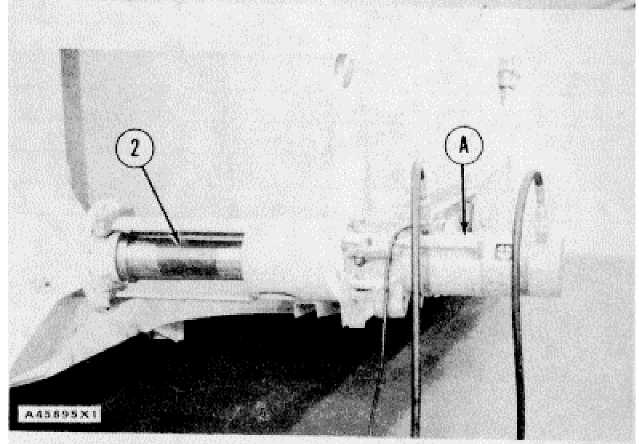
INSTALL SCRAPER AXLES

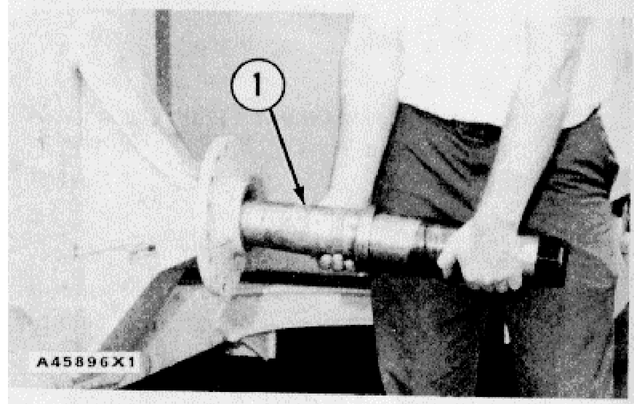
	Tools Needed	A
FT959	Adapter	1
5F9889	Plug	1
5F9892	Pin	1

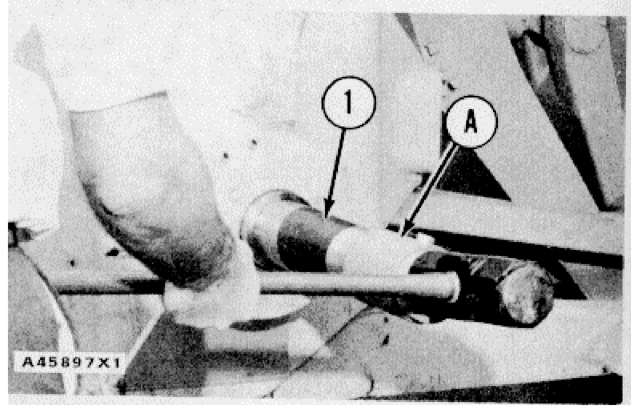
1. Put the axle (1) in position in the scraper frame.
2. Install the plate and bolts that hold the axle in the
3. Install tooling (A) on the end of axle (1).
4. Hit the axle with a hammer until the bolts that hold the axle can not be tightened more at a torque of 200 to 220 lb. ft. (270 to 295 N-m).
5. Remove the bolts and plate that hold the axle in.
6. Add enough shims behind the plate that holds the axle to get a minimum distance from the end of the axle to the plate of .125 in. (3.18 mm).
7. Install the shims. plate, plate (lock) and bolts to hold the axle. Tighten the bolts to a torque of 200 to 220 lb. ft. (270 to 295 N. m).

end by:
a) install scraper wheel assemblies, bearings and seals









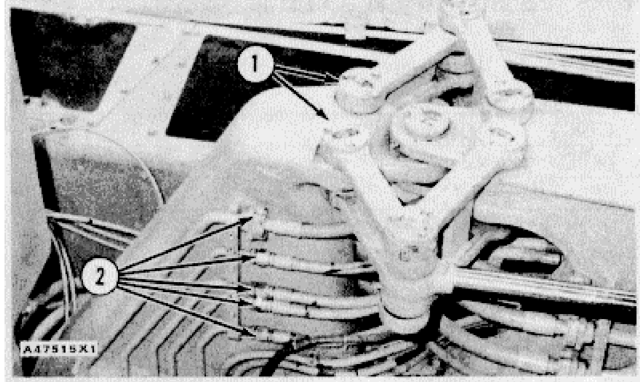
SEPARATION OF TRACTOR AND SCRAPER

	Tools Needed	A	B	C	D
8S7630	Stand	2			
8S7631	Tube	2			
8S7625	Collar	2			
8S8048	Saddle	2			1
8S7650	Cylinder	2			
8S7615	Pin	4			
8S7645	Hose Group	1			
5P3100	Pump Group	1			
2P8287	Box Wrench		1		
2P8286	Adapter		1		
2P8285	Tubular Arm		1		
2B9886	Hydraulic Jack			1	
857640	Stand				1
8S7611	Tube				1
8S7615	Pin				1

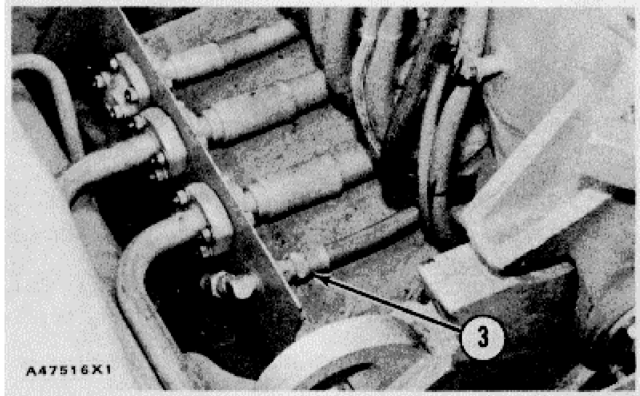
1. Drain the hydraulic oil from the hydraulic system. The capacity of the hydraulic system is 24 U.S. gal. (91 litre).

2. With the parking brake in released position, remove cotter pin and pin from the parking brake. Put blocks in front and behind of rear wheels.

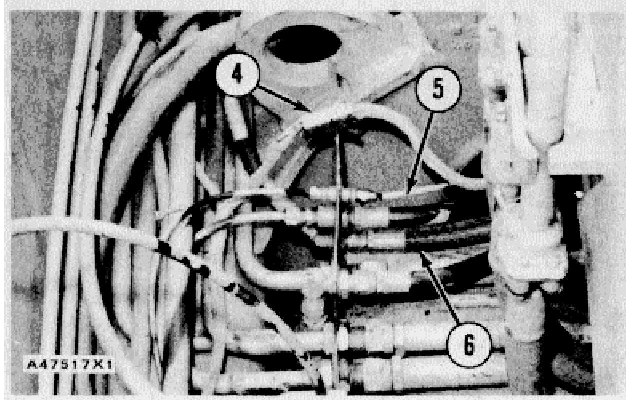
3. Remove bolts and covers (1). Remove the steering link pins under the covers.



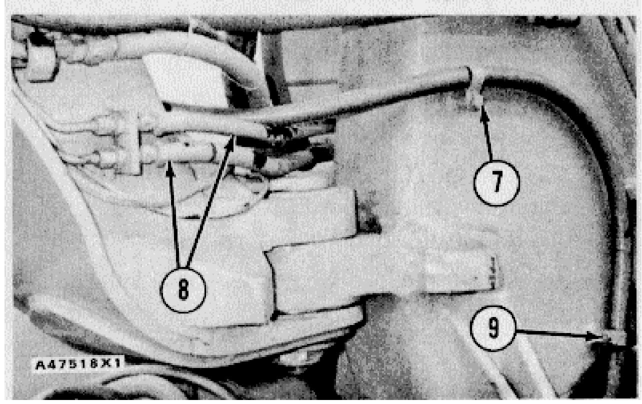
4. Disconnect hoses (2) from the side of the hitch. Put caps and identification as to the location on the hoses.



5. Disconnect hose (3) from the angle assembly.



6. Disconnect electrical connection (4), fuel line (5) and hose (6).



7. Disconnect hoses (8) from the draft frame. Remove bolts (7) and (9) from the hitch. Put caps and identification as to the location on the hoses.

SEPARATION OF TRACTOR AND SCRAPER

8. Disconnect hoses (10) from the right side of the hitch.

9. Remove three bolts and clamps (13) from the draft frame. Remove all but the top bolts from brackets (I 11) and (12).

10. Move the oil lines forward and put tooling (A) in position under draft frame as shown.

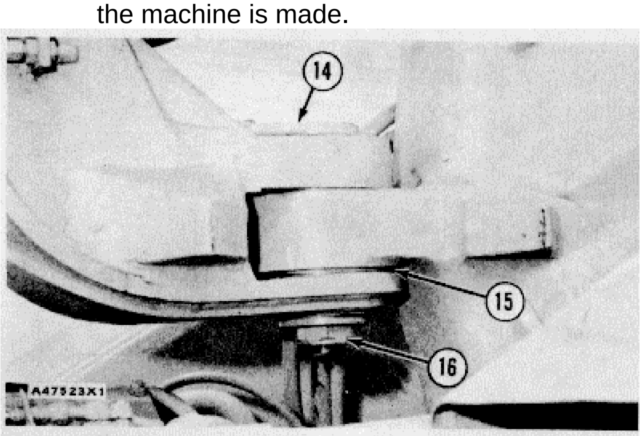
11. Fasten a hoist to the front of the tractor as shown.

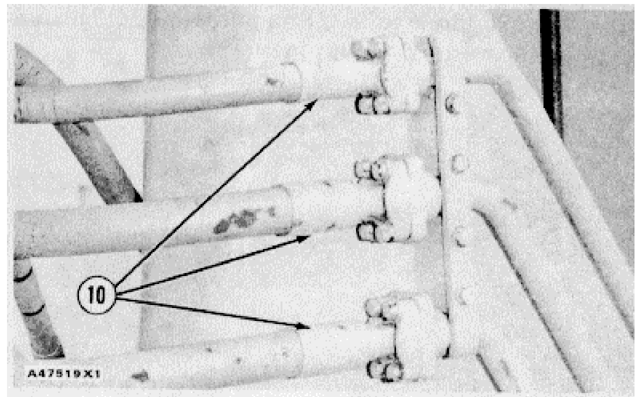
12. Put blocks under each side of the hitch to keep it in position when the hitch pins are removed.

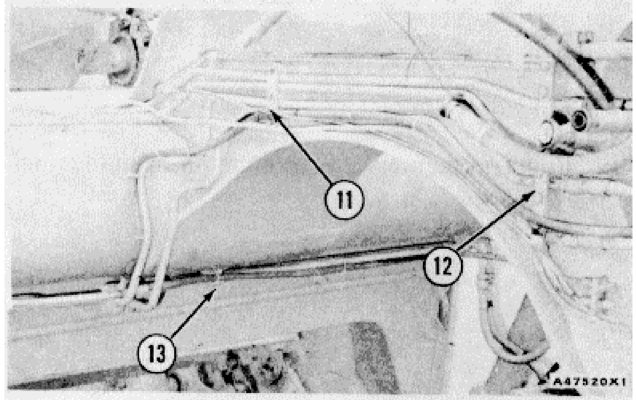
13. Use tool (B) to remove nut (16), the washer and shims from the lower hitch pin.

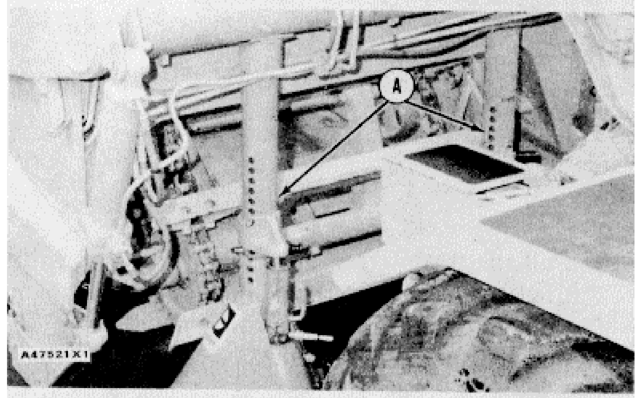
NOTE: Keep the shims together for reference at installation.

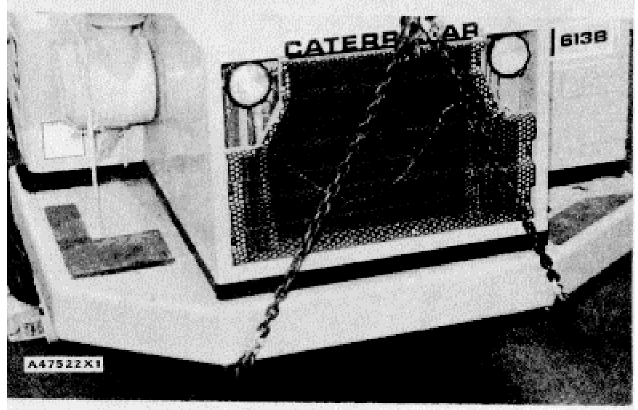
14. Remove bottom vertical pin (14) from the hitch. Remove thrust washer (15) after a separation of the machine is made.





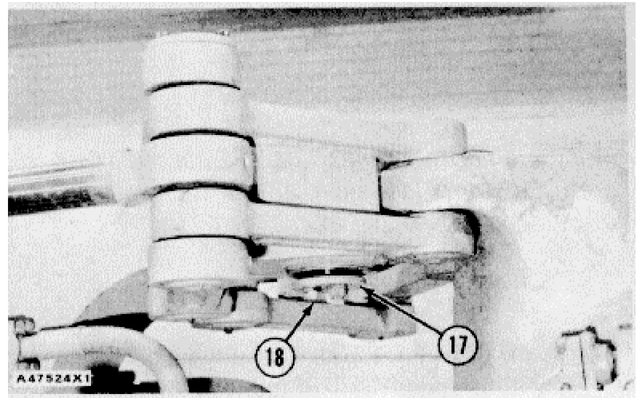




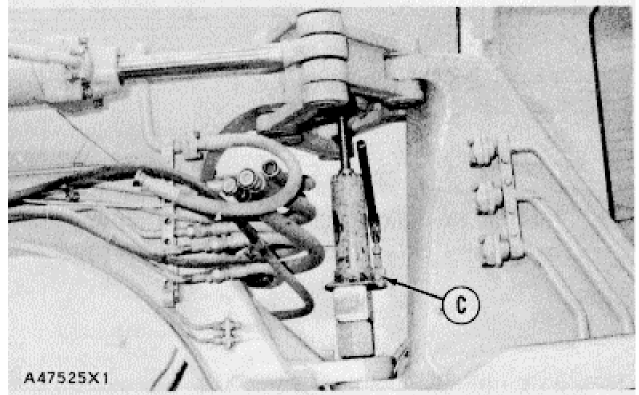


SEPARATION OF TRACTOR AND SCRAPER

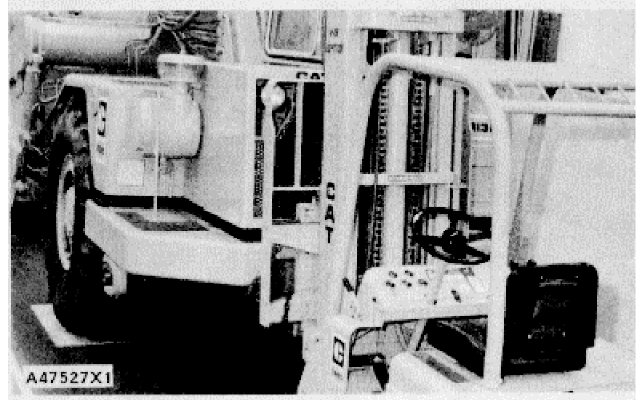
15. Remove three bolts (18) and retainer (17) from the top vertical hitch pin.



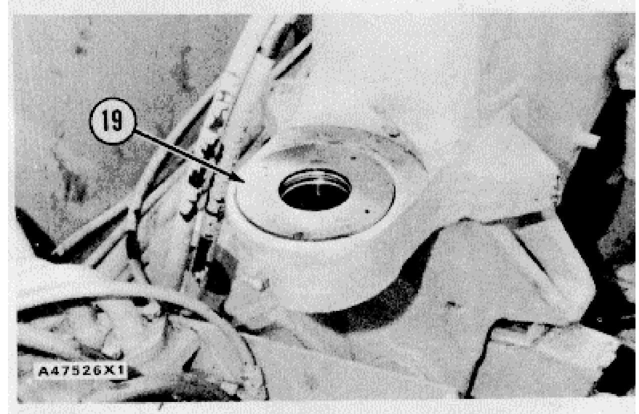
16. Remove the top vertical hitch pin from the hitch with tool (C).



17. Pull the tractor free of scraper with a fork lift truck. If fork lift truck and hoist have to be removed before connection, install tool (D) under front of the tractor.

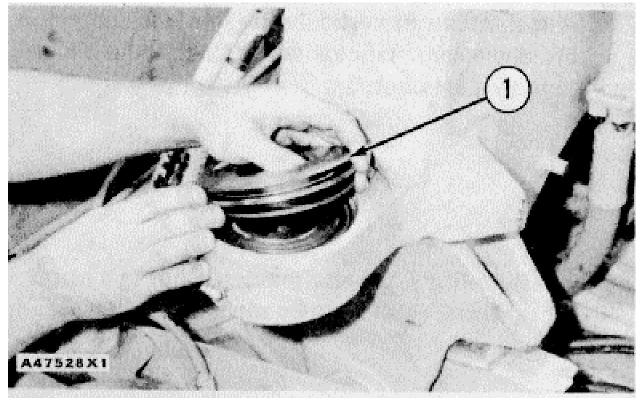


18. Remove three washers (19) from the hitch.

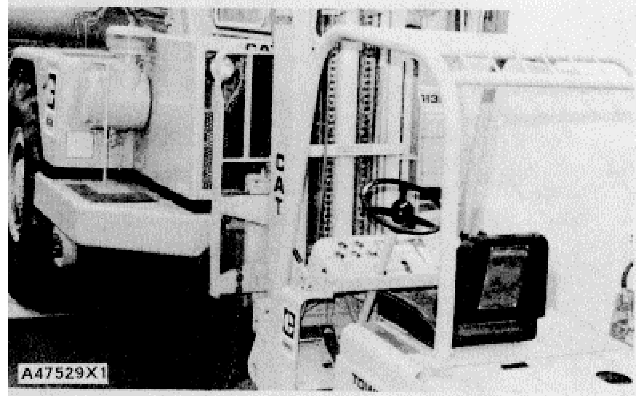


CONNECTION OF TRACTOR AND SCRAPER

	Tools Needed	A	B	C	D
2P8288	Gauging Washer	1			
8H3390	Nut	1			
2P8287	Box Wrench		1		
2P8286	Adapter		1		
2P8285	Tubular Arm		1		
8S7640	Stand			1	
8S7611	Tube			1	
8S8048	Saddle			1	2
8S7615	Pin			1	
8S7630	Stand				2
8S7631	Tube				2
8S7625	Collar				2
8S7650	Cylinder				2
8S7615	Pin				4
8S7645	Hose Group				1
5P3100	Pump Group				1

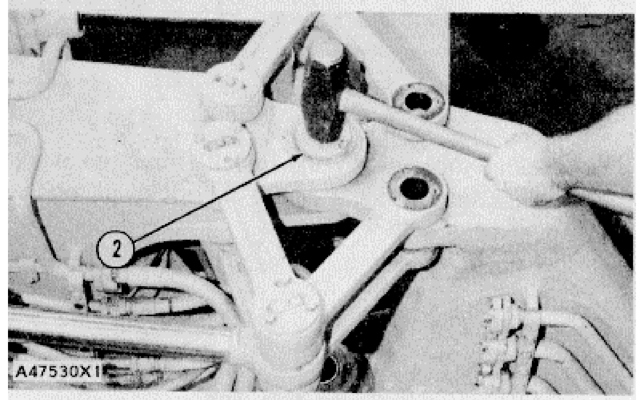


1. Install washers (1) in the lower hole of the hitch.



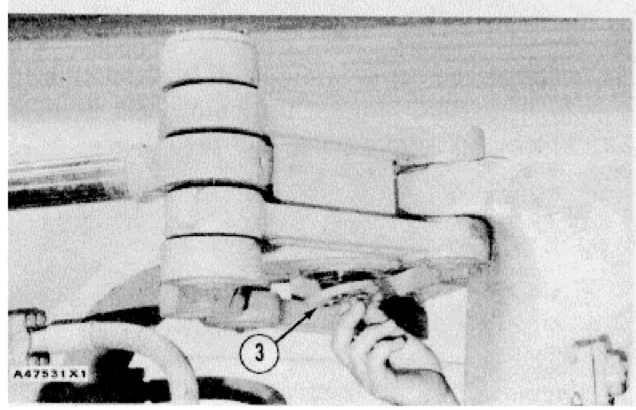
2. If tooling (C) was installed during the separation, fasten a hoist to the front of the tractor and remove the stand.

3. Put a fork lift truck in position and fasten to the front of the tractor as shown.



4. Push the tractor until the hitch and draft frame are in alignment. Make sure steering links are in correct position during alignment.

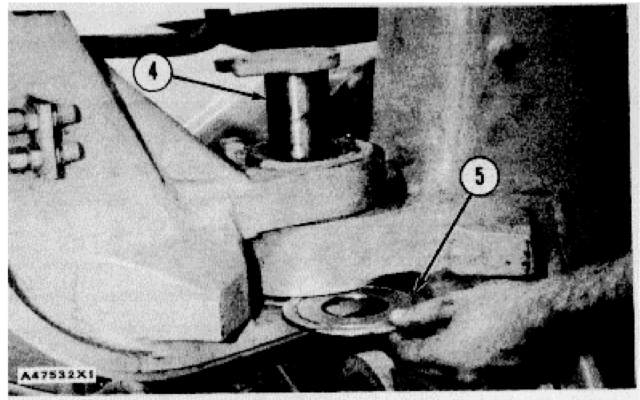
5. Install top vertical pin (2).



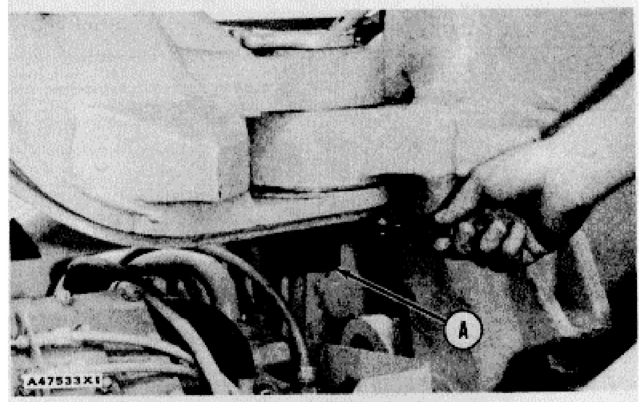
6. Install retainer (3) and the bolts to the bottom of the pin.

CONNECTION OF TRACTOR AND SCRAPER

7. Start the bottom vertical pin (4) in the bore. Put thrust washer (5) in position. Install the pin all of the way in its bore.

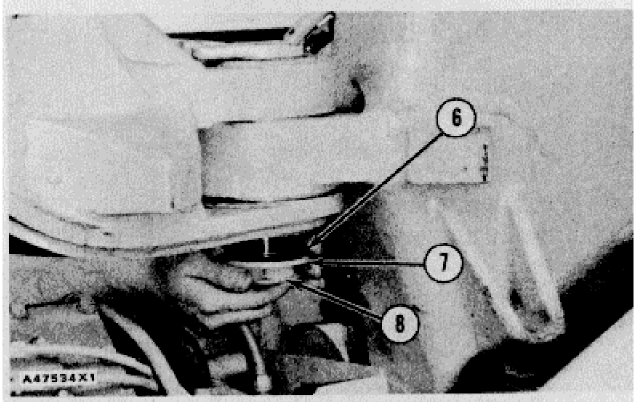


8. Install tooling (A) and tighten the nut to a torque of 500 lb. ft. (680 N. m) with tooling (B).

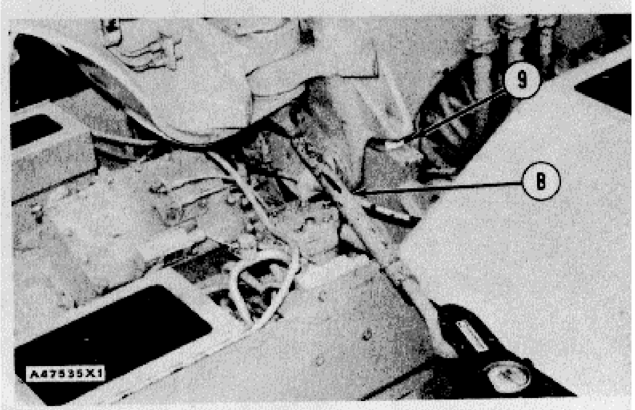


9. Measure the space with a feeler gauge as shown and subtract that dimension from the gauging washer thickness of .200 in. (5.08 mm). Measure the shims needed to get a dimension +.000 to -.010 in. (+.00 to - 0.25 mm).

10. Remove tooling (A) and install shims (6) of the needed dimension, washer (7) and nut (8) on the lower pin.



11. Tighten nut (8) to a torque of 700 to 900 lb. ft. (950 to 1220 N. m) with tooling (B). Remove blocks (9) from each side of the hitch.



12. Remove fork lift truck and hoist from tractor.

CONNECTION OF TRACTOR AND SCRAPER

13. Remove tooling (D) from under the draft frame. Put lines (10) in position and install the three clamps that hold the lines under the draft frame.

14. Install the bolts in the two clamps on the right side of the draft frame.

15. Connect three hoses (11) on the right side of the hitch.

16. Connect hose (12) to the hitch.

17. Connect hoses (13) on side of draft frame.

18. Connect fuel line (15), hose (16) and electrical connection (14).

19. Connect hose (17) to the angle.

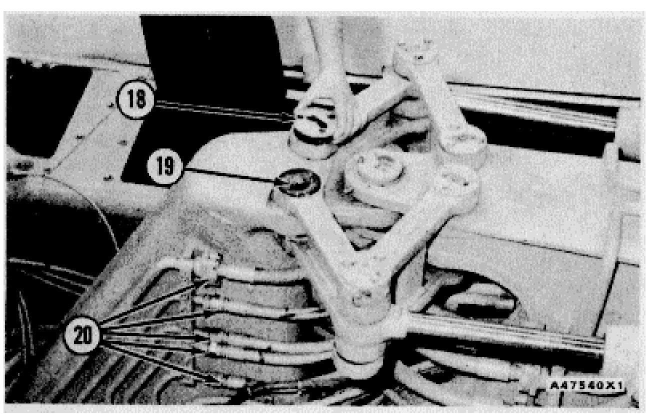
20. Connect hoses (20) on side of hitch.

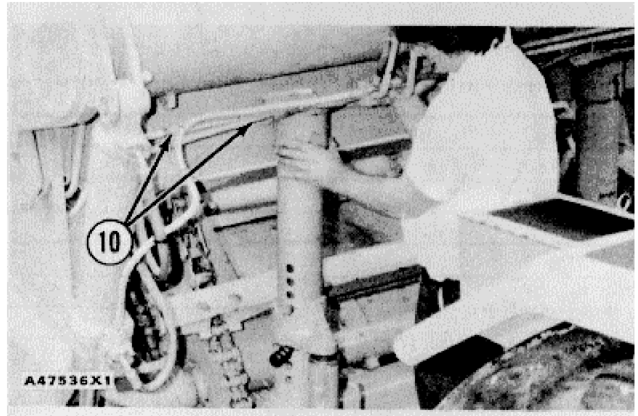
21. Put steering pins (19) in the bores and install covers (18) and the bolts to hold the pins.

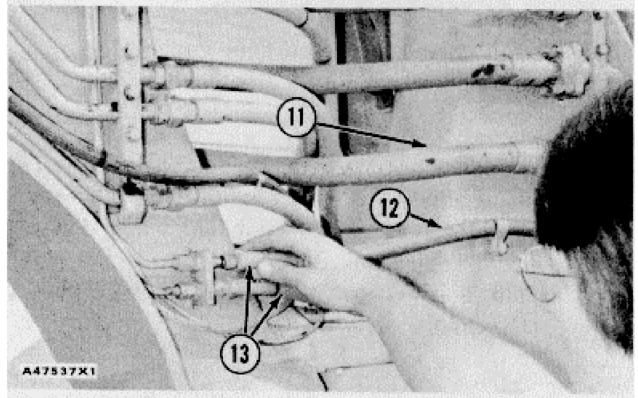
22. Fill hydraulic tank, start engine and operate hydraulic controls to remove air from hydraulic system. Stop the engine and check the oil level in the hydraulic tank.

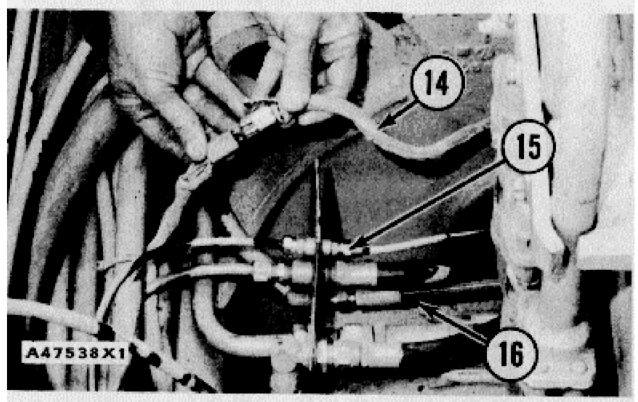
23. Install pin and locking pin in the parking brake.

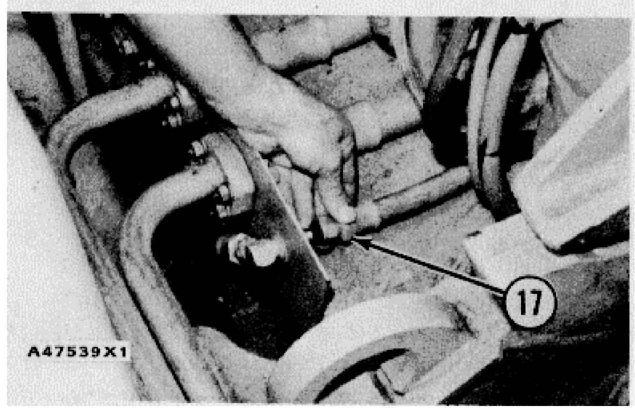
24. Remove blocks from scraper wheels.











DRAFT FRAME

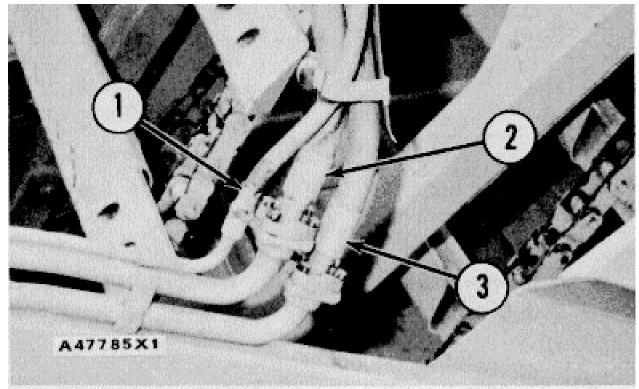
REMOVE DRAFT FRAME

	Tools Needed	A	B
FT600	Cable Saver	2	
5P3100	Pump Group		1
9S5558	Stud		1
1P1833	Pulling Adapter		1
1 P544	Nut		1
5H9817	Hydraulic Puller		1
7F6068	Sleeve		1

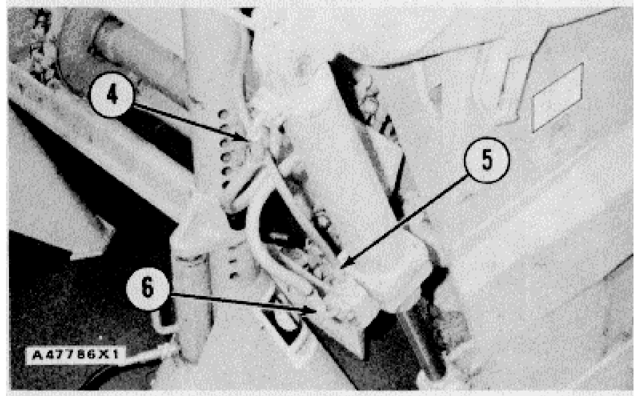
start by:
a) separation of tractor and scraper

NOTE: Put caps and identification on the lines as to their location for installation.

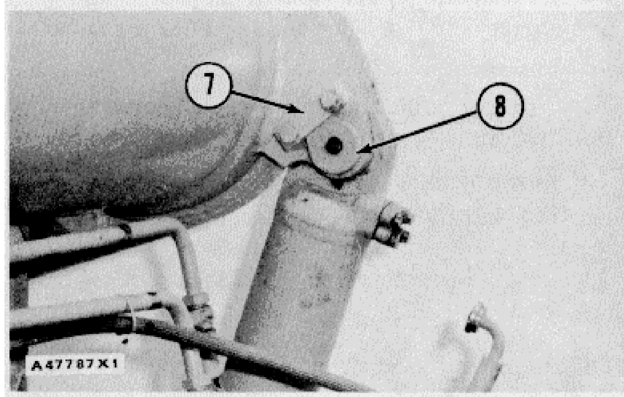
1. Disconnect hoses (1), (2) and (3) on the left side of the bowl.



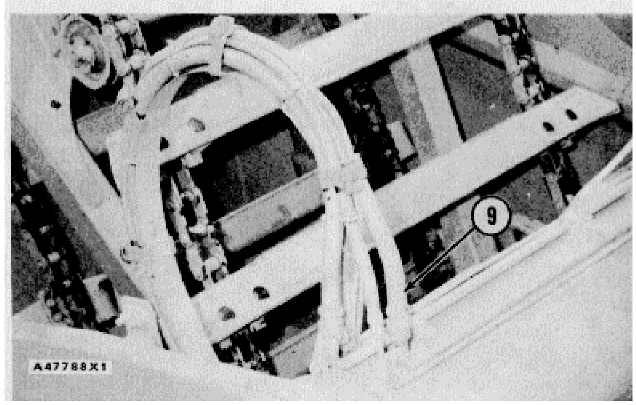
2. Disconnect hoses (4), (5) and (6) from the bowl lift cylinders on both sides.



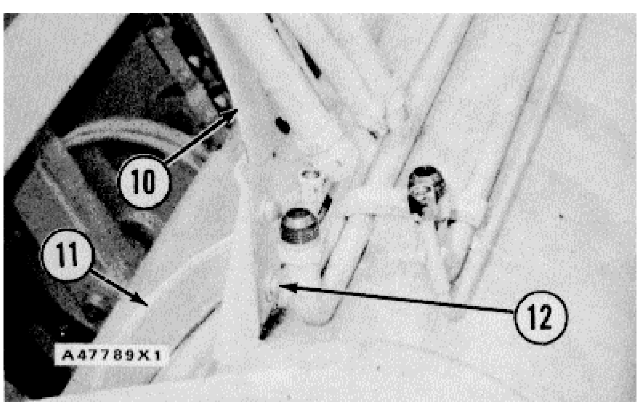
3. Fasten a hoist to the bowl lift cylinders and remove bolts, bar (7) and pin (8) that hold both bowl lift cylinders. Lower the cylinders to the floor.



4. Disconnect four hoses (9) (one hose can not be seen) on the right side of the draft frame.

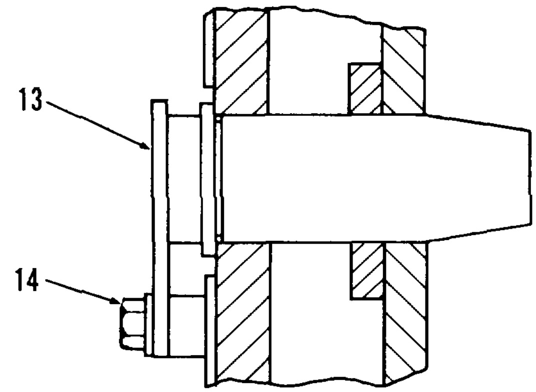


5. Remove bolts (12) from support assembly (10). Remove bands that hold fuel line and electrical cable (11) to the draft frame.

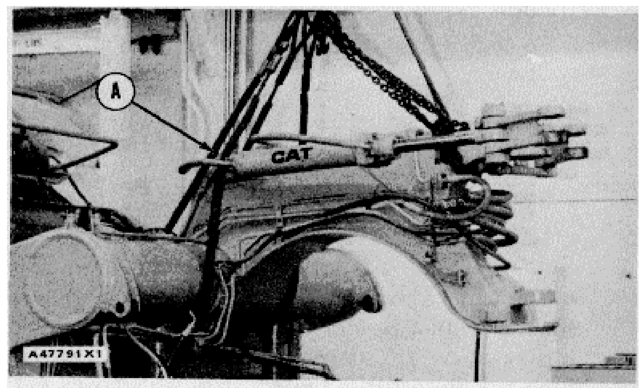


DRAFT FRAME

6. Remove the bolt (14) and washer from each side of the bowl.



7. Fasten a hoist to the draft frame with tooling (A) and chain as shown. Remove pin (13) from both sides of the bowl.



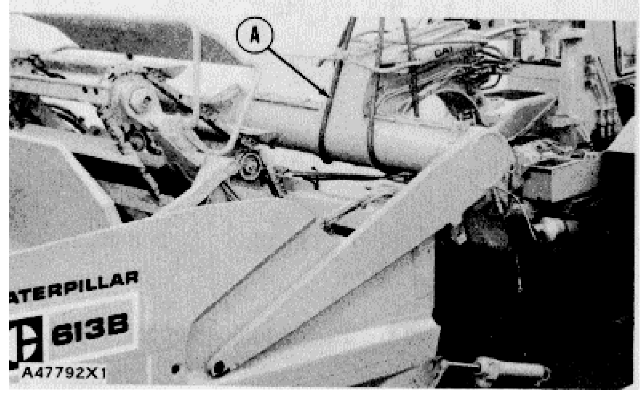
8. Remove the draft frame. The weight of the draft frame is 2600 lb. (1170 kg).

9. Remove the bushings from the ends of the draft frame arms with tooling (B) if necessary.

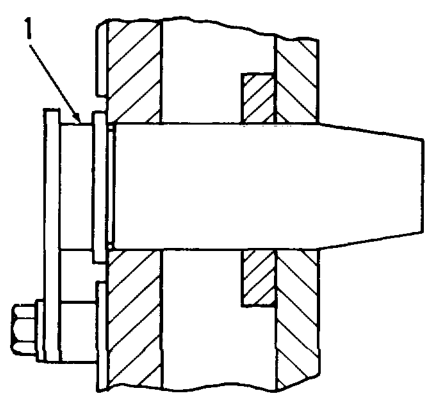
INSTALL DRAFT FRAME

	Tools Needed	A
FT600	Cable Saver	1

1. If the bearings were removed, lower the temperature of the bearings to - 500F (-46°C) and install the bearings to the draft frame arms.



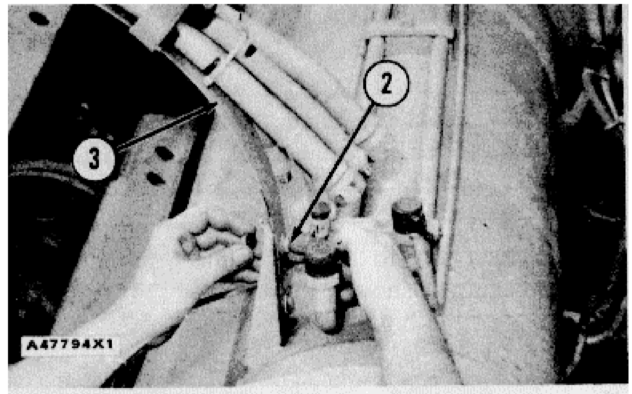
2. Fasten a hoist to the draft frame with tooling (A) and chain. Put the frame in position.



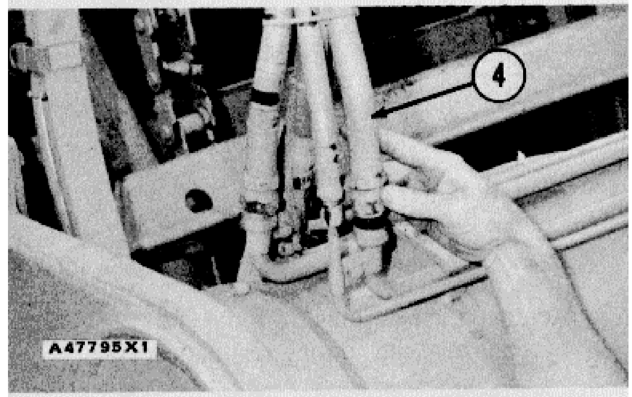
3. Install pin (1) washers, and bolts on both sides of the bowl.

DRAFT FRAME

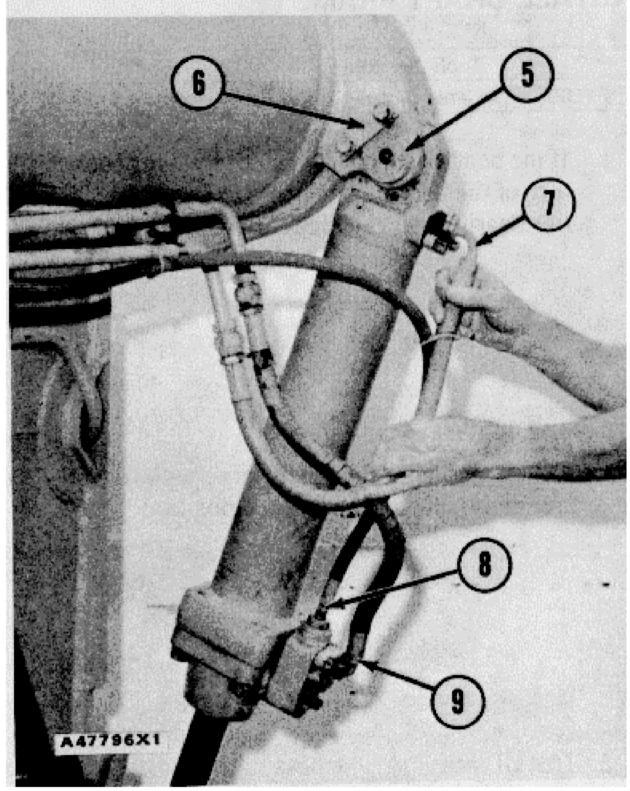
4. Install bolts (2) to support assembly (3) on the top of draft frame. Install bands that hold fuel line and electrical cable to the draft frame.



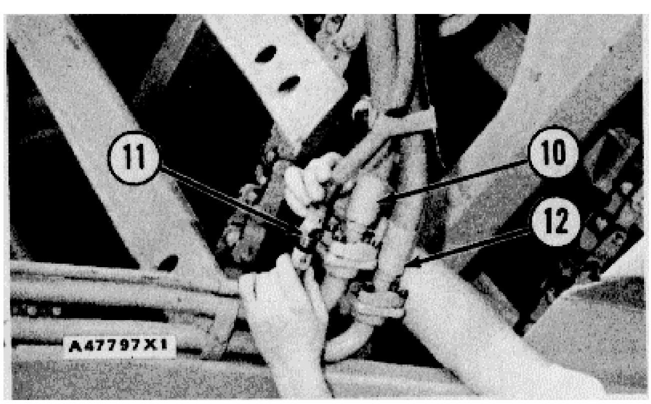
5. Connect four hoses (4) at the top of the draft frame.



6. Fasten a hoist to and lift the bowl lift cylinders into position. Install pins (5), bars (6) and bolts to hold the bowl lift cylinders. Connect hoses (7), (8) and (9) to the cylinders.



7. Connect hoses (10), (11) and (12) on the left side of the bowl.
end by:
a) connection of tractor and scraper

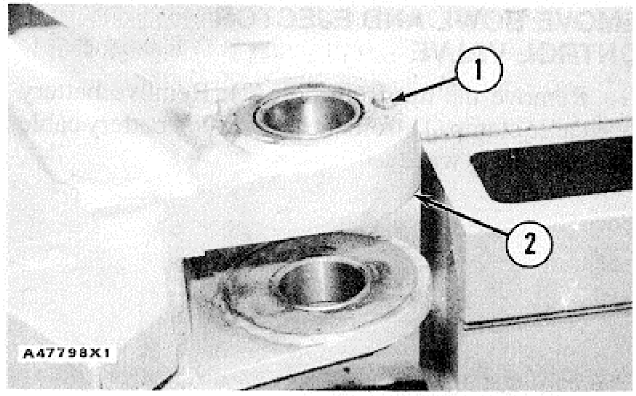


DRAFT FRAME BEARINGS

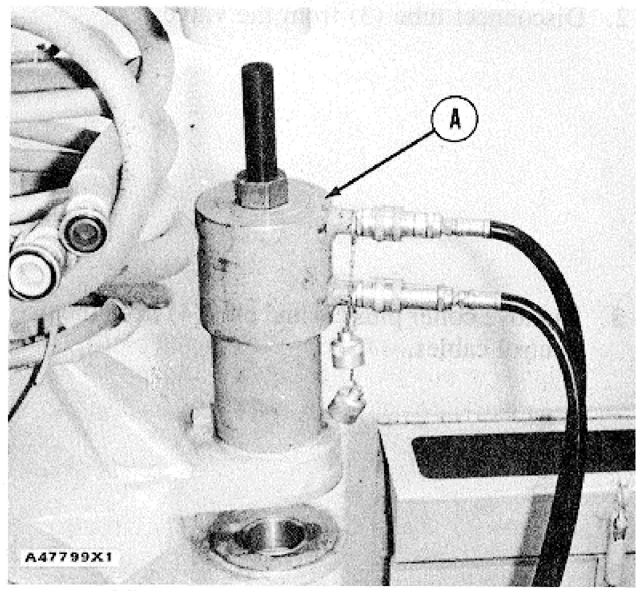
REMOVE AND INSTALL DRAFT FRAME BEARINGS

	Tools Needed	A
5P3100	Pump Group	1
5H9817	Hydraulic Puller	1
5P4184	Stud	1
7H7539	Nut	1
1P1835	Pulling Adapter	1
5F7693	Spacer	1

start by:
a) separation of tractor and scraper

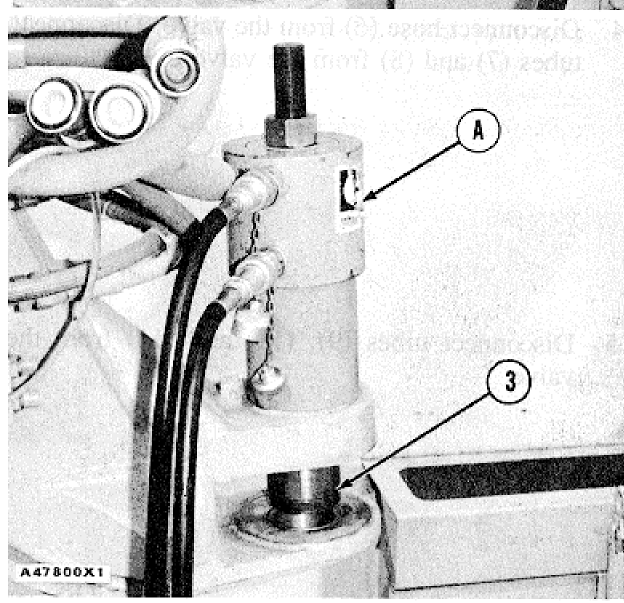


1. Remove fitting (1) from draft frame (2).



2. Put tooling (A) in position on the draft frame and remove the lower bearings.

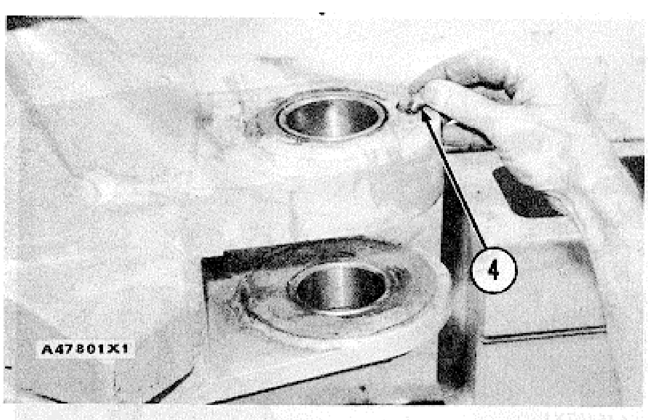
3. Install lower bearings (3) with tooling (A). Turn spacer (5F7693) around for the installation.



4. Install fitting (4) in the draft frame.

5. Do Steps 2 and 3, to remove the two bearings at the top of the draft frame.

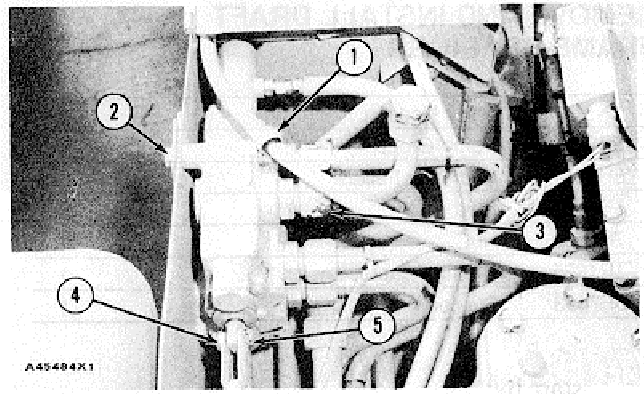
a) connection of tractor and scraper



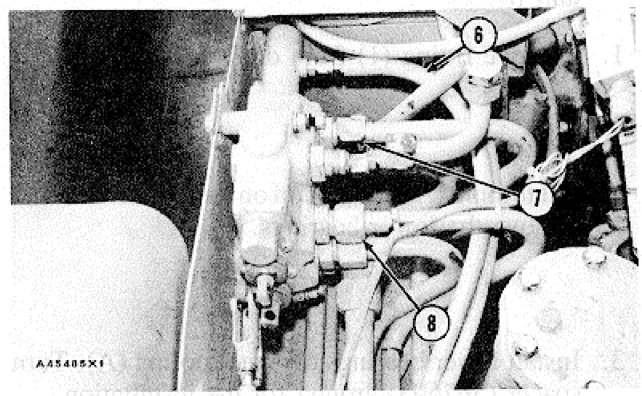
BOWL AND EJECTOR CONTROL VALVE

REMOVE BOWL AND EJECTOR CONTROL VALVE

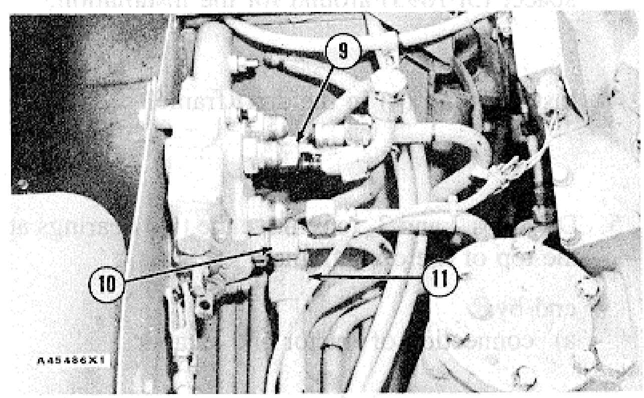
1. Remove the nut from bolt (2). Remove battery cable clamp (1) from the bolt. Move battery cable out of the way.



2. Disconnect tube (3) from the valve.

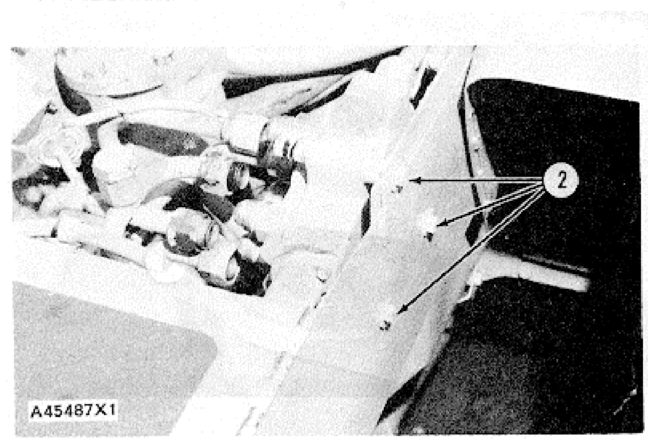


3. Remove cotter pins (5) and pins (4) from the two control cables.



4. Disconnect hose (6) from the valve. Disconnect tubes (7) and (8) from the valve.

5. Disconnect tubes (9), (10) and (II) from the valve.

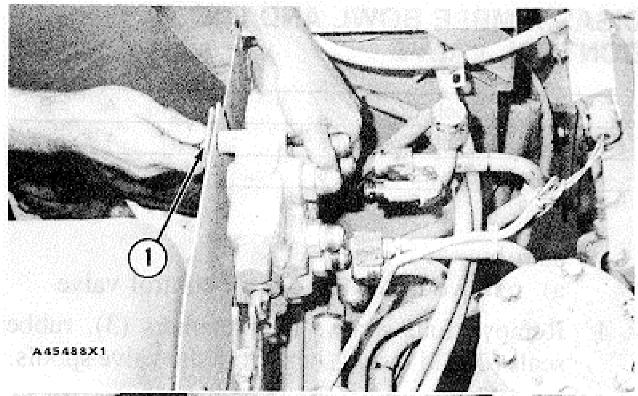


6. Remove nuts and bolts (2). Remove the valve.

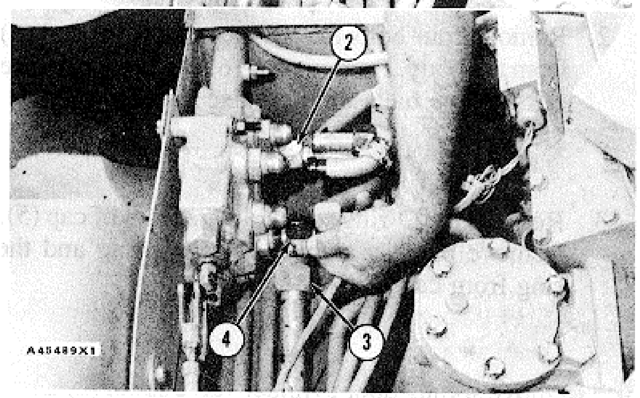
BOWL AND EJECTOR CONTROL VALVE

INSTALL BOWL AND EJECTOR CONTROL VALVE

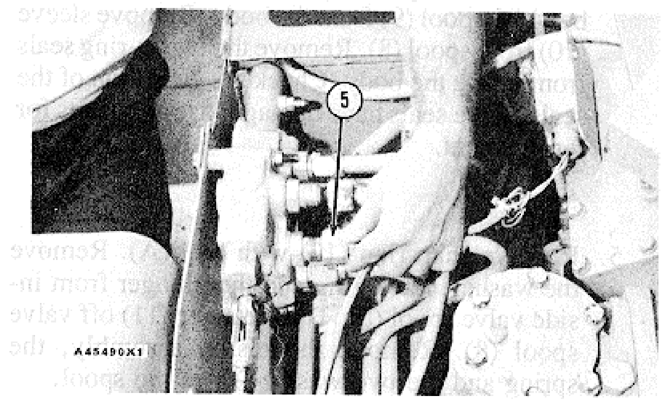
1. Install the valve and bolts (1).



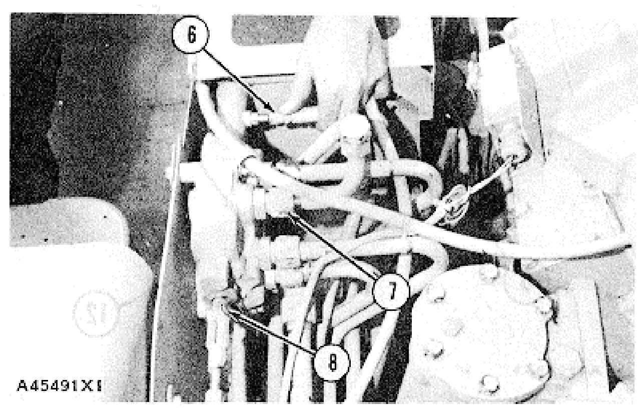
2. Connect tubes (2), (3) and (4) to the valve.



3. Connect tube (5) to the valve.



4. Connect tube (7) and hose (6) to the valve. To connect the two cables to the valve, install pin and cotter pin (8).



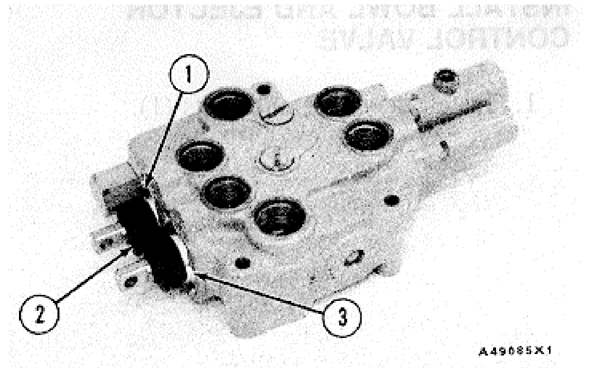
BOWL AND EJECTOR CONTROL VALVE

DISASSEMBLE BOWL AND EJECTOR CONTROL VALVE

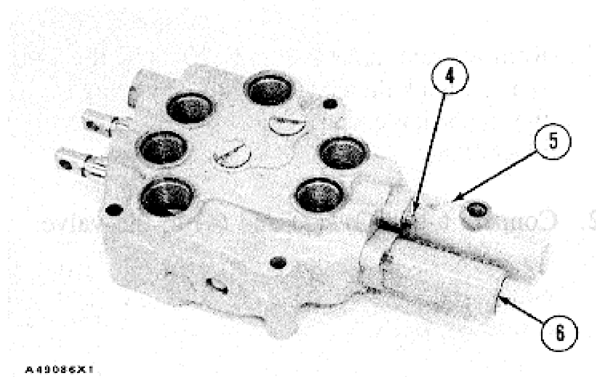
	Tools Needed	A	B
1P1857	Snap Ring Pliers	1	
1P1856	Snap Ring Pliers		1

start by:
a) remove bowl and ejector control valve.

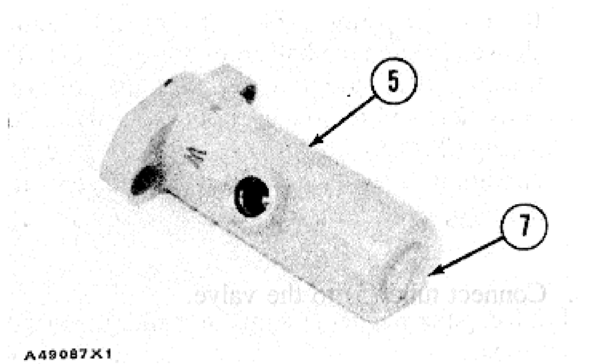
1. Remove four screws (1), retainers (3), rubber seals (2) and the washers from the valve spools.



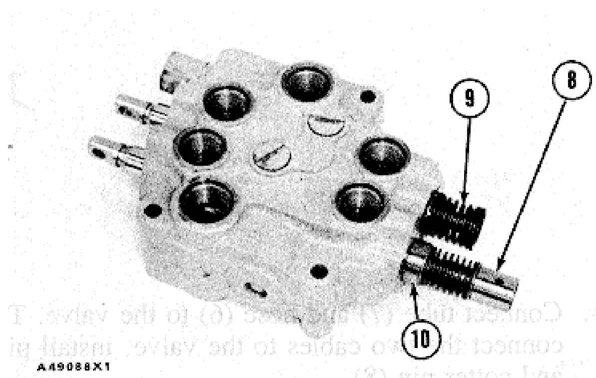
2. Remove four bolts (4). Remove caps (5) and (6) from the body. Remove cap (6) carefully because of the three balls on the valve spool.



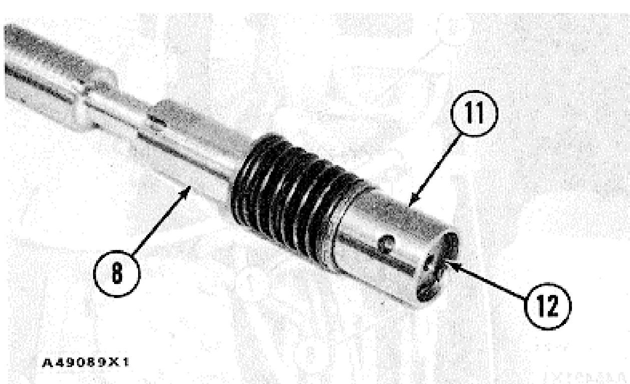
3. Remove the O-ring seal from the front of cap (5). Remove plug assembly (7), the spring and the ring from cap (5).



4. Remove sliding door cylinder valve spool (8) and bowl lift spool (9) from the body. Remove sleeve (10) from spool (8). Remove the two O-ring seals from inside the body. Check the condition of the seals. If the seals have damage, use new parts for replacement.

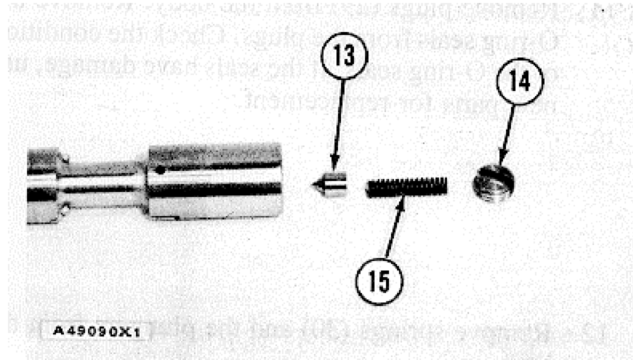


5. Remove snap ring (12) with tool (A). Remove the washer, the spring and the plunger from inside valve spool (8). Turn retainer (i 1) off valve spool (8). Remove the piston assembly, the spring and the two washers from the spool.

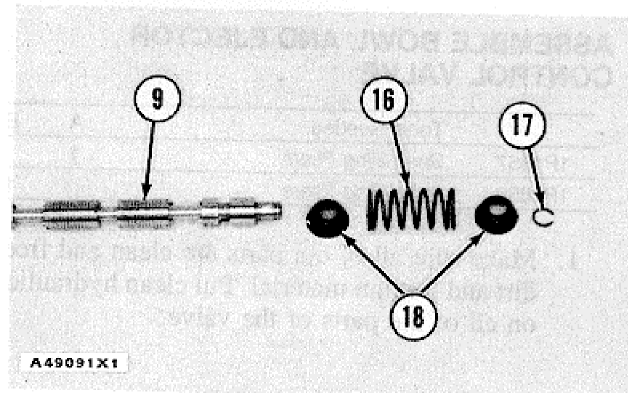


BOWL AND EJECTOR CONTROL VALVE

6. Remove screw (14), spring (15) and poppet (13) from the inside of the valve spool.

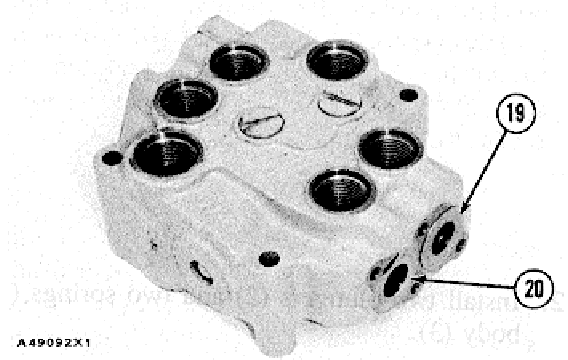


7. Remove snap ring (17) from valve spool (9) with tool (B). Remove washers (18) and spring (16) from the valve spool.

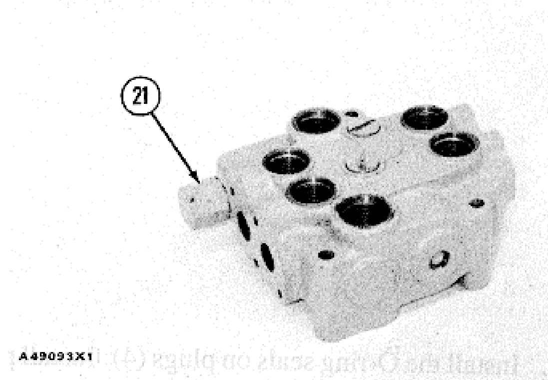


WARNING: Retainer is under tension from the spring that is behind it.

8. Remove retainers(19) and (20) and the O-ring seals. Check the condition of the O-ring seals. If the seals have damage, use new parts for replacement.

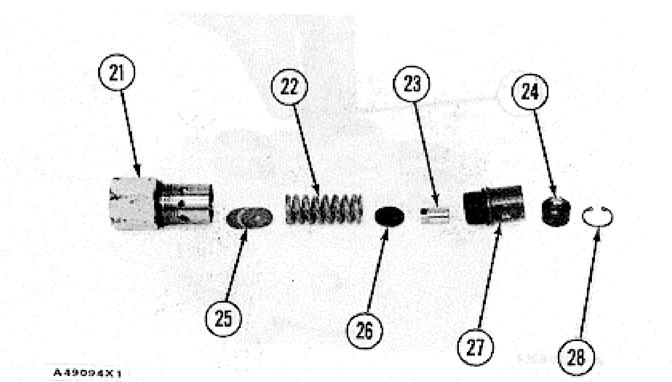


9. Remove relief valve assembly (21) from the body. Remove the washer and the seal from inside the body.



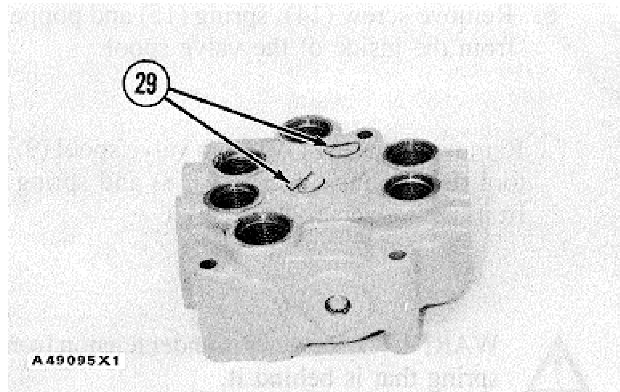
10. Remove snap ring (28) with tool (A). Remove sleeve (24) and the ball from housing (27). Turn housing (27) counterclockwise off the valve body (21) and remove piston (23), washer (26), spring (22) and washers (shims) (25). Check the condition of the O-ring seals. If the seals have damage, use new parts for replacement.

NOTE: Keep the washers (shims) together for installation purpose.

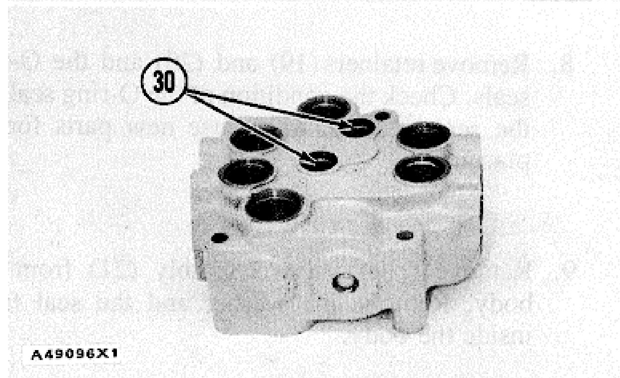


BOWL AND EJECTOR CONTROL VALVE

11. Remove plugs (29) from the body. Remove the O-ring seals from the plugs. Check the condition of the O-ring seals. If the seals have damage, use new parts for replacement.



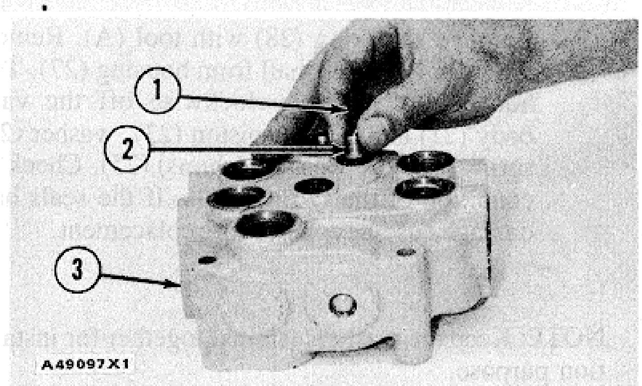
12. Remove springs (30) and the plungers from the body.



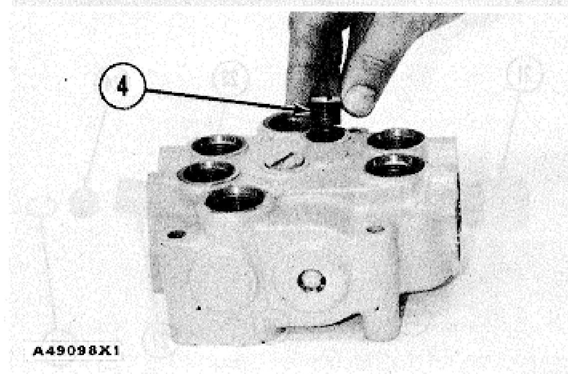
ASSEMBLE BOWL AND EJECTOR CONTROL VALVE

	Tools Needed	A	B
1P1857	Snap Ring Pliers	1	
1P1856	Snap Ring Pliers		1

1. Make sure all of the parts are clean and free of dirt and foreign material. Put clean hydraulic oil on all of the parts of the valve.



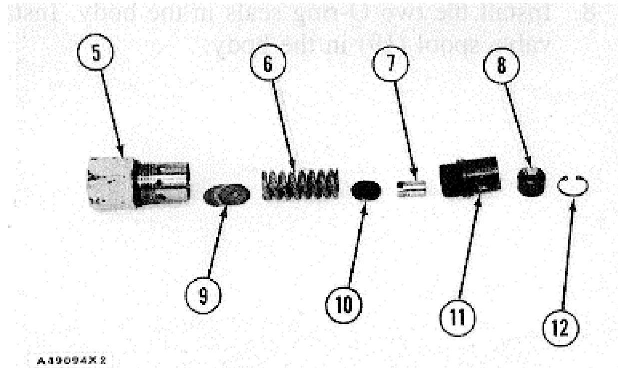
2. Install two plungers (2) and two springs (1) in body (3).



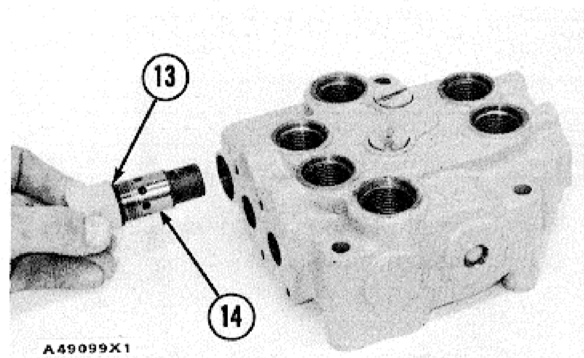
3. Install the O-ring seals on plugs (4). Install plugs (4) in the body.

BOWL AND EJECTOR CONTROL VALVE

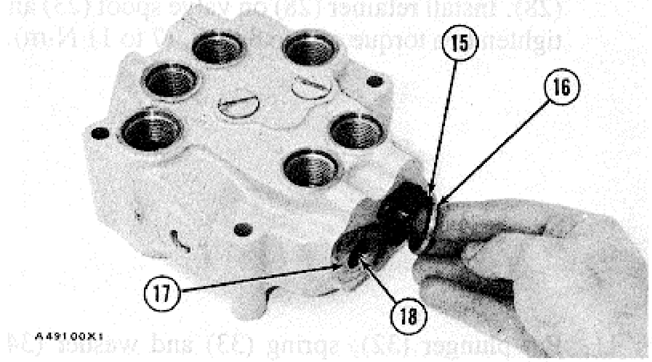
4. Install washers (shims) (9), spring (6), washer (10) and piston (7) in valve body (5). Put the O-ring seal on housing (11) and install the housing in valve body (5). Install the ball and sleeve (8) in the housing. Install snap ring (12) in the housing with tool (A). See TESTING AND ADJUSTING for correct adjustment.

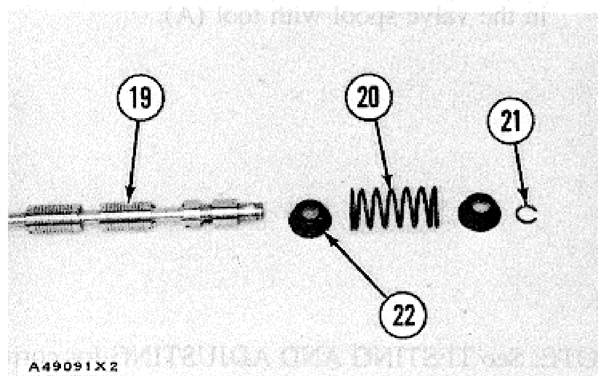


5. Install the seal and the washer in the inside of the body. Put O-ring seal (13) on relief valve assembly (14) and install it in the body.



6. Install O-ring seal (18) and retainer (17) in the body. Put O-ring seal (15) in retainer (16) and install the retainer in the body.

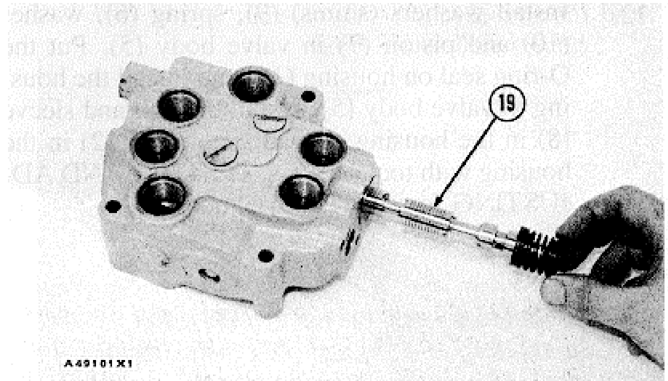




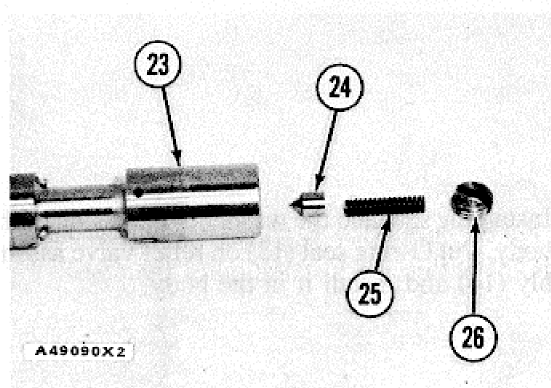
7. Put retainer (22), spring (20) and retainer on valve spool (19). Install snap ring (21) on the valve spool with tool (B).

BOWL AND EJECTOR CONTROL VALVE

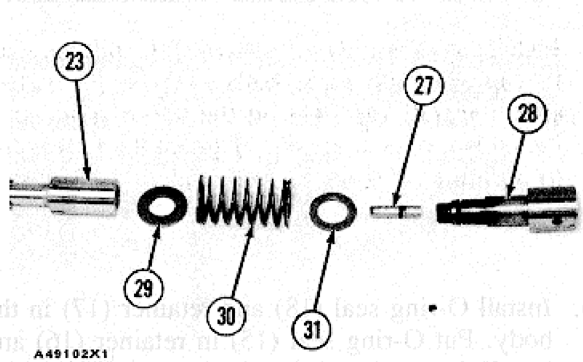
8. Install the two O-ring seals in the body. Install valve spool (19) in the body.



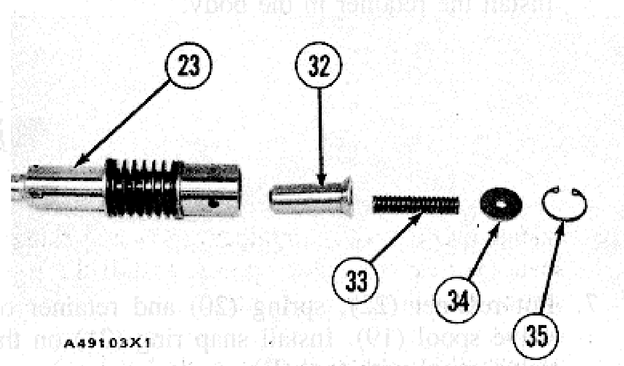
9. Put poppet (24), spring (25) and screw (26) inside valve spool (23) and tighten the screw.



10. Install O-ring seals on piston assembly (27) and retainer (28). Put washer (29), spring (30), washer (31) and piston assembly (27) on retainer (28). Install retainer (28) on valve spool (23) and tighten to a torque of 5 to 8 lb. ft. (7 to 11 N. m).



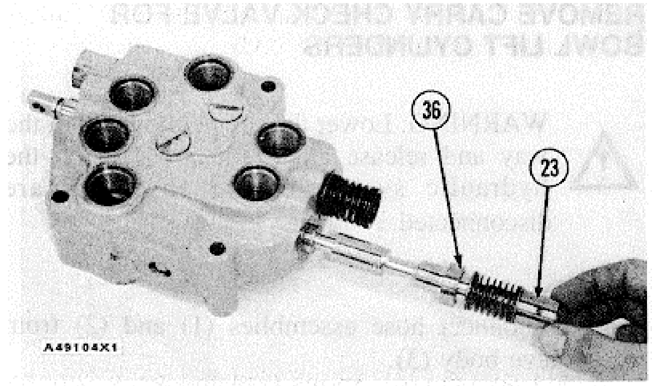
11. Put plunger (32), spring (33) and washer (34) inside valve spool (23) and install snap ring (35) in the valve spool with tool (A).



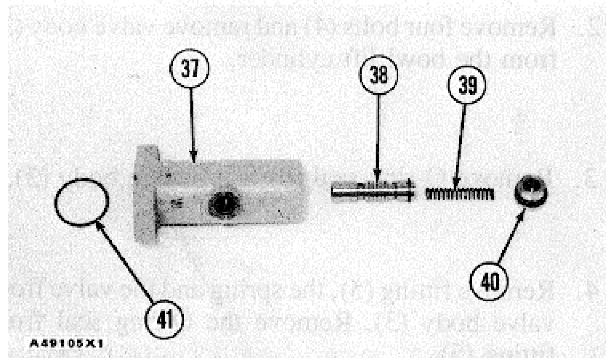
NOTE: See TESTING AND ADJUSTING for correct pressure to open poppet valve.

BOWL AND EJECTOR CONTROL VALVE

12. Install sleeve (36) on valve spool (23). Install the valve spool in the body.

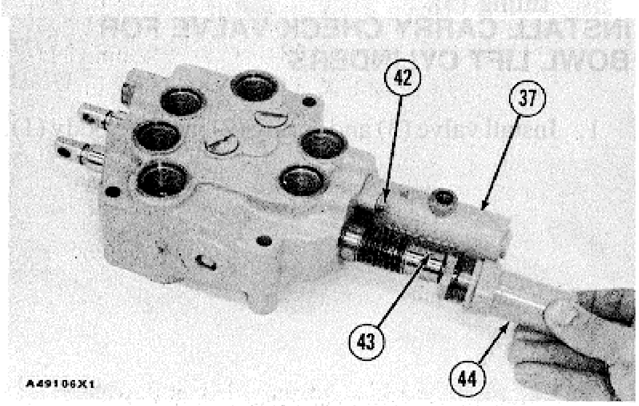


13. Install O-ring seal (41) in cap (37). Put the seals on valve spool (38) and plug (40). Install valve spool (38), spring (39) and plug (40) in cap (37).



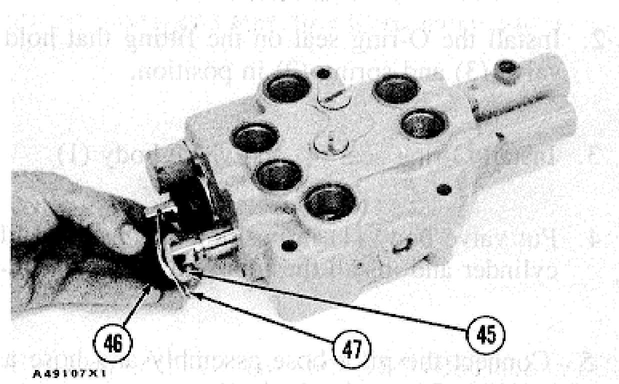
NOTE: Put 4L7464 Silicone Grease on the ends of the valve spools before the installation of the caps.

14. Install cap (37) and two bolts (42). Install the seal in cap (44) and three balls (43) on the valve spool. Install cap (44) on the valve spool and install two bolts to hold it. Tighten the four bolts to a torque of 10 to 13 lb. ft. (14 to 18 N. m).



NOTE: Put 4L7464 Silicone Grease on the ends of the valve spools before the installation of the rubber seals.

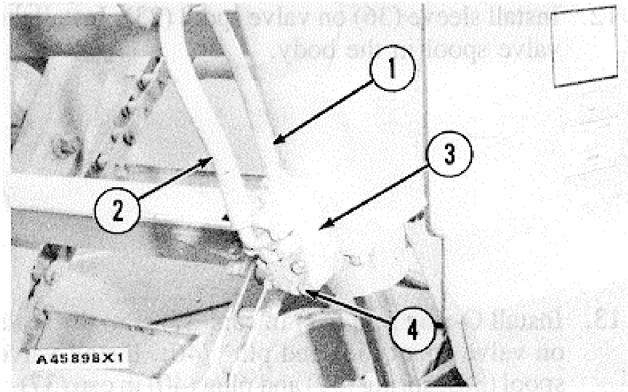
15. Install washers (45), retainers-(47) and rubber seals (46) on the valve spools. Install the four screws that hold the retainers.
    end by:
    a) install bowl and ejector control valve



CARRY CHECK VALVE FOR BOWL LIFT CYLINDERS

REMOVE CARRY CHECK VALVE FOR BOWL LIFT CYLINDERS

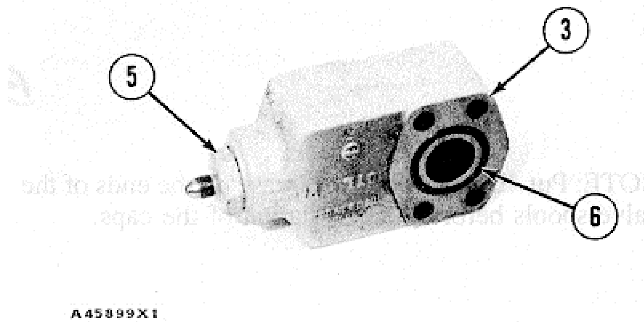
WARNING: Lower the scraper bowl all of the way and release all of the pressure on the hydraulic system before any lines are disconnected.



1. Disconnect hose assemblies (1) and (2) from valve body (3).

2. Remove four bolts (4) and remove valve body (3) from the bowl lift cylinder.

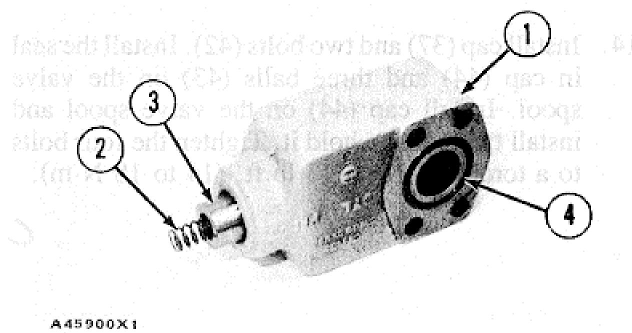
3. Remove O-ring seal (6) from salve body (3).



4. Remove fitting (5), the spring and the valve from valve body (3). Remove the O-ring seal from fitting (5).

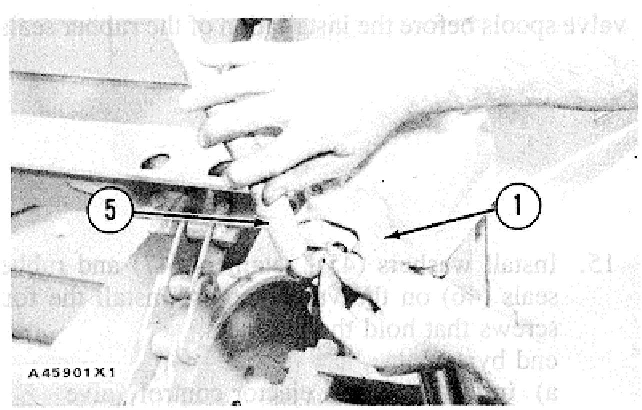
INSTALL CARRY CHECK VALVE FOR BOWL LIFT CYLINDERS

1. Install valve (3) and spring (2) in valve body (1).



2. Install the O-ring seal on the fitting that holds valve (3) and spring (2) in position.

3. Install O-ring seal (4) and valve body (1).



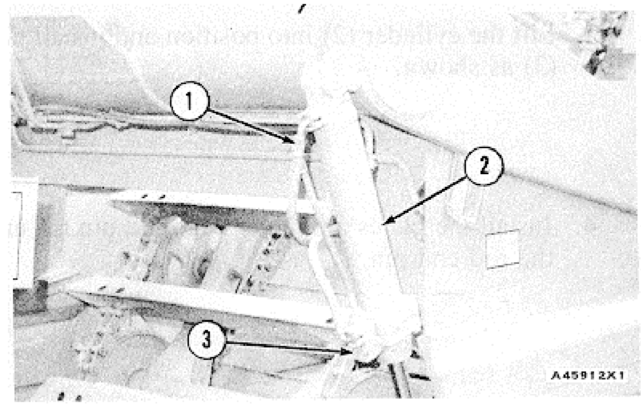
4. Put valve body (1) in position on the bowel lift cylinder and install the four bolts that hold it.

5. Connect the pilot hose assembly and hose assembly (5) to body (1).

BOWL LIFT CYLINDERS

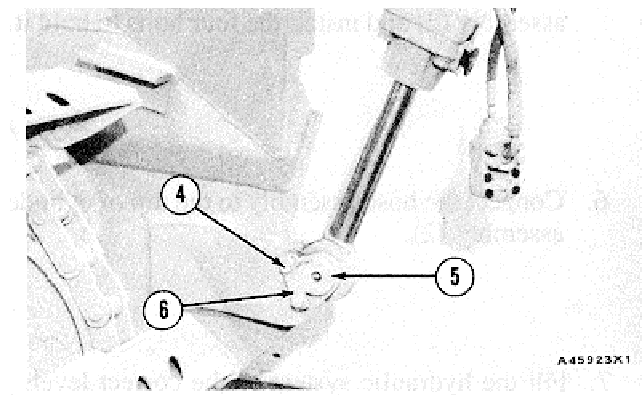
REMOVE BOWL LIFT CYLINDERS

1. Lower the bowl before the hydraulic lines are disconnected.



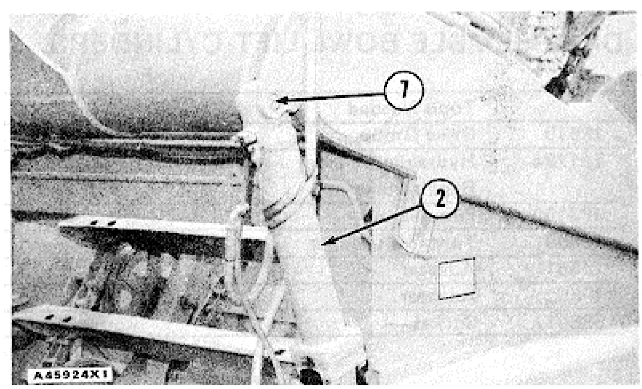
2. Disconnect hose assembly (I) from cylinder assembly (2).

3. Remove the four bolts that hold carry check valve (3) to cylinder assembly (2).



4. Fasten a hoist to cylinder assembly (2).

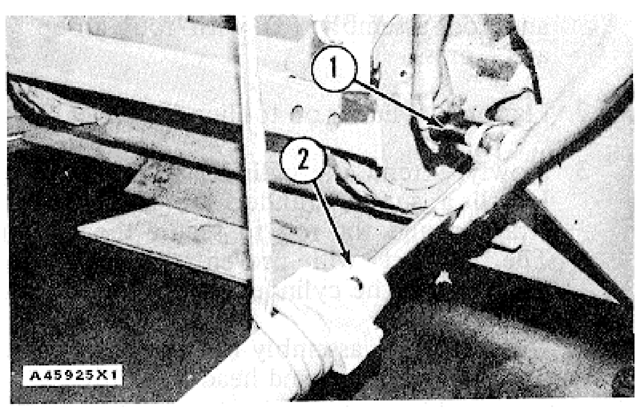
5. Remove the two bolts (4), plate (6) and pin (5) that hold the rod end of cylinder assembly (2) to the scraper.



6. Remove the two bolts, plate and pin (7) that hold cylinder assembly (2) and remove the cylinder assembly from the machine. The weight of the cylinder assembly is 105 lb. (47. 3 kg).

INSTALL BOWL LIFT CYLINDERS

1. Fasten a hoist to cylinder assembly (2) and put the rod end in position in the scraper.



2. Install pin (1) to hold the rod end of the cylinder assembly.

BOWL LIFT CYLINDERS

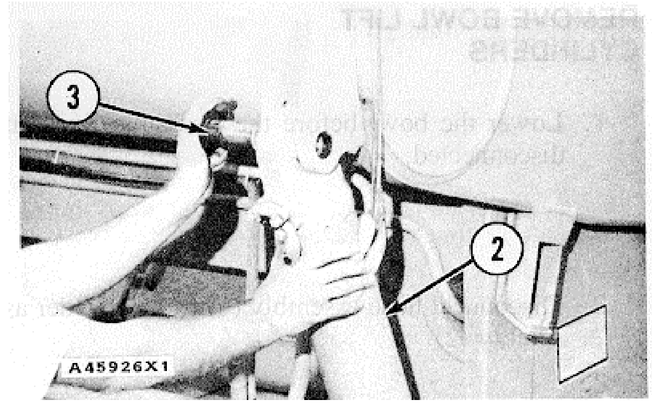
3. Lift the cylinder (2) into position and install pin (3) as shown.

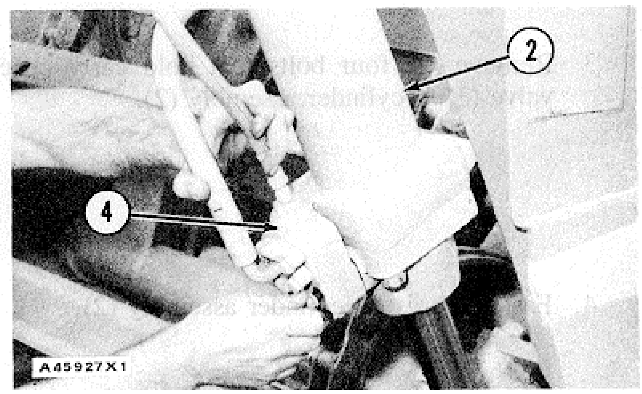
4. Install the plates and bolts that hold pin (3) and the rod end pin.

5. Put carry check valve (4) in position on cylinder assembly (2) and install the four bolts to hold it.

6. Connect the hose assembly to the top of cylinder assembly (2).

7. Fill the hydraulic system to the correct level.





DISASSEMBLE BOWL LIFT CYLINDERS

	Tools Needed	A	B	C
1P510	Drive Group	1		
1P1784	Hydraulic Cylinder Repair Stand		1	
5P3100	Pump Group			1
1P850	Torque Multiplier			1
lP851	Adapter			1
1P852	Adapter			1
5S6077	Socket			1

1. Remove bearings (l) from the cylinder (2) and rod assembly (3) with tool group (A) and a press.

2. Place the cylinder on tooling (B).

3. Slowly extend the cylinder to drain the oil. Install a support under the rod. Fasten a strap around the rod to secure the support. The support will prevent the rod from dropping as the cylinder head is pulled away.

4. Unscrew head assembly (4) and pull cylinder (2) away from rod and head assembly.

5. Remove nut (5) and washer (6) that retains piston (7) to rod (2) with tooling (C).

6. Remove piston (7) from rod.

7. Remove two rings (8) and seal assembly (9) from piston (7).

8. Remove seal (10) from piston.

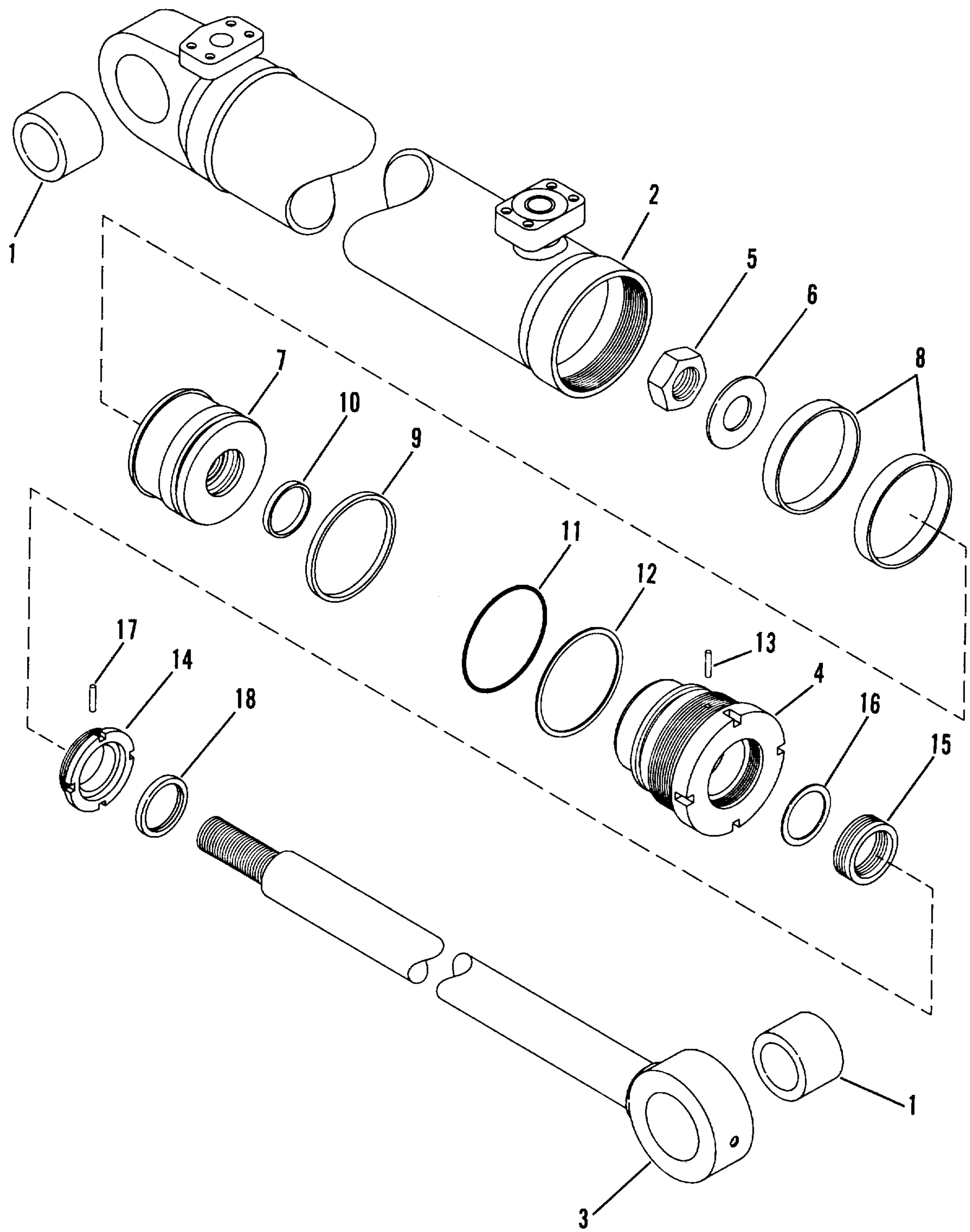
9. Remove seal (11) and ring (12) from head (3).

10. Remove plug (13) and unscrew gland assembly (14) from head (3).

11. Remove packing (15) and washer (16) from head (3).

12. Remove plug (17) and seal (18) from gland assembly (14).

Refer to page 4-93 for illustration.


1
2
5
6
8
7
10
9
11
12
13
4
16
15
17
14
18
1
3

ASSEMBLE BOWL LIFT CYLINDERS

	Tools Needed	A	B	C	D	E	F
5P2980	Seal Installer	1					
lP510	Drive Group		1				
1P764	Seal Guide			1			
4S9181	Seal Expander				1		
1P1784	Hydraulic Cylinder Repair Stand					1	
5P3100	Pump Group					1	
1P850	Torque Multiplier						1
1P851	Adapter						1
1P852	Adapter						1
5S6077	Socket						1

1. Use tool (A) to install washer (16) in head (4).

2. Install packing (15).

3. Use tool group (B) to install seal (18) in gland assembly (14). Install plug (1 7).

4. Install backup ring (12) and seal (11) on head (4).

5. Screw gland assembly (14) into head (4) and install plug (13).

6. Position the cylinder assembly (2) and rod (3) on tooling (E).

7. Partially thread head (4) onto cylinder assembly (2).

8. Install tool (C) on rod (3). Apply clean hydraulic oil on the seal lips in the head (4). Push the cylinder assembly (2) and head (4) onto rod (3).

9. Unscrew head (4) from cylinder assembly ('2). Remove tool (C).

10. Use tool (D) to enlarge plastic seal assembly (9). Install seal assembly (9) and rings (8).

11. Install seal (10).

12. Install piston (7), washer (6) and nut (5) on rod (3).

13. Tighten nut (5) with tooling (F) to a torque of 1200 + 120 lb. ft. (1620 ± 160 N•m).

14. Apply clean hydraulic oil on seal (9) and rings (8). Also apply clean hydraulic oil to seal to (11) and backup ring (12).

15. Slowly push the cylinder assembly (2) onto piston (7) and head (4) until head can be threaded in cylinder (2). Be careful not to damage o-ring seal and backup ring on head (4).

16. Make sure rod (2) is fully extended from the cylinder assembly and screw head assembly into cylinder.

17. Remove the cylinder from tooling (E).

18. Use a press and tool group (B) to install bearings (1) in the cylinder assembly (2) and rod
(3).

Refer to page 4-93 for illustration.

ELEVATOR HYDRAULIC PUMP

REMOVE ELEVATOR HYDRAULIC PUMP

start by:

a) remove crankcase guard*

*This operation is in ENGINE DISASSEMBLY AND ASSEMBLY section.

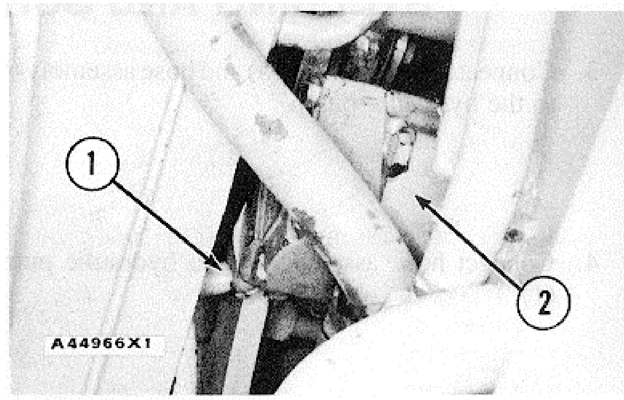
1. Drain the oil from the hydraulic system and torque converter housing.

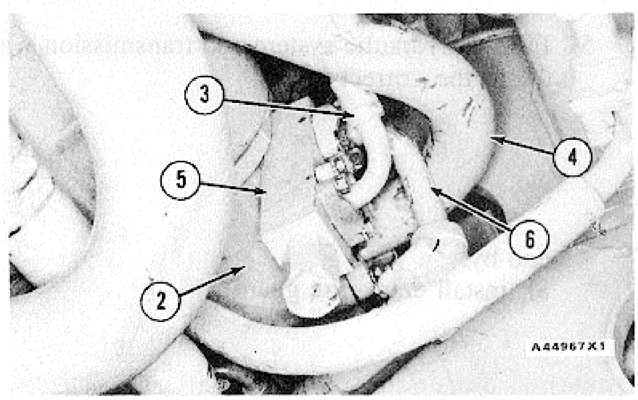
2. Disconnect hose assembly (I) from the rear of hydraulic pump (2).

3. Disconnect tube assembly (4) and hose assembly (3) from hydraulic pump (2).

4. Disconnect tube assembly (6) and remove housing (5) from hydraulic pump (2).

5. Remove the two bolts that hold hydraulic pump (2) to the left rear of torque converter housing. Lower the hydraulic pump from the machine.

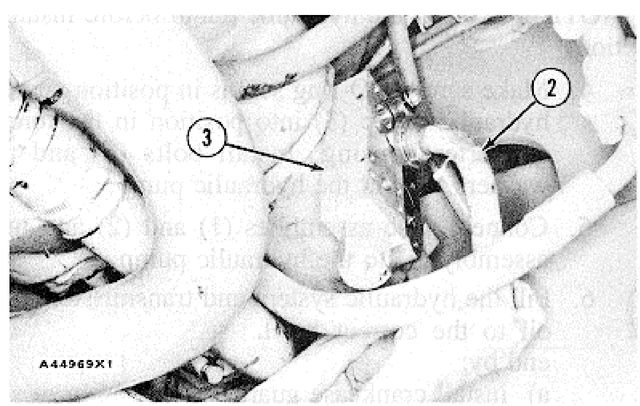




INSTALL ELEVATOR HYDRAULIC PUMP

NOTE: Put oil in the hydraulic pump before installation

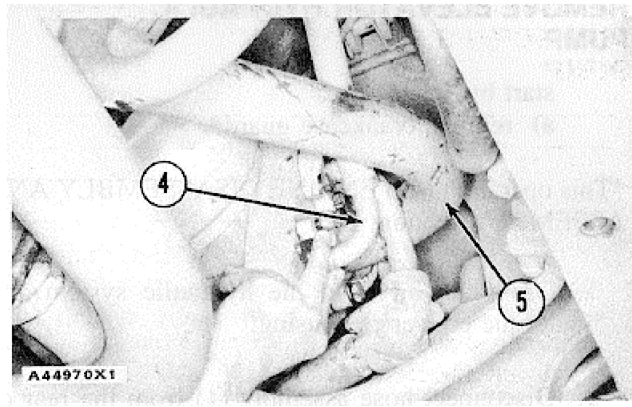
1. Make sure the O-ring seal is in position and lift hydraulic pump (I) into position in the torque converter housing. Install the bolts and washers to hold the hydraulic pump.



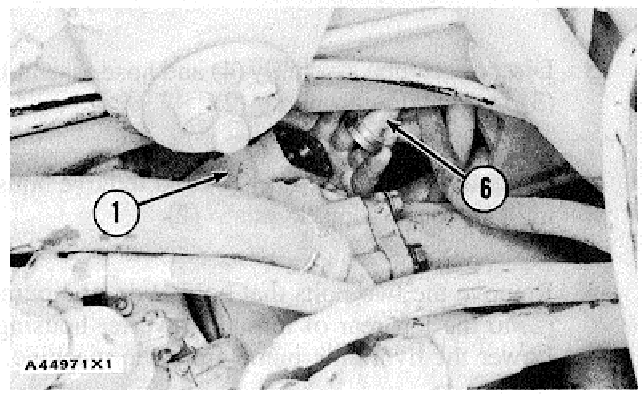
2. Put the O-ring seal and housing (3) in position on the hydraulic pump and connect tube assembly (2).

ELEVATOR HYDRAULIC PUMP,
STEERING AND SCRAPER HYDRAULIC PUMP

3. Connect tube assembly (5) and hose assembly (4) to the hydraulic pump.



4. Connect hose assembly (6) to hydraulic pump (l).



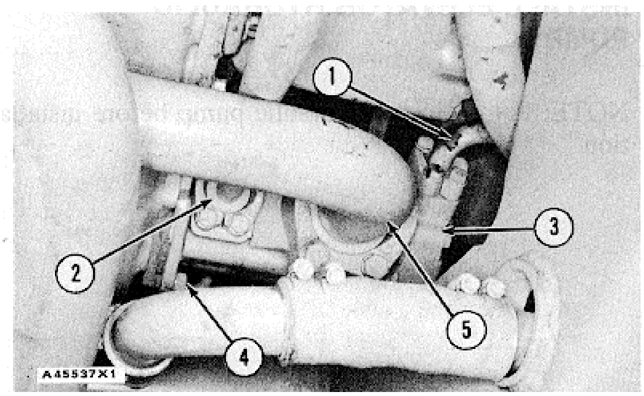
5. Fill the hydraulic system and transmission with oil to the correct levels.

end by:
a) install crankcase guard*

REMOVE AND INSTALL STEERING AND SCRAPER HYDRAULIC PUMP

start by:
a) remove crankcase guard*

1. Drain the oil from the hydraulic system and torque converter housing.
2. Disconnect tube assembly (5) and hose assemblies (1) and (2) from hydraulic pump (3).
3. Remove the two bolts (4) and washers that hold hydraulic pump (3) in position. Lower the hydraulic pump from the torque converter. The weight of the hydraulic pump is 45 lb. (20 kg).



NOTE: Put oil in the hydraulic pump before installation.

4. Make sure the O-ring seal is in position and lift hydraulic pump (3) into position in the torque converter housing. Install bolts (4) and the washers to hold the hydraulic pump.
5. Connect hose assemblies (l) and (2) and tube assembly (5) to the hydraulic pump.
6. Fill the hydraulic system and transmission with oil to the correct level.

end by:
a) install crankcase guard*

*This operation is in ENGINE DISASSEMBLY AND ASSEMBLY section.

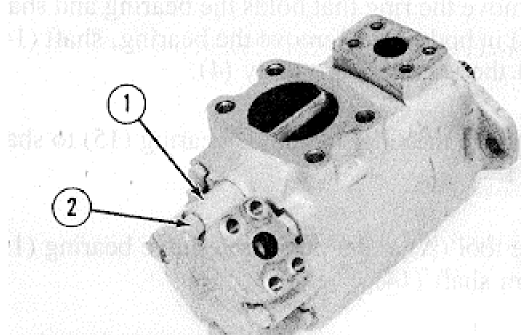
ELEVATOR OR STEERING AND SCRAPER HYDRAULIC PUMP

DISASSEMBLE ELEVATOR OR STEERING AND SCRAPER HYDRAULIC PUMP

	Tools Needed	A
9S9152	Bearing Puller Attachment	1

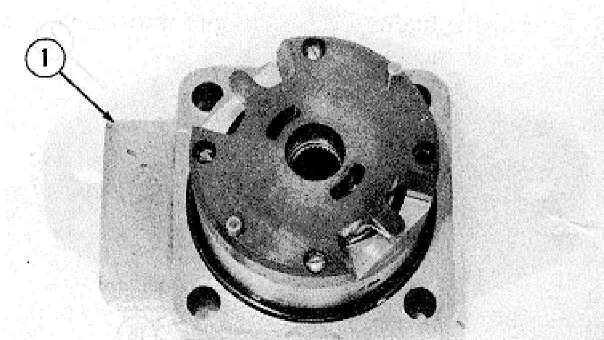
start by:
a)remove elevator or steering and scraper hydraulic pump

1. Remove bolts (2) from the pump. Remove cover (1) and the cartridge assembly as a unit from the pump.



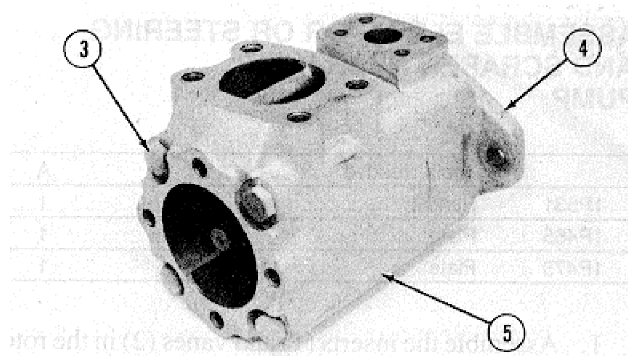
A44972X1

2. Remove the cartridge assembly from cover (1).



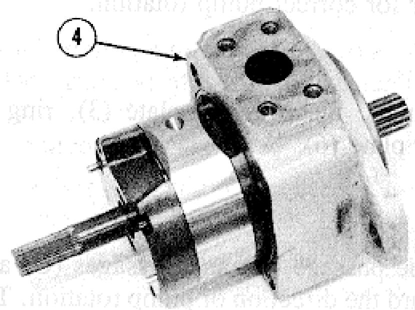
A44973X1

3. Remove bolts (3) and remove cover (5) from body (4).



A44974X1

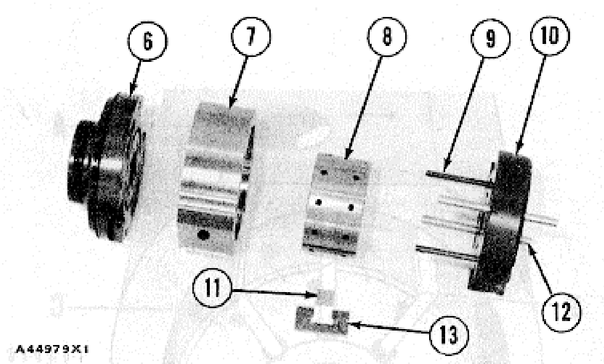
4. Remove the cartridge assembly from body (4).



A44975X1

5. Disassemble the two cartridge assemblies as follows:

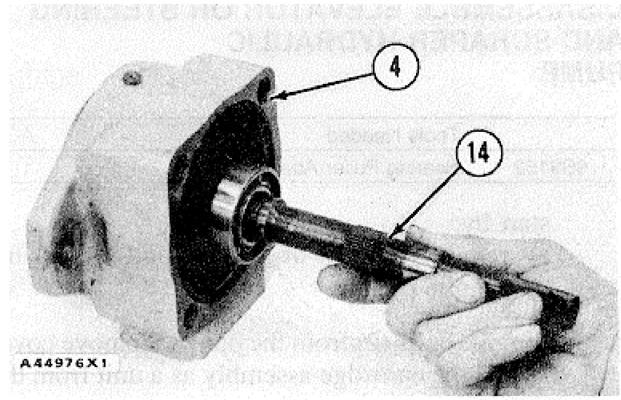
   a) Put identification marks on pressure plate (6), ring (7) and wear plate (10) for assembly purposes.
   b) Loosen two screws (9) and make a separation of pressure plate (6), ring (7) and wear plate (10).
   c) Remove pins (12) from wear plate (10).
   d.)Remove rotor (8) from ring (7). Remove vanes (13) and inserts (11) from rotor (8).



A44979X1

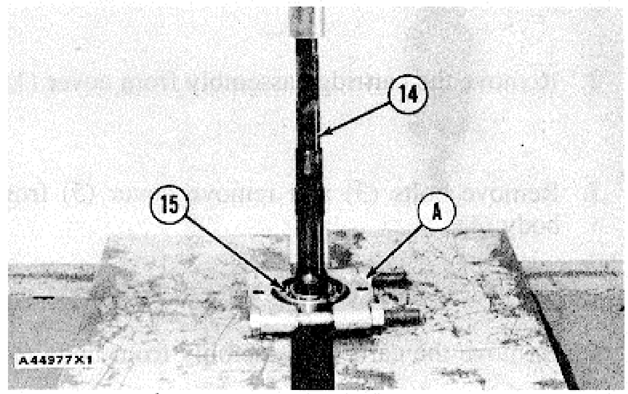
ELEVATOR OR STEERING AND SCRAPER HYDRAULIC PUMP

6. Remove the ring that holds the bearing and shaft (14) in body (4). Remove the bearing, shaft (14) and the washer from body (4).

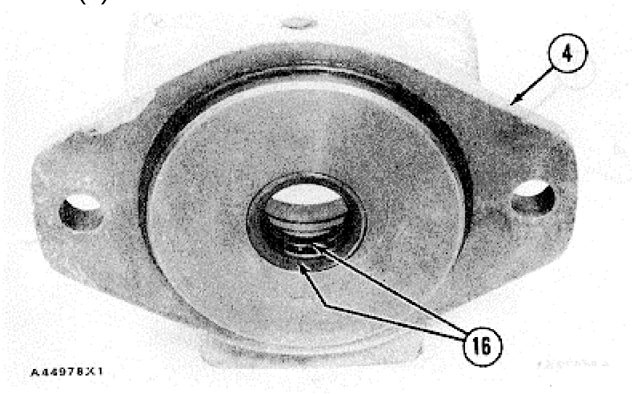


7. Remove the ring that holds bearing (15) to shaft (14).

8. Use tool (A) and a press to remove bearing (15) from shaft (14).



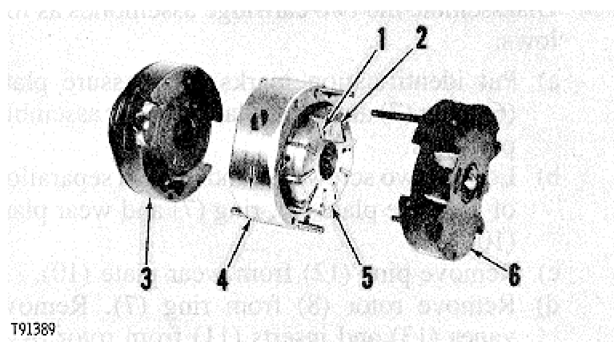
9. Remove the two lip type seals (16) from body (4).



ASSEMBLE ELEVATOR OR STEERING AND SCRAPER HYDRAULIC PUMP

	Tools Needed	A
1P531	Handle	1
1P465	Plate	1
1P475	Plate	1

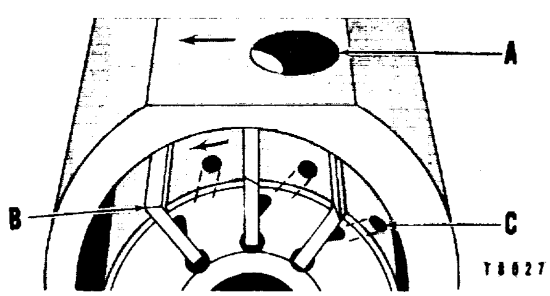
1. Assemble the inserts (I) and vanes (2) in the rotor (5) and install the rotor in ring (4). The sharp edge of the vanes must be on the same side as the direction shown by the arrows on the ring and rotor for correct pump rotation.



TYPICAL EXAMPLE

2. Assemble the pressure plate (3), ring (4) and wear plate (6).

NOTE: The passage (A) and passages (C) are on an angle toward the direction of pump rotation. The sharp edge of the vanes (B) must be toward the direction of pump rotation.

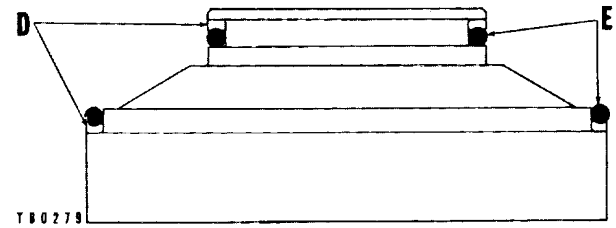


TYPICAL EXAMPLE

ELEVATOR OR STEERING AND SCRAPER HYDRAULIC PUMP

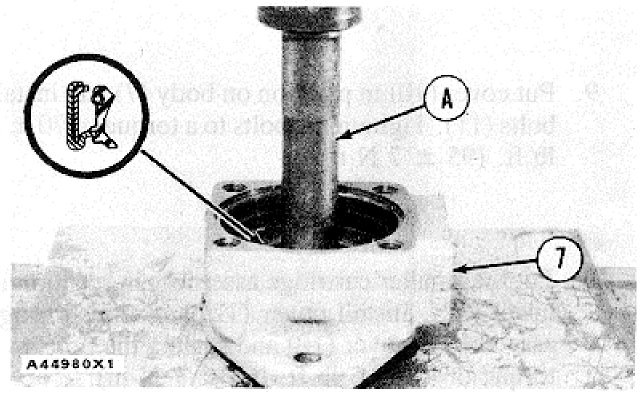
ROTATION:

Pump rotation, clockwise (CW), or counterclockwise (CCW), is the direction the pump turns when viewed from the drive shaft end. See the TESTING AND ADJUSTING and SPECIFICATIONS for pump rotation.

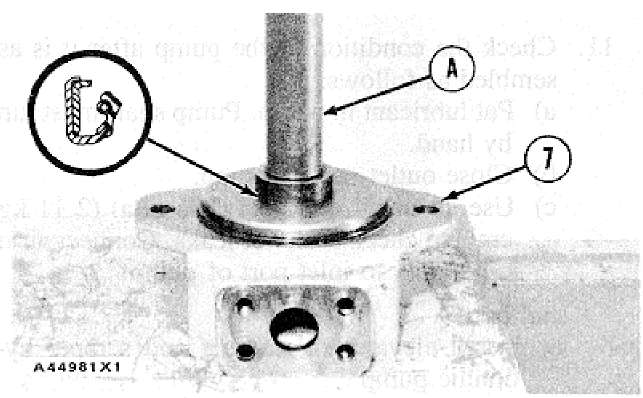


TYPICAL EXAMPLE

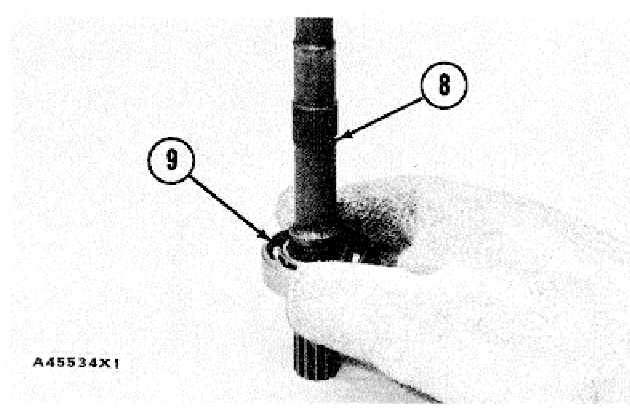
3. If new back-up rings (D) and O-ring seals (E) are installed on the pressure plate, they must be installed as shown. Put lubrication on the parts and install the back-up rings so the sides that make a curve in are next to the O-ring seals.



4. Use tool (A) and a press to install the inner lip type seal in body (7) with the lip of the seal toward the inside as shown.



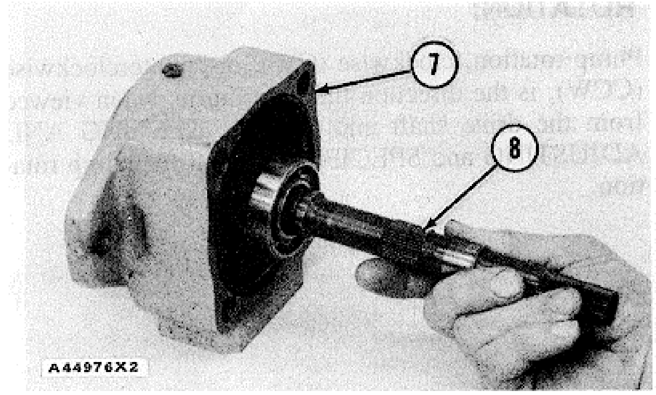
5. Use tool (A) and a press to install the outer lip type seal in body (7) with the lip of the seal toward the outside as shown.



6. Heat bearing (9) in oil to a maximum temperature of 275°F (135°C) and install it on shaft (8). Install the ring that holds bearing (9) on shaft (8).

ELEVATOR OR STEERING AND SCRAPER HYDRAULIC PUMP

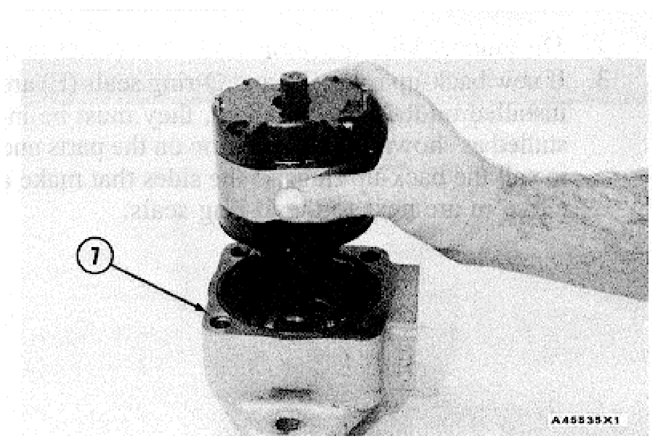
7. Put the washer and shaft (8) in position in body (7). Install the ring that holds shaft (8) and the bearing in body (7).



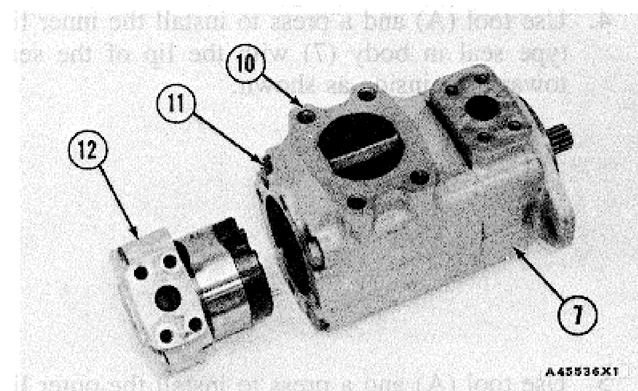
8. Install the larger cartridge assembly and seals in body (7).

NOTE: Make sure that the pins in the cartridge assemblies are in alignment with the holes in the covers before the bolts are tightened.

9. Put cover (0) in position on body (7) and install bolts (11). Tighten the bolts to a torque of 70 ± 5 lb. ft. (95 + 7 N·m).



10. Put the smaller cartridge assembly in position in cover (12). Install cover (12) and the cartridge assembly in cover (10) and tighten the bolts to a torque of 45 + 5 lb. ft. (60 + 7 N·m).



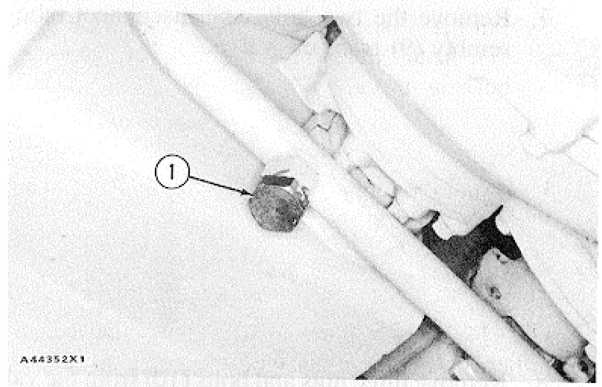
11. Check the condition of the pump after it is assembled as follows:
a) Put lubricant in pump. Pump shaft must turn by hand.
b) Close outlet port of pump.
c) Use air or oil at 30 psi (205 kPa) (2. 11 kg/ cm2) to check seals for leaks. Connect air or oil supply to inlet port of pump.

end by:
a) install elevator or steering and scraper hydraulic pump

ELEVATOR CONTROL VALVE

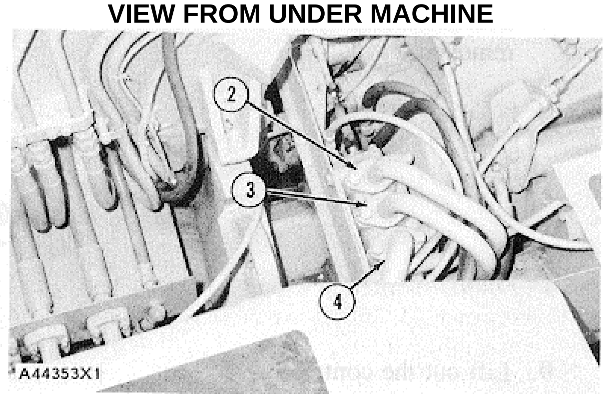
REMOVE ELEVATOR CONTROL VALVE

1. Remove drain plug (1) and drain hydraulic oil from the lines and the tank. Install the drain plug.

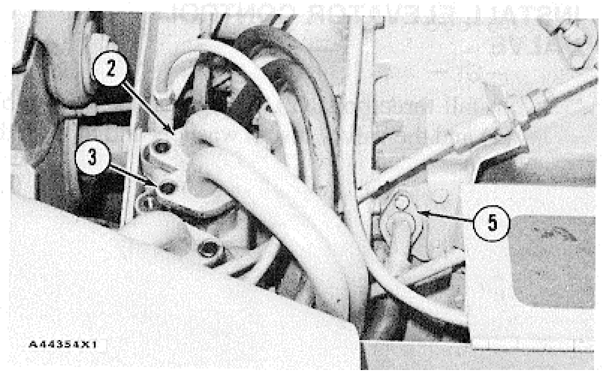


VIEW FROM UNDER MACHINE

2. Disconnect tube assemblies (2) and (3) at both ends. Remove the two bolts and disconnect tube assembly (4) at the valve only.

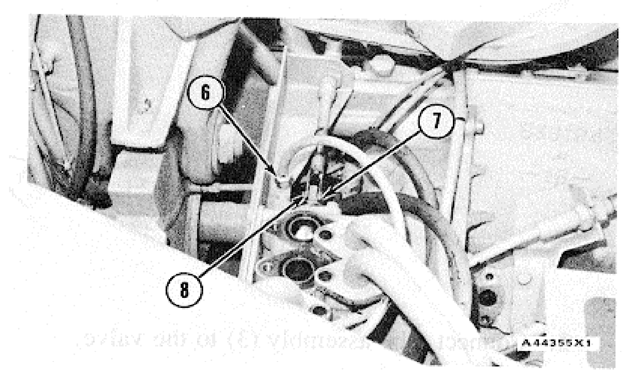


3. Remove the two bolts and disconnect oil line (5) from the transmission. Then move tube assemblies (2) and (3) to the rear as far as possible.



4. Disconnect hose assembly (6) from the valve.

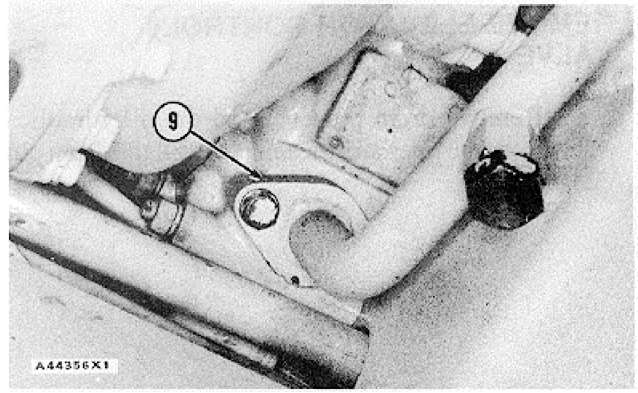
5. Remove cotter pin (7).



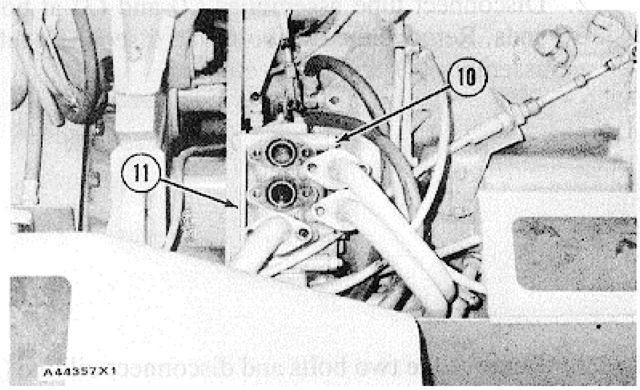
6. Remove pin (8) that connects the cable to the valve.

ELEVATOR CONTROL VALVE

7. Remove the two bolts and disconnect tube assembly (9) from the valve.



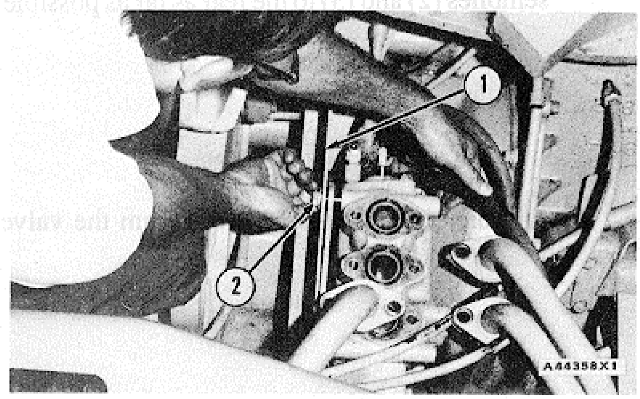
8. Remove three nuts and bolts (10) from the valve. Bracket assembly (I I) will fall after bolts are removed.



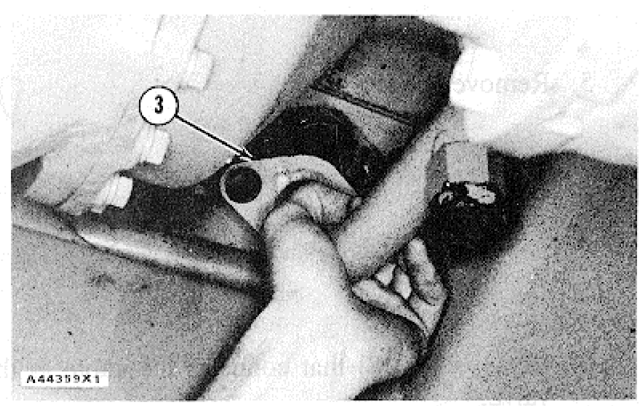
9. Lift out the control valve.

INSTALL ELEVATOR CONTROL VALVE

1. Install three bolts (2) through bracket assembly (1) and the valve. Install * ashers and nuts on the bolts.



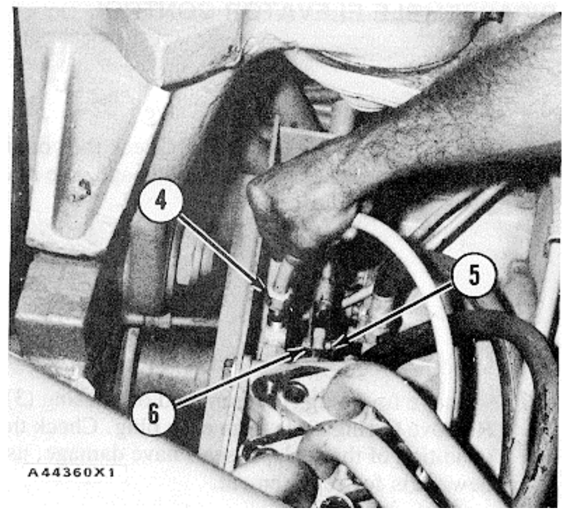
2. Connect tube assembly (3) to the valve.



View From Under Machine

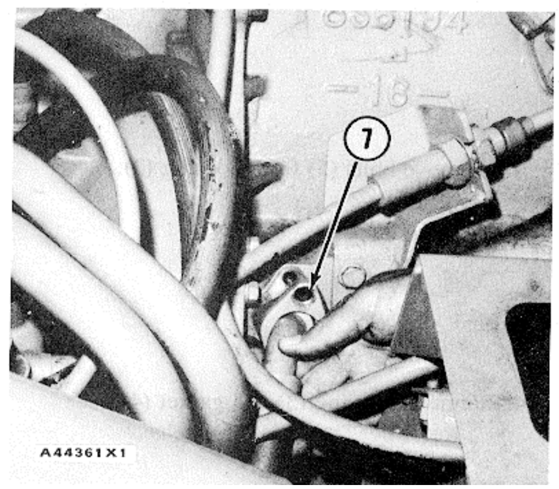
ELEVATOR CONTROL VALVE

3. Install pin (6) that connects the cable to the valve.

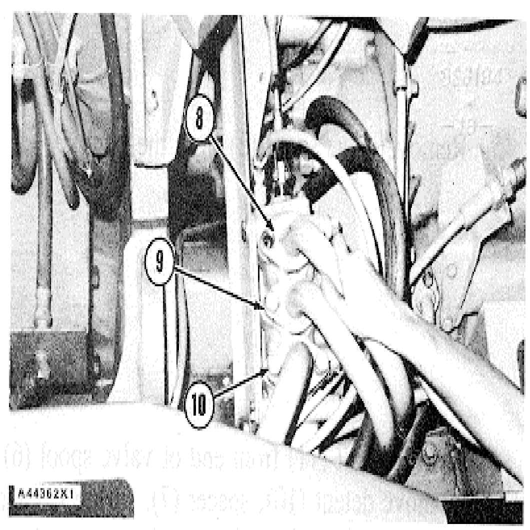


4. Install cotter pin (5) in pin (6).

5. Connect hose assembly (4) to the valve.



6. Move the tube assemblies back into position. Connect oil line (7) to the transmission.



7. Install the two bolts to tube assembly (10) and connect to the valve. Connect tube assemblies (8) and (9) at both ends.

8. Check the hydraulic system for the correct level.

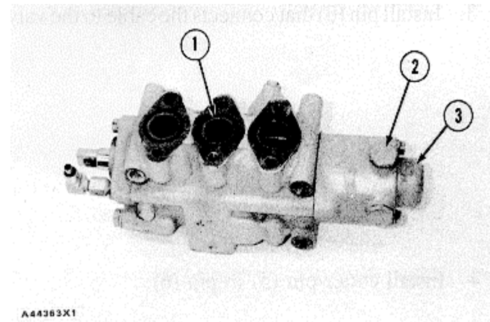
ELEVATOR CONTROL VALVE

DISASSEMBLE ELEVATOR CONTROL VALVE

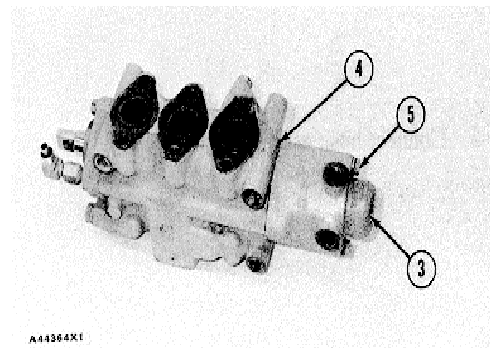
start by:

a) remove elevator control valve

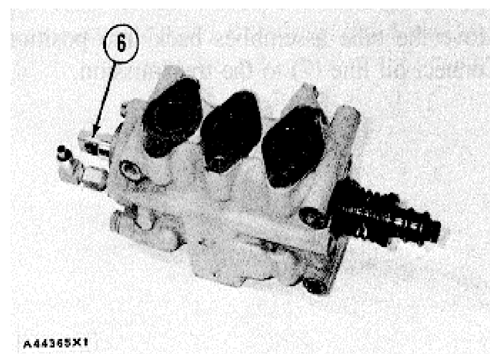
1. Remove four O-ring seals (1). Check the condition of the seals. If seals have damage, use new parts for replacement.



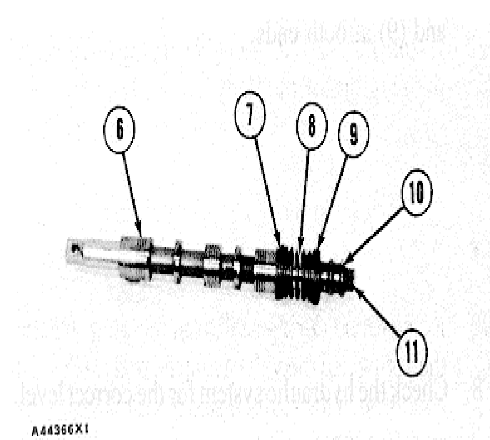
2. Remove four plugs (2) from end of housing (3). Remove O-ring seals from each plug. Check the condition of the seals. If seals have damage, use new parts for replacement.



3. Remove bolts (5) from housing (3).



4. Remove housing (3) and gasket (4).

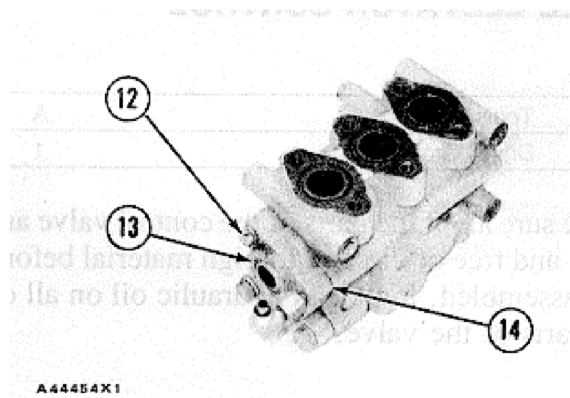


5. Remove valve spool (6) from the body.

6. Remove bolt (11) from end of valve spool (6). Remove detent (10), spacer (7), spring (8) and spacer (9) from the valve spool.

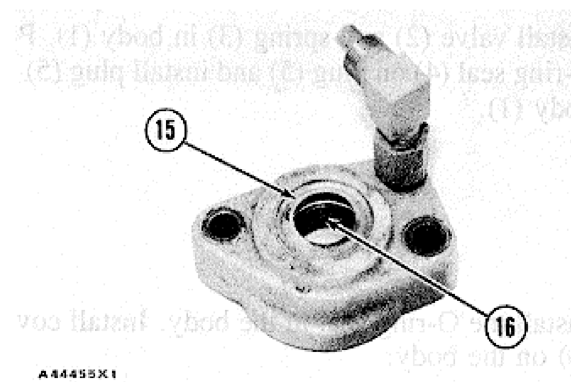
ELEVATOR CONTROL VALVE

7. Remove two bolts (12) from retainer (13).



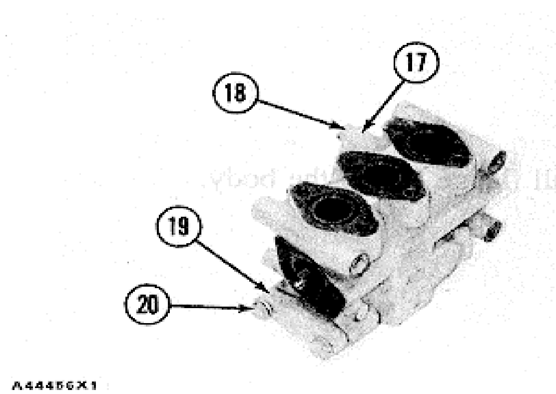
8. Remove retainer (13) and gasket (14) from the body.

9. Remove seals (15) and (16) from the retainer.



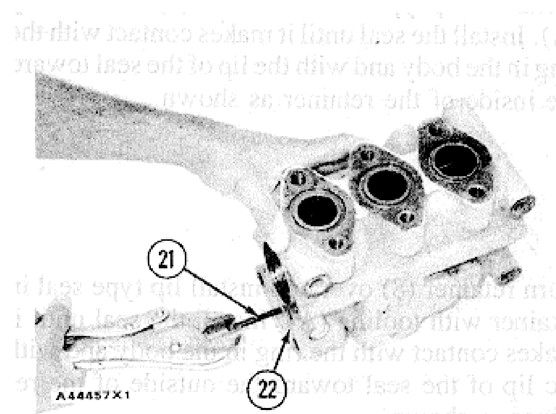
NOTE: There is a lockring between seals (15) and (16). The ring can be removed if replacement is necessary.

10. Remove two bolts (18) and cover (17). Remove the O-ring seal from the body. Check the condition of the seals. If seal has damage, use new parts for replacement.



11. Remove bolts (20) and flange (19) from the body.

12. Install a l/4"-20 NC bolt (21) in plug (22) and pull the plug out of the body.

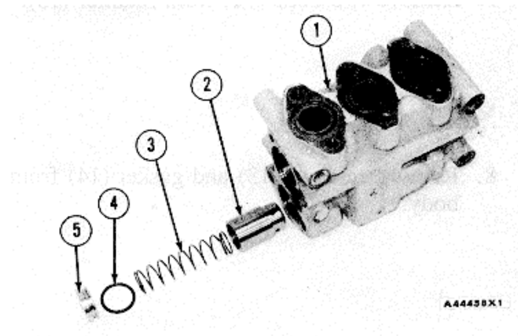


13. Remove the O-ring seal from the plug. Remove the spring and the valve from the body. Check the condition of the seals. If seal has damage use new parts for replacement.

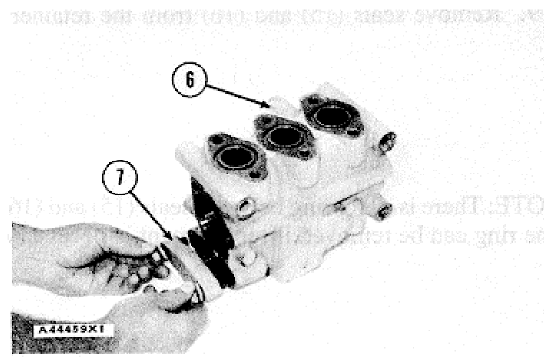
ELEVATOR CONTROL VALVE

ASSEMBLE ELEVATOR CONTROL VALVE

	Tools Needed	A
1P510	Driver Group	1

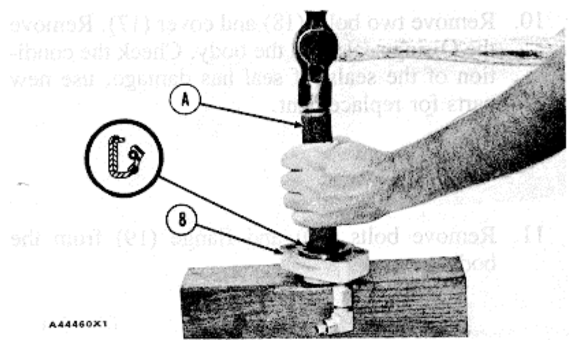


1. Make sure all of the parts of the control valve are clean and free of dirt and foreign material before it is assembled. Put clean hydraulic oil on all of the parts of the valve.

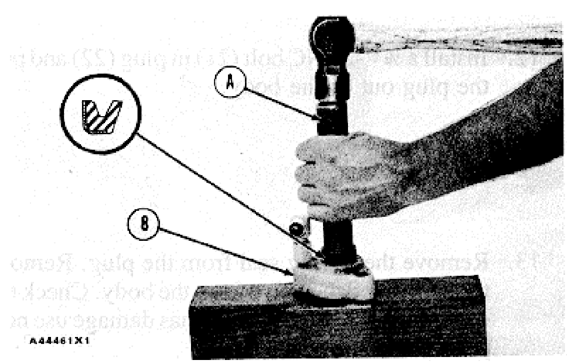


2. Install valve (2) and spring (3) in body (1). Put O-ring seal (4) on plug (5) and install plug (5) in body (1).

3. Install the O-ring seal in the body. Install cover (6) on the body.



4. Install flange (7) on the body.

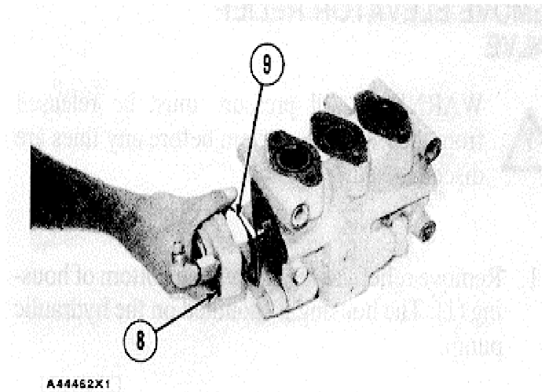


5. Install the lip type seal in retainer (8) with tooling (A). Install the seal until it makes contact with the ring in the body and with the lip of the seal toward the inside of the retainer as shown.

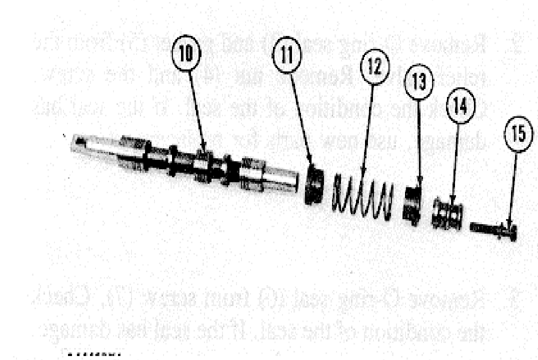
6. Turn retainer (8) over and install lip type seal in retainer with tooling (A). Install the seal until it makes contact with the ring in the body and with the lip of the seal toward the outside of the re-tainer as shown.

ELEVATOR CONTROL VALVE

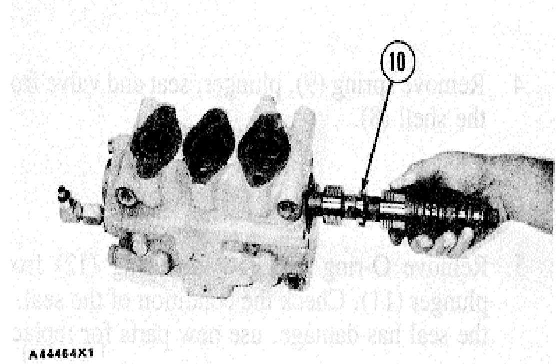
7. Install gasket (9) and retainer (8) on the body.



8. Install spacer (1), spring (12), spacer (13) and detent (14) on valve spool (10). Install bolt (15).



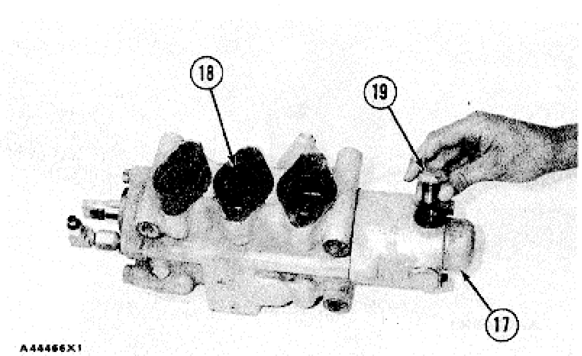
9. Install valve spool (10) in the body.

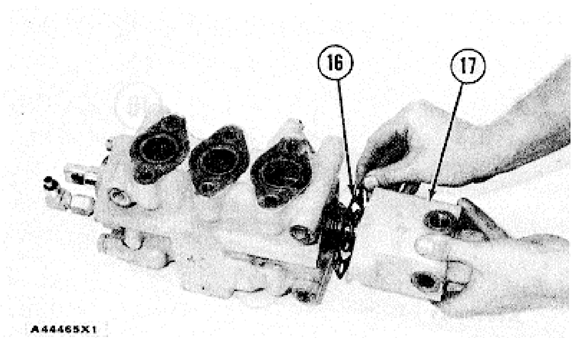


10. Install gasket (16) and housing (17) to the body.

11. Install four seals (18) in the body.

12. Install four plugs (19) in housing (17). Tighten the plugs to a torque of 42 + 4 lb. ft. (58 + 5 N. m).
    end by:
    a) install elevator control valve



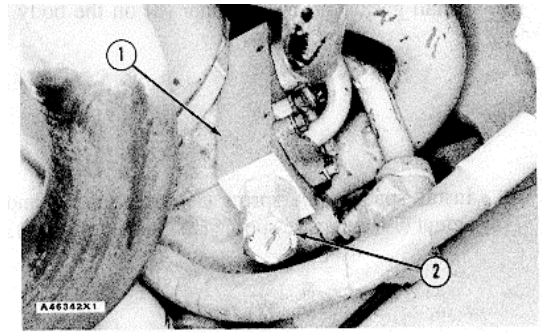


ELEVATOR RELIEF VALVE

REMOVE ELEVATOR RELIEF VALVE

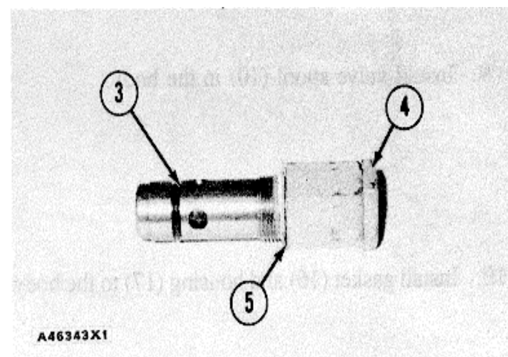
WARNING: All pressure must be released from the hydraulic system before any lines are disconnected.

1. Remove relief valve (2) from the bottom of housing (1). The housing is mounted on the hydraulic pump.

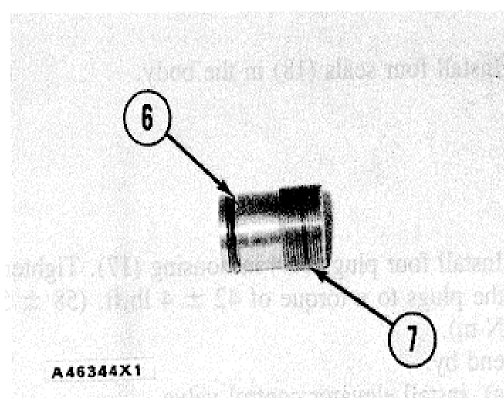


VIEW FROM UNDER MACHINE

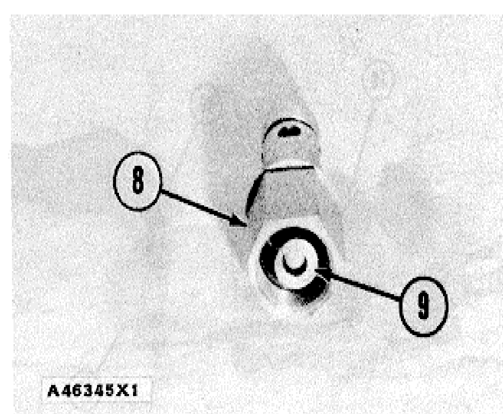
2. Remove O-ring seal (3) and gasket (5) from the relief valve. Remove nut (4) and the screw. Check the condition of the seal. If the seal has damage, use new parts for replacement.



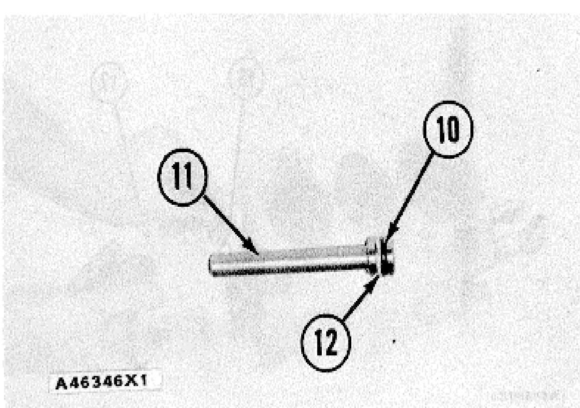
3. Remove O-ring seal (6) from screw (7). Check the condition of the seal. If the seal has damage, use new parts for replacement.



4. Remove spring (9), plunger, seat and valve from the shell (8).



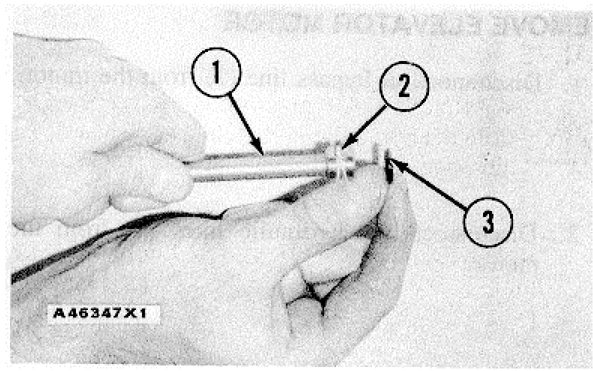
5. Remove O-ring seal (10) and ring (12) from plunger (I I). Check the condition of the seal. If the seal has damage, use new parts for replacement.



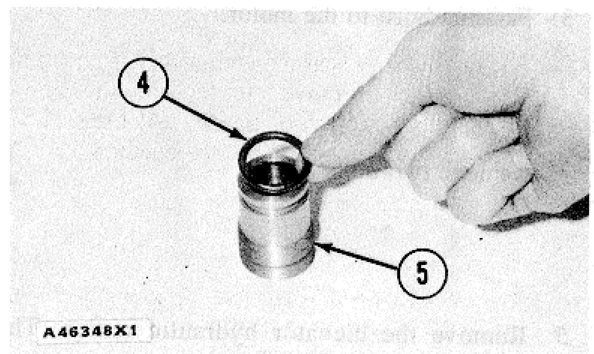
ELEVATOR RELIEF VALVE

INSTALL ELEVATOR RELIEF VALVE

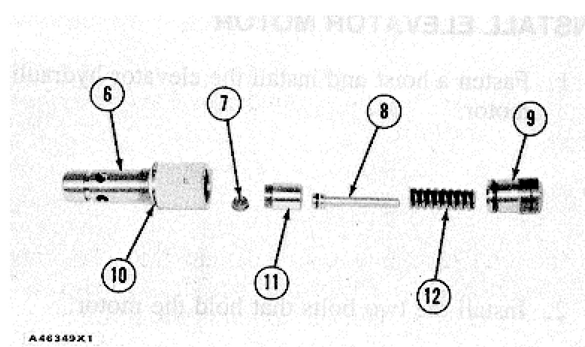
1. Install ring (2) and O-ring seal (3) on plunger(l).



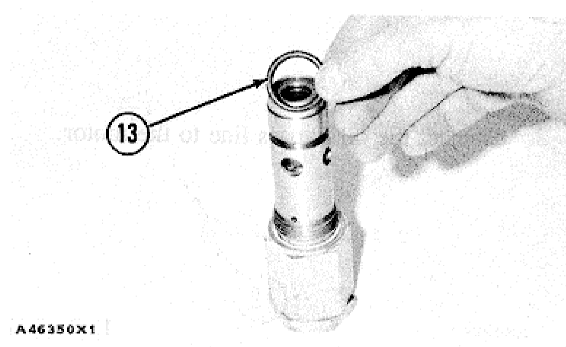
2. Install O-ring seal (4) on screw (5).



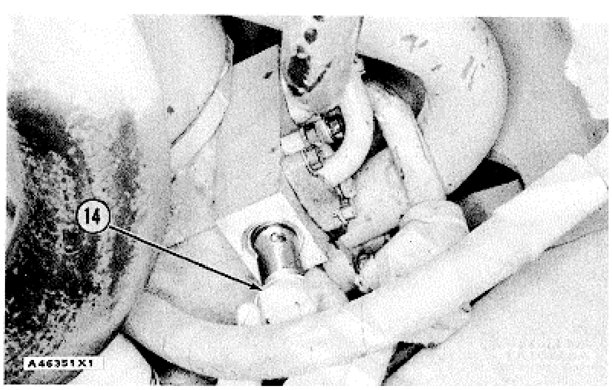
3. Install valve (7), seat (11), plunger (8), spring (12) and screw (9) in shell (6). Install gasket (10) on the shell. Turn the screw in completely and install the nut.



4. Install O-ring seal (13) on relief valve.



5. Install relief valve (14) in the housing.

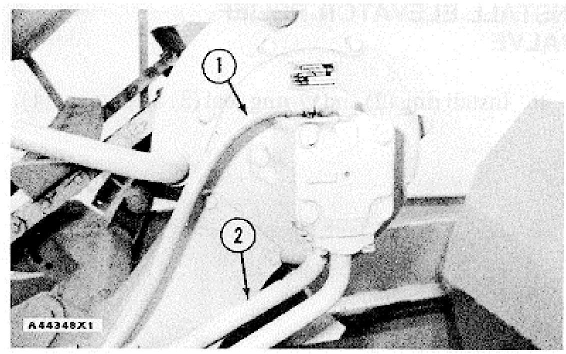


VIEW FROM UNDER MACHINE

ELEVATOR MOTOR

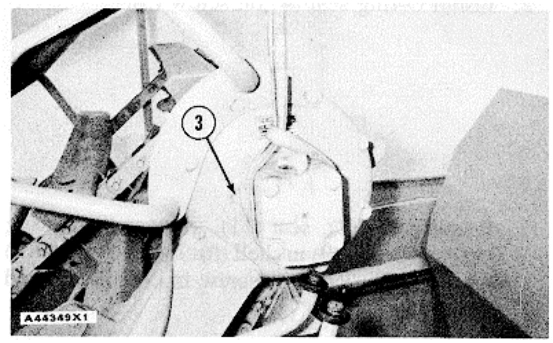
REMOVE ELEVATOR MOTOR

1. Disconnect oil bypass line (1) from the motor.



2. Disconnect two hydraulic lines (2) from the motor.

3. Fasten a hoist to the motor.

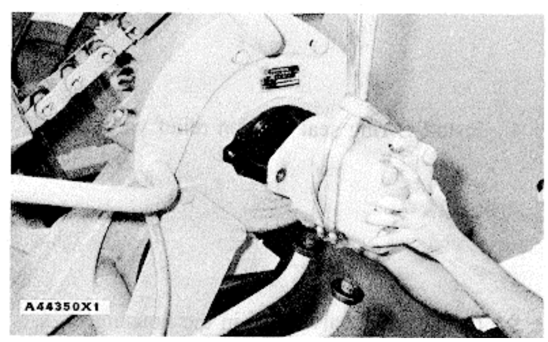


4. Remove two bolts (3).

5. Remove the elevator hydraulic motor. The weight is 70 lb. (32 kg).

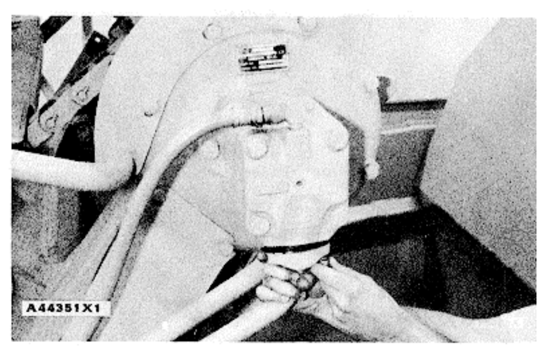
INSTALL ELEVATOR MOTOR

1. Fasten a hoist and install the elevator hydraulic motor.



2. Install the two bolts that hold the motor.

3. Connect the oil bypass line to the motor.



4. Connect the two hydraulic lines to the motor.

ELEVATOR MOTOR

DISASSEMBLE ELEVATOR MOTOR

	Tools Needed A
1P1859	Pliers

start by:
a) remove elevator hydraulic motor

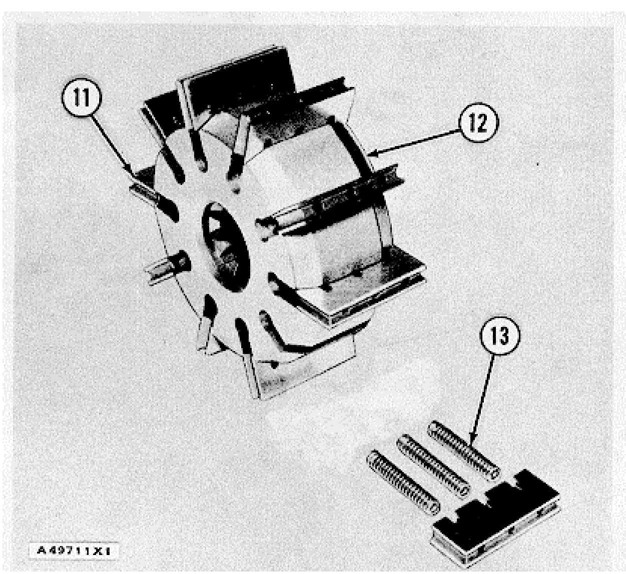
1. Remove bolts (I) from the body. Remove body (3) from cover (2).

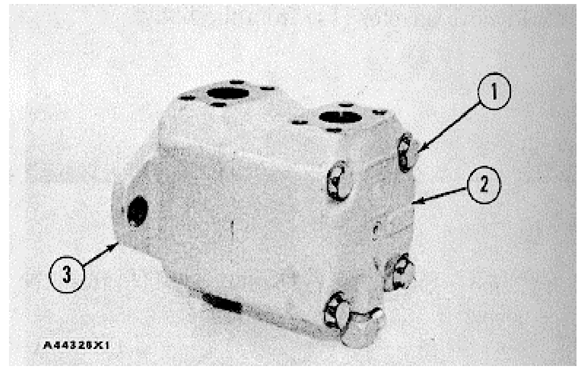
2. Remove teflon seal (4) from cartridge assembly (6). Remove O-ring seal (5) from the cover. Check seals for damage. If seals have damage, use new parts for replacement.

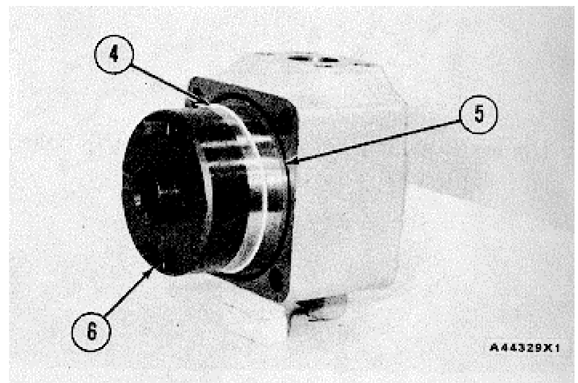
3. Remove cartridge assembly (6) from the cover.

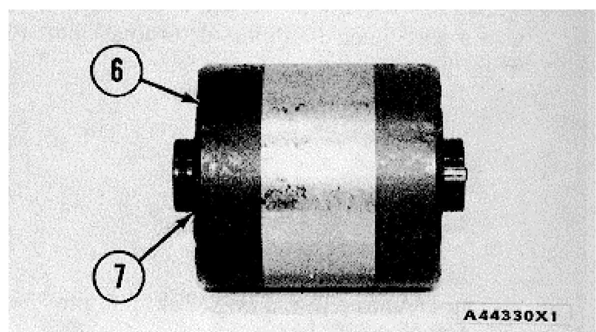
4. Remove the ring and seal (7) from each end of cartridge assembly (6). Check ring and seal for damage. If ring or seal have damage, use new parts for replacement.

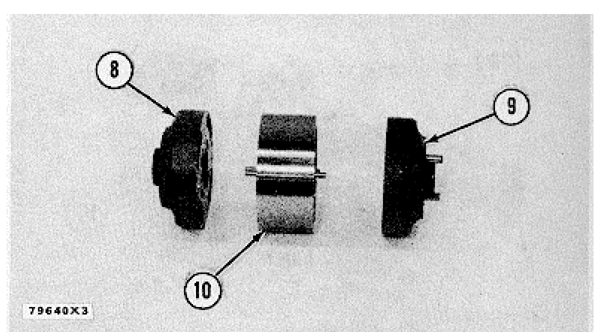
5. Disassemble the cartridge assembly to clean and inspect as follows:
   a) Put identification marks on plate (8), ring (10) and plate assembly (9).
   b) Remove two screws from the cartridge assembly. Remove plate (8) and plate assembly (9) from ring (10).
   c) Remove rotor (12) and vanes (II) from the ring.
   d) Remove ten vanes (11) and thirty springs (13) from the rotor.





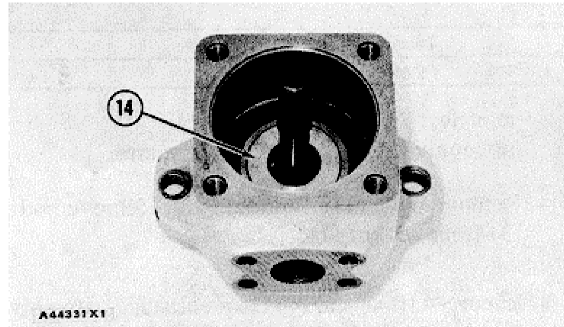




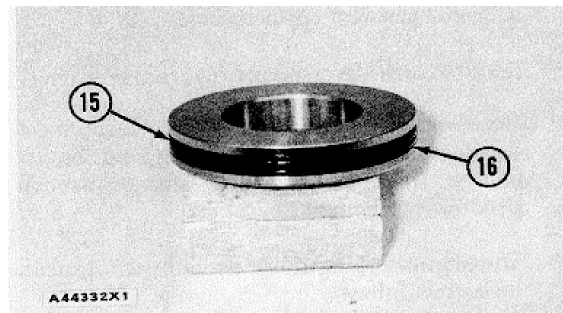


ELEVATOR MOTOR

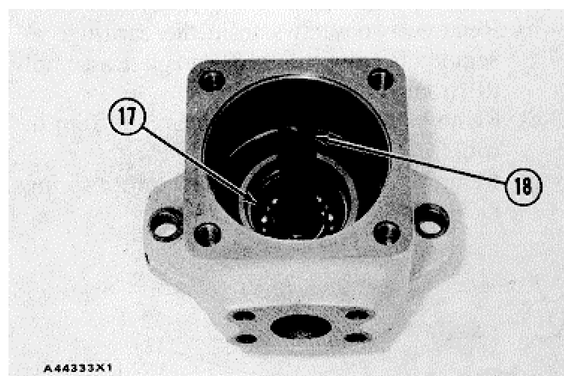
6. Remove adapter (14) from the body.



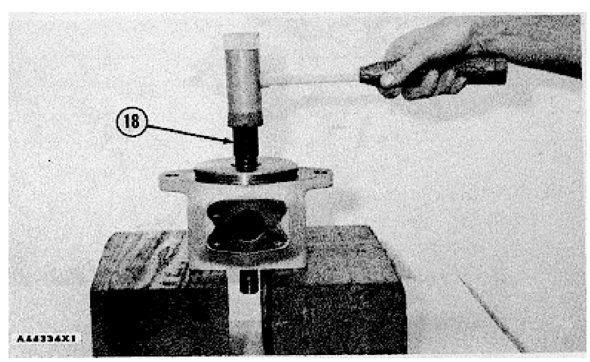
7. Remove O-ring seal (15) and ring (16) from the adapter.



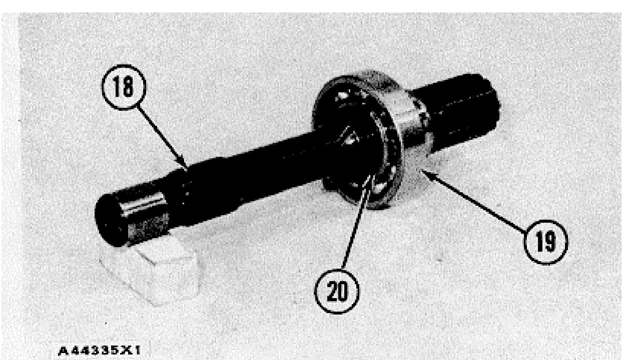
8. Remove spiral ring (17) that holds the bearing and shaft (18) in position.



9. Turn the body and put on wood blocks as shown. Use a soft faced hammer to remove shaft (18) from the body.

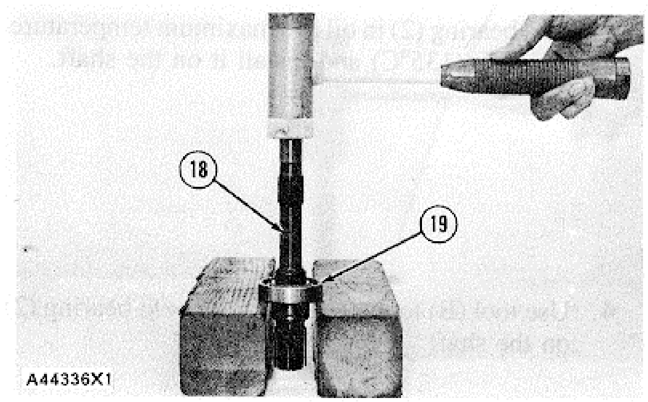


10. Use tool (A) to remove ring (20) that holds bearing (19) to shaft (18).

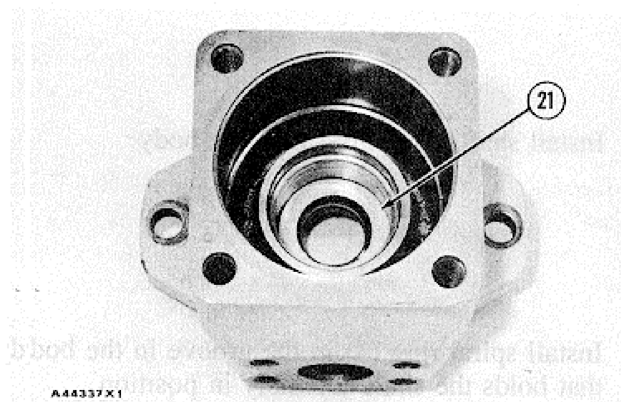


ELEVATOR MOTOR

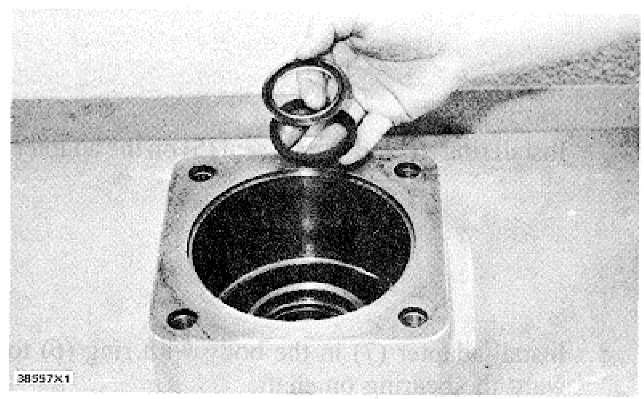
11. Put bearing (19) and shaft (18) on wooden blocks as shown. Use a soft faced hammer and remove shaft (18) from bearing (19).



12. Remove washer (21) from the body.



13. Remove the seal and wiper from the body.

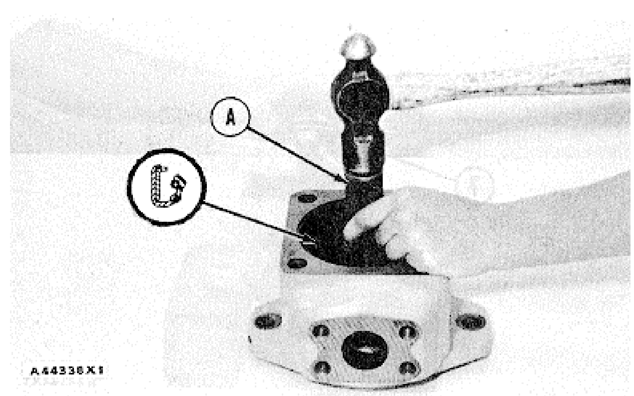


ASSEMBLE ELEVATOR MOTOR

	Tools Needed	A	B
1P510	Driver	1	
1P1859	Pliers		1

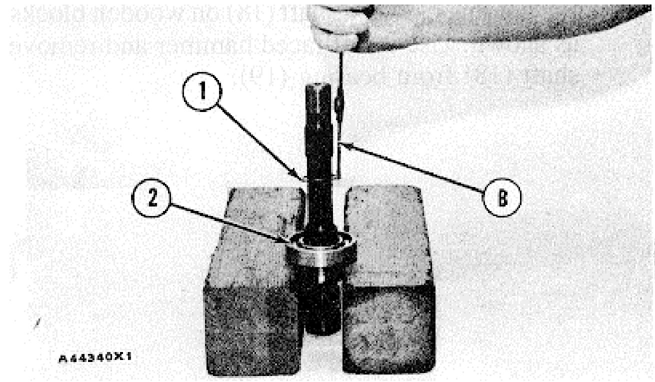
1. Install the wiper. Install the lip type seal with tooling (A). Install the seal until it makes contact with the counterbore in the body and with the lip of the seal toward the inside of the body.

2. Install the washer inside the body next to the seal.



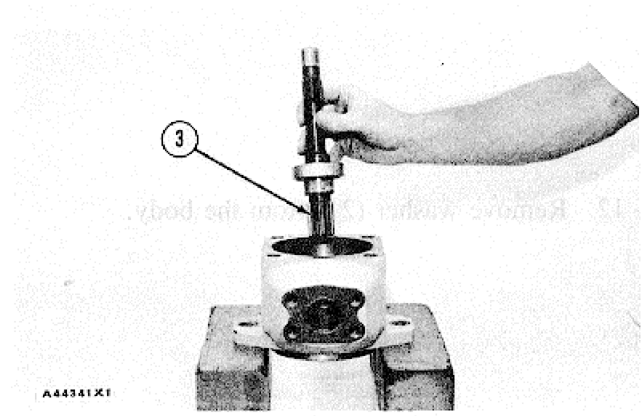
ELEVATOR MOTOR

3. Heat bearing (2) in oil to a maximum temperature of 275°F (135°C) and install it on the shaft.



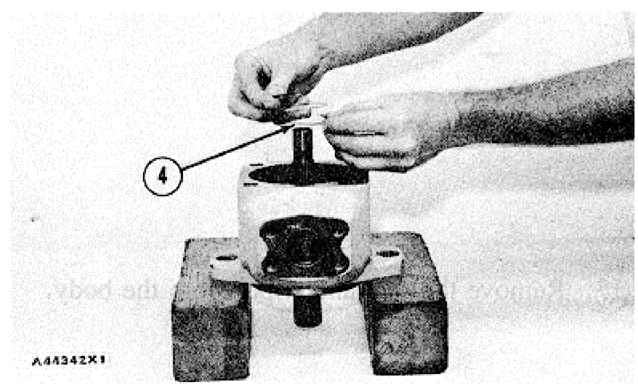
4. Use tool (B) to install ring (I) to hold bearing (2) on the shaft.

5. Install shaft assembly (3) in the body.

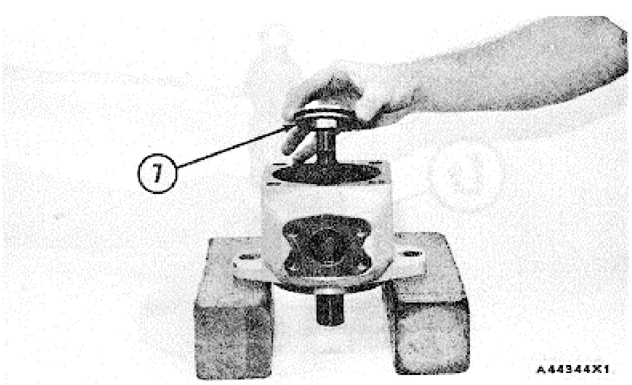


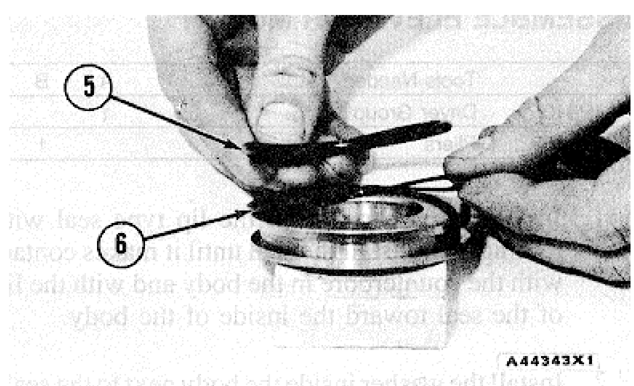
6. Install spiral ring (4) in the groove in the body that holds the shaft assembly in position.

7. Install ring (6) and O-ring seal (5) on the adapter.



8. Install adapter (7) in the body with ring (6) toward the bearing on shaft.





ELEVATOR MOTOR

9. Install springs (10) and vanes (8) in rotor (9). Push the vanes in the rotor. Slide rotor (9) in the ring.

10. Put the identification marks in alignment. Put plate (11) and plate assembly (12) in position on ring (13) and install the two screws. Tighten the screws toa torque of 10 + 2 lb. ft. (14 + 3 Nm).

11. Install an O-ring seal (14) and back-up ring (15) on both ends of cartridge assembly (16) with the back-up ring toward the outside.

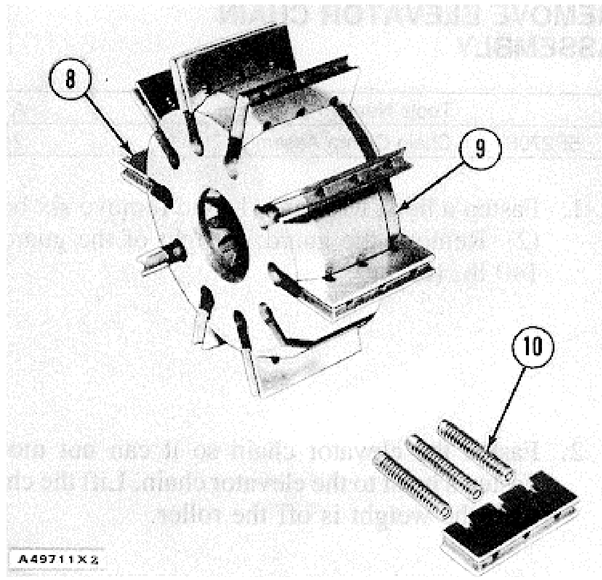
12. Install the cartridge assembly in cover (19). Install O-ring seal (17) in the groove on the cover. Install teflon seal (20) on the cartridge assembly and against the cover.

13. Put body (18) in position on cover (19) and install the four bolts to hold it. Tighten the bolts to a torque of 200 + 10 Ib. ft. (270 + 14 N. m).

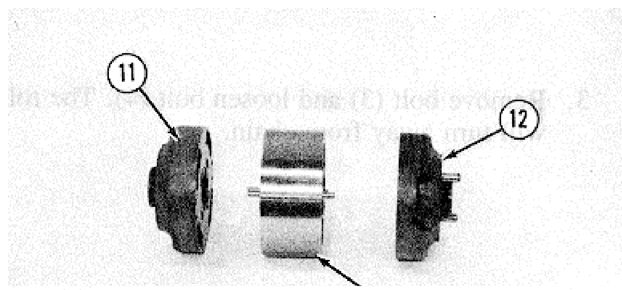
14. Check the condition of the motor after it is assembled as follows:

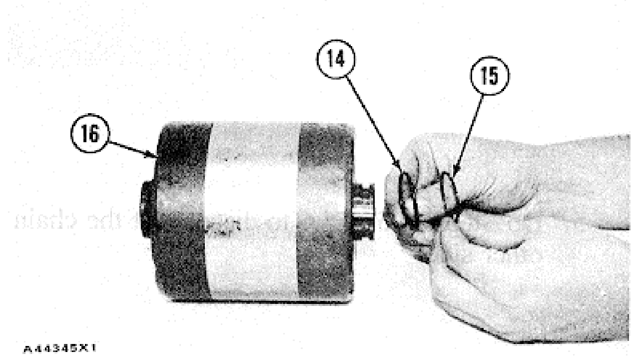
a)Put lubricant in motor. Motor shaft must turn by hand.
b)Close outlet port of motor.
c)Use air or oil at 30 psi (206. 9 kPa) (2. 11 kg/cm2) to check seals for leaks. Connect air or oil supply to inlet port of motor.

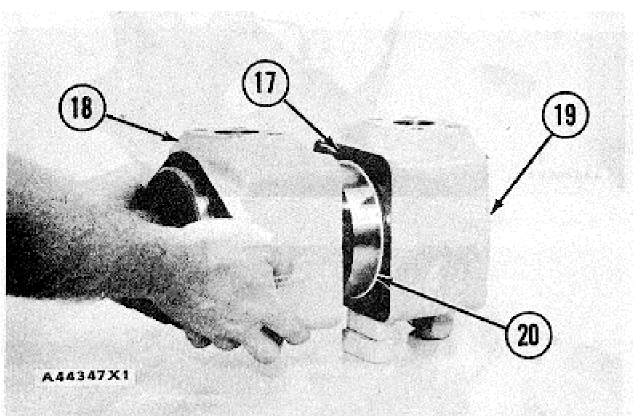
end by:
a)install elevator motor



TYPICAL EXAMPLE





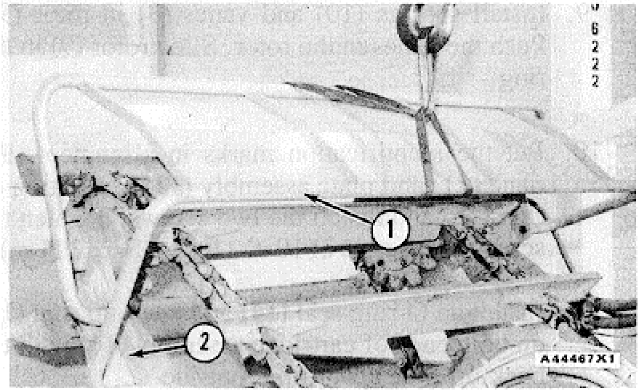


ELEVATOR CHAIN ASSEMBLY

REMOVE ELEVATOR CHAIN ASSEMBLY

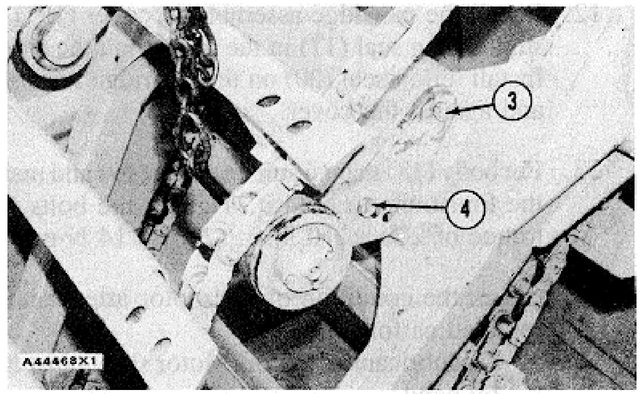
	Tools Needed	A
5P2706	Chain Clamp Assembly	2

1. Fasten a hoist to guard (1) and remove six bolts (2). Remove the guard. Weight of the guard is 140 lb. (63 kg).

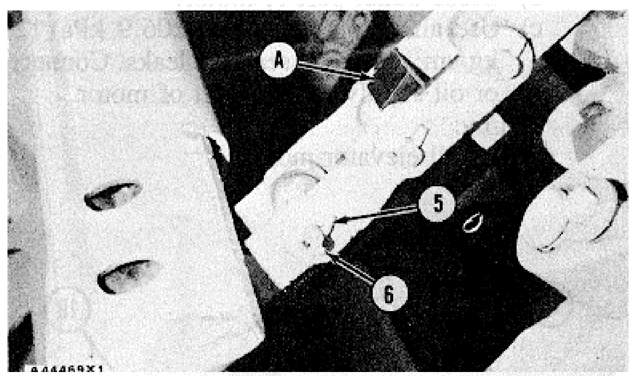


2. Fasten the elevator chain so it can not move. Fasten a hoist to the elevator chain. Lift the chain until the weight is off the roller.

3. Remove bolt (3) and loosen bolt (4). The roller will turn away from chain.

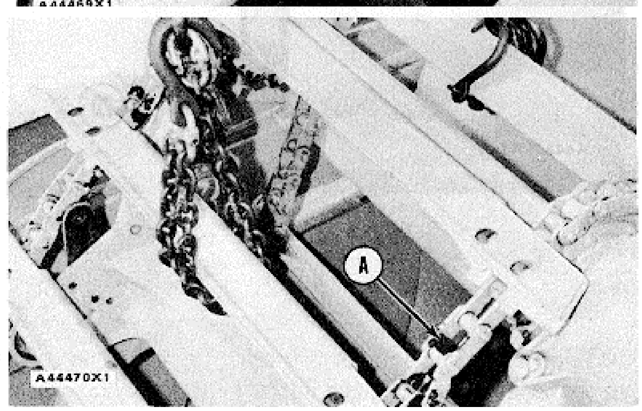


4. Install tool (A) on the chain and tighten it until the chain link moves freely and remove lockpin (5) and pin (6).



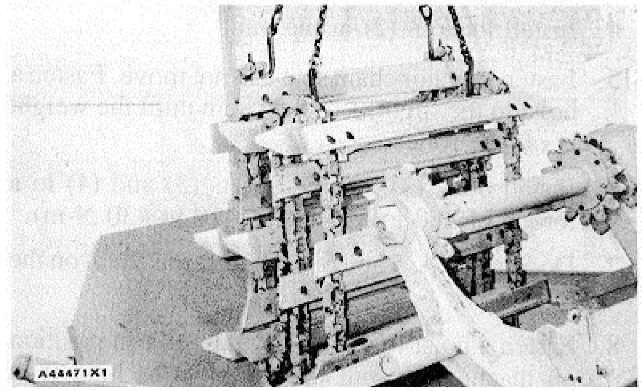
5. Do Steps 4, 5 and 6 to disconnect the chain on other side.

6. Fasten a hoist to the chain flights and remove tooling (A) from both sides. Turn the upper drive sprocket and let the chain fall in the scraper bowl.



ELEVATOR CHAIN ASSEMBLY

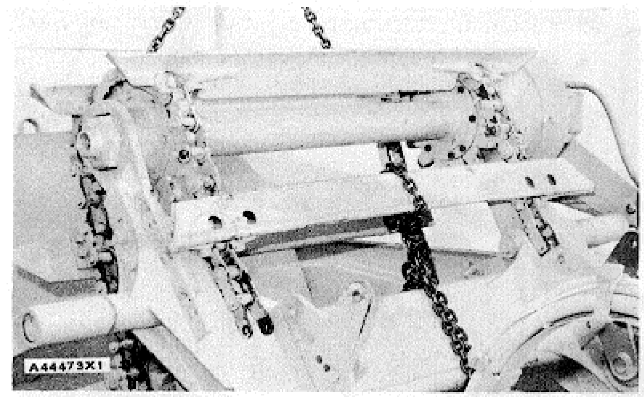
7. Fasten a hoist to chain and remove chain from bowl. The weight of the chain assembly is 1300 lb. (585 kg).



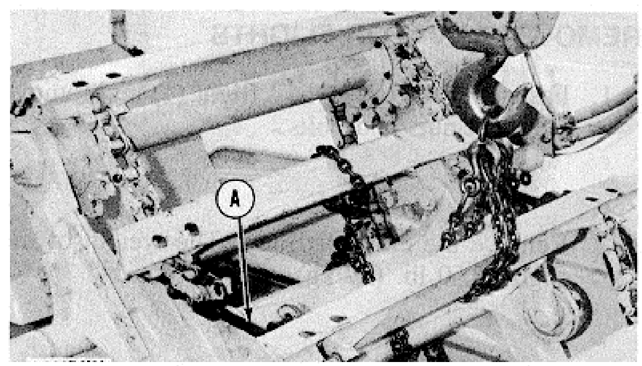
INSTALL ELEVATOR CHAIN ASSEMBLY

	Tools Needed	A
5P2706	Chain Clamp Assembly	2

NOTE: Use 5P960 Multipurpose Type Grease on bolts and nuts.

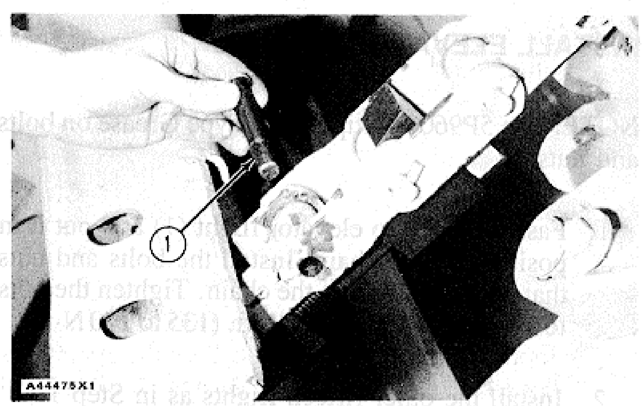


1. Put chain in bowl and fasten hoist to flight nearest the chain separation. Lift the flight and put on sprockets as shown. Install chain around flight and frame to hold chain.



2. Fasten hoist to other end of chain. Lift the chain to position shown and fasten tooling (A) to end of chain. Tighten tooling (A) until the chain link is together.

3. Install pin (1) in the linkage.



NOTE: The flat area on pin and flat area on linkage must be in alignment for correct installation.

ELEVATOR CHAIN ASSEMBLY, ELEVATOR FLIGHTS

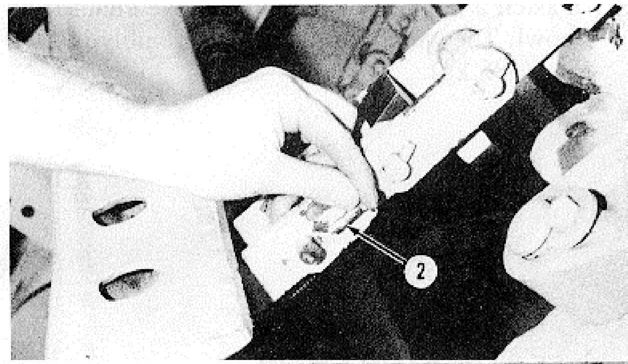
4. Install lockpin (2) in the pin.

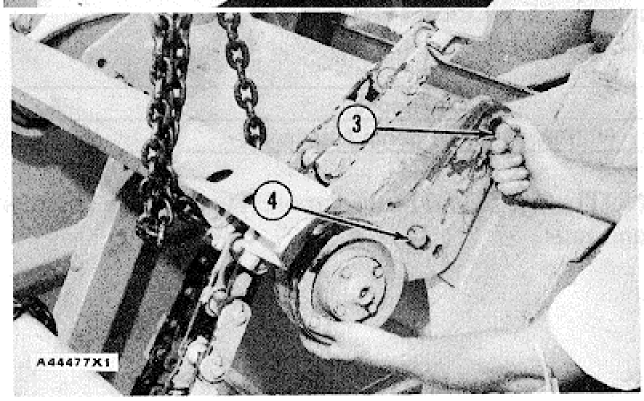
5Fasten elevator chain so it can not move. Fasten a hoist to the flight. Lift the chain until the weight is off the roller.

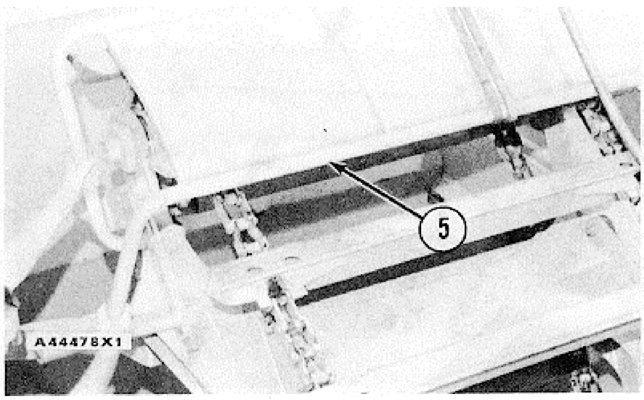
6. Install bolts (3). Tighten bolts (3) and (4) to a torque of 300 to 315 lb. ft. (410 to 430 N. m).

7. Do Steps 3, 4, 5 and 6 to connect the chain on the other side.

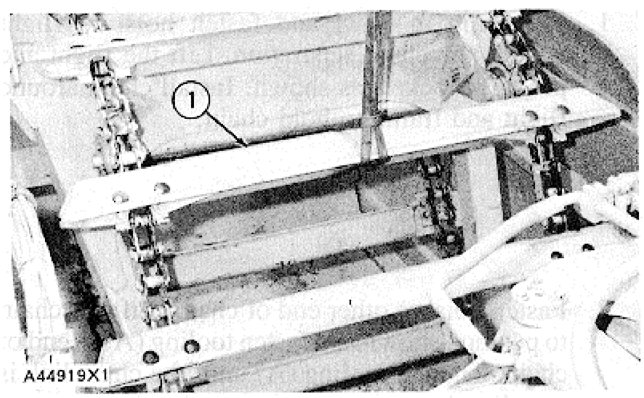
8. Fasten a hoist to guard (5) and put it in position on machine. Install the six bolts to hold it in place.







REMOVE ELEVATOR FLIGHTS

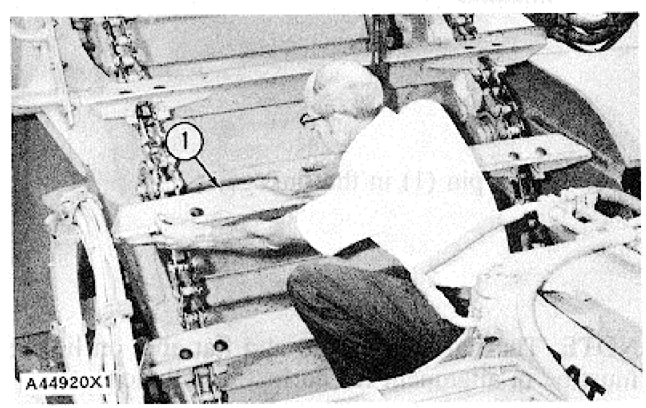


1. Fasten a hoist to elevator flight (1) and remove the eight nuts and bolts.

2. Remove the elevator flight. The weight of the flight is 60 lb. (27 kg).

3. Remove the other fifteen flights as in Step 2.

INSTALL ELEVATOR FLIGHTS



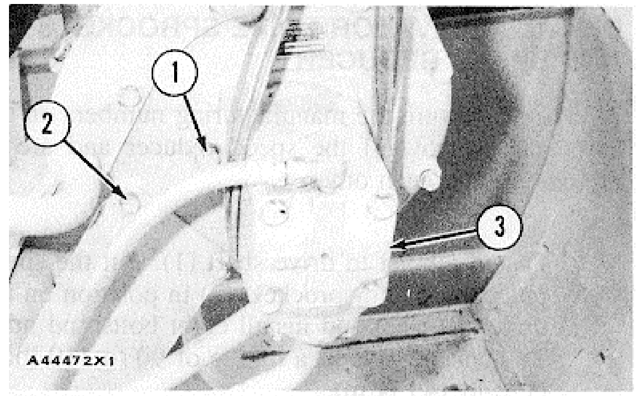
NOTE: Use 5P960 Multipurpose Type Grease on bolts and nuts.

1. Fasten a hoist to elevator flight (I) and put it in position on the chain. Install the bolts and nuts that hold the flight to the chain. Tighten the nuts to a torque of 10to 125 lb. ft. (135 to 170N. m).

2. Install the other fifteen flights as in Step 1.

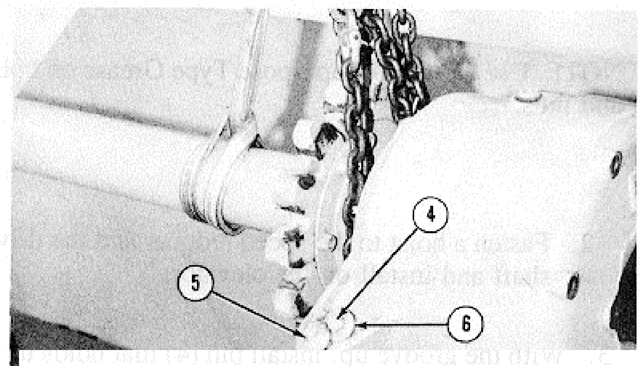
ELEVATOR DRIVE SPROCKETS AND SPEED REDUCER

REMOVE ELEVATOR DRIVE SPROCKETS AND SPEED REDUCER



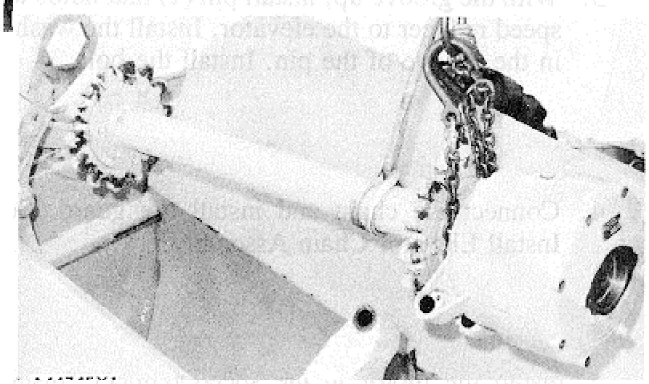
1. Drain the oil from the speed reducer.

2. Fasten a hoist to elevator hydraulic motor (3) and remove two bolts (1). Remove bolts (2) from the bracket. Slide the motor out of the speed reducer and lower the motor and guard over the side of the bowl.

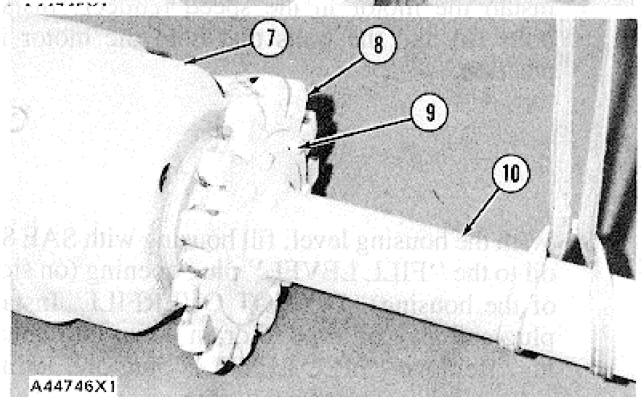


3. Remove the guard and make a separation of the elevator chain. See Remove Elevator Chain Assembly.

4. Fasten a hoist to the shaft and the speed reducer. Remove bolts (4) and washer (6). Remove pin (5) from the bottom of the speed reducer with a punch and hammer.



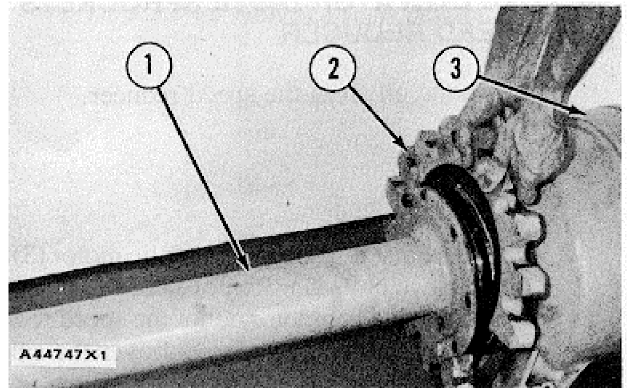
5. Remove the speed reducer, drive shaft and drive sprockets as a unit. The weight of the unit is 570 lb. (257 kg).



6. Fasten a hoist to the shaft. Remove eight nuts and bolts (9) that hold speed reducer (7) and drive sprockets (8) to drive shaft (10). Remove the drive shaft. The weight of the drive shaft is 176 lb. (79 kg). The weight of the speed reducer is 365 lb. (164 kg).

ELEVATOR DRIVE SPROCKETS AND SPEED REDUCER

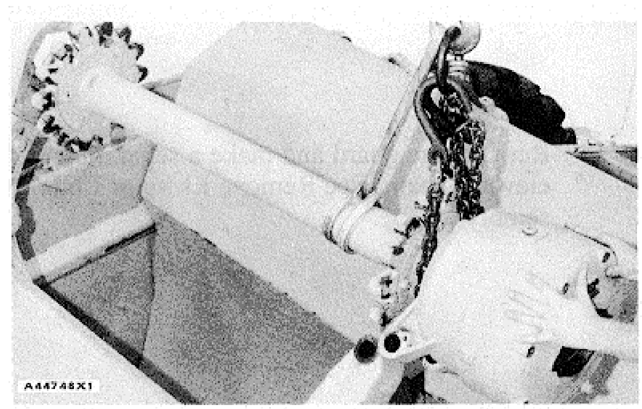
INSTALL ELEVATOR DRIVE SPROCKETS AND SPEED REDUCER



NOTE: Make sure the manufacturing numbers on the sprockets are toward the speed reducer and are in alignment with each other.

1. Fasten a hoist to drive shaft (1). Put the speed reducer (3) and sprockets (2) in position on the drive shaft (I) and install eight bolts and nuts. Tighten the nuts to a torque of 90 to 110 Ib. ft. (120 to 149 N m).

NOTE: Use 5P960 Multipurpose Type Grease on bolts and nuts.



2. Fasten a hoist to the speed reducer and the drive shaft and install on the elevator.

3. With the groove up, install pin (4) that holds the speed reducer to the elevator. Install the washer in the groove of the pin. Install the bolt.

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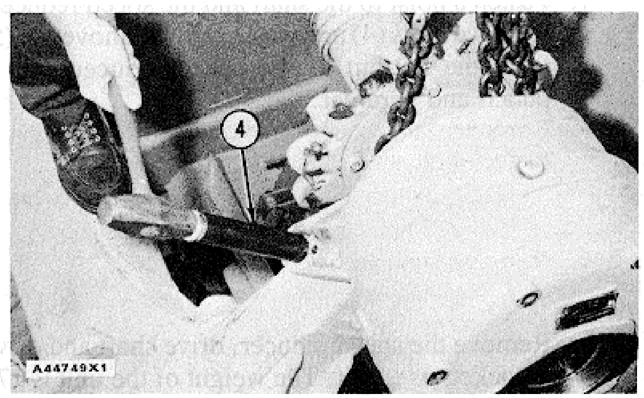
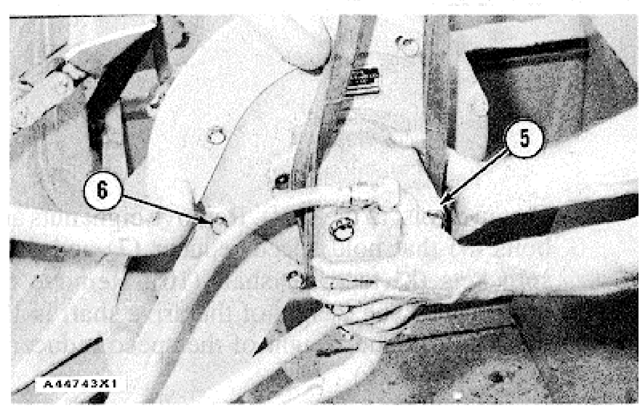


4. Connect the chain and install the guard. See Install Elevator Chain Assembly.

5. Fasten a hoist to elevator hydraulic motor (5) and install the motor in the speed reducer. Install bolts (6) and the bolts that hold the motor in position.



6. With the housing level, fill housing with SAE 80 oil to the "FILL LEVEL" plug opening (on side of the housing). DO NOT OVERFILL. Install plug and give oil time to drain down into housing. Remove ’FILL LEVEL" plug and let all extra oil drain out. Install plug.

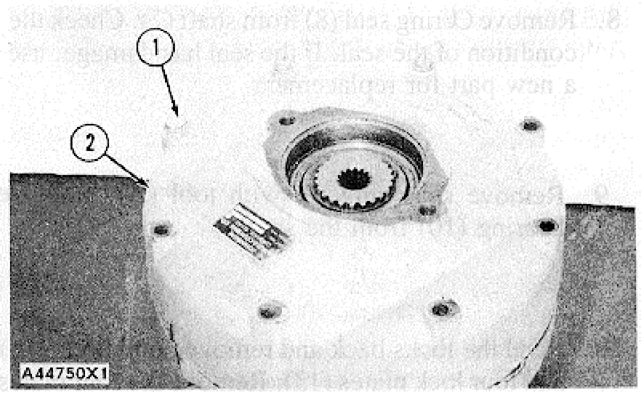
ELEVATOR SPEED REDUCER

DISASSEMBLE ELEVATOR SPEED REDUCER

	Tools Needed	A	B
1P1863	Snap Ring Pliers	1	
1H3107	Puller Assembly		1
1H3108	Leg		2
1H3110	Bearing Puller Attachment		1
S2398	Spacer		1

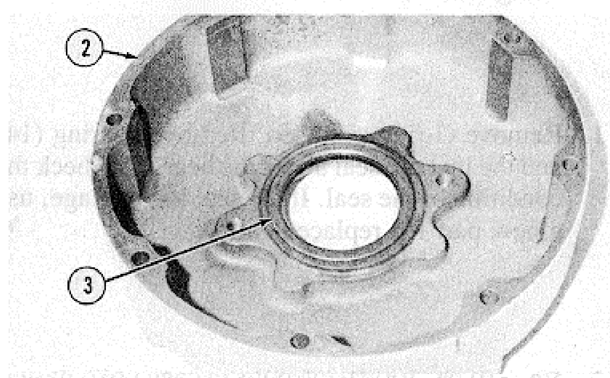
start by:
a) remove elevator drive sprockets and speed reducer

1. Remove bolts (1) from the housing. Put identification marks for correct assembly.

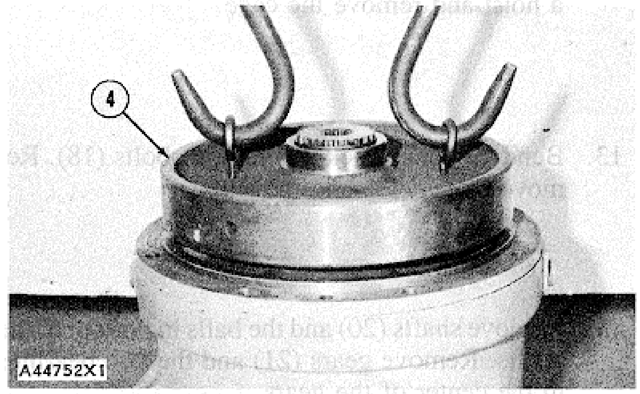


2. Remove housing (2) from the ring. Put identification marks for correct assembly.

3. Remove seal (3) from housing (2).

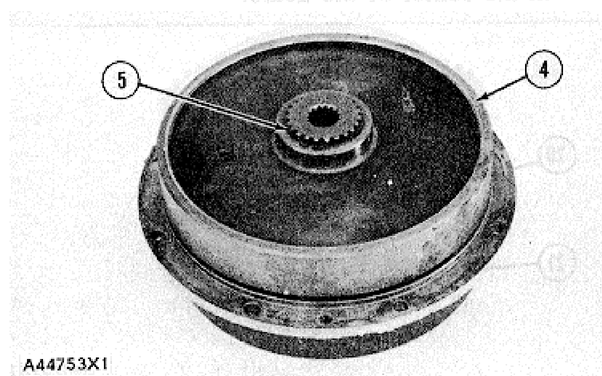


4. Install two 3/8"-16 NC forged eyebolts in flywheel (4). Fasten a hoist to the flywheel, ring and gear and remove as a unit. The weight of the unit is 100 lb. (45 kg).

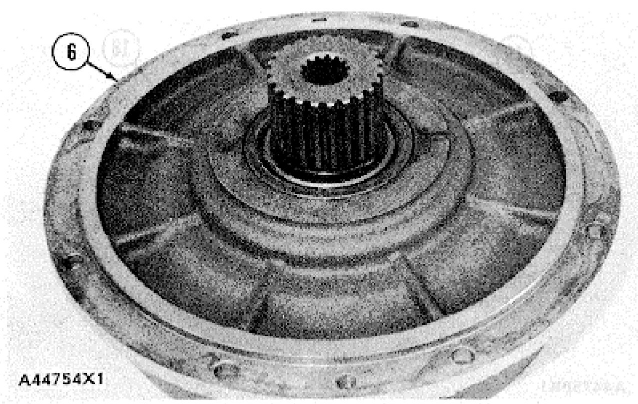


5. Remove snap ring (5) that holds the flywheel (4) to the shaft with tool (A).

6. Remove flywheel (4) from the shaft.



7. Remove ring (6) from the shaft.

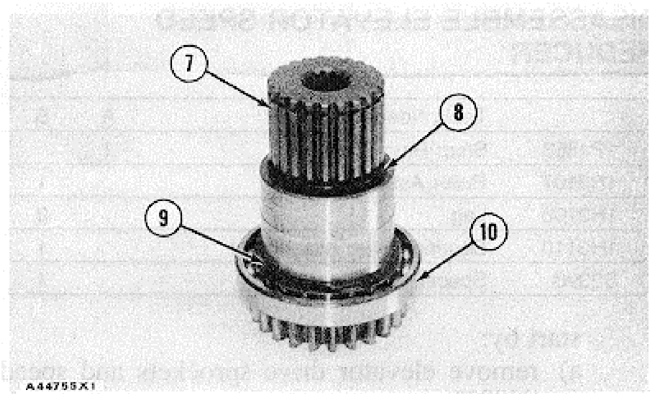


ELEVATOR SPEED REDUCER

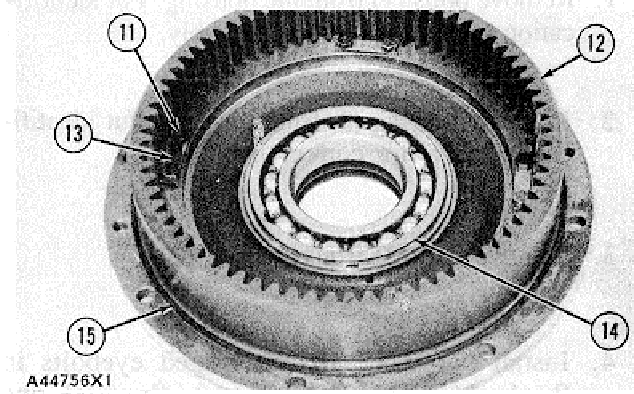
8. Remove O-ring seal (8) from shaft (7). Check the condition of the seal. If the seal has damage, use a new part for replacement.

9. Remove snap ring (9) with tool (A). Remove bearing (10) from the shaft.

10. Bend the locks back and remove eight bolts (11) and four lock plates (13). Remove the four plates and gear (12).

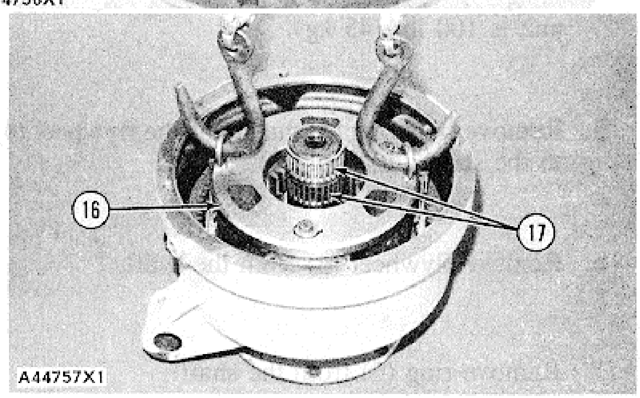


11. Remove O-ring seal (15). Remove bearing (14) and the lip type seal under the bearing. Check the condition of the seal. If the seal has damage, use a new part for replacement.

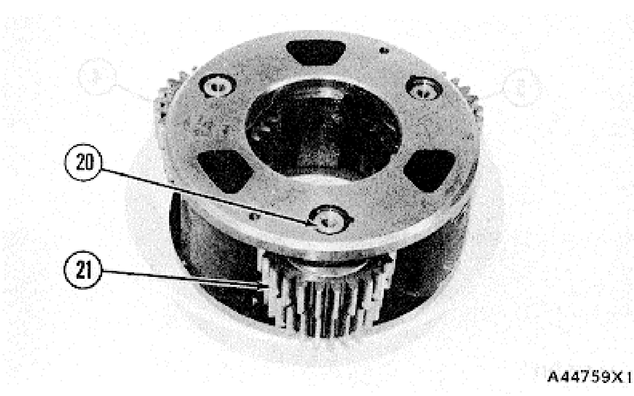


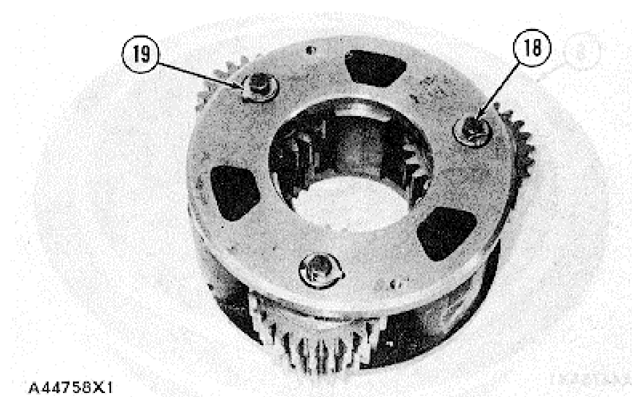
12. Remove two roller bearings (17). Install two 3/8"'-16 NC forged eyebolts in cage (16). Fasten a hoist and remove the cage.

13. Bend the locks back and remove bolts (18). Re- move plates (19) and the shims.



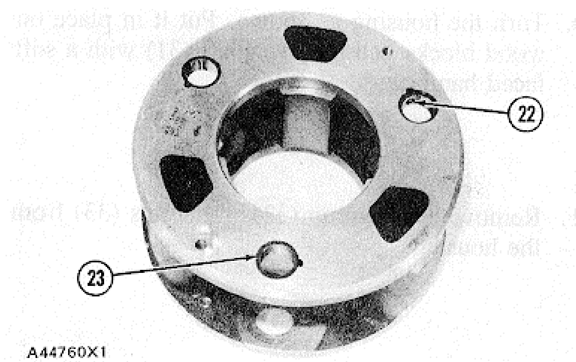
14. Remove shafts (20) and the balls in bottom of the shafts. Remove gears (21) and the two bearings in the center of the gears.



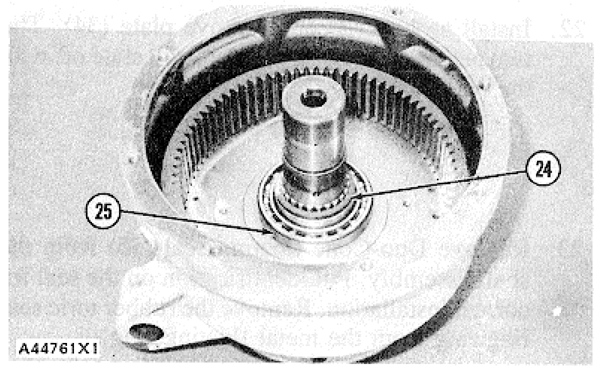


ELEVATOR SPEED REDUCER

15. Remove balls (22) and sleeves (23).

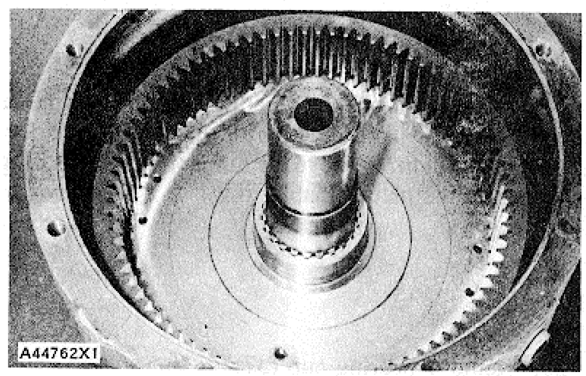


16. Remove lockring (24) and bearing (25).

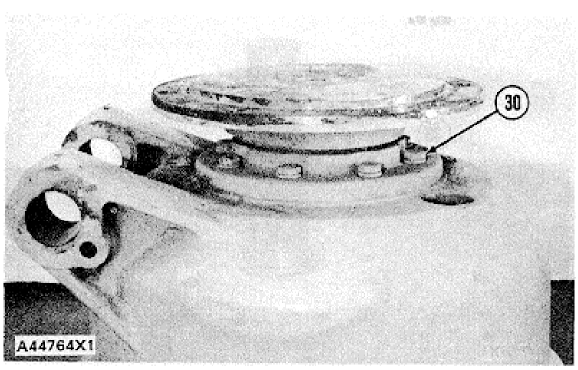


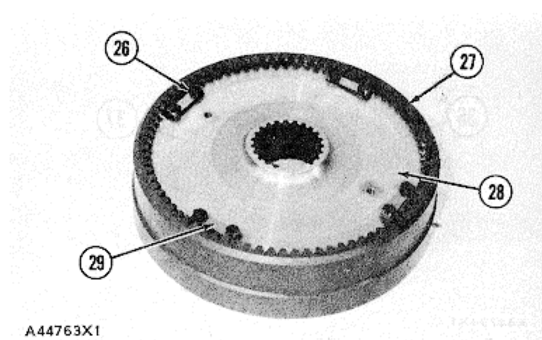
17. Remove the plate and the gear as a unit.

18. Bend the locks back and remove bolts (26) and locks. Remove the four plates (29) and make a separation of plate (28) from gear (27).



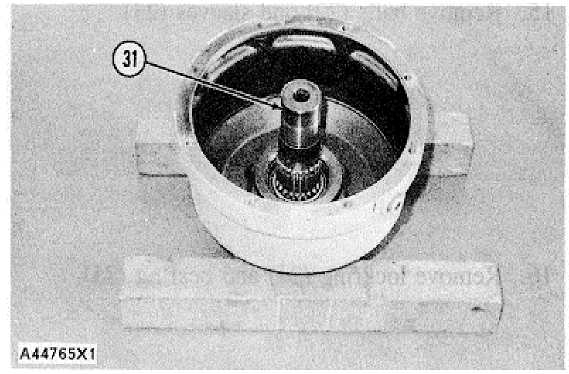
19. Turn the housing as shown. Remove eight bolts (30) from the housing.



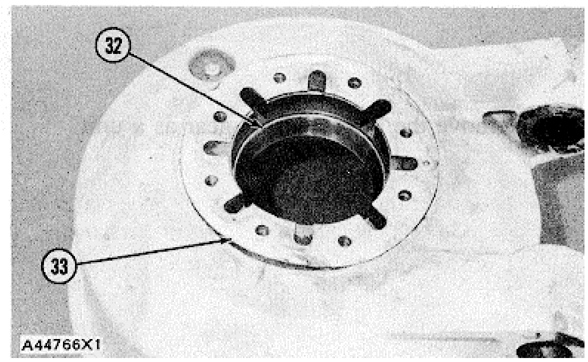


ELEVATOR SPEED REDUCER

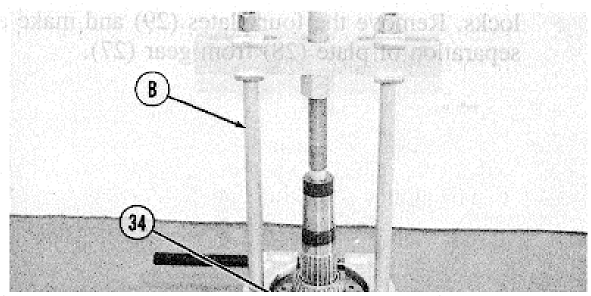
20. Turn the housing as shown. Put it in place on wood blocks and remove shaft (31) with a soft faced hammer.



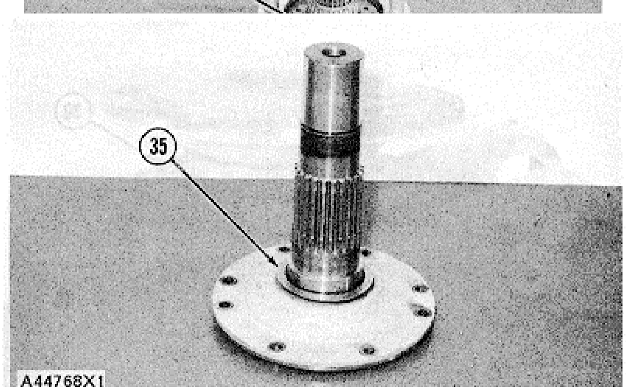
21. Remove bearing cup (32) and shims (33) from the housing.



22. Install tooling (B) and remove plate (34). The two bearings on top of the plate will slide off with the plate.

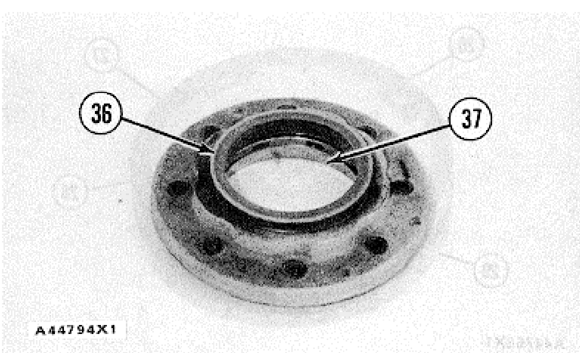


23. Remove Duo-Cone floating seal (35) from the shaft assembly. Put identification on the seal for correct installation. Remove the rubber toric sealing ring from the metal floating ring.



24. Remove Duo-Cone floating seal (36) from the plate. Put identification on the seal for correct installation. Remove the rubber toric sealing ring from the metal floating ring.

25. Remove bearing cup (37).

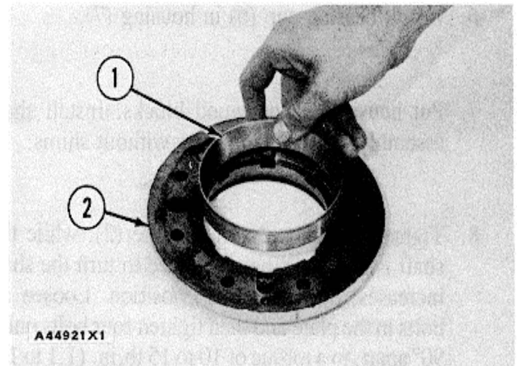


ELEVATOR SPEED REDUCER

ASSEMBLE ELEVATOR SPEED REDUCER

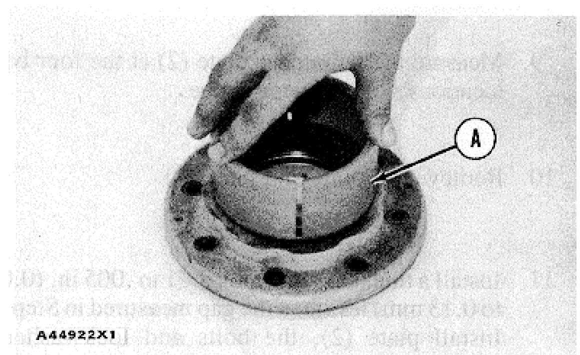
	Tools Needed	A	B	C
5M2160	Duo-Cone Seal Installer	1		
1P520	Driver Group		1	
1P163	External Snap Ring Pliers			1

1. Install bearing cup (1) in plate (2).

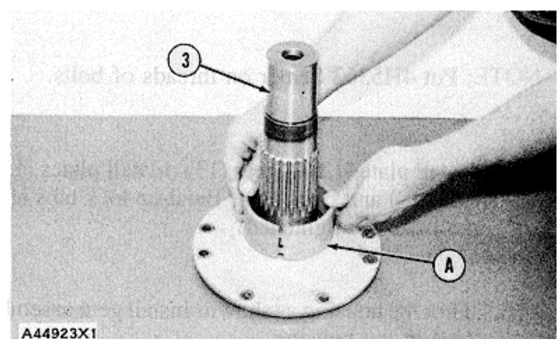


NOTE: Make sure the Duo-cone seals are clean and dry. Make sure all metal surfaces that the seal makes contact with are clean and dry. Put clean oil on the contact surfaces of the metal seals.

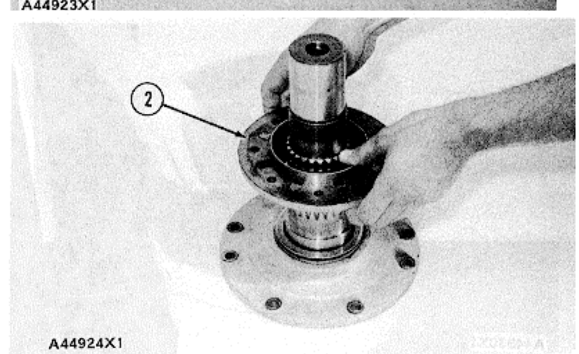
2. Install rubber toric sealing ring to the metal floating ring. Turn the-plate as shown. Install the Duo-Cone seal in the plate with tool (A).



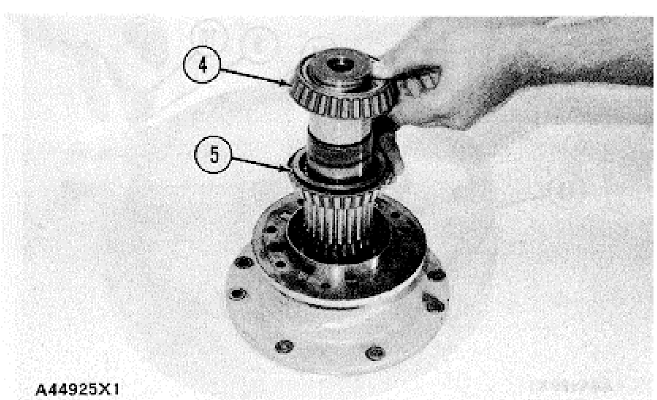
3. Install rubber toric sealing ring on the metal floating ring. Install the Duo-Cone seal in shaft (3) with tool (A).



4. Install plate (2) on the shaft.

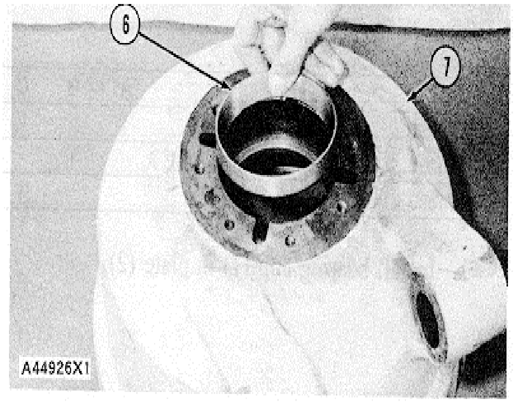


5. Install bearings (4) and (5) on the shaft as shown.



ELEVATOR SPEED REDUCER

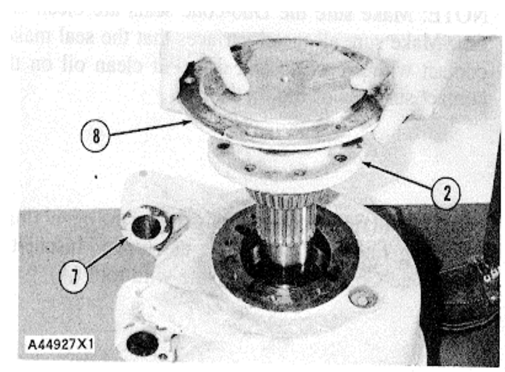
6. Install bearing cup (6) in housing (7).



7. Put housing (7) on wood blocks. Install shaft assembly (8) in the housing without shims.

8. Tighten the bolts that hold plate (2), while the shaft is turned. When the force to turn the shaft increases, bearings are in position. Loosen all bolts in the plate and then tighten four bolts only, 90° apart, to a torque of 10 to 15 Ib.in. (1.1 to 1.7 N.m).

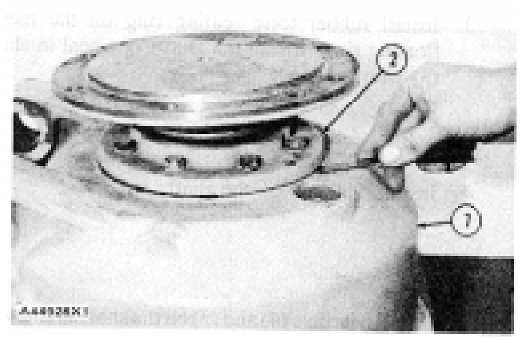
9. Measure the gap under plate (2) at the four bolt locations with a feeler gauge.



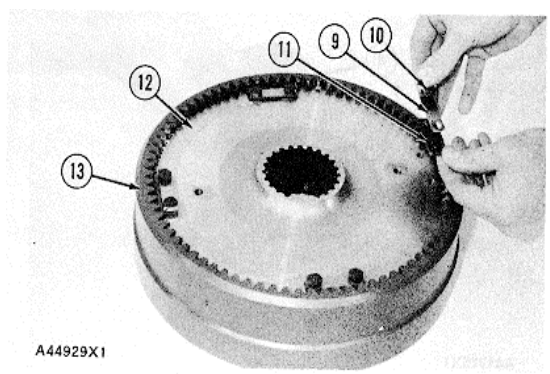
10. Remove the bolts and plate (2).

11. Install a thickness of shims .001 to .005 in. (0.03 to 0. 13 mm) less than the gap measured in Step 8. Install plate (2), the bolts and lockwashers. Tighten the bolts to a torque of 32 ± 5 Ib.ft. (45 ± 7 N.m).

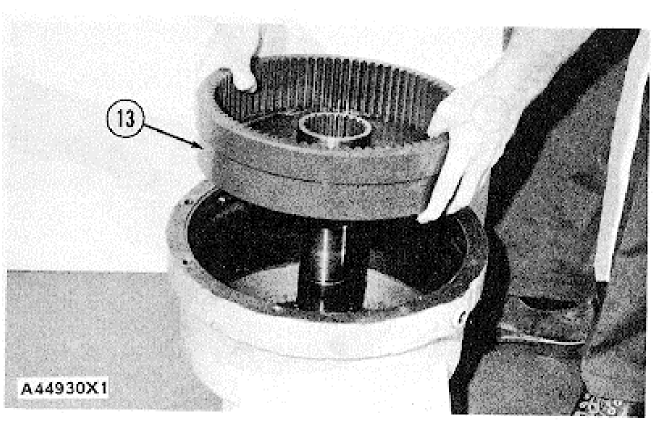
NOTE: Put 4H5363 Sealer on threads of bolts.



12. Install plate (12) in gear (13). Install plates (I 1), locks (9) and bolts (10). Bend up lock tabs after the bolts are tightened.



13. Turn the housing as shown. Install gear assembly (13) in the housing.



ELEVATOR SPEED REDUCER

14. Install lockring (15) on shaft (14). Install bearing (16).

15. Install sleeves (18) and balls (19) in cage (17). Alignment of the hole in the sleeve and the notch in the cage must be correct before ball can be installed in position. Be careful in next step so that balls do not fall out of sleeves.

16. Put cage (17) on its side as shown. Put the bearings in gears (20) and install the gears in the cage. Install shafts (2 I) through the cage and the gears. Put balls (22) in the holes at the end of the shafts and install the balls in the notches in the cage.

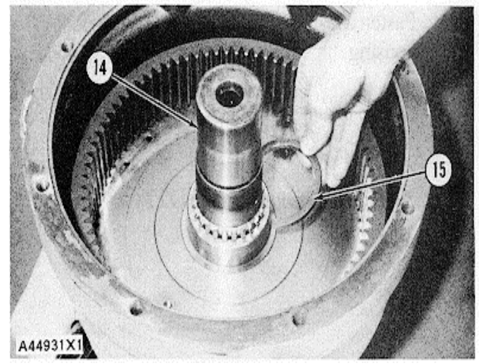
17. Put the cage in position as shown and be careful so that shafts do not slide out. To adjust bearing, install bolt (23) and washer (26) without shims (25). Tighten bolt until gear does not turn freely.

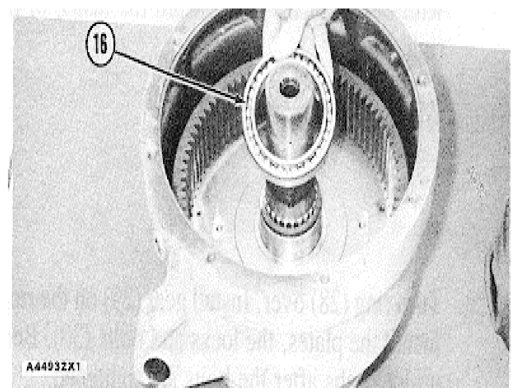
18. Measure the gap under the washer with a feeler gauge to get the thickness for shims.

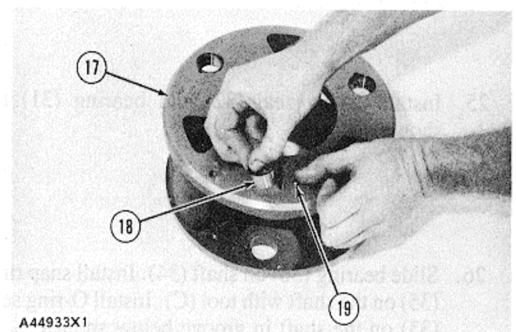
19. Remove bolts (23) and washers (26).

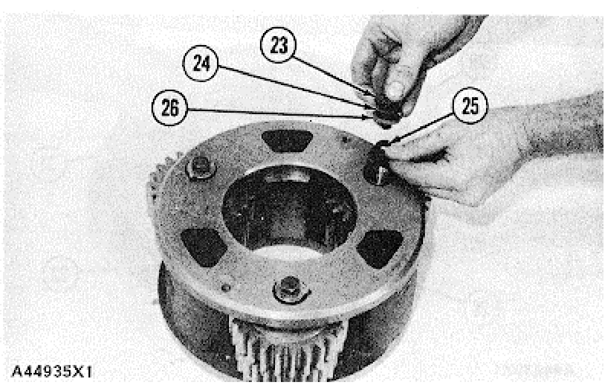
20. Install the thickness of shims (25) measured in Step 18 and install washer (26), lock (24) and bolt (23). Tighten the bolt to a torque of 50 + 10 lb.ft. (70 $^{+}$ 14 N.m). Do each bolt separately.

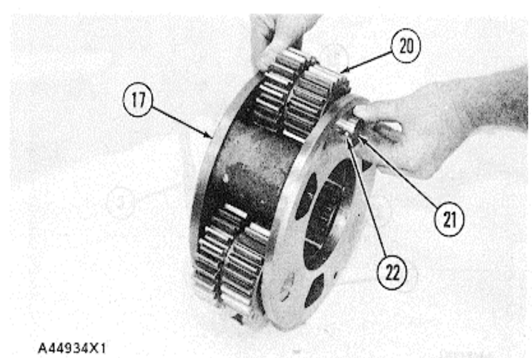
NOTE: Gear must turn freely with no end play on bearings, .000 to .002 in. (0.00 to 0.05 mm) tight.





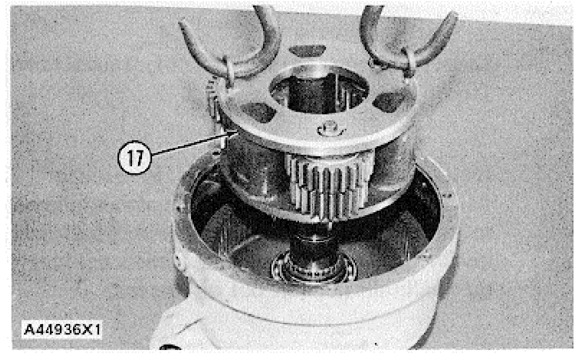




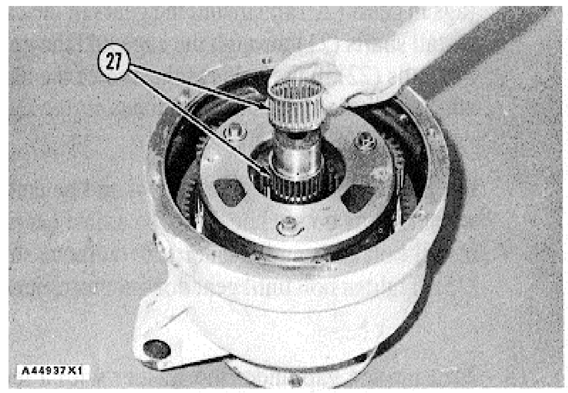


ELEVATOR SPEED REDUCER

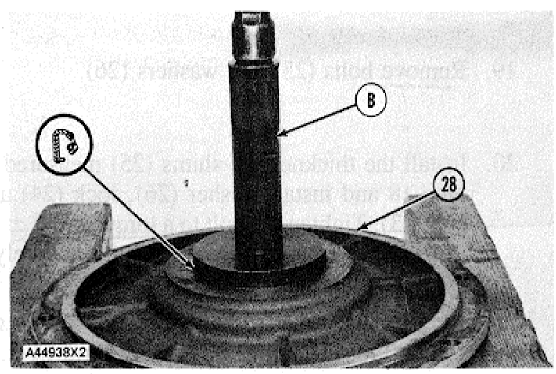
21. Fasten a hoist to cage (17). Install the cage in the housing.



22. Install two roller bearings (27) on the shaft.

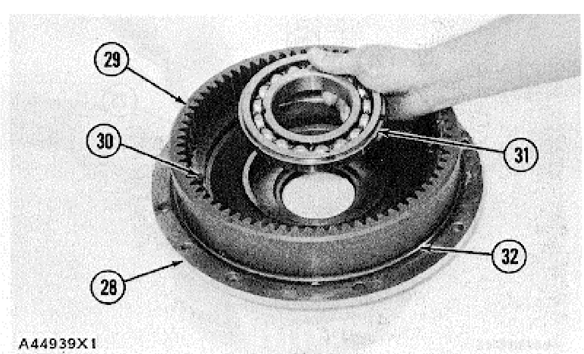


23. Put ring (28) on wood blocks. Install the seal with tooling (B). Install the seal until it makes contact with the counterbore in the housing and with the lip of the seal toward the inside of the ring.

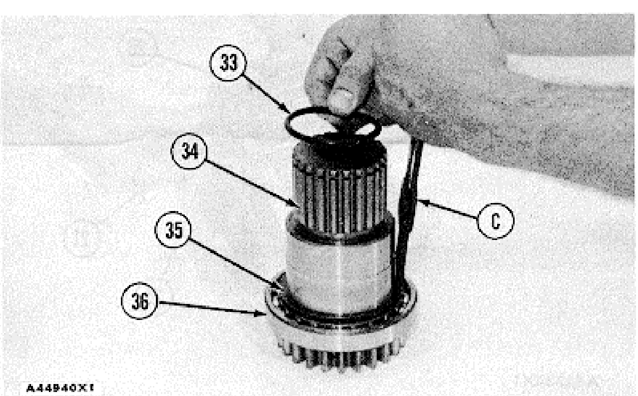


24. Turn ring (28) over. Install gear (29) on the ring. Install the plates, the locks and bolts (30). Bend up lock tabs after the bolts are tightened.

25. Install O-ring seal (32) and bearing (31) as shown.

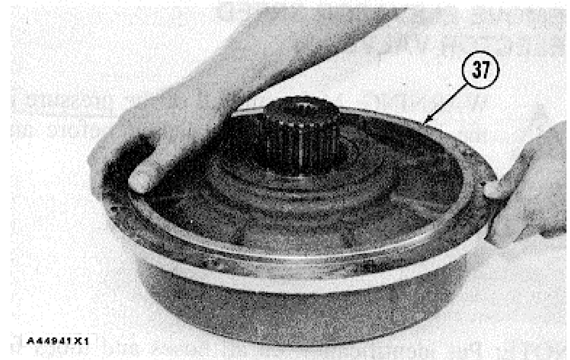


26. Slide bearing (36) on shaft (34). Install snap ring (35) on the shaft with tool (C). Install O-ring seal (33) on the shaft in groove below splines.

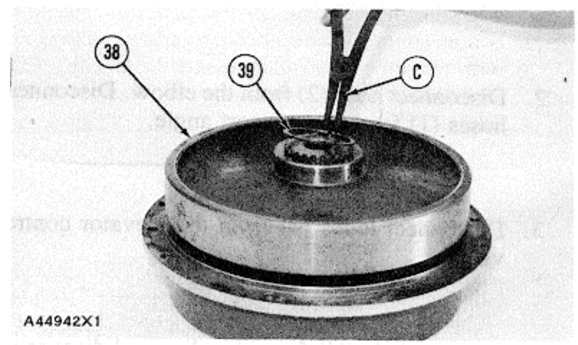


ELEVATOR SPEED REDUCER

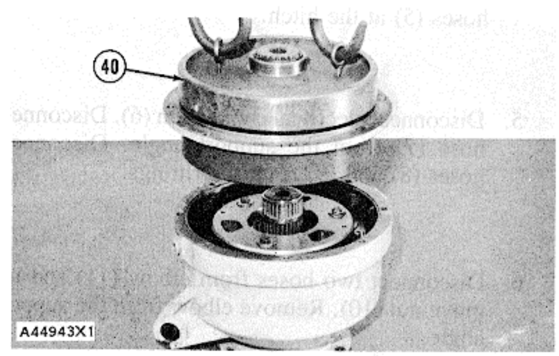
27. Install ring assembly (37) on the shaft.



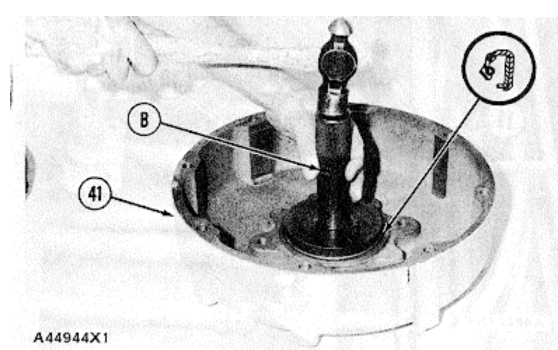
28. Install flywheel (38) and snap ring (39). Install the snap ring with tool (C).



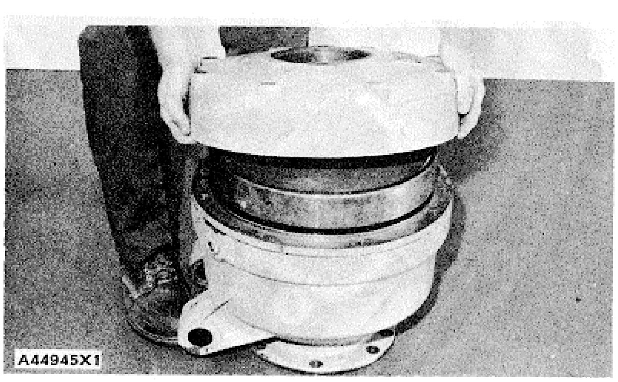
29. Fasten a hoist to the flywheel. Install the flywheel assembly (40) in the housing.



30. Install the seal with tooling (B) in housing (41). Install the seal with the lip toward the inside of the housing.



31. Install the housing and the three bolts.
end by:
   a) install elevator drive sprockets and speed reducer



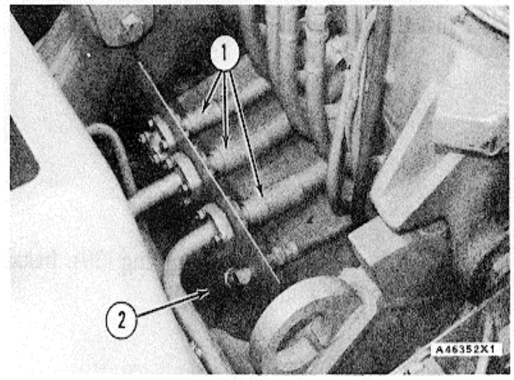
ELEVATOR SPEED SELECTOR VALVE

REMOVE ELEVATOR SPEED SELECTOR VALVE

WARNING: Make sure all of the pressure in the hydraulic system is released before any lines are disconnected.

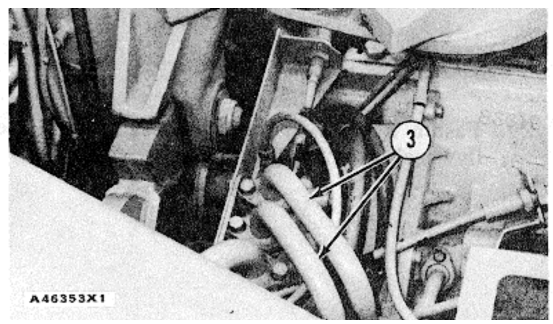
1. Drain the oil from the hydraulic tank.

NOTE: Put identification on all hoses and tubes for correct assembly.

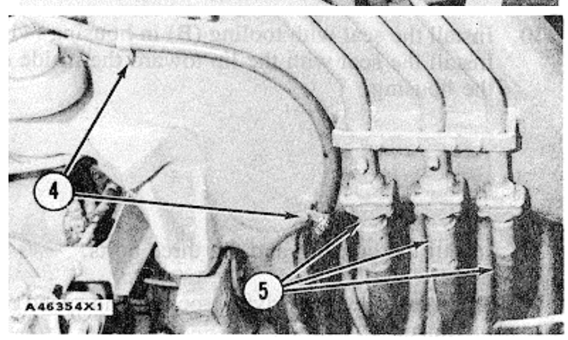


2. Disconnect hose (2) from the elbow. Disconnect hoses (I) from the support angle.

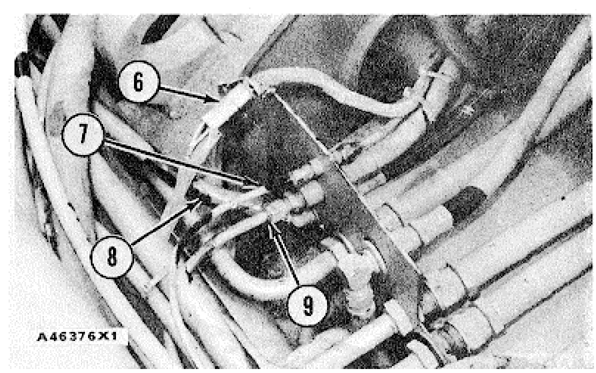
3. Disconnect tubes (3) from the elevator control valve.



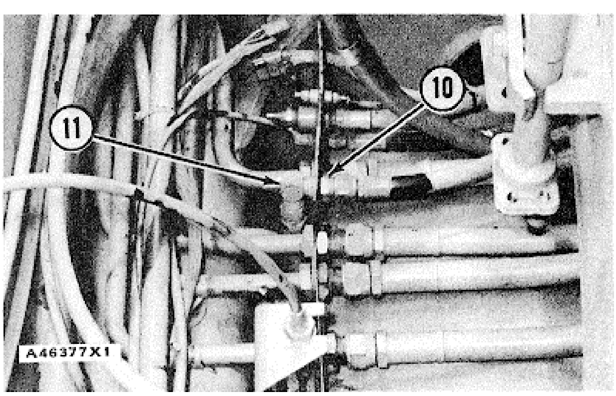
4. Remove bolts (4) from the clips and disconnect hoses (5) at the hitch.



5. Disconnect electrical connection (6). Disconnect hose (7) from the support angle. Disconnect hoses (8) and (9) from the fittings.

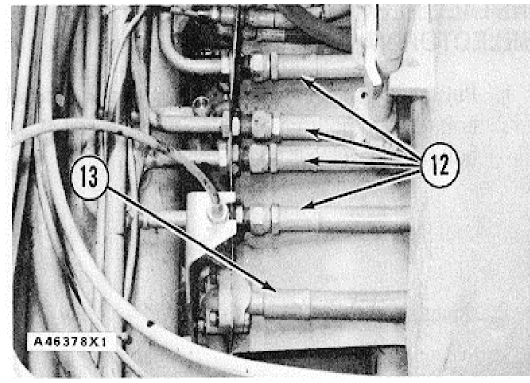


6. Disconnect two hoses from elbow (11) and remove nut (10). Remove elbow from the support angle.



ELEVATOR SPEED SELECTOR VALVE

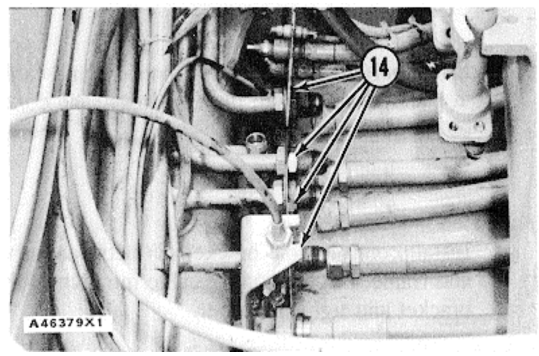
7. Remove tile four bolts and disconnect hose (13).



8. Disconnect four hoses (12) from the fittings.

9. Remove four nuts (14) on the inside of the support angle. Then slide the support angle toward the inside of the machine.

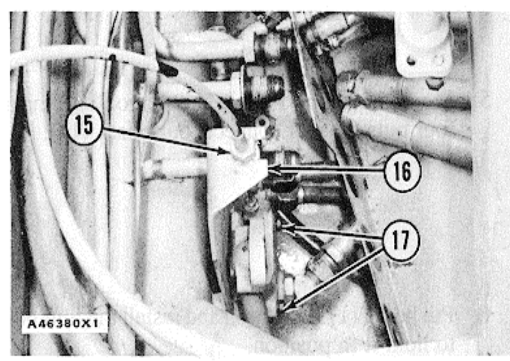
10. Loosen nut (15) on the cable control.



11. Loosen bolts (17) and remove bracket (16).

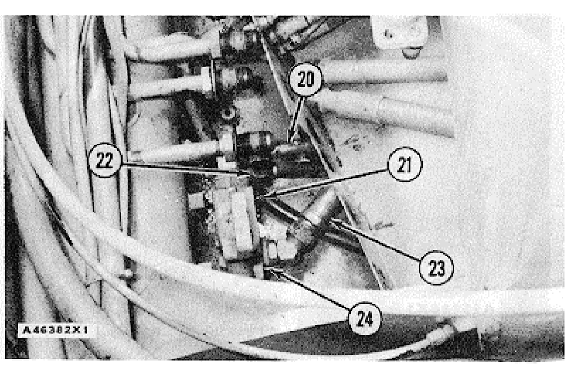
12. Remove cotter pin (18) from pin (19). Remove the pin.

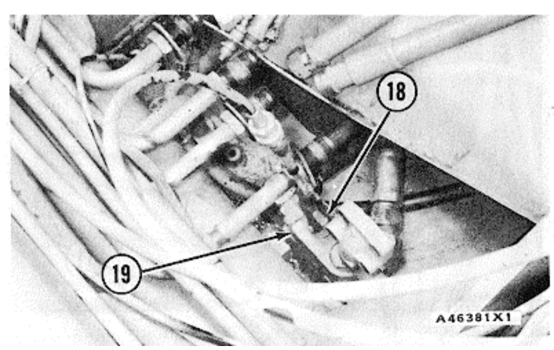
13. Remove bolt (21) from the valve. Disconnect top tube (20). Turn the valve down to disconnect bottom tube (22).



14. Disconnect hose (23) and remove bolt (24) from the valve.

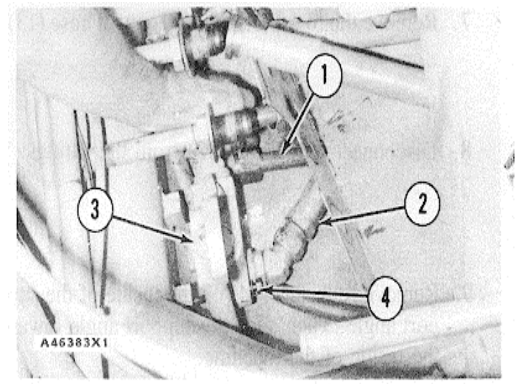
15. Remove the valve.





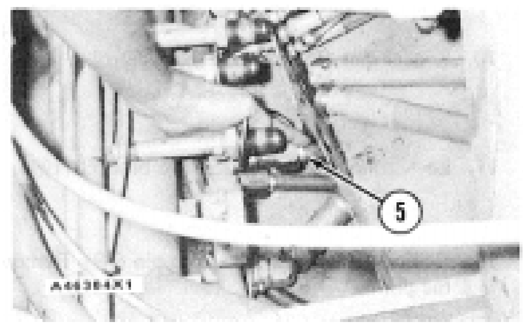
ELEVATOR SPEED SELECTOR VALVE

INSTALL ELEVATOR SPEED SELECTOR VALVE



1. Put speed control valve (3) in position and install bolt (4). Do not tighten bolt. Install hose (2) and bottom tube (I) on the valve.

2. Install top tube (5) on the valve.

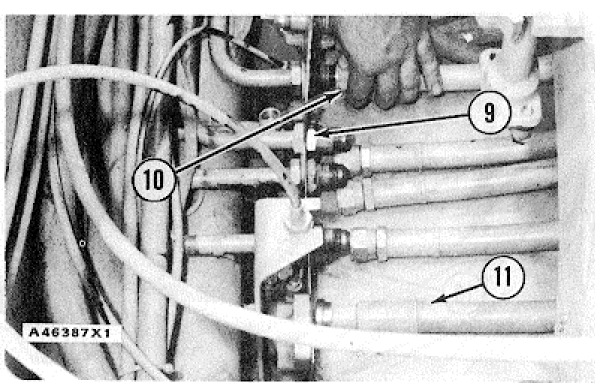


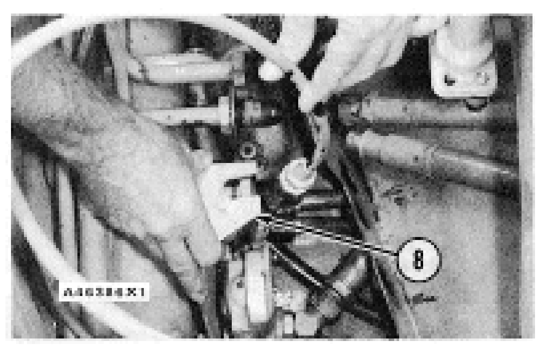
3. Install bolt (6) on the valve. Put the control cable in position and install pin (7). Install the cotter pin through the pin.

4. Install control cable bracket (8) between valve and frame. Put the control cable in notch of the bracket and tighten the nut.

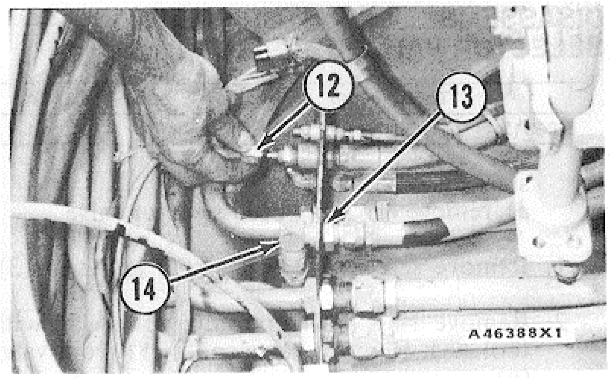
5. Move the support angle in position and install four nuts (9) and connect four hoses (10).

6. Put hose (I) in position and install the four bolts to hold it in position.



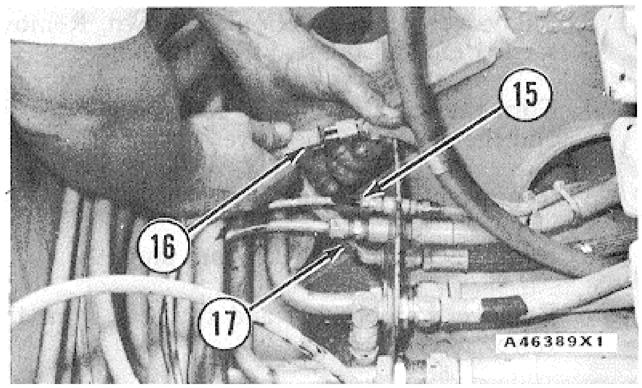


7. Put elbow (14) in position and install nut (13). Connect a hose to each end of the elbow.

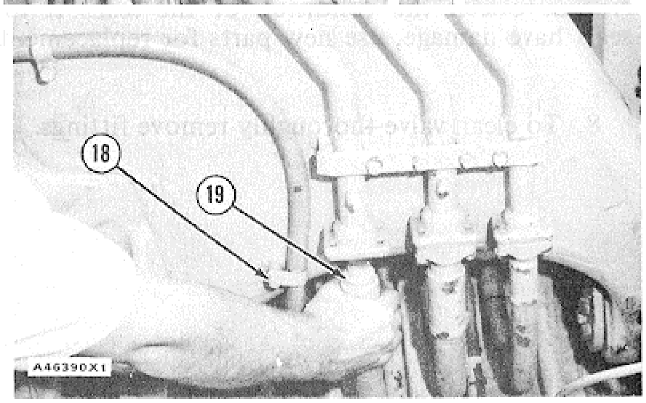


8. Connect hose (12) to the fitting on the support angle.

9. Connect hoses (15) and (17) to their fittings. Connect electrical connection (16).



10. Install two bolts (18) to the hose on the hitch. Connect three hoses (19) to the tubes on the hitch.

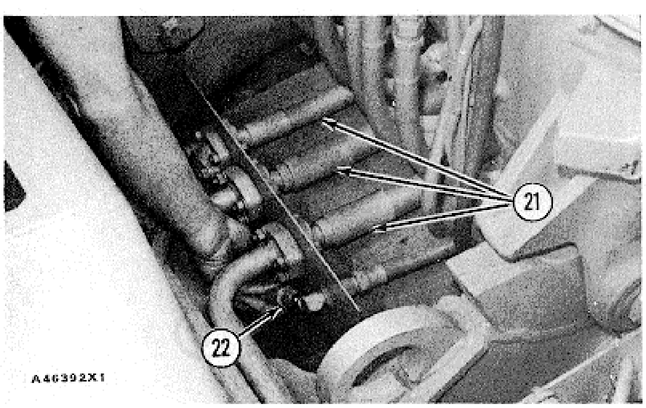


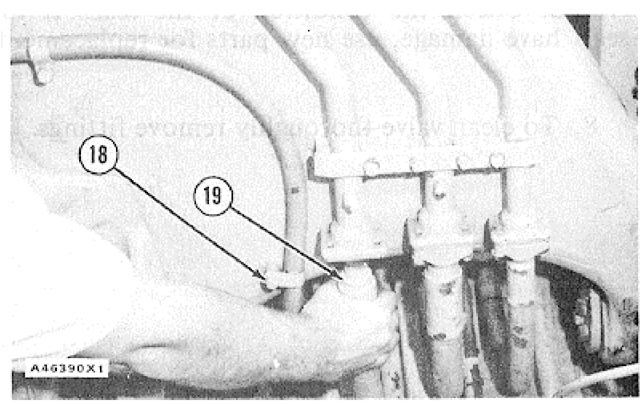
11. On the elevator control valve, connect lines (20) to the valve.

12. Connect hoses (21) to the support angle.

13. Connect hose (22) to the elbow.

14. Fill hydraulic tank with specified hydraulic oil to correct level.

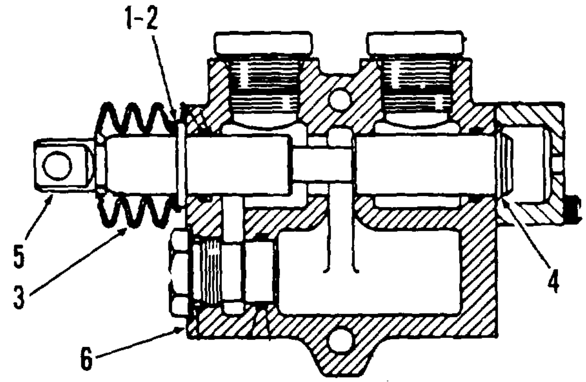




ELEVATOR SPEED SELECTOR VALVE

DISASSEMBLE ELEVATOR SPEED SELECTOR VALVE

	Tools Needed	A
2P8312	Retaining Ring PLers	1

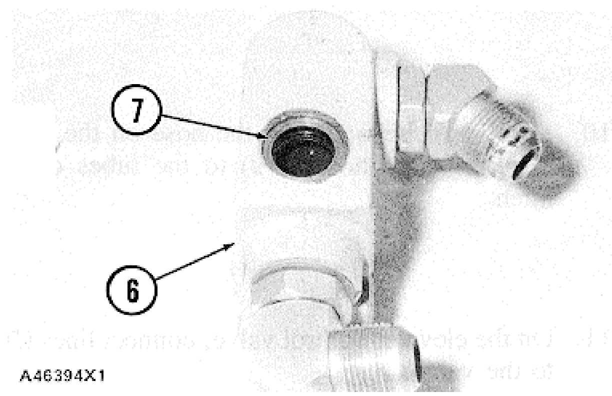


start by:
a) remove elevator speed selector valve

1. Remove screw (1), washer (2) and seal (3).

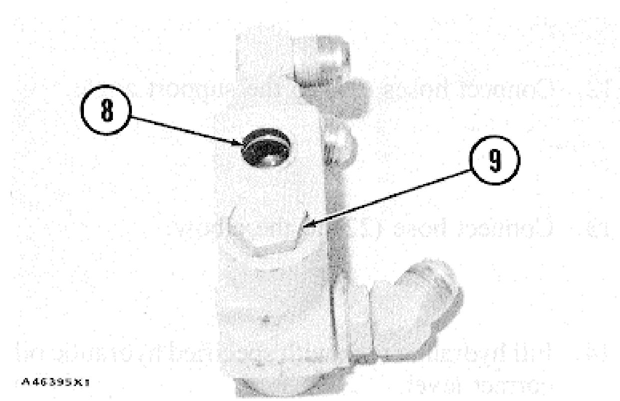
2. Remove ring (4) from valve spool (5) with tool (A). Remove valve spool (5) from valve (6).

3. Put valve (6) in position as shown. Remove washer (7) and the seal from the valve.



4. Turn the valve as shown. Remove washer (8) and the seal from the valve.

5. Remove plug (9) from the valve.

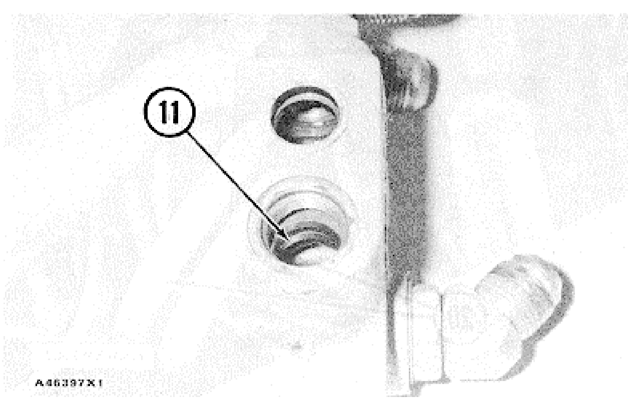


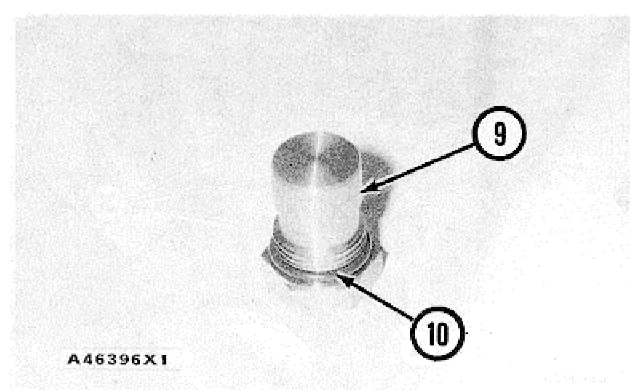
6. Remove O-ring seal (10) from plug (9).

7. Remove washer (11) and the seal from the valve.

NOTE: Check the condition of the seals. If the seals have damage, use new parts for replacement.

8. To clean valve thoroughly remove fittings.



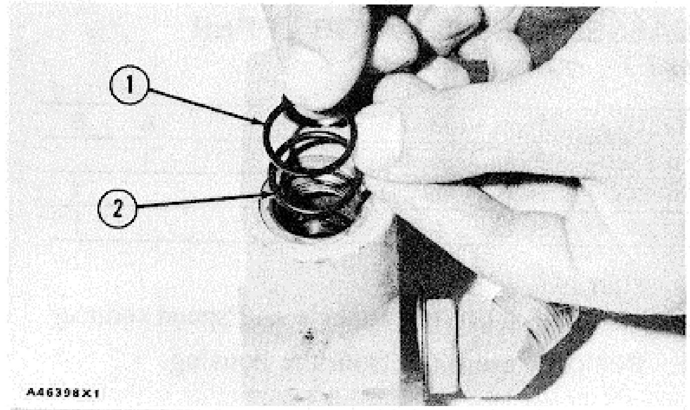


ELEVATOR SPEED SELECTOR VALVE

ASSEMBLE ELEVATOR SPEED SELECTOR VALVE

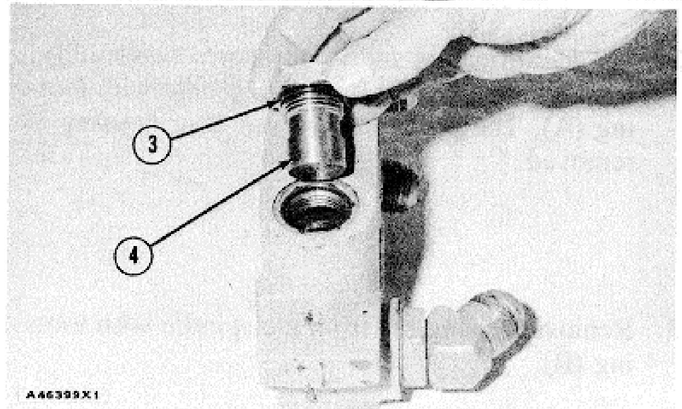
	Tools Needed	A
2P8312	Retaining Ring Pliers	1

NOTE: Make sure all of the parts of the speed selector valve are clean and free of dirt and foreign material. Put clean hydraulic oil on all of the parts of the valve.



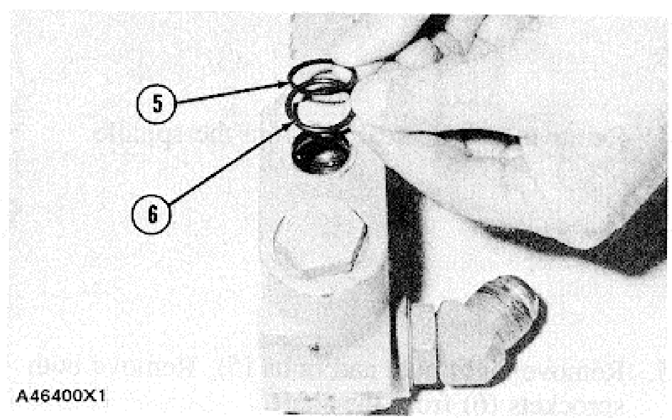
1. Install seal (2) and washer (1) in the valve as shown.

2. Install O-ring seal (3) on plug (4).

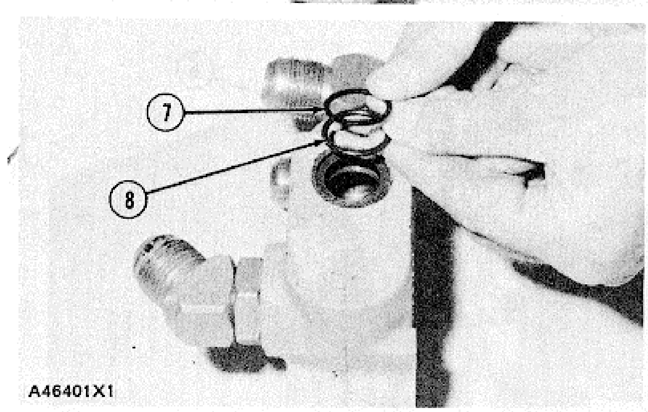


3. Install the plug in the valve.

4. Install O-ring seal (6) and washer (5).



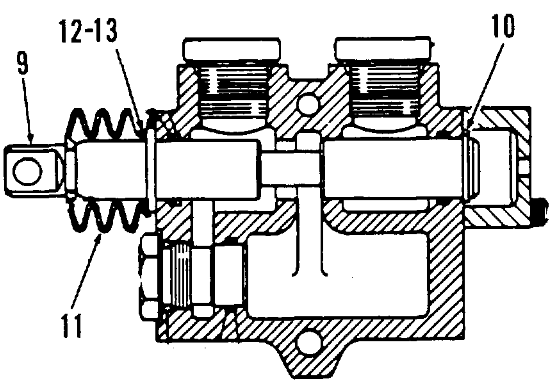
5. Turn the valve as shown and install O-ring seal (8) and washer (7).



6. Install valve spool (9) in the valve. Install ring (10) on valve spool (9) with tool (A). end by:

7. Position seal (11) on spool (9) and install washer (12) and screw (13).

   a) install elevator speed selector valve



ELEVATOR UPPER SHAFT

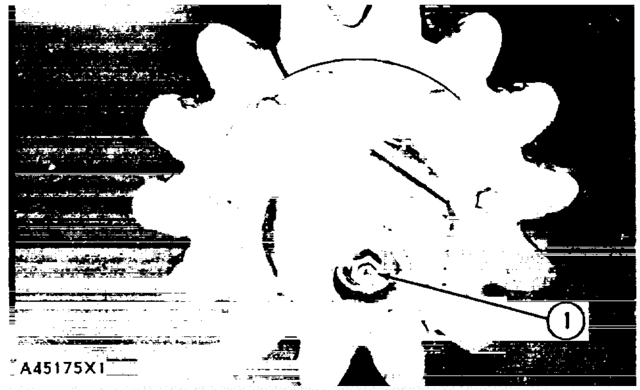
DISASSEMBLE ELEVATOR UPPER SHAFT

	Tools Needed	A	B
1 P2321	Puller Assembly	1	
1 P2320	Puller Assembly		1
L1774	Spacer		1

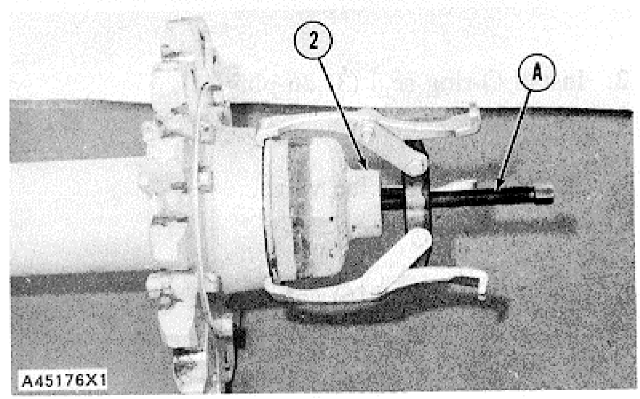
start by:

a) remove drive sprockets and speed reducer

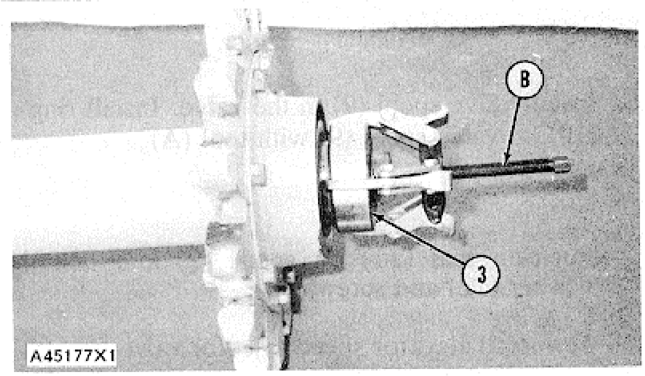
1. Remove fitting (1) from the housing.



2. Put identification marks for correct assembly. Remove housing (2) from the spindle with tooling (A). The plate fall out after housing is removed.

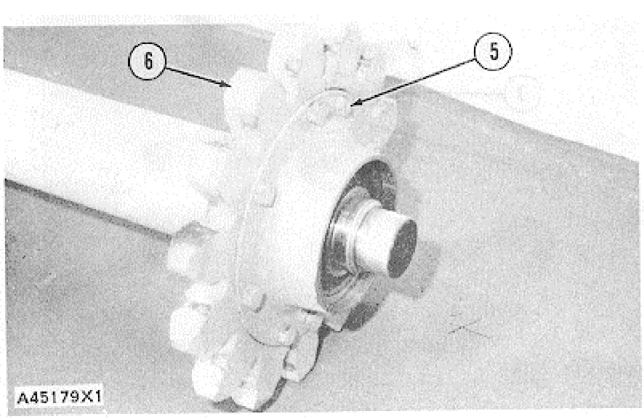


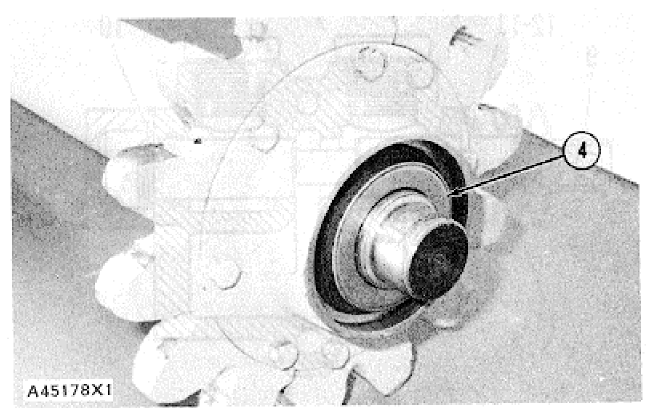
3. Remove bearing (3) from the spindle with tooling (B).



4. Remove lip type seal (4) from the spindle.

5. Remove eight nuts and bolts (5). Remove both sprockets (6) from the shaft.





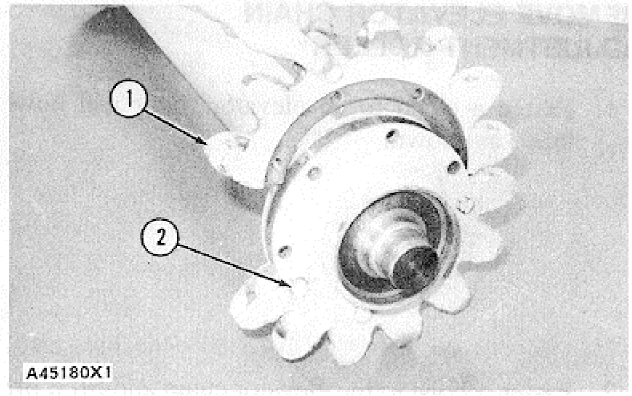
ELEVATOR UPPER SHAFT

ASSEMBLE ELEVATOR UPPER SHAFT

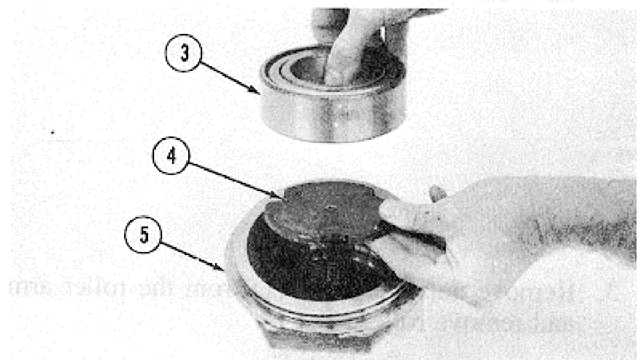
	Tools Needed	A
1P520	Driver Group	1

NOTE: Assemble the sprockets with the manufacturers numbers toward the speed reducer and in alignment with each other.

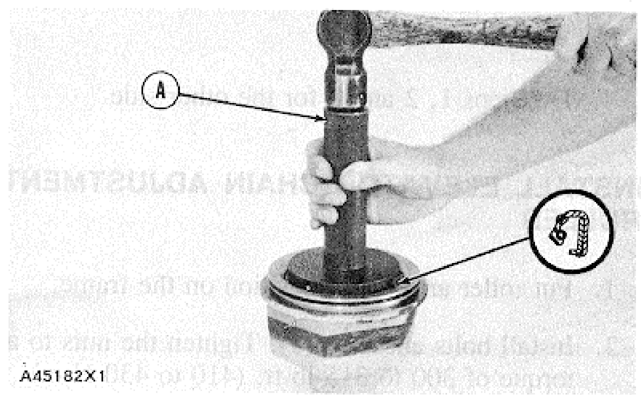
1. Install sprockets (I) on the shaft. Use 5P960 Multipurpose Type Grease on bolts and nuts. Install eight bolts and nuts (2). Tighten the nuts to a torque of 90 to 110 lb.ft. (120 to 149 N-m).



2. Install plate (4) in housing (5). Install bearing (3) in the housing with tool group (A).

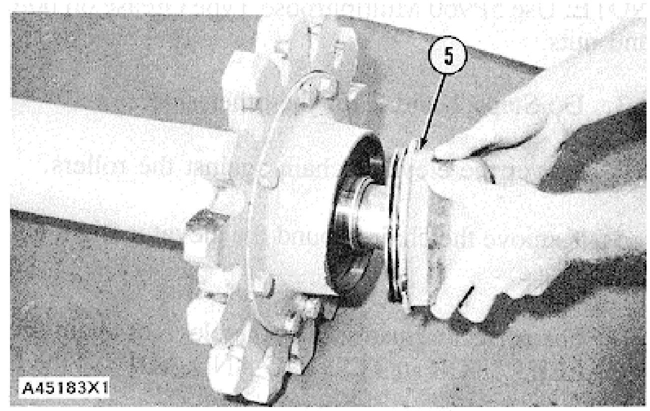


3. Install the seal in the housing with tool group (A). Install the seal until it makes contact with the counterbore in the housing and with the lip of the seal toward the inside of the housing.



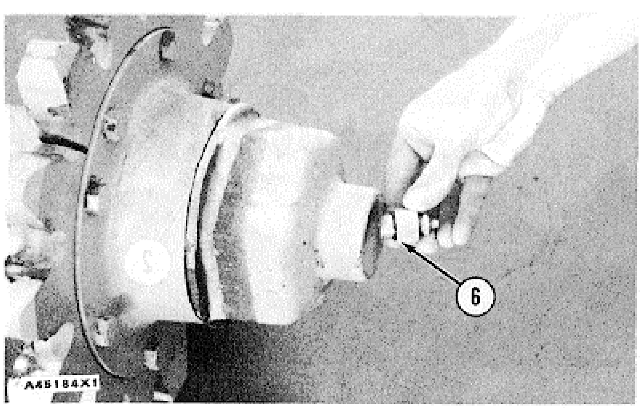
4. Install housing (5) on the spindle.

NOTE: Housing must be installed on shaft assembly so the housing is in the center of the hanger and is free to turn.



5. Install fitting (6) in the end of the housing.

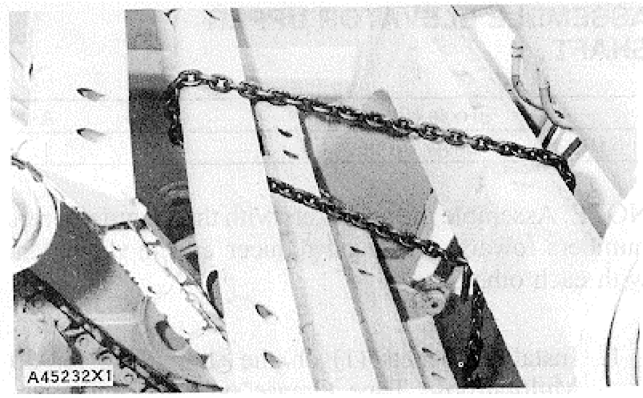
NOTE: Fill with clean grease until grease appears between housing and spindle assembly. Put grease in with care. Make sure that housing is not pushed off of spindle assembly by pressure. If housing is pushed off the spindle assembly, the assembly must be disassembled and checked.



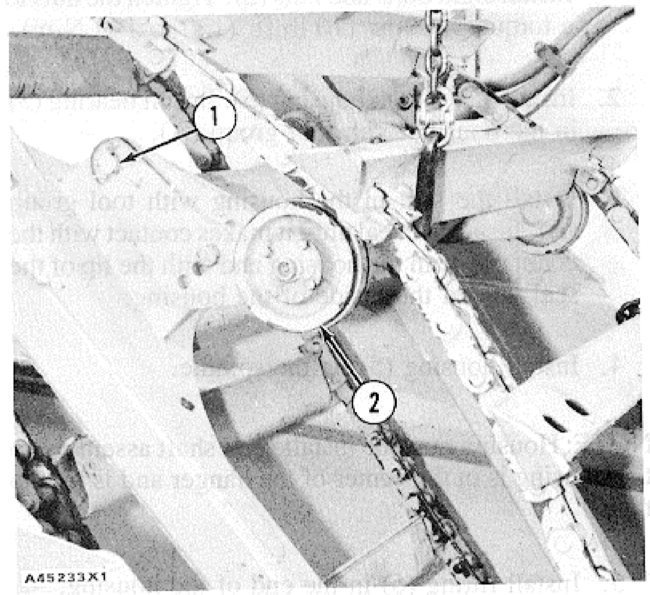
ELEVATOR CHAIN ADJUSTMENT ROLLER

REMOVE ELEVATOR CHAIN ADJUSTMENT ROLLER

1. Fasten a chain to an elevator flight and bowl brace as shown.



2. Fasten a hoist to the elevator chain and lift it off the roller (2).



3. Remove nuts and bolts (1) from the roller arm and remove roller (2).

4. Do Steps 1, 2 and 3 for the other side.

INSTALL ELEVATOR CHAIN ADJUSTMENT ROLLER

1. Put roller arm (2) in position on the frame.

2. Install bolts and nuts (1). Tighten the nuts to a torque of 300 to 315 lb.ft. (410 to 430 N.m).

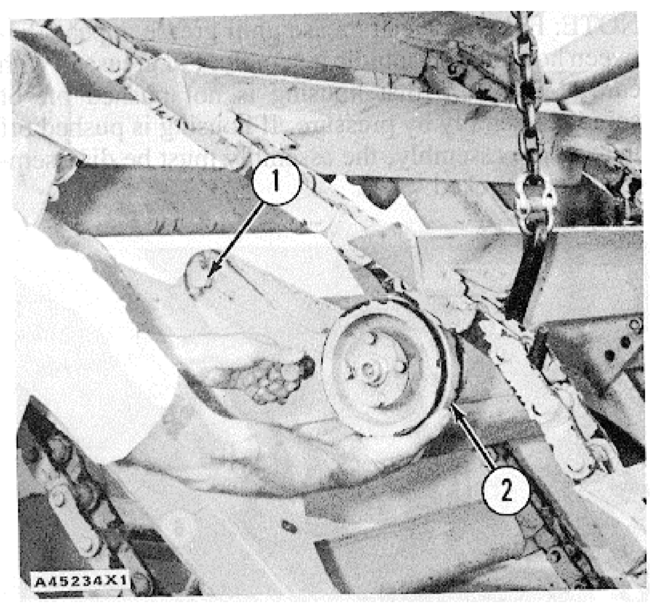
NOTE: Use 5P960 Multipurpose Type Grease on bolts and nuts.

3. Do Steps 1 and 2 for the other side.

4. Lower the elevator chain against the rollers.

5. Remove the chain around the elevator flight and brace.

6. For correct adjustment of the elevator chain see ELEVATOR in TESTING AND ADJUSTING.



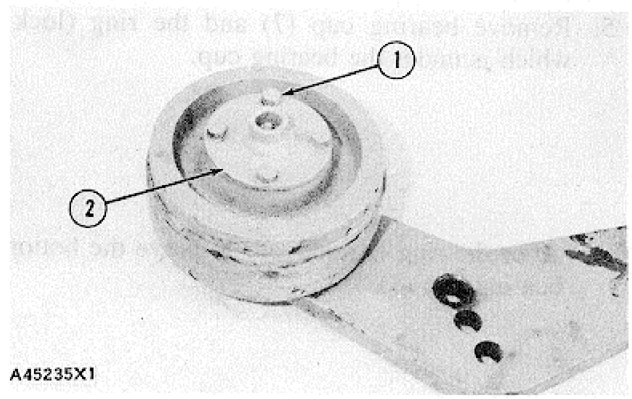
ELEVATOR CHAIN ADJUSTMENT ROLLER

DISASSEMBLE ELEVATOR CHAIN ADJUSTMENT ROLLER

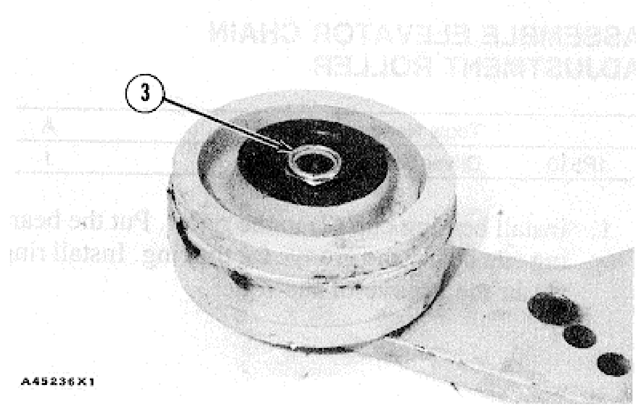
	Tools Needed	A
1P2322	Puller Assembly	1
T774	Spacer	1

start by:
a) remove elevator chain adjustment roller

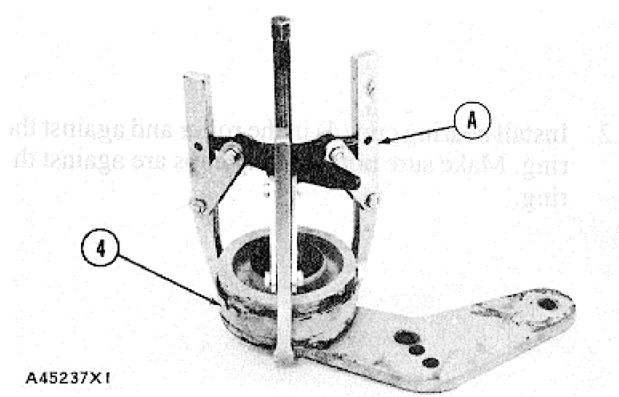
1. Remove bolts (1) from the cap. Remove cap (2) and the gasket from the roller.



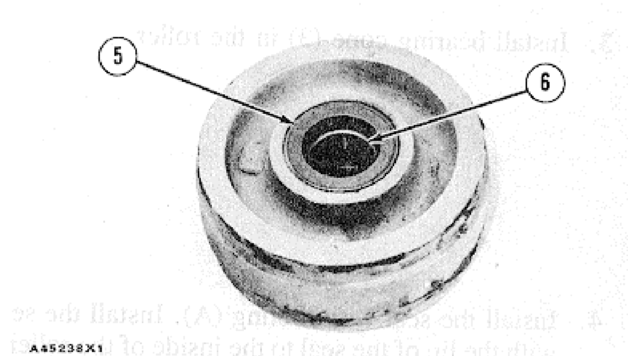
2. Remove nut (3) and the washer.



3. Remove roller (4) with tooling (A). The bearing cone and a spacer can fall out of the roller after it is removed. Inspect sleeve on shaft and make a replacement if needed.

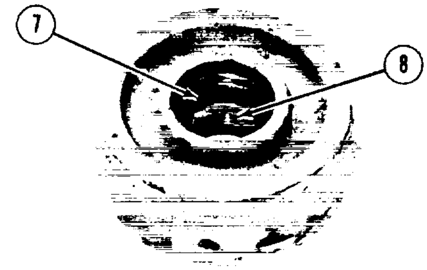


4. Remove seal (5) and bearing cone (6) from the roller.



ELEVATOR CHAIN ADJUSTMENT ROLLER

5. Remove bearing cup (7) and the ring (lock) which is under the bearing cup.

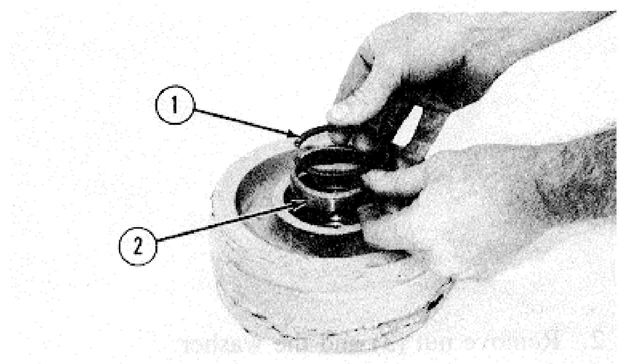


6. After the ring is removed. Remove the bottom bearing cup (8).

ASSEMBLE ELEVATOR CHAIN ADJUSTMENT ROLLER

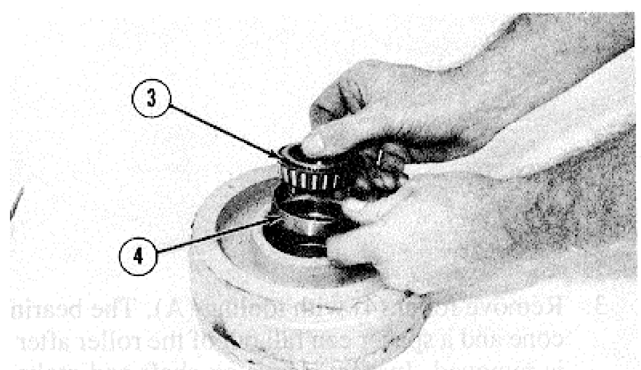
	Tools Needed	A
1P510	Driver Group	1

1. Install bearing cup (2) in the roller. Put the bearing cup below the groove for the ring. Install ring (I) in the groove of the roller.



A45240X1

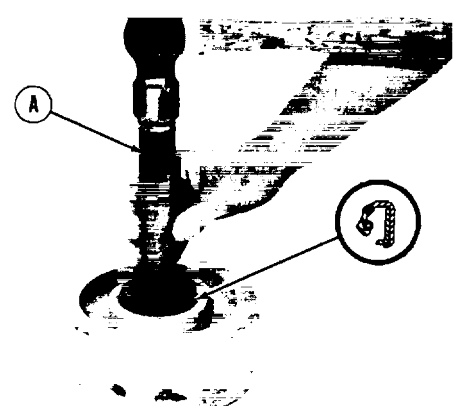
2. Install bearing cup (4) in the roller and against the ring. Make sure both bearing cups are against the ring.



A45241X1

3. Install bearing cone (3) in the roller.

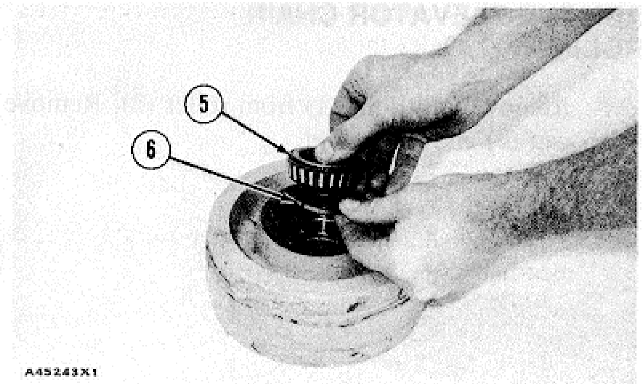
4. Install the seal with tooling (A). Install the seal with the lip of the seal to the inside of the roller.



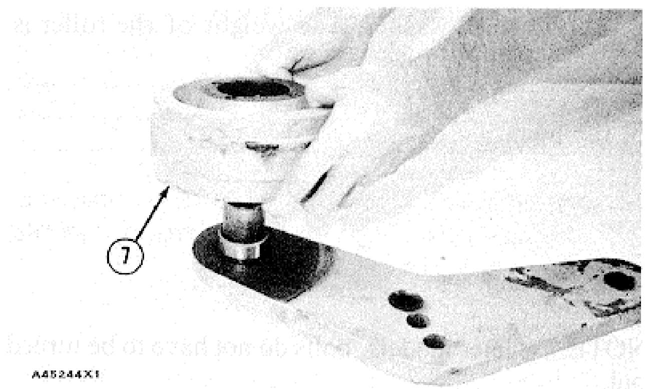
A45242X1

ELEVATOR CHAIN ADJUSTMENT ROLLER

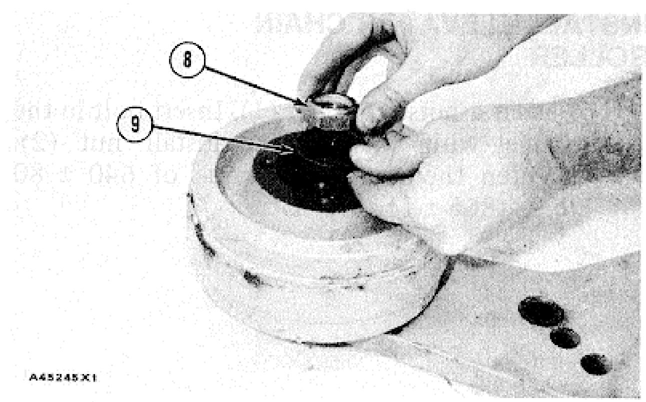
5. Turn the roller as shown. Install spacer (6) and bearing cone (5) in the roller.



6. Turn roller (7) as shown, and install the roller on the shaft. Be careful so the bearing cone and the spacer do not fall from the roller.

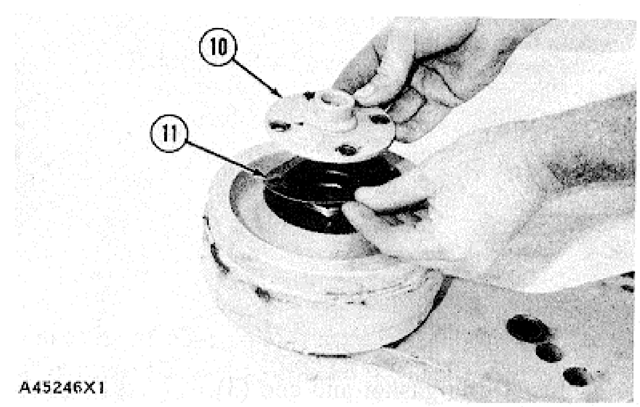


7. Install washer (9) and nuts (8) on the shaft. Tighten the nut to a torque of 240 to 260 lb.ft. (320 to 354 N.m).



8. Install gasket (11) and cap (10) on the roller.

9. Fill with 5P960 Multipurpose Type Grease.



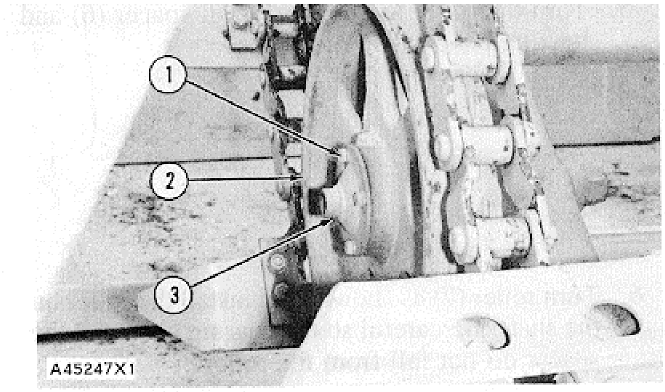
end by:

a) install elevator chain adjustment roller

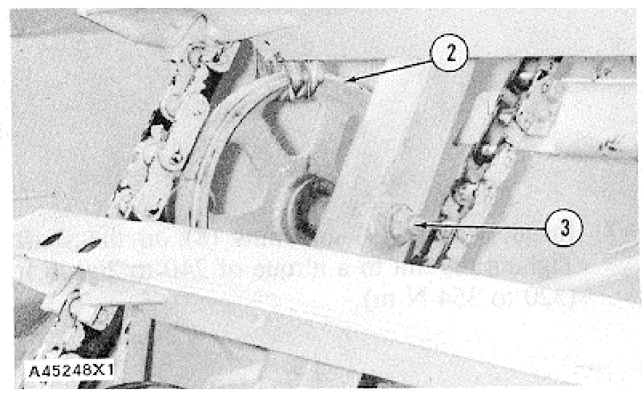
ELEVATOR CHAIN ROLLER

REMOVE ELEVATOR CHAIN ROLLER

1. Remove four bolts (I) from roller (2). Remove cap (3) and the gasket.



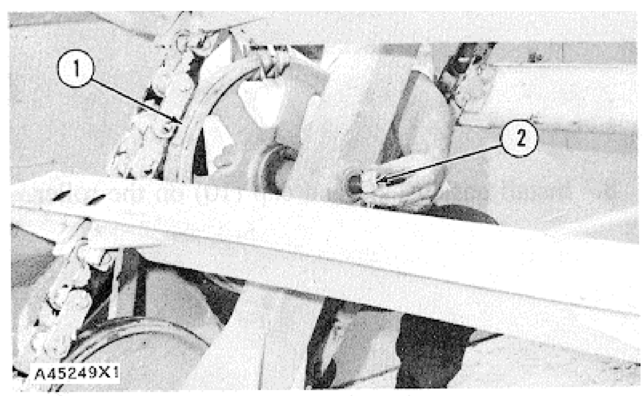
2. Fasten a hoist to roller (2). Remove nut and bolt with washer. The weight of the roller is 56 lb. (25 kg).



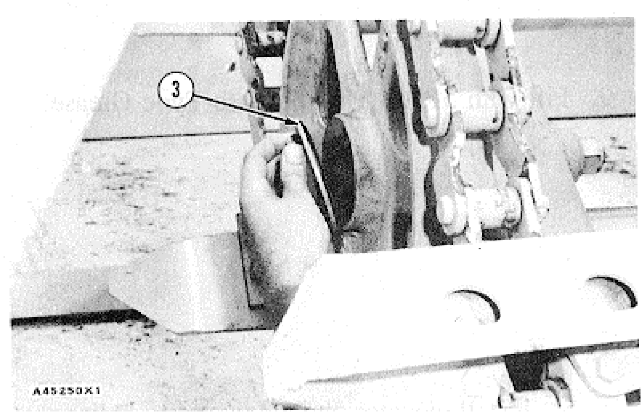
NOTE: On later models, bolts do not have to be turned out.

INSTALL ELEVATOR CHAIN ROLLER

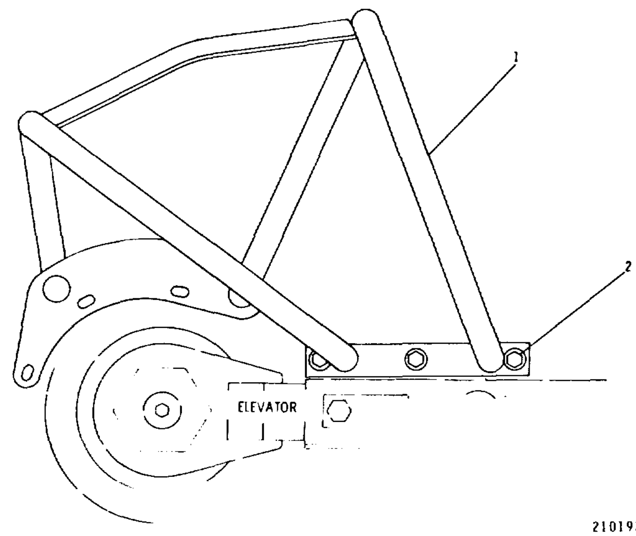
1. Fasten a hoist to roller (1). Insert bolt in the frame with washer and install nut (2). Tighten the nut to a torque of 640 + 80 lb.ft. (865 + 110 N-m).



2. Install the gasket and cap (3).



ELEVATOR ROCK GUARD



REMOVE ELEVATOR ROCK GUARD

1. Fasten a hoist to elevator rock guard (1).
2. Remove three nuts, washers, and bolts (2).
3. Lift elevator rock guard (1) from elevator.

INSTALL ELEVATOR ROCK GUARD

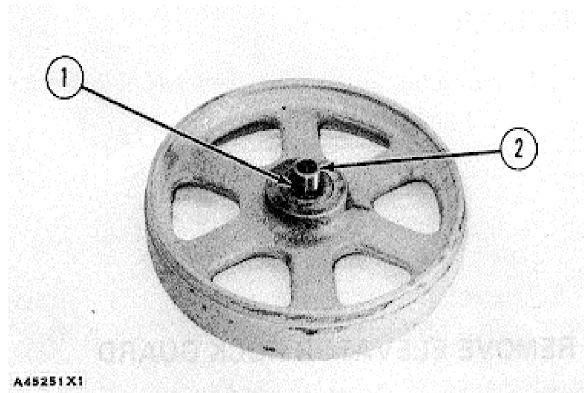
1. Fasten a hoist to elevator rock guard (1).
2. Place elevator rock guard (1) in position on elevator.
3. Install three bolts, washers, and nuts (2).

ELEVATOR CHAIN ROLLER

DISASSEMBLE ELEVATOR CHAIN ROLLER

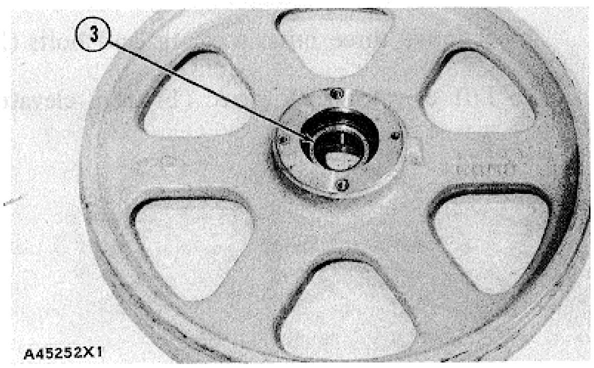
start by:

a) remove elevator chain roller

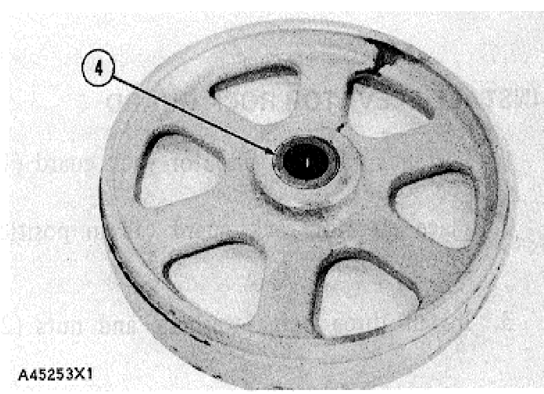


I. Remove shims (I) and bushing (2) from the roller.

2. Turn the roller over. Remove bearing cone (3) and the spacer.

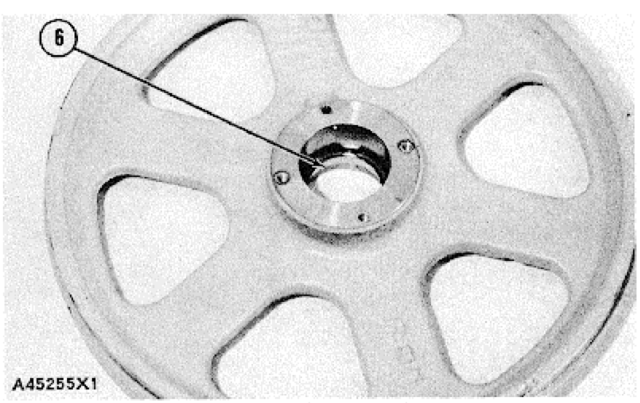


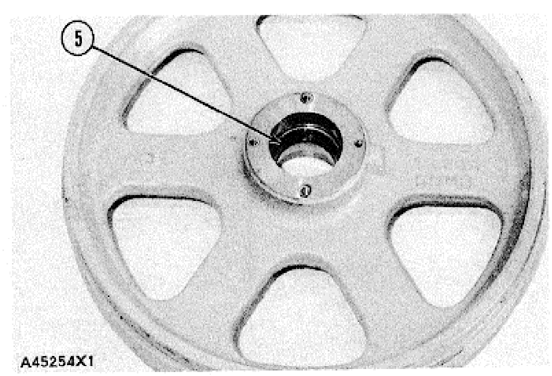
3. Turn the roller over again. Remove seal (4) and the bearing cone from the roller.



4. Turn the roller over again. Remove bearing cup (5) from the roller.

5. Remove lower bearing cup (6). Remove the ring that keeps the bearing cups apart from the roller if necessary.



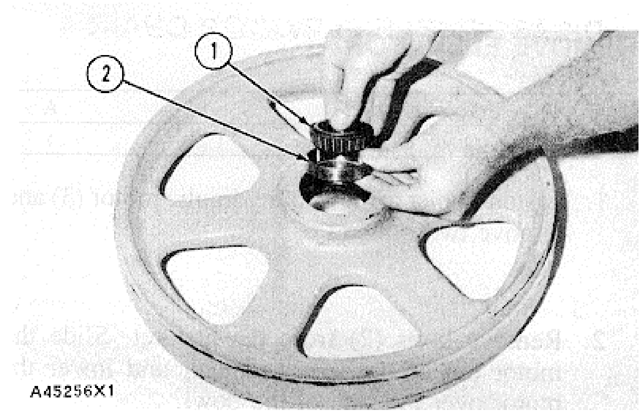


ELEVATOR CHAIN ROLLER

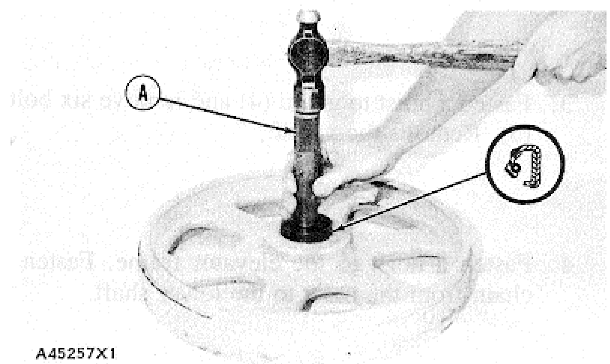
ASSEMBLE ELEVATOR CHAIN ROLLER

1. From the inside of the roller install bearing cup (2) and bearing cone (1).

2. Install lip type seal with tooling (A). Install the seal with the lip to the inside of the roller.

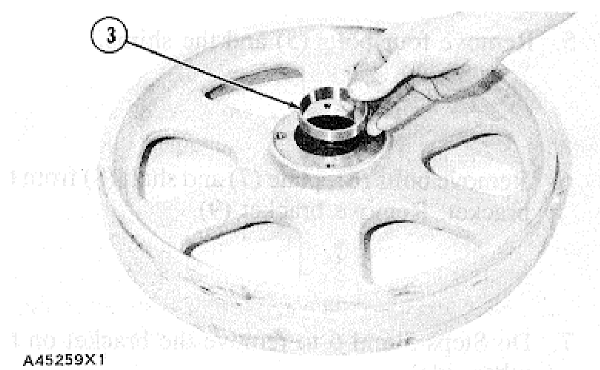


3. Turn the roller over. Install bearing cup (3).



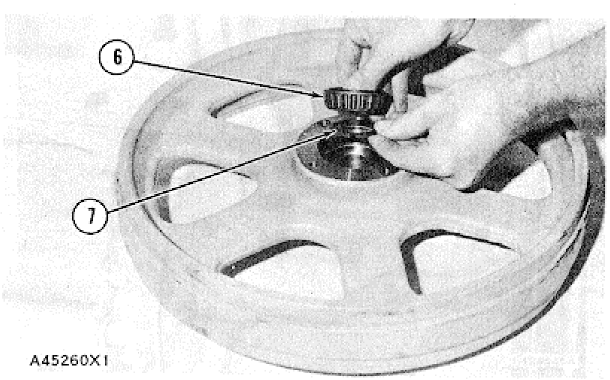
4. Turn the roller over again. Install bushing (5) and shims (4).

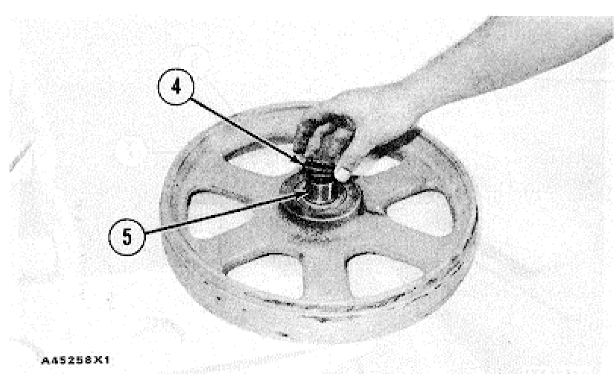
NOTE: Use shims (IJ5334) as needed to put the idlers in center of chain links.



5. Turn the roller over again. Install spacer (7) and bearing cone (6).

   end by:
   (a) install elevator chain roller





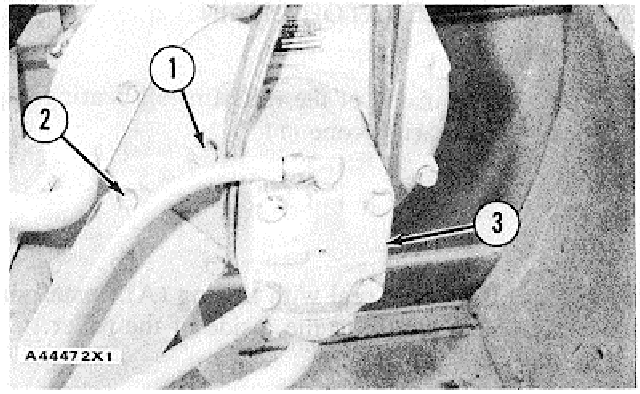
ELEVATOR

REMOVE ELEVATOR

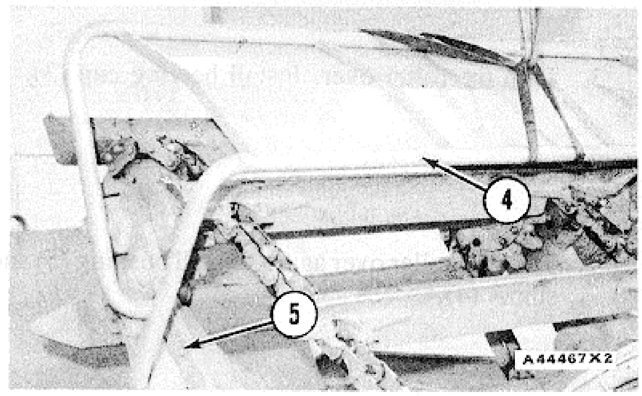
	Tools Needed	A
1P510	Driver Group	1

1. Fasten a hoist to elevator hydraulic motor (3) and remove two bolts (1).

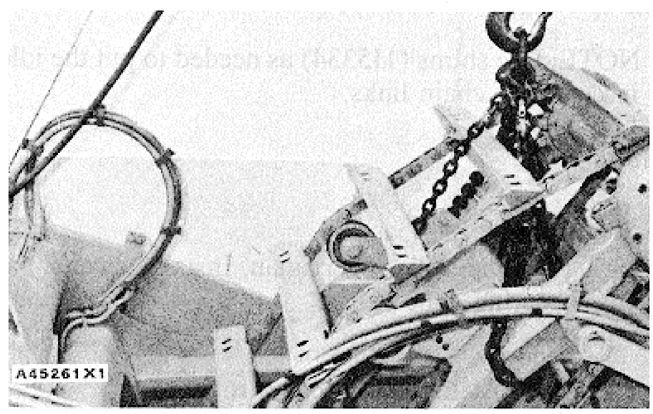
2. Remove bolts (2) from the bracket. Slide the motor out of the speed reducer and lower the motor over the side of the bowl.



3. Fasten a hoist to guard (4) and remove six bolts (5). Remove the guard.



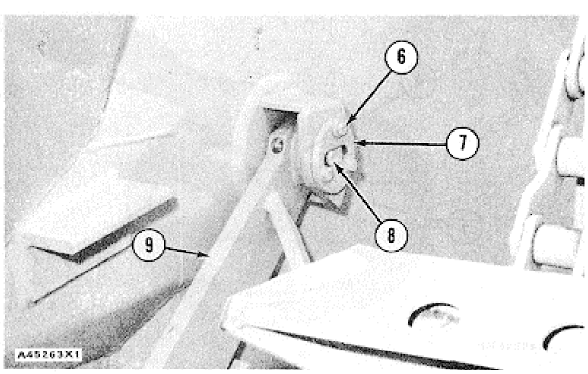
4. Fasten a hoist to the elevator frame. Fasten a chain from the hoist to the lower shaft.

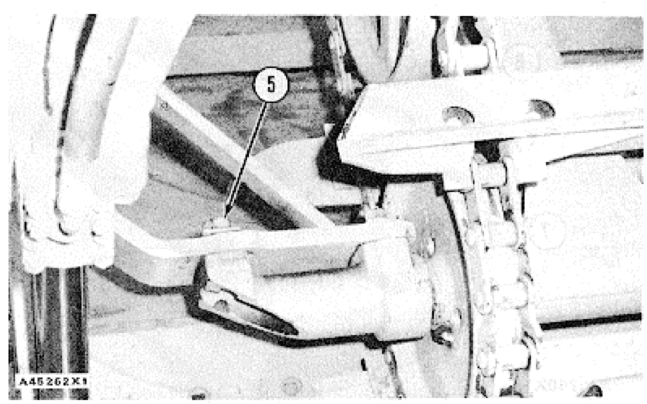


5. Remove four bolts (5) and the shims.

6. Remove bolts (6), plate (7) and shaft (8) from the bracket. Remove bracket (9).

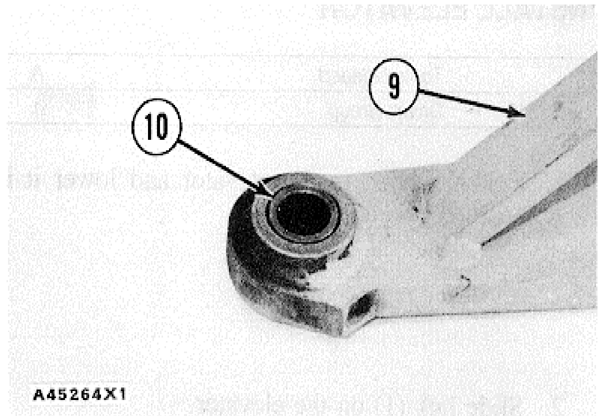
7. Do Steps 5 and 6 to remove the bracket on the other side.



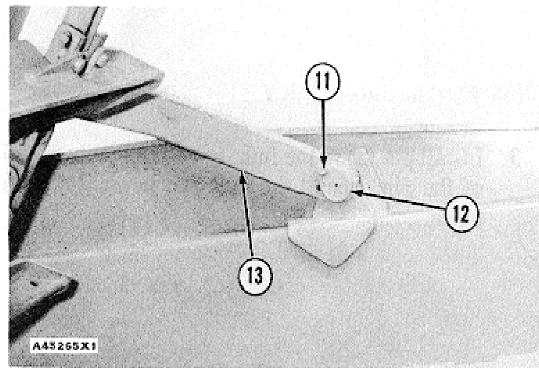


ELEVATOR

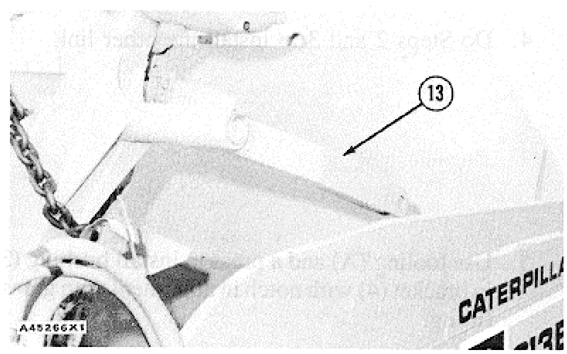
8. Use tooling (A) and a press to remove two bushings (10) from bracket (9).



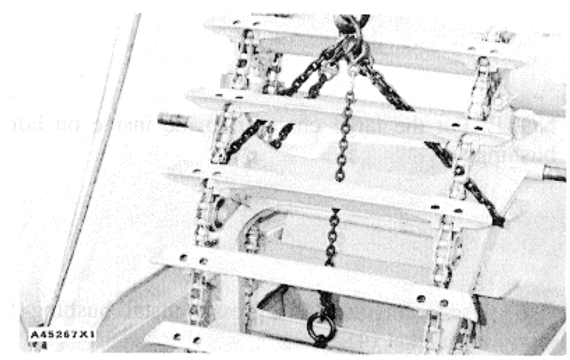
9. Remove bolt (11) from pin (12). Remove the nut from the back side of the pin. Remove the pin from link (13).



10. Slide link (13) off the shaft.



11. Do Steps 8 and 9 to remove the bracket on the other side.

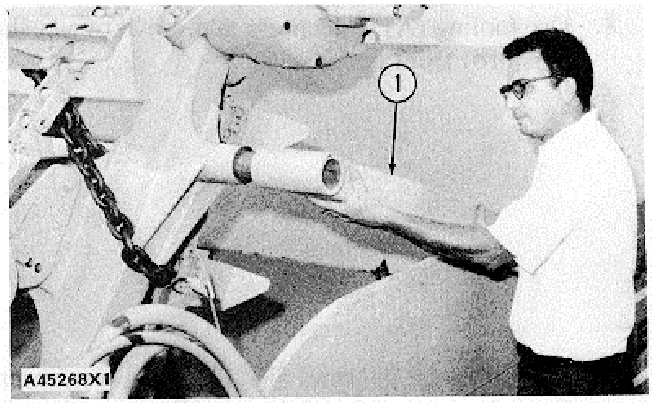


12. Remove the elevator from the bowl.

INSTALL ELEVATOR

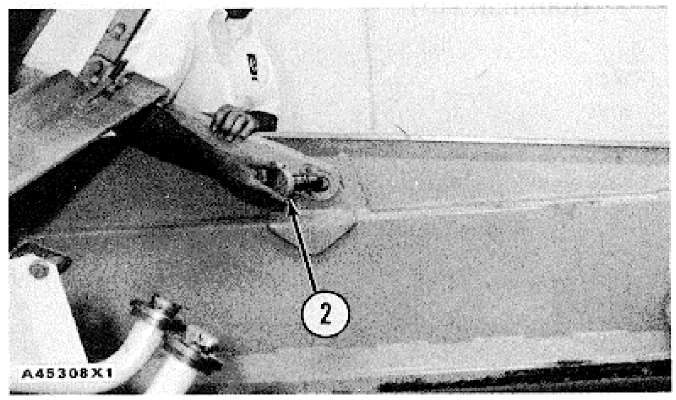
	Tools Needed	A
1P510	Driver Group	1

1. Fasten a hoist to the elevator and lower it in position.

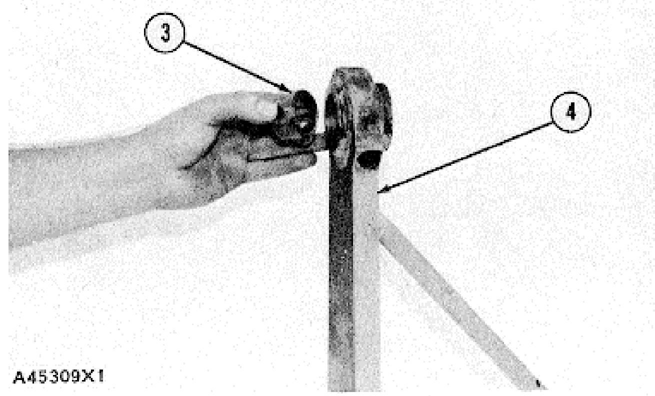


2. Slide link (1) on the elevator.

3. Install pin (2) in the link. Install nut on back side of the pin. Install the bolt that holds the pin in place.

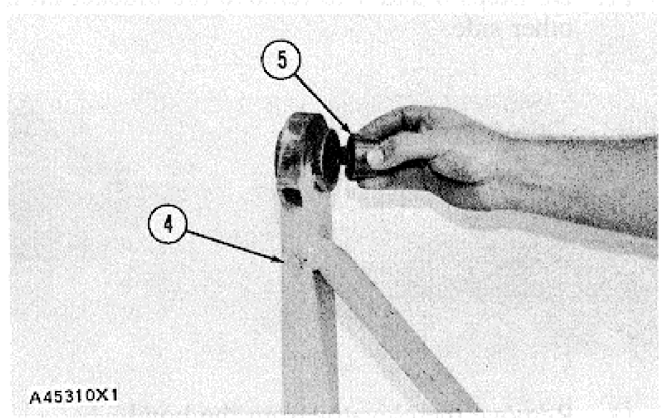


4. Do Steps 2 and 3 to install the other link.



5. Use tooling (A) and a press to install bushing (3) in bracket (4) with notch in alignment with grease fitting.

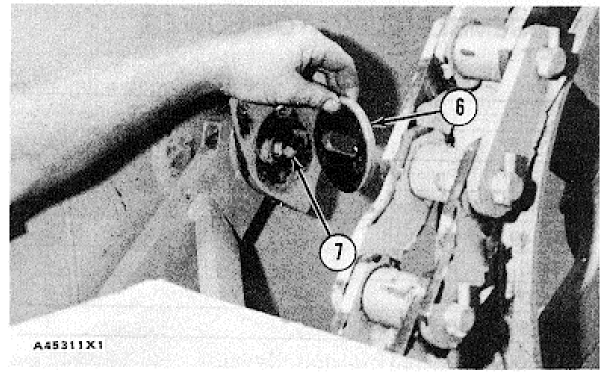
NOTE: Put the large chamfer to the inside on both bushings.



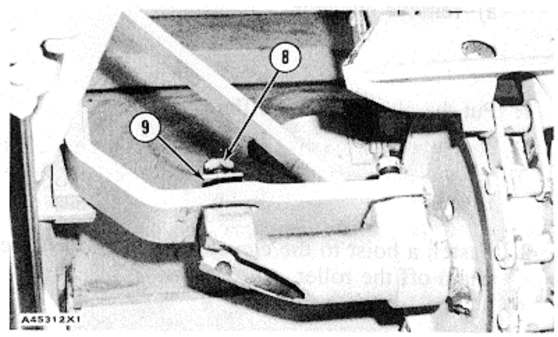
6. Use tooling (A) and a press to install bushing (5) in bracket (4).

ELEVATOR

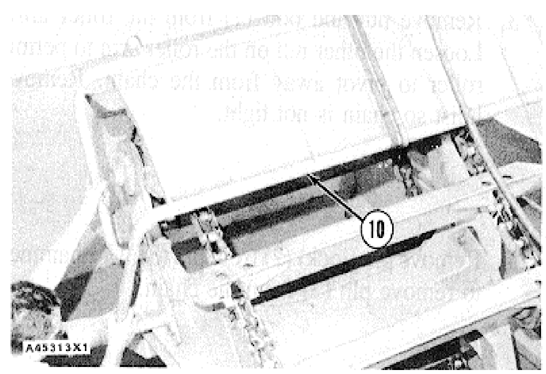
7. Put the bracket in position and install shaft (7) and plate (6).



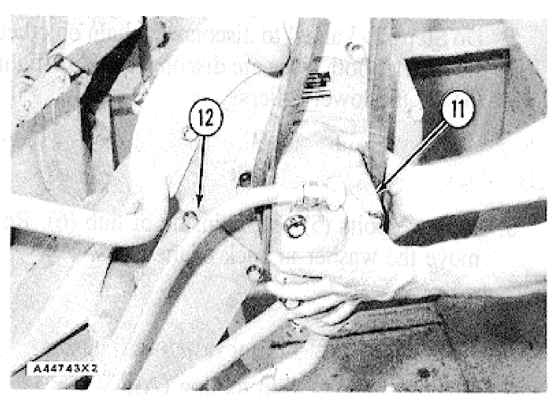
8. Install shims (9) and four bolts (8).



9. Do Steps 7 and 8 to install other bracket.



10. Install guard (10).



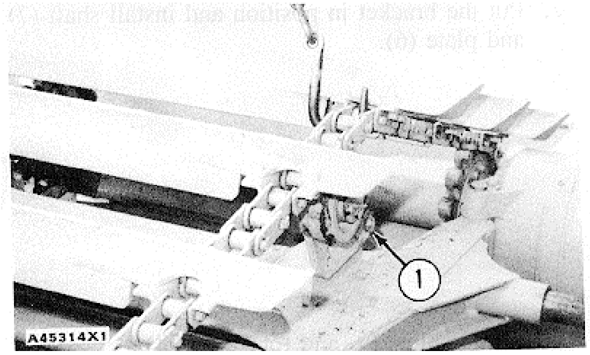
I1. Fasten a hoist to elevator hydraulic motor (II1) and install motor.

12. Install bracket (12) to the speed reducer.

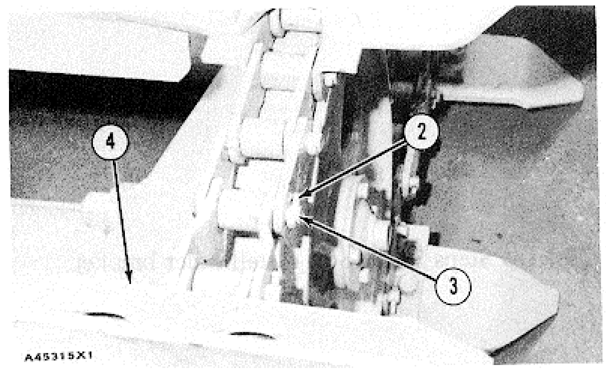
ELEVATOR LOWER SHAFT

DISASSEMBLE ELEVATOR LOWER SHAFT

	Tools Needed	A
8B7551	Bearing Puller Attachment	1
8B7548	Puller Assembly	1
8H684	Ratchet Box Wrench	1
8B7549	Leg	2
3H465	Plate	4
1B4207	Nut	2
8S6586	Screw	1

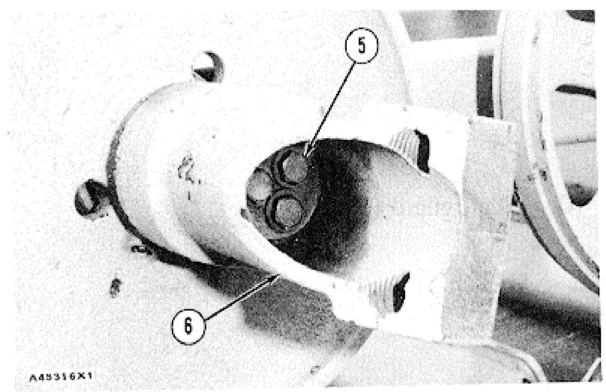


start by:
a) remove elevator



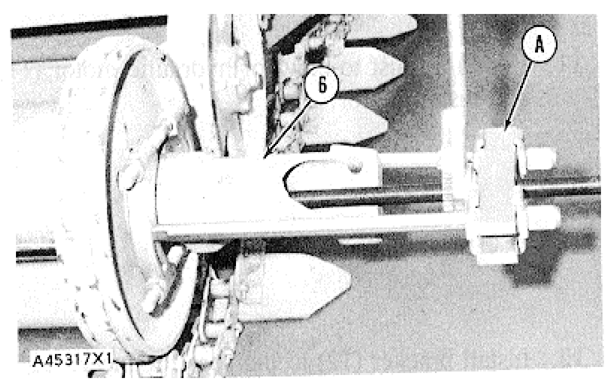
I. Put the elevator on the floor.

2. Fasten a hoist to the elevator chain and lift the chain off the roller.



3. Remove nut and bolt (I) from the roller arm. Loosen the other nut on the roller arm to permit roller to pivot away from the chain. Remove hoist so chain is not tight.

4. Remove pin (lock) (2) from pin (3). Use hammer to remove pin (3) from the chain.

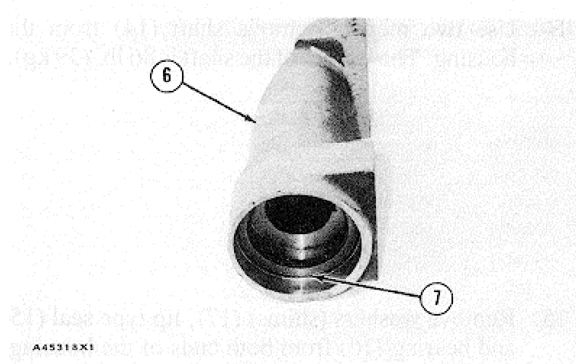


5.Do Steps 2, 3 and 4 to disconnect chain on other side. After both sides are disconnected lift flight (4) off the lower rollers.

6. Remove bolts (5) on the inside of hub (6). Remove the washer in back of the bolts.

7. Remove hub (6) with tooling (A).

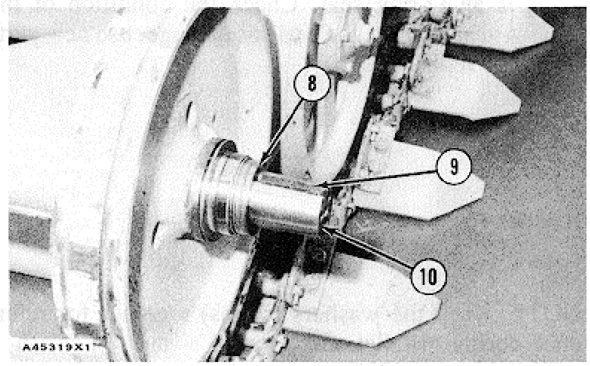
8. Remove seal (7) from hub (6).



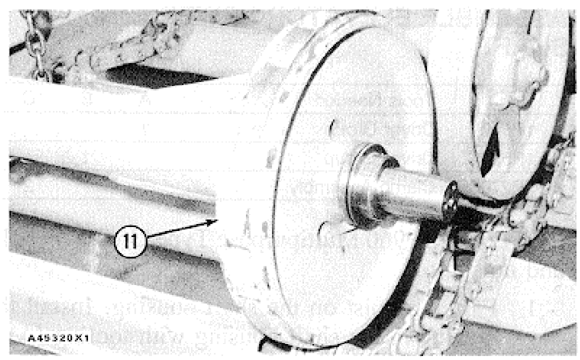
9. Remove key (9) and washers (shims) (8) from shaft (10).

NOTE: Keep the washers (shims) together for reference during installation.

10. Fasten a hoist to the shaft housing. Lift the housing so the roller is free to turn. Use two men to slide roller (11) off of the shaft. The weight of the roller is 70 lb. (32 kg).

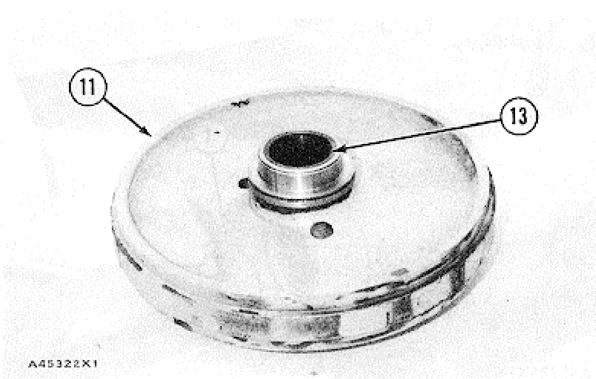


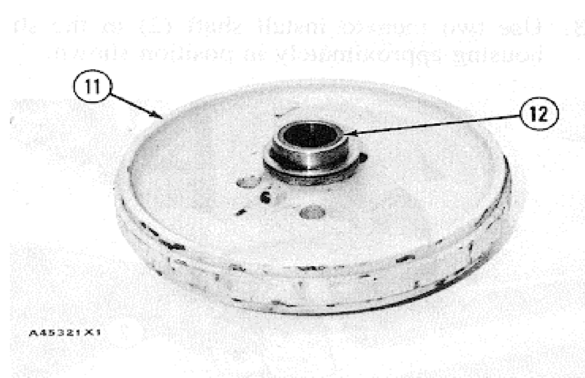
11. Remove bearing (12) from roller (II11).



12. Turn the roller over. Remove bearing (13) from roller (I 1).

13. Do Steps 6 through 12 on other side of the shaft.

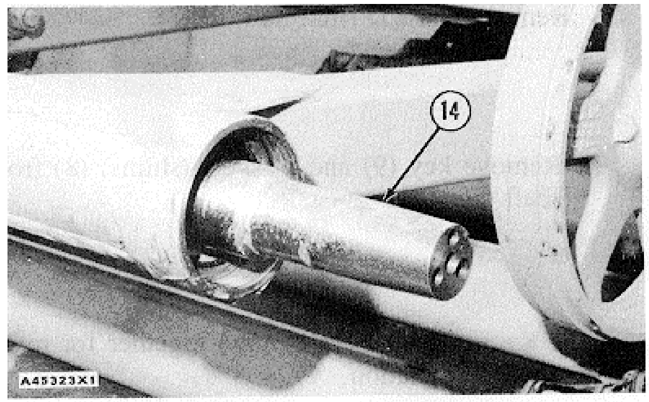




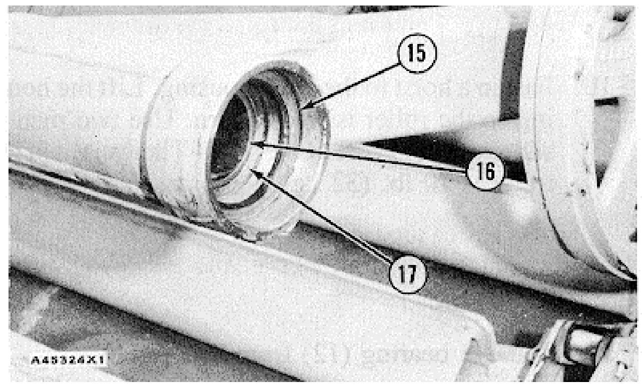
TM 5-3805-260-24

ELEVATOR LOWER SHAFT

14. Use two men to remove shaft (14) from the housing. The weight of the shaft is 86 lb. (39 kg).



15. Remove washers (shims) (17), lip type seal (15) and bearing (16) from both ends of the housing. On the inside diameter at the rear of bearing (I 16) is an O-ring seal. Check the condition of the O-ring seal. If the seal has damage, use new parts for replacement.

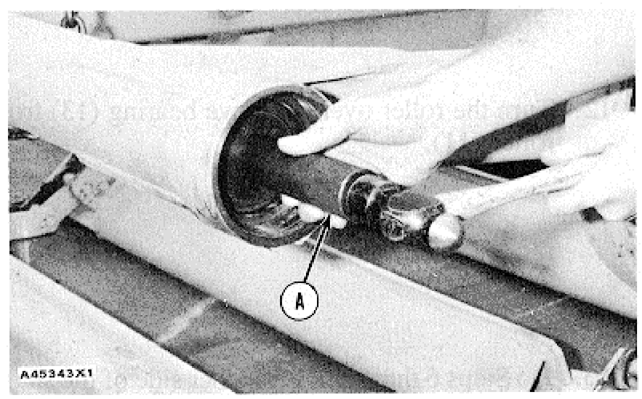


NOTE: Keep the washers (shims) together for reference during installation.

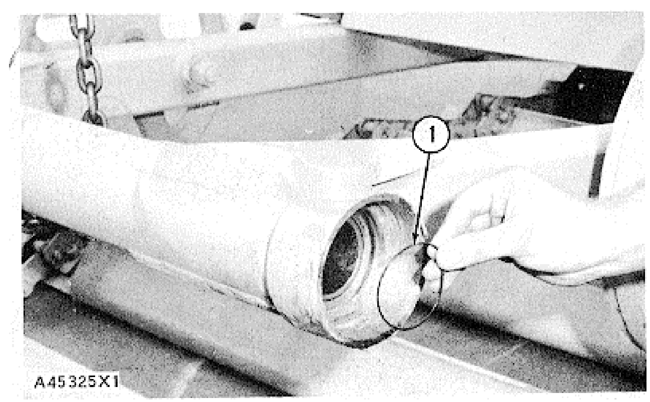
ASSEMBLE ELEVATOR LOWER SHAFT

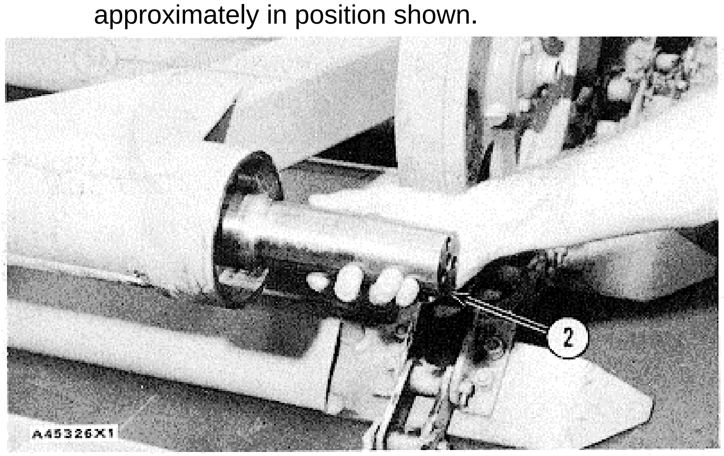
	Tools Needed	A	B	C
1P510	Driver Group	1		
1P520	Driver Group	1		
5P2706	Clamp Assembly			2

NOTE: Use 5P960 Multipurpose Type Grease on bolts and nuts.



1. Fasten a hoist on the shaft housing. Install the bearing in the shaft housing with tooling (A).
2. Install O-ring seal (1) in the bearing.
3. Use two men to install shaft (2) in the shaft housing approximately in position shown.

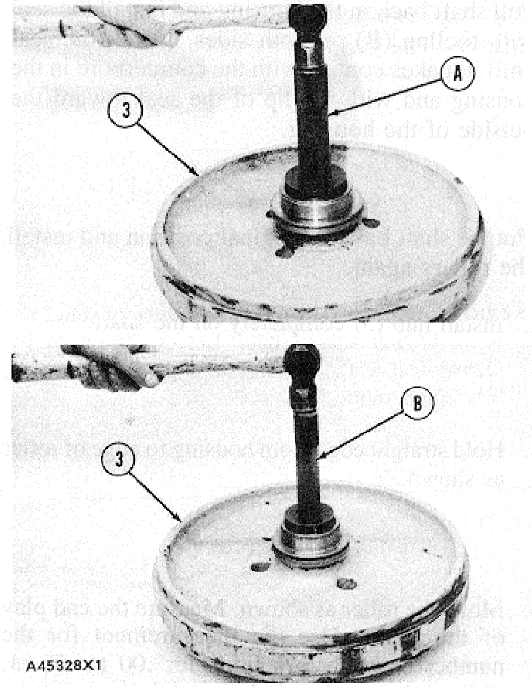




ELEVATOR LOWER SHAFT

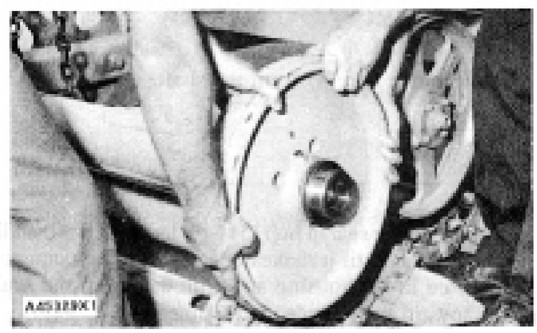
4. Install bearing in the inside of roller (3) with tooling (A).

5. Turn the roller over. Install bearing in the outside of roller (3) with tooling (B).

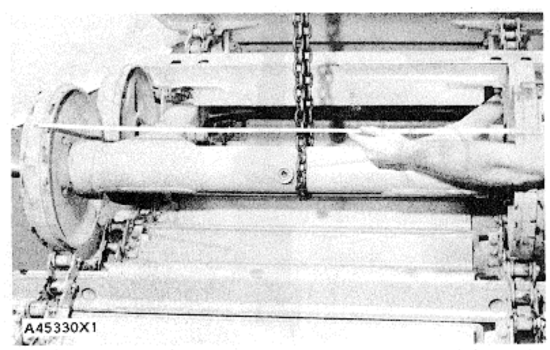


6. Do Steps 4 and 5 to the roller on the other side.

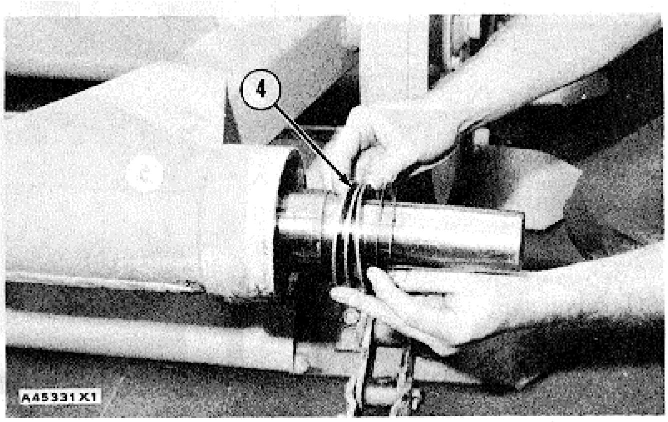
7. Install both rollers as shown. Make sure the rollers are installed all of the way on the shaft.



8. Measure the distance between the center of the outside diameter of both rollers. Subtract the distance between the rollers from 47.00 inches (119.4 cm) to find the correct width of washers (shims). Divide the washers (shims) in half.

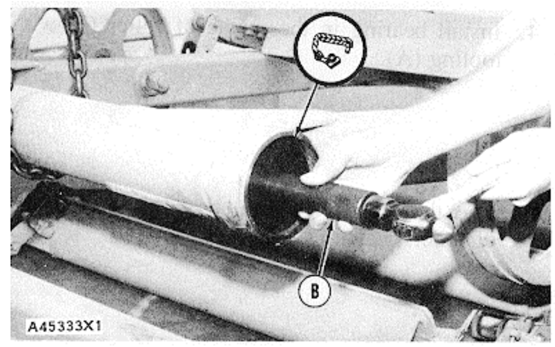


9. Remove the rollers again. Install half the washers (shims) (4) in each end of the housing.

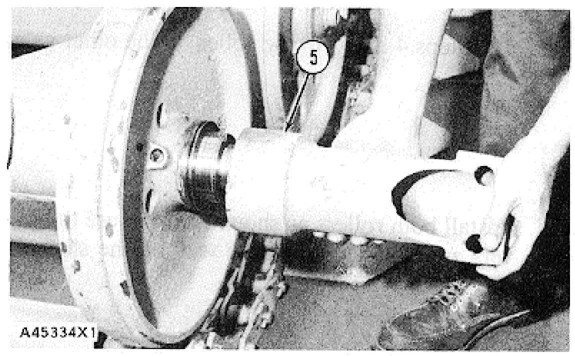


ELEVATOR LOWER SHAFT

10. Pull shaft back in the housing and install the seal with tooling (B) on both sides. Install the seal until it makes contact with the counterbore in the housing in the housing and with the lip of the seal toward the outside of the housing.

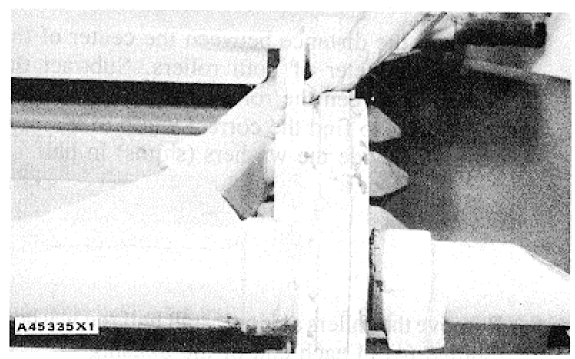


11. Put the shaft back in original position and install the rollers again.



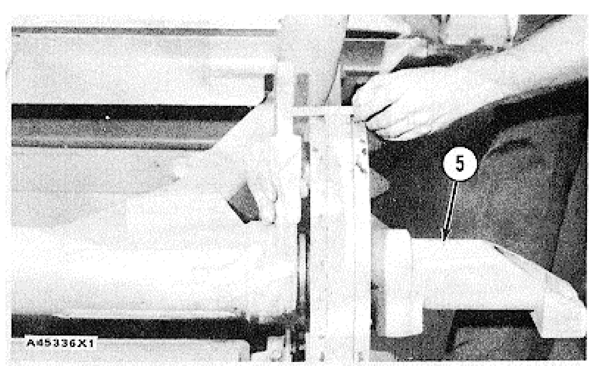
12. Install hub (5) completely on the shaft.

13. Hold straight edge from housing to edge of roller as shown.

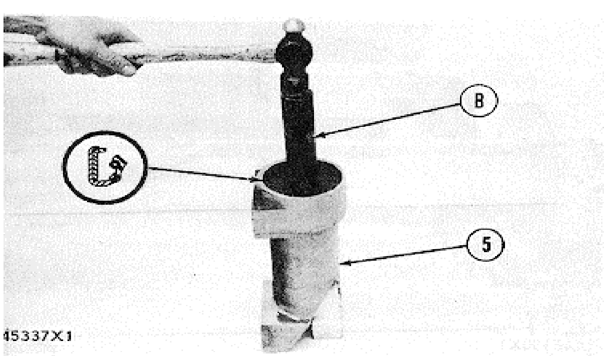


14. Move the roller as shown. Measure the end play of the roller. Use the measurement for the number of washers (shims) for .00 to .06 in. (0.00 to 1.5 mm) end play total for both sides.

15. Remove hub (5) from the shaft.

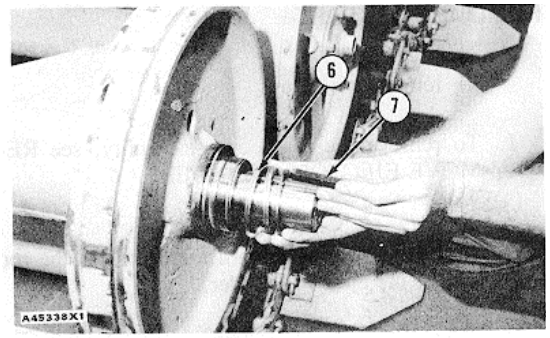


16. Install the seal in hub (5) with tooling (B). Install the seal until it makes contact with the counter-bore in the housing and with the lip of the seal toward the outside of the housing.



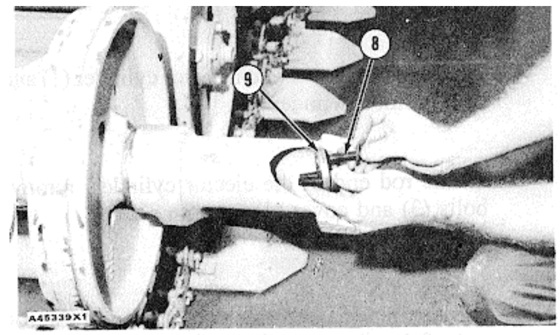
ELEVATOR LOWER SHAFT

17. Divide in half the number of washers (shims) (6). Install half the washers (shims) as shown. Install key (7) on the shaft.

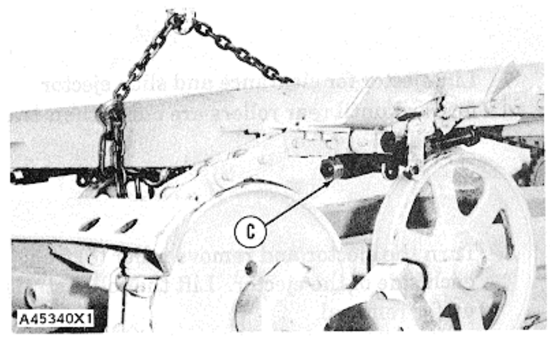


18. Do Steps 16 and 17 to the other side.

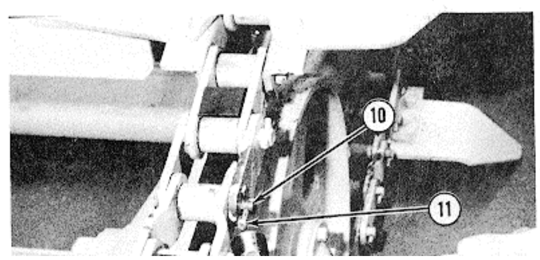
19. Install both hubs on the tapered shaft with a hammer. Install two washers (9) and six bolts (8) on the shaft. Tighten the bolts to a torque of 100 to I 10 lb.ft. (135 to 149 N m). Hit the hubs with the hammer again and tighten the bolts to a torque of 100 to 110 lb.ft. (135 to 149 N.m) again. When bolts can not be tightened after hubs are hit with hammer the rollers and shaft are in position.



20. Install a chain around flights as shown. Tighten the chain and install tooling (C) to both sides of elevator chain. Tighten tooling (C) to pull the elevator chain together.



21. Install pin (1 10) and pin (lock) (11) on both sides.



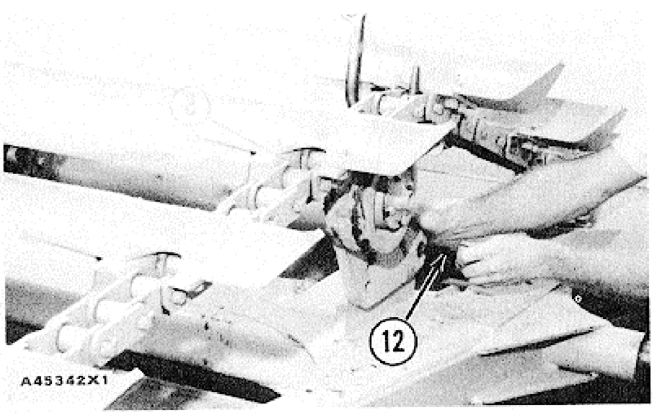
22. Fasten a hoist to the elevator chain and lift the chain off the roller.

23. Install bolts and nuts (12) to the roller arm. Tighten two nuts to a torque of 300 to 315 lb.ft. (410 to 430 N.m).

24. Do Steps 22 and 23 to other side.

25. Fill the rollers with 5P960 Multipurpose Type Grease.

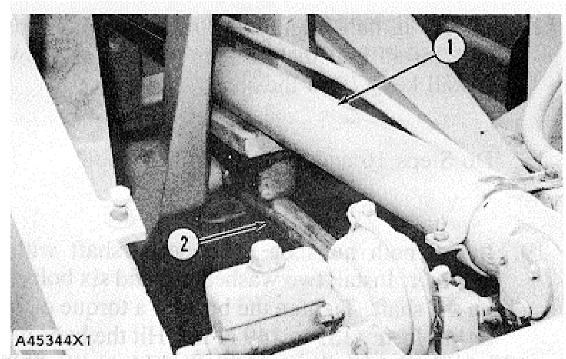
end by:
a) install elevator



EJECTOR

REMOVE EJECTOR

start by:
a) remove elevator

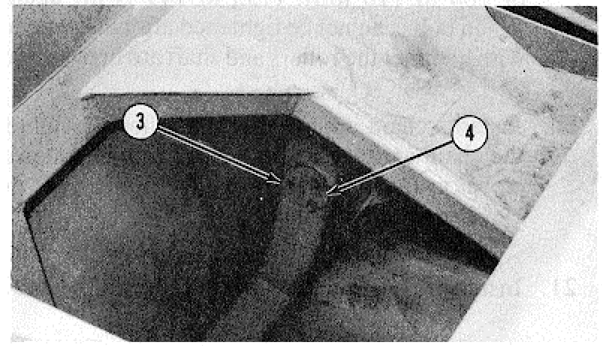


1. To remove the rear cover assembly, see REMOVE EJECTOR CYLINDER.

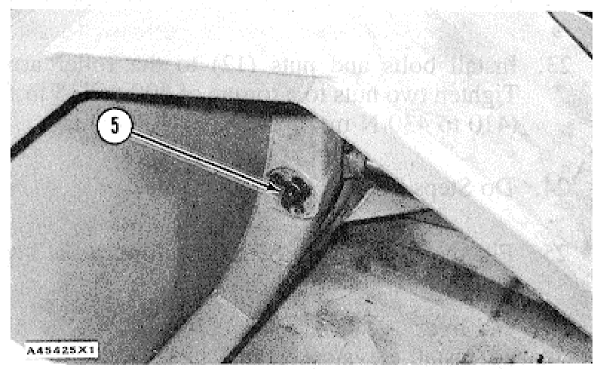
2. Move the ejector forward for access to the rod end of the ejector cylinder.

3. Fasten a hoist to the lifting eye on the top of the ejector.

4. Put wood blocks between ejector cylinder (1) and sliding floor cylinder (2).



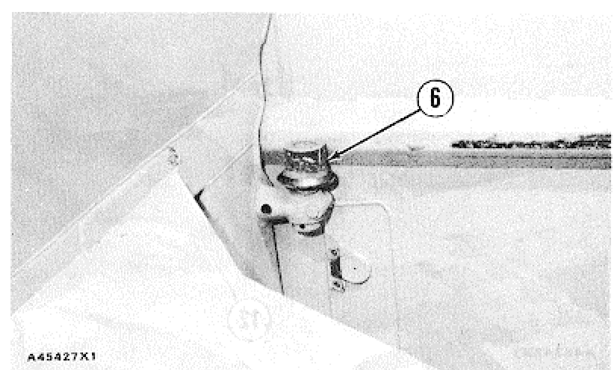
5. At the rod end of the ejector cylinder, remove bolts (3) and cover (4) on both sides.



6. Remove pin (5) to make a separation of the rod end of the ejector cylinder from the ejector.

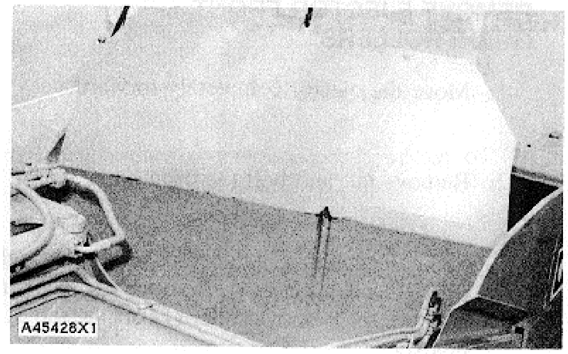
7. Lift ejector for clearance and slide ejector forward until rear rollers are out of their track.

8. Turn the ejector and remove roller (6) from each side of the ejector. Lift the roller straight up for removal.



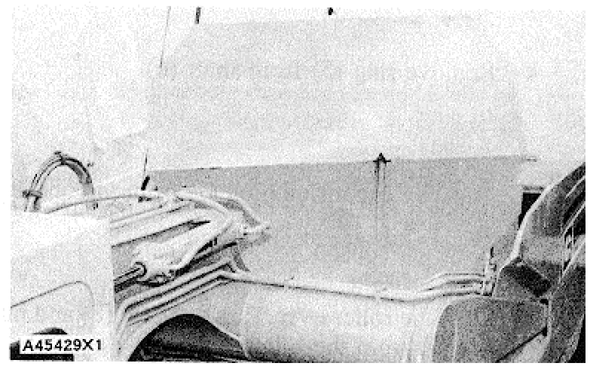
EJECTOR

9. Turn the ejector as shown and remove from the bowl.
The weight of the ejector is 1150 lb. (518 kg).



INSTALL EJECTOR

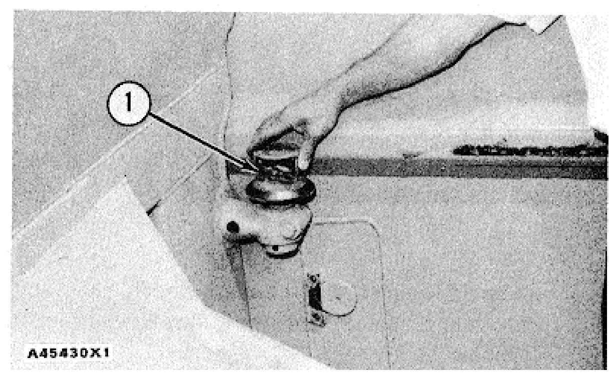
1. Fasten a hoist to the lifting eye and install the ejector in the bowl.



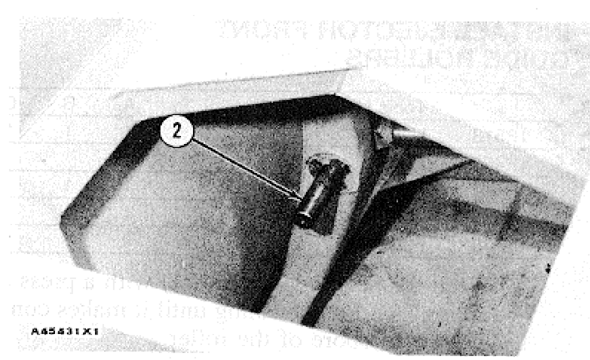
2. Install rollers (1) on both sides of the ejector.

3. Slide the ejector to the rear. Put the rear rollers in their track and install pin (2) in the rod end of ejector cylinder.

4. Install the cover and the bolts on both sides of the pin. Remove the wood blocks between the cylinders.

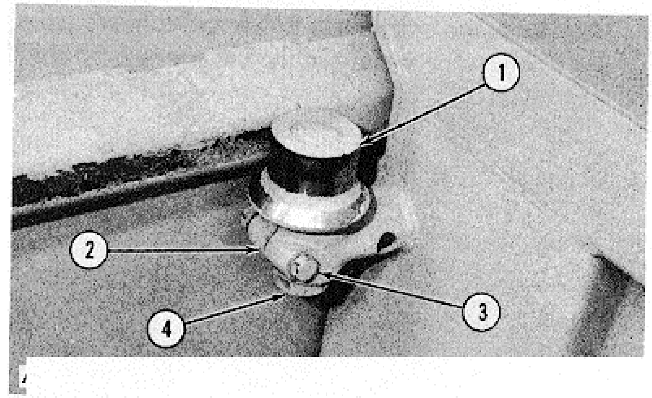


5. Install rear cover assembly, see INSTALL EJECTOR CYLINDER.
end by:
a) install elevator

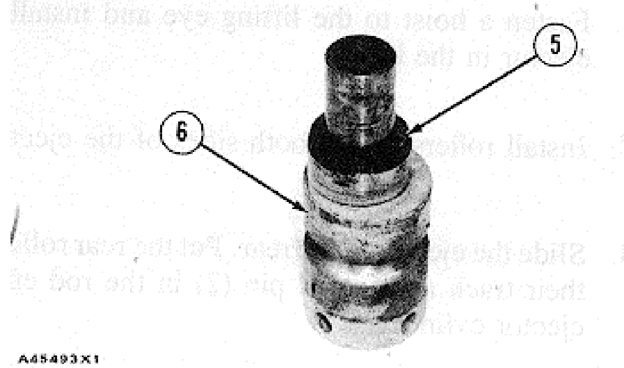


EJECTOR FRONT GUIDE ROLLERS

REMOVE EJECTOR FRONT GUIDE ROLLERS

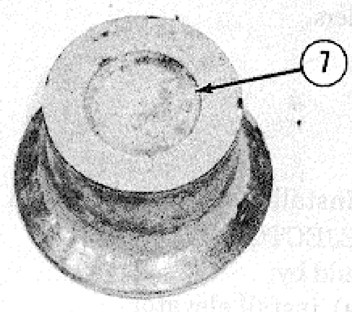


1. Move the ejector completely forward.
2. Remove nut and bolt (3) from bracket (2).
3. Make the opening in the bracket large enough to remove roller shaft (4). Remove the shaft from the bottom. Remove roller (1) off the top of the bracket.
4. Remove ring (5) from shaft (6).



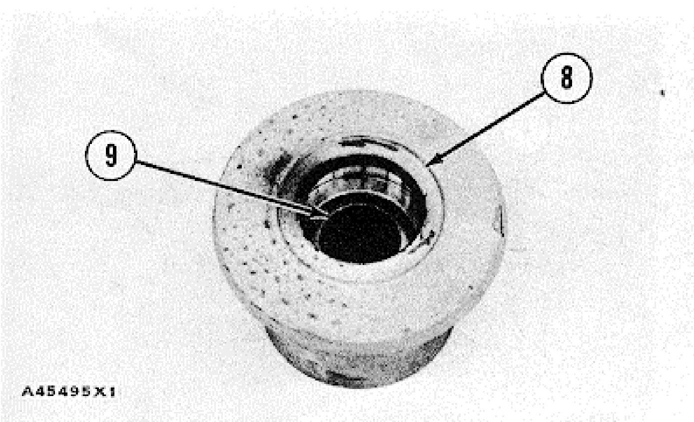
A45493X1

5. Remove expansion plug (7) from top of the roller.



A45494X1

6. Turn the roller over. Remove seal (8) and bushing (9) from the roller.

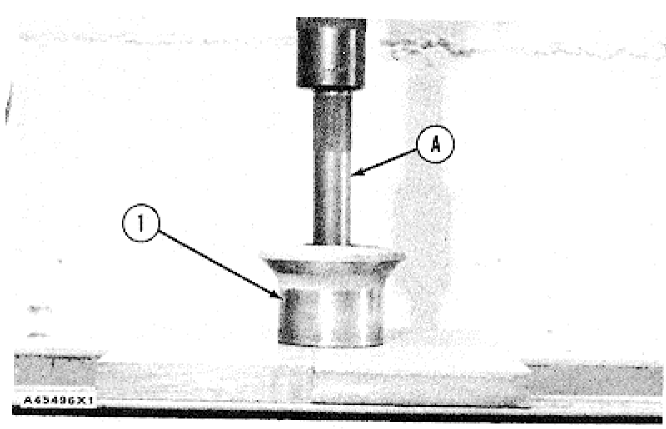


A45495X1

INSTALL EJECTOR FRONT GUIDE ROLLERS

	Tools Needed	A	B	C	
1P513	Handle		1 1		1
1P466	Plate		1		
1P477	Plate		1 1		
1P489	Plate		1		
1 P478	Plate				1

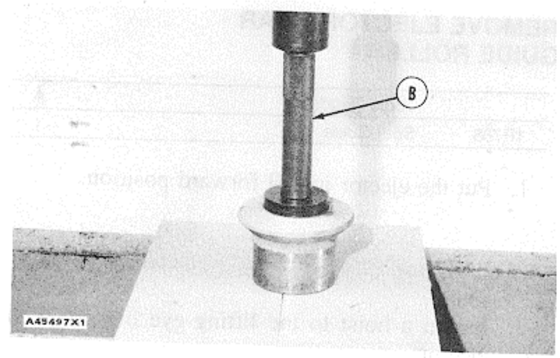
1. Install the bushing in roller (1) with a press and tooling (A). Push bushing until it makes contact with counterbore of the roller.



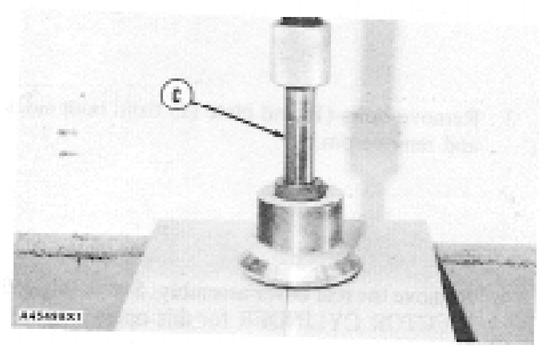
A45496X1

EJECTOR FRONT GUIDE ROLLERS

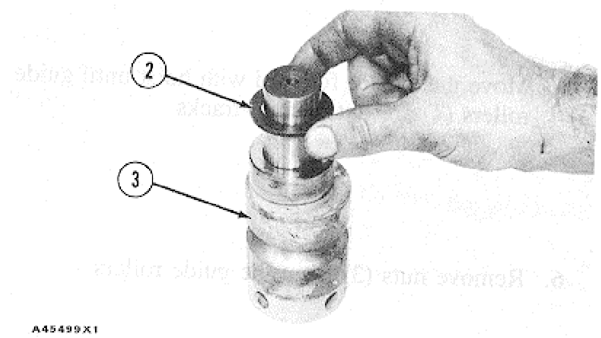
2. Install the lip type seal in the roller with tooling (B). Install the seal until it makes contact with the counterbore in the roller and with the lip of the seal toward the inside of the roller.



3. Turn the roller over. Install the expansion plug with a press and tooling (C). Install the expansion plug until it makes contact with the counterbore n the roller.

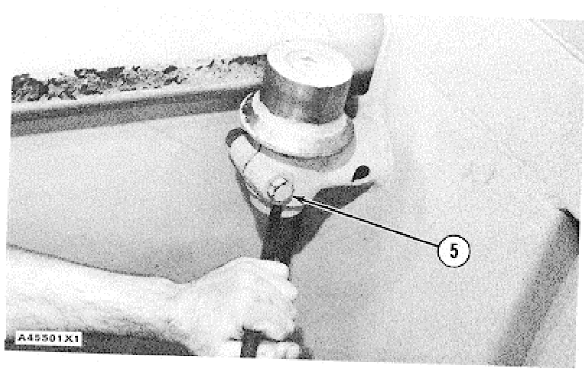


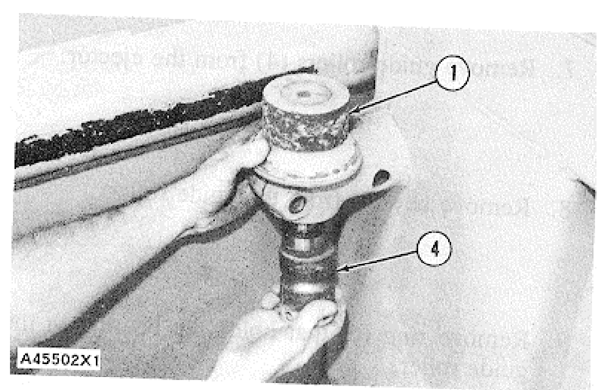
4. Install ring (2) on shaft (3).



5. Fill roller with 5P960 Multipurpose Type Grease. Put roller (1) on top of the bracket. Install shaft (4) from the bottom of the bracket.

6. Install bolt and nut (5) and adjust the roller against rail as shown. Tighten the nut.

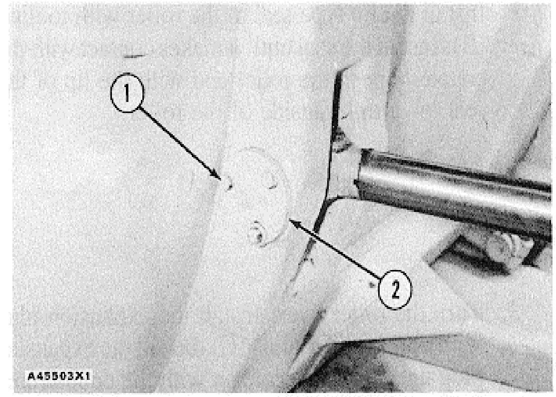




EJECTOR REAR GUIDE ROLLER

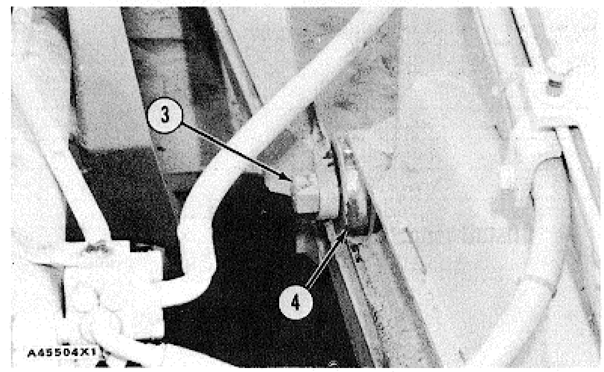
REMOVE EJECTOR REAR GUIDE ROLLER

	Tools Needed	A
1P765	Seal Guide	1



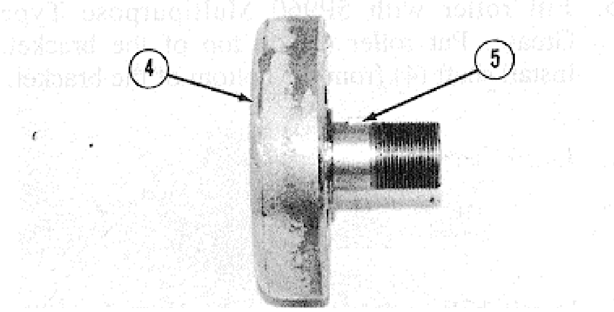
1. Put the ejector in full forward position.

2. Fasten a hoist to the lifting eye on top of the ejector.



3. Remove bolts (I) and plate (2) from both sides and remove pin.

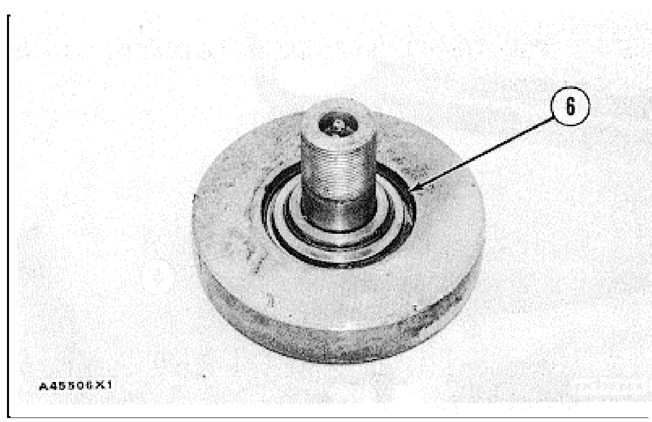
4. Remove the rear cover assembly. See REMOVE EJECTOR CYLINDER for this operation.



5. Move the ejector forward with hoist until guide rollers (4) are out of their tracks.

6. Remove nuts (3) from the guide rollers.

7. Remove guide rollers (4) from the ejector.

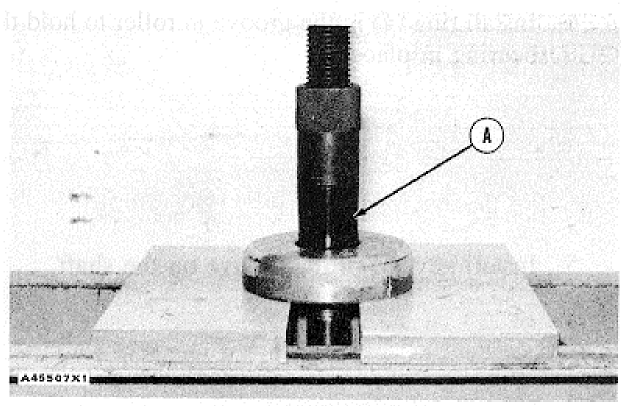


8. Remove key (5) from the guide roller.

9. Remove ring (6) that holds the bearing in the guide roller.

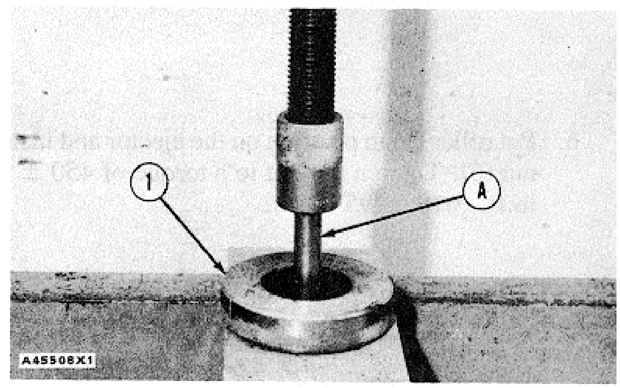
EJECTOR REAR GUIDE ROLLER

10.Use tool (A) and a press to remove the plug, bearing and shaft from the roller as shown.

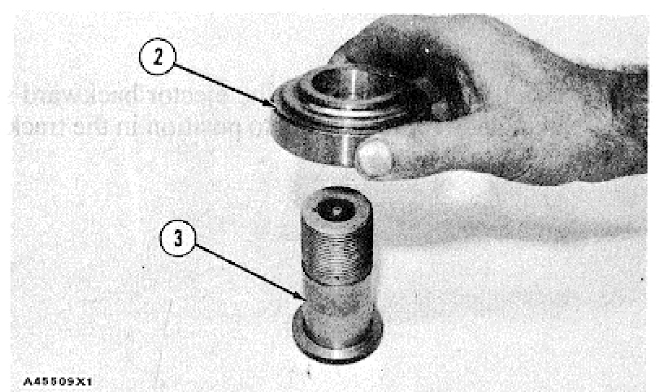


INSTALL EJECTOR REAR GUIDE ROLLER

	Tools Needed	A	B
1P471	Drive Plate	1	
1P487	Drive Plate		1
1P774	Seal Guide		1

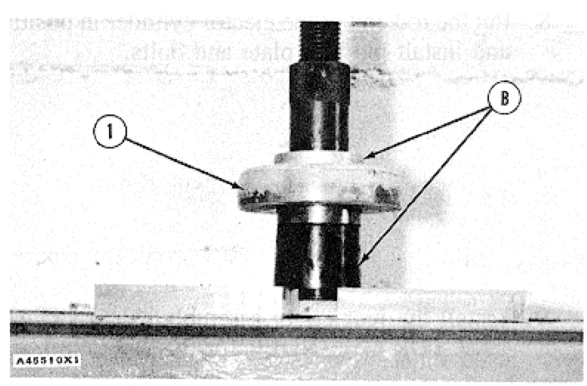


1. Use tool (A) and press to install the plug in roller (1).



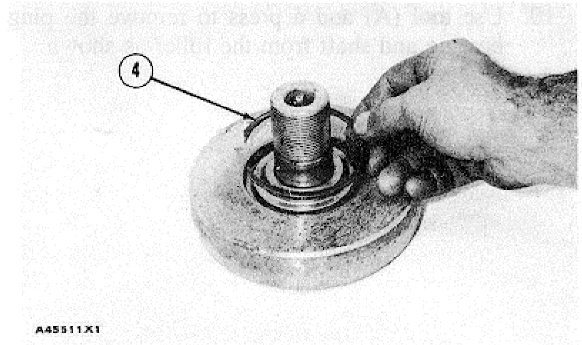
2. Install bearing (2) on shaft (3).

NOTE: Make sure the high side on the bearing is to the top as shown.

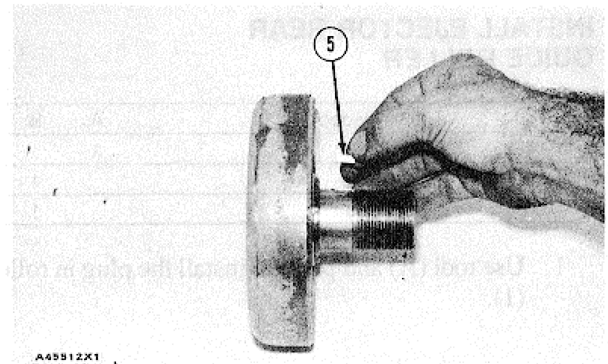


3. Use tooling (B) and a press to install roller () on the bearing.

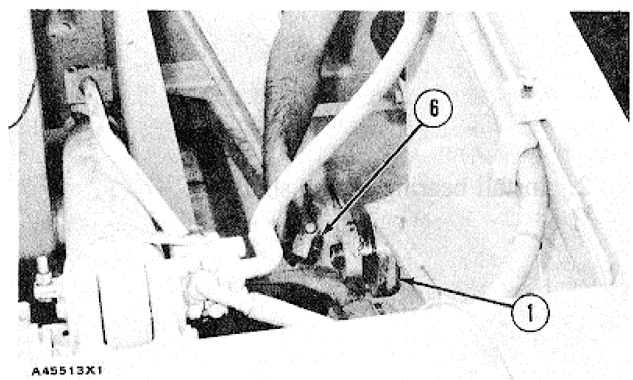
4. Install ring (4) in the groove in roller to hold the bearing in place.



5. Install key (5) in the groove on the shaft.

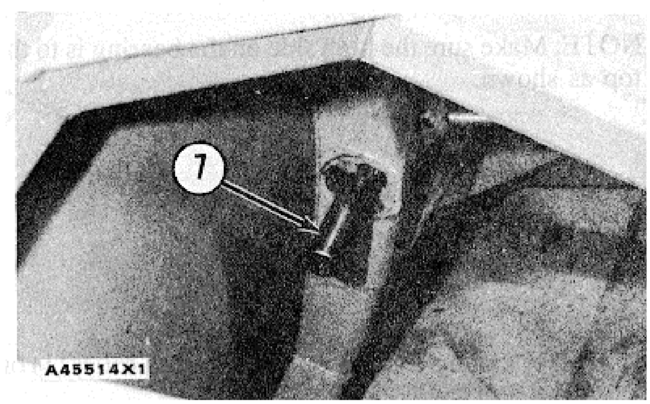


6. Put roller(l) in position on the ejector and install nut (6). Tighten the nut to a torque of 450 ± 70 lb.ft. (610 + 95 N.m).



7. Use the hoist and move the ejector backward so that guide rollers slide into position in the track.

8. Put the rod end of the ejector cylinder in position and install pin (7), plate and bolts.



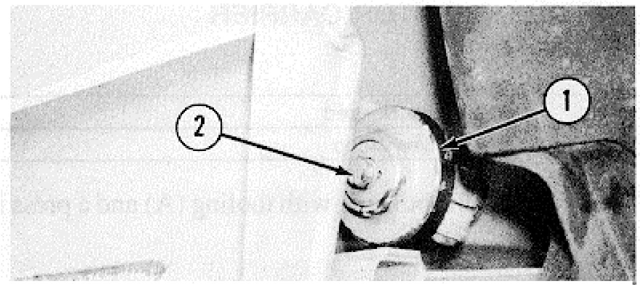
9. Install the rear cover assembly, see INSTALL EJECTOR CYLINDER for this operation.

EJECTOR CARRIER ROLLER

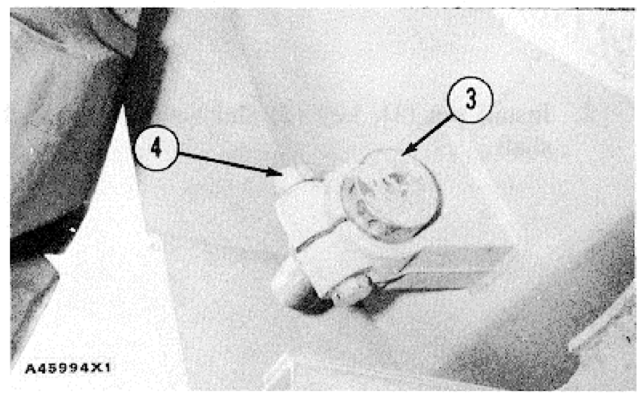
REMOVE EJECTOR CARRIER ROLLER

	Tools Needed	A
1P510	Driver Group	1

1. Fasten a hoist to the lifting eye on the top of the ejector. Lift the ejector to permit the roller to be removed.

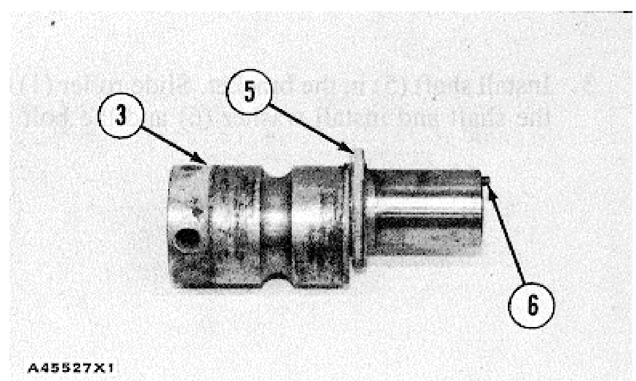


2. Remove bolt (2) and the washer from the roller. Remove roller (1) from the shaft.



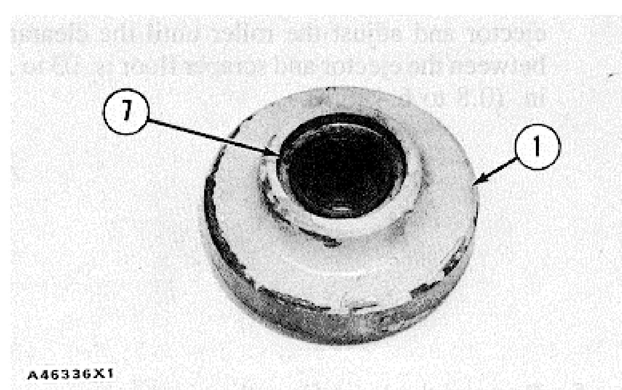
VIEW FROM UNDER MACHINE 1

3. Remove nut and bolt (4) from the roller bracket. Make the opening in the bracket large enough to remove roller shaft (3). Remove the shaft.



4. Remove washer (5) and the key from shaft (3). Remove pin (6) from the front of the shaft.

5. Remove bushing (7) from roller (1).

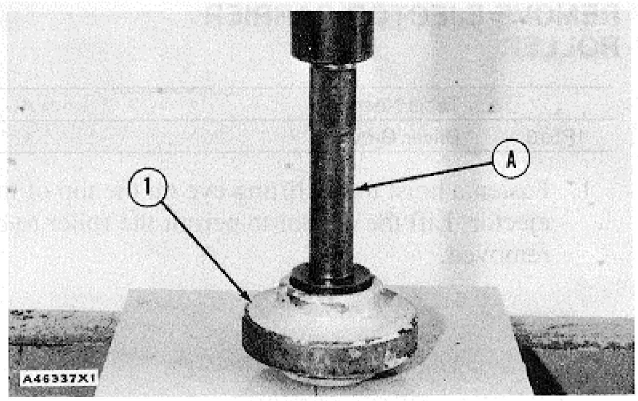


EJECTOR CARRIER ROLLER

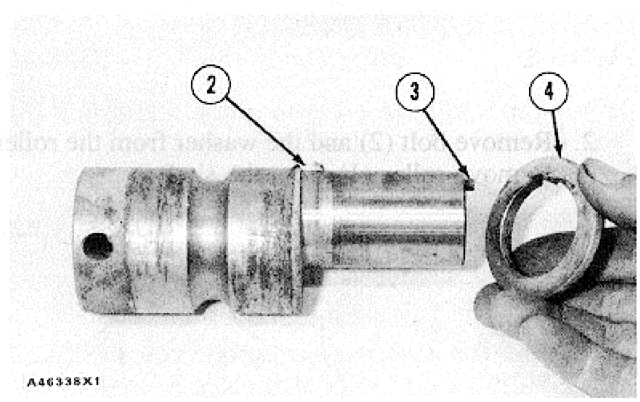
INSTALL EJECTOR CARRIER ROLLER

	Tools Needed	A
1P510	Driver Group	1

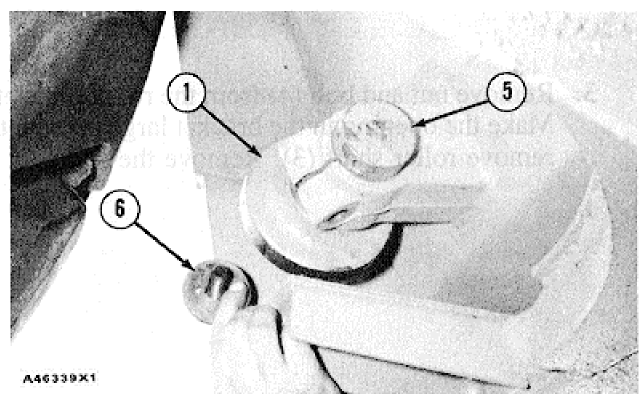
1. Install the bushing with tooling (A) and a press in roller (I).



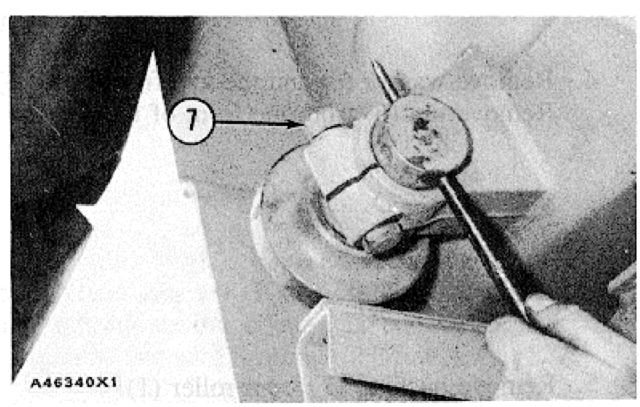
2. Install pin (3), key (2) and washer (4) on the shaft.



3. Install shaft (5) in the bracket. Slide roller (1) on the shaft and install washer (6) and the bolt.



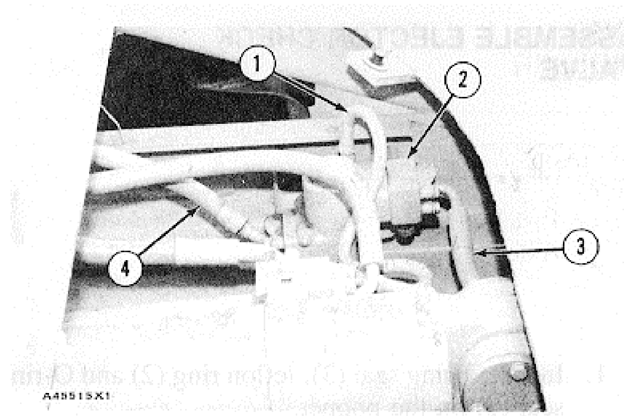
4. Install bolt and nut (7) in the bracket. Lower the ejector and adjust the roller until the clearance between the ejector and scraper floor is .03 to .25 in. (0.8 to 6.4 mm).



5. Remove the hoist from the ejector.

EJECTOR CHECK VALVE

REMOVE EJECTOR CHECK VALVE



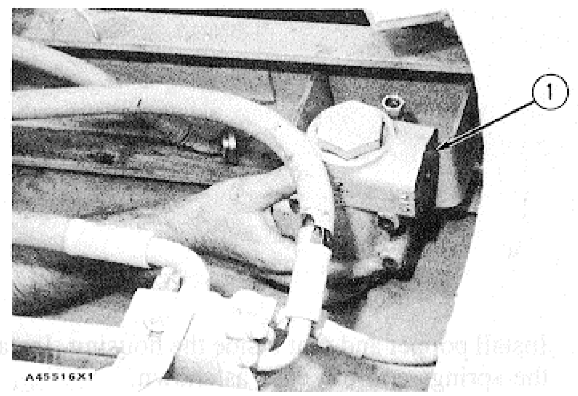
1. To remove the rear cover assembly, see RE MOVE EJECTOR CYLINDER for this operation.

2. Disconnect hose assemblies (1), (3) and (4). Remove connector (2) from the check valve.

3. Remove the four nuts and lockwashers from the check valve.

4. Remove the check valve.

INSTALL EJECTOR CHECK VALVE



1. Put check valve (1) in position and install the lockwashers and nuts.

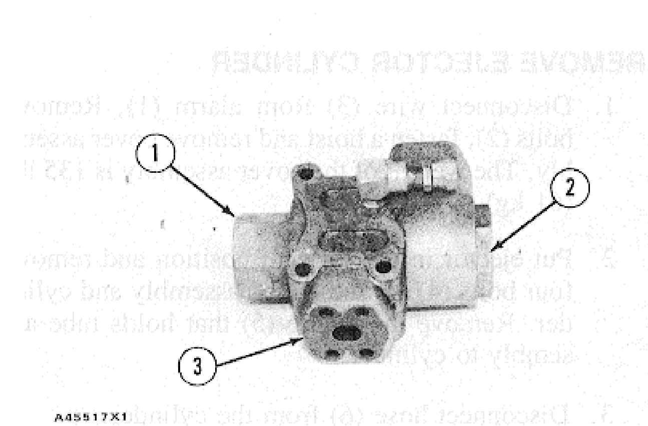
2. Put the connector in position and connect the three hose assemblies.

3. Install the rear cover assembly. See INSTALL EJECTOR CYLINDER for this operation.

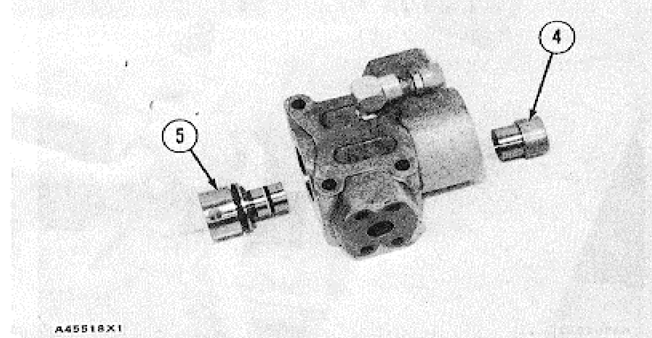
DISASSEMBLE EJECTOR CHECK VALVE

start by:
a) remove ejector check valve

1. Remove caps (1) and (2) from check valve housing (3). Remove springs from each cap. Check the condition of the O-ring seals on the caps. If the seals have damage, use new parts for replacement.



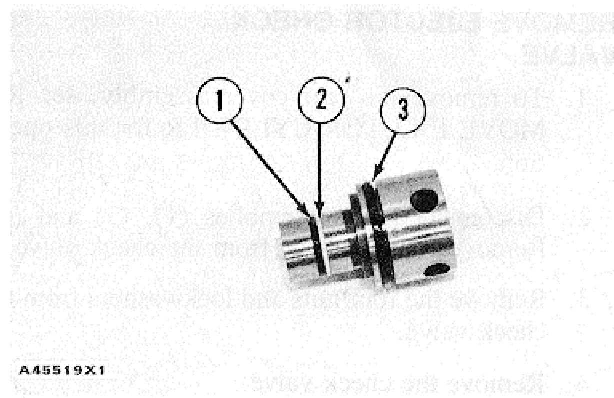
2. Remove seat (4) and poppet (5) from the inside of the housing. Remove the O-ring seals and teflon ring from the poppet. Check the condition of the O-ring seal and teflon ring. If they have damage, use new parts for replacement.



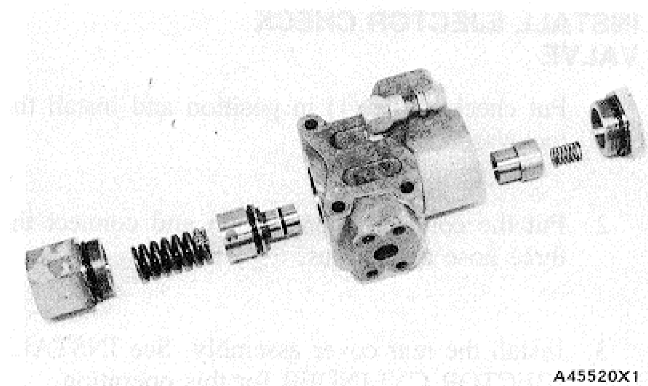
EJECTOR CHECK VALVE, EJECTOR CYLINDER

ASSEMBLE EJECTOR CHECK VALVE

1. Install O-ring seal (3), teflon ring (2) and O-ring seal (I) on the poppet.

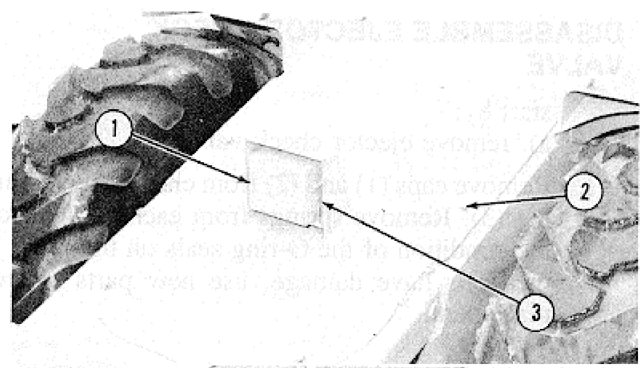


2. Install poppet and seat inside the housing. Install the springs and the caps as shown.

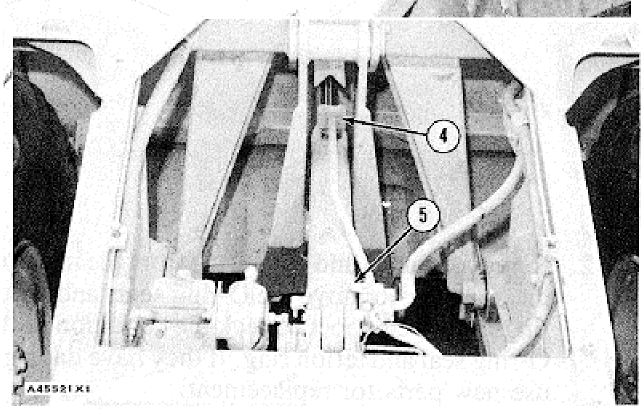


REMOVE EJECTOR CYLINDER

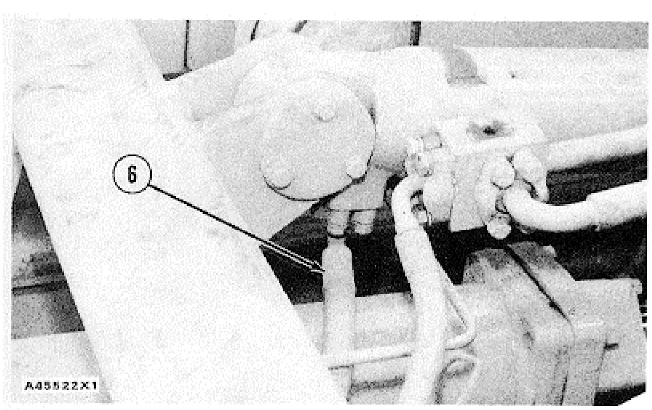
1. Disconnect wire (3) from alarm (1), Remove bolts (2), fasten a hoist and remove cover assembly. The weight of the cover assembly is 135 lb. (61 kg).



2. Put ejector in the forward position and remove four bolts (4) from the tube assembly and cylinder. Remove the clamp (5) that holds tube assembly to cylinder.

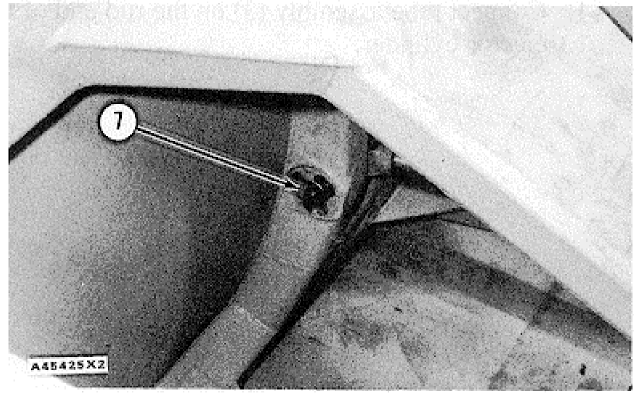


3. Disconnect hose (6) from the cylinder.

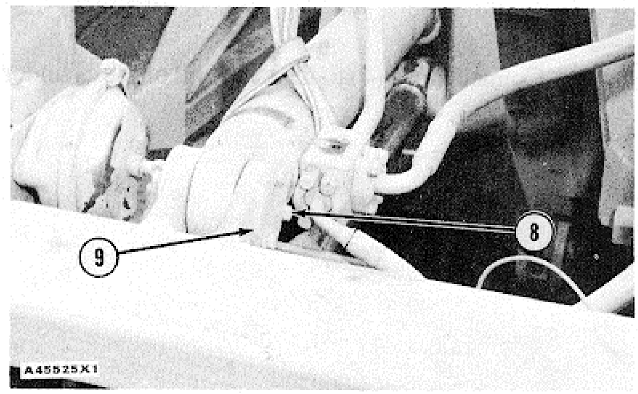


EJECTOR CYLINDER

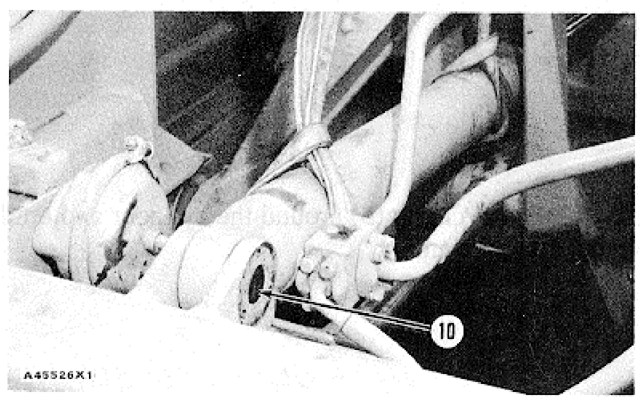
4. Fasten a hoist to the ejector cylinder. Remove the covers from both sides of the ejector. Remove pin (7) that holds the cylinder rod to the ejector.



5. Remove bolts (8) and covers (9) from both sides.



6. Remove pin (10) from the head end of the ejector cylinder. Remove the ejector cylinder. The weight of the cylinder is 98 lb. (44 kg).

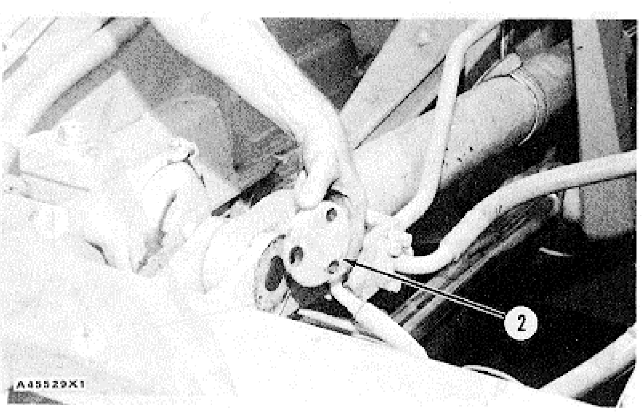


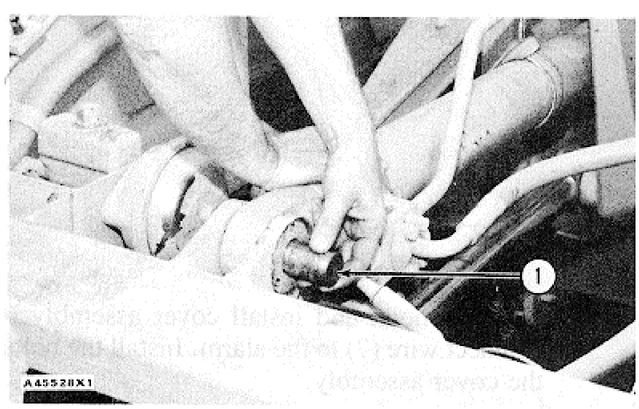
INSTALL EJECTOR CYLINDER

1. Fasten a hoist to the cylinder and put in position. Install pin (l) in the head end of the cylinder.

2. (2) and the bolts on both sides.

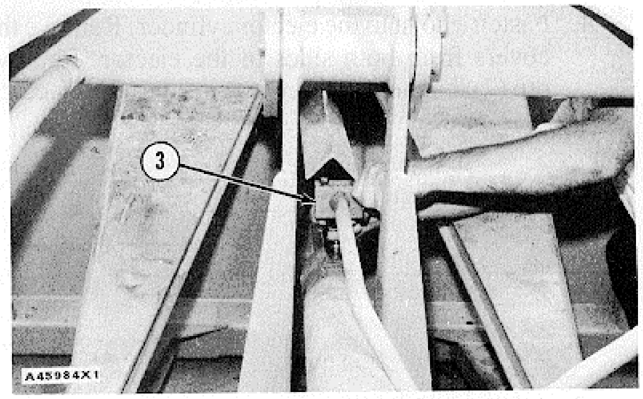
3. Put the ejector cylinder rod in position and install the pin and covers that hold the rod to the ejector.



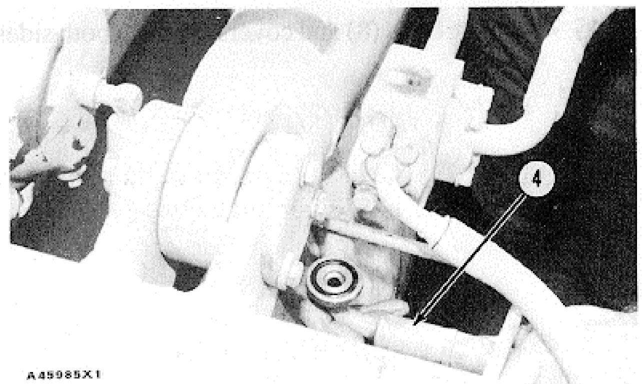


EJECTOR CYLINDER

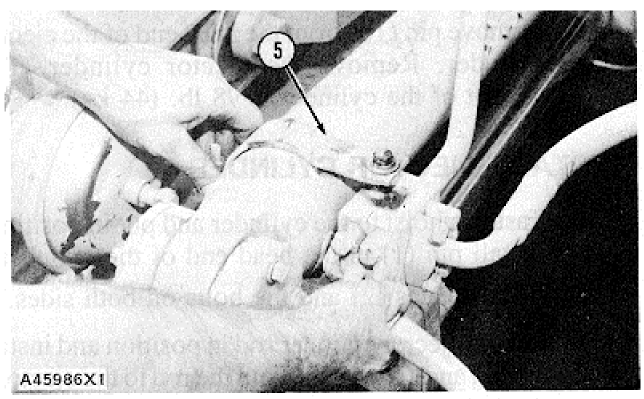
4. Connect tube assembly (3) on the rod end of the ejector cylinder.



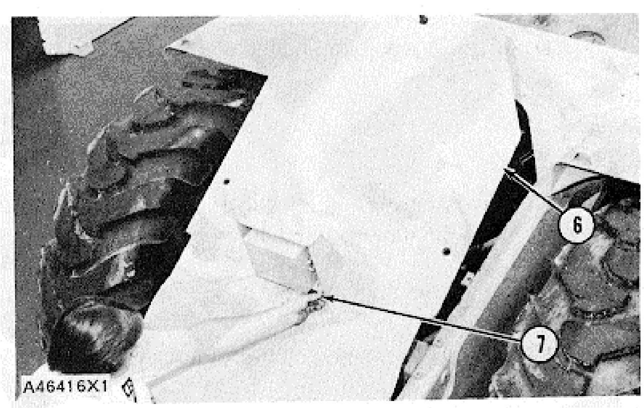
5. Connect hose (4) to the head end of the cylinder.



6. Install clamp (5) around the cylinder and on the tube assembly.



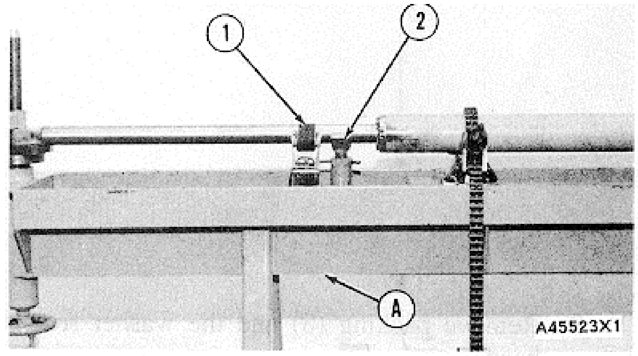
7. Fasten a hoist and install cover assembly (6). Connect wire (7) to the alarm. Install the bolts to the cover assembly.



EJECTOR CYLINDER

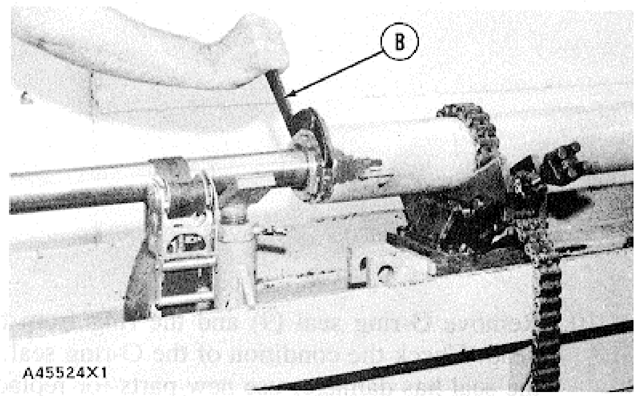
DISASSEMBLE EJECTOR CYLINDER

	Tools Needed	A	B	C	D	E
1P1784	Hydraulic Cylinder Repair Stand	1				
5P3100	Pump Group	1				
1P2854	Spanner Wrench		1			
2P8343	Torque Multiplier			1		
1P851	Spline Adapter			1		
1P852	Male Adapter			1		
5P3520	Spanner Wrench				1	
2P2257	Extension				1	
2P2258	Adapter				1	
1P2852	Spanner Wrench					1



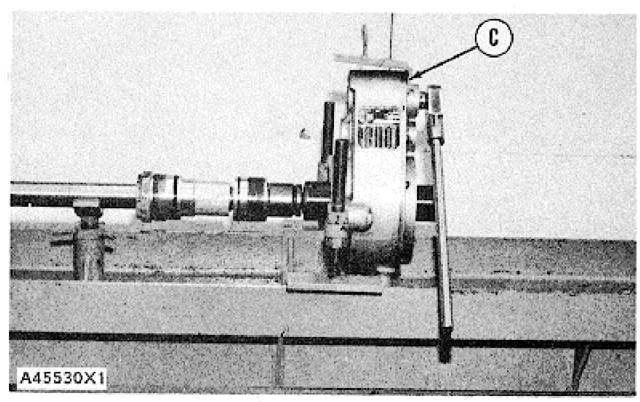
start by:
a) remove ejector cylinder

1. Pull the rod out of the cylinder as shown and put the cylinder in position on tooling (A).



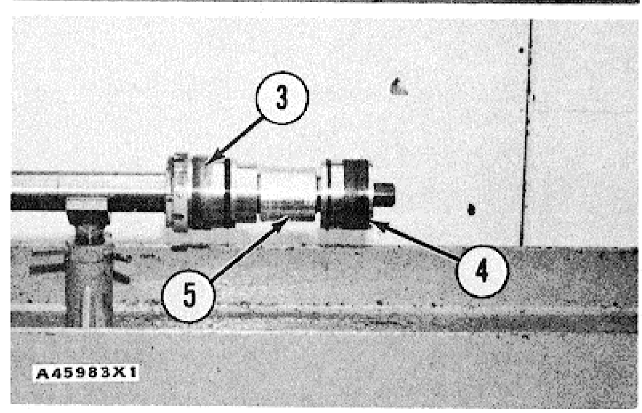
2. Install support (I) under the rod.

3. Fasten a strap (2) around the rod to hold it in position.



4. Use tool (B) to loosen the head. Remove the head and the rod from the tube.

5. Remove the nut from the rod with tooling (C).

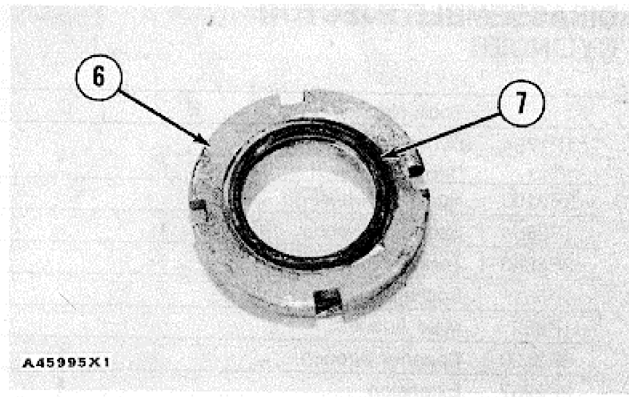


6. Remove piston (4) with tooling (D) from the rod. Remove spacer (5) and head (3) from the rod.

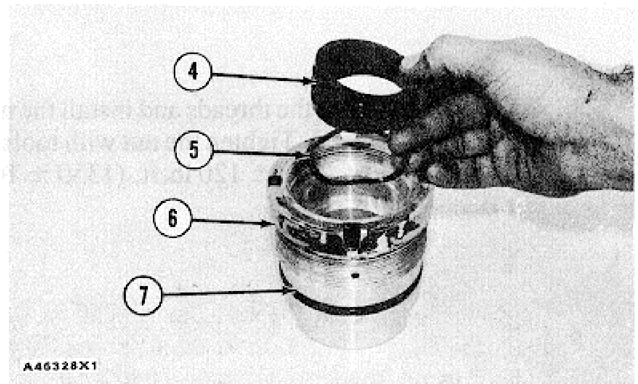
7. Use tool (E) to remove the gland assembly from head (3).

EJECTOR CYLINDER

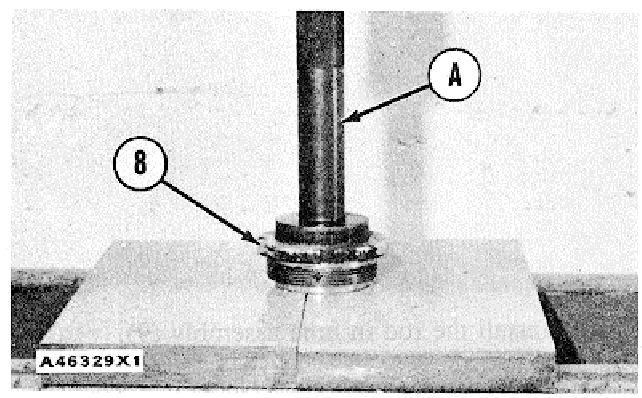
8. Remove wiper (7) from gland assembly (6).



9. Remove packing (8) and the washer from the head.



10. Remove O-ring seal (9) and the ring from the head. Check the condition of the O-ring seal. If the seal has damage, use new parts for replacement.

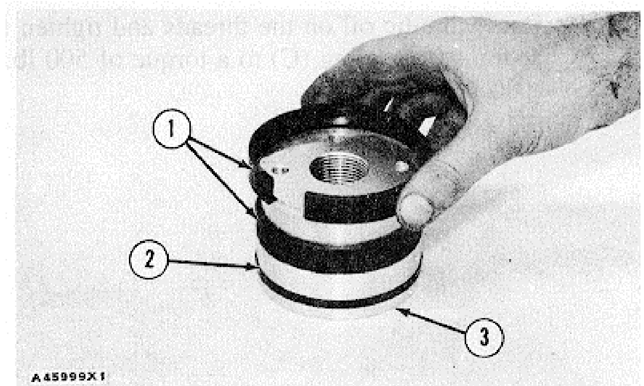


11. Remove rings (10) and seal assembly (11) from piston (4).

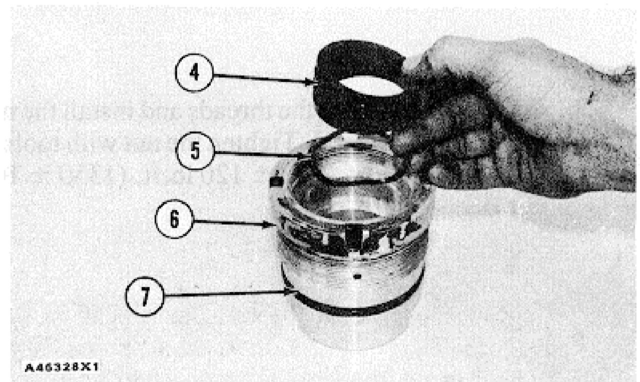
EJECTOR CYLINDER

ASSEMBLE EJECTOR CYLINDER

	Tools Needed	A	B	C	D	E
1P510	Driver Group	1				
1P2852	Spanner Wrench		1			
5P3520	Spanner Wrench			1		
FT1344	Handle			1		
2P2257	Extension			1		
2P2258	Adapter			1		
2P8343	Torque Multiplier			1		
8H8541	Socket				1	
1P2854	Spanner Wrench					1

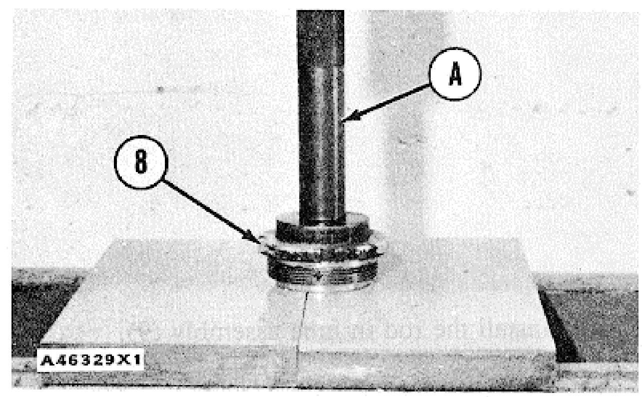


1. Install seal assembly (2) on piston (3) with the rubber expander ring under the plastic seal ring.



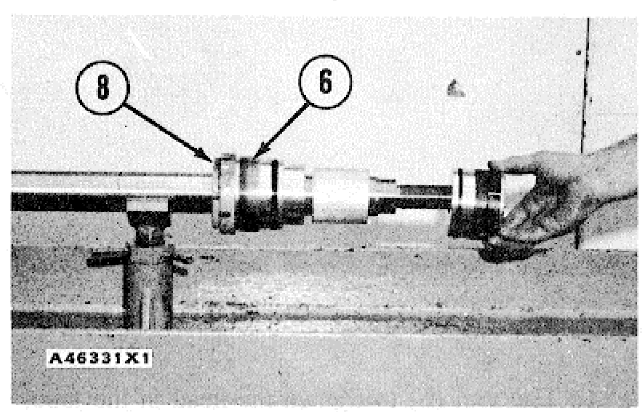
2. Install seal rings (1) on piston (3) with the openings (joint) of the rings 180° apart.

3. Install the back-up ring and O-ring seal (7) on head (6) with the back-up ring toward the threads on the head.



4. Install washer (5) and packing (4) in the head.

5. Install the wiper in gland assembly (8) with tooling (A) with the lip of the seal toward the outside when installed.

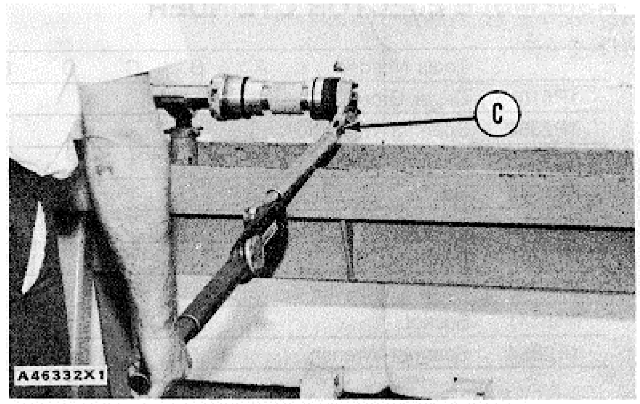


6. Install gland assembly (8) in the head and tighten the gland assembly with tool (B).

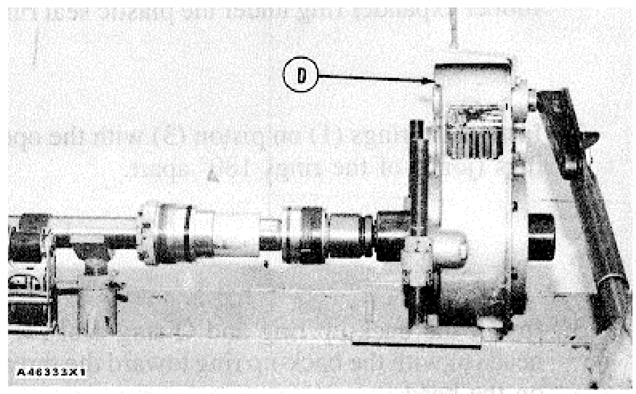
7. Install the head, the spacer and piston on the rod.

EJECTOR CYLINDER

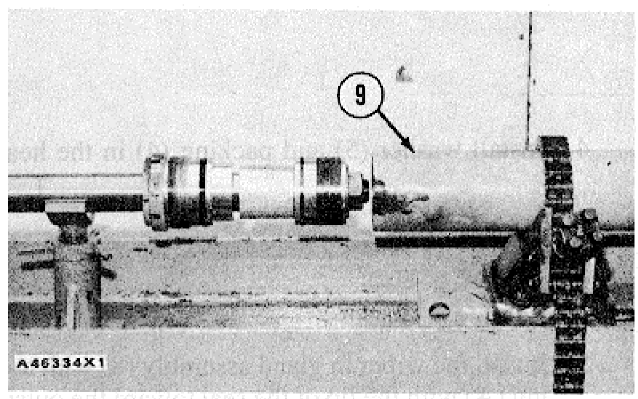
8. Put hydraulic oil on the threads and tighten the piston with tooling (C) to a torque of 500 lb.ft. (680 N.m).



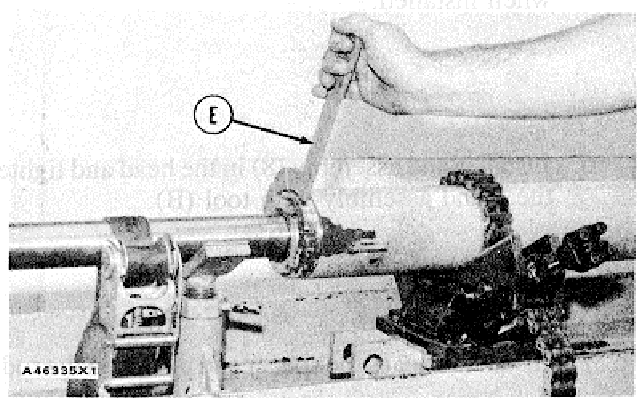
9. Put hydraulic oil on the threads and install the nut on the end of the rod. Tighten the nut with tooling (D) to a torque of 1000 + 120 Ib.ft. (1350 + 160 N.m).



10. Install the rod in tube assembly (9).



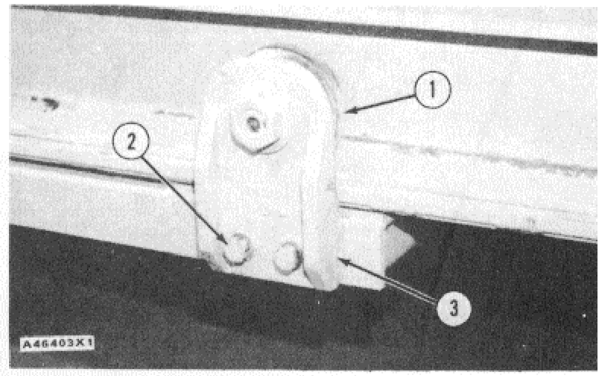
11. Use tool (E) to tighten the head in the tube.



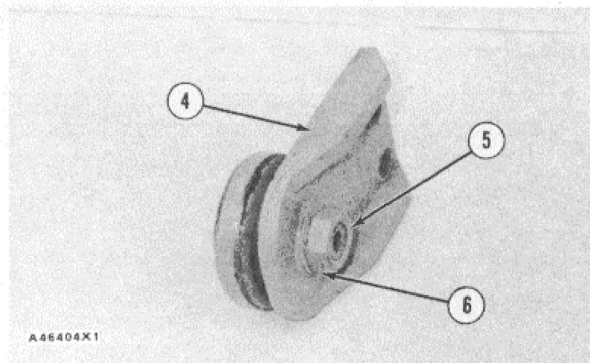
REMOVE SLIDING FLOOR ROLLER

	Tools Needed	A	B
1P7461	Leg	2	
887554	Bearing Cup Puller Attachment	1	
1P74	Slide Hammer Puller	1	
5F7342	Adapter	1	
5P7458	Snap Ring Pliers		1

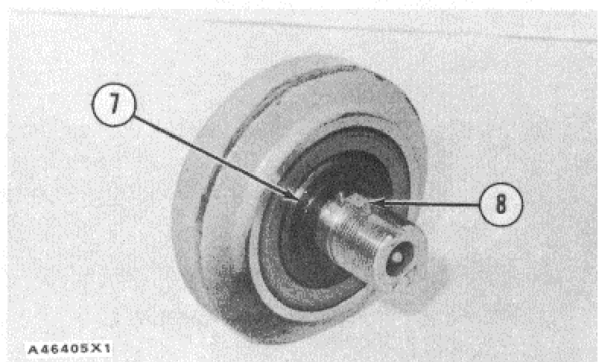
1. Put a floor jack in position under the door assembly and lift the weight off of roller assembly (1). Remove bolts (2) to remove roller assembly (1) and shims (3).



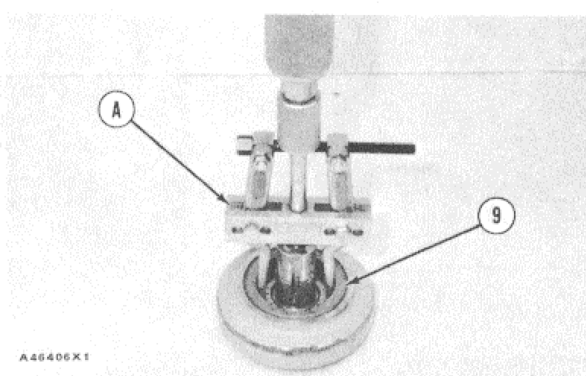
2. Bend lock (6) away from nut (5). Remove the nut and plate (4) from the roller.



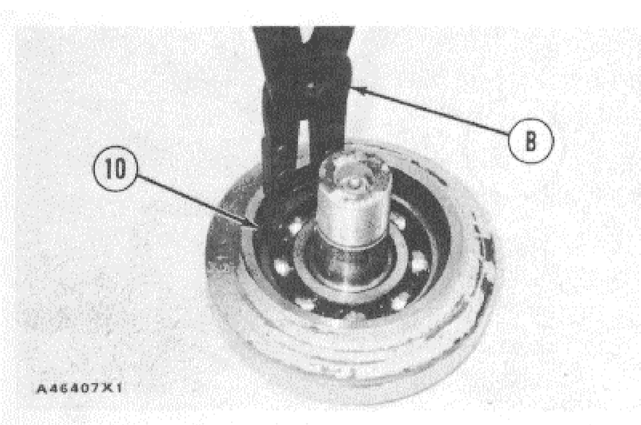
3. Remove key (8) and spacer (7) from the roller shaft.



4. Remove seal (9) with tooling (A) from the roller.

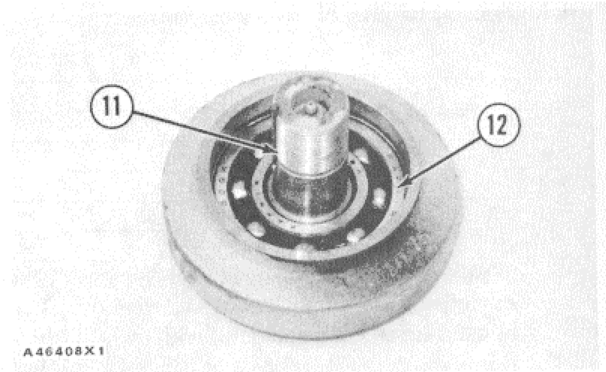


5. Remove lockring (10) with tool (B).



SLIDING FLOOR ROLLER

6. Pull up on the shaft and remove the shaft (11) and bearing (12) together.

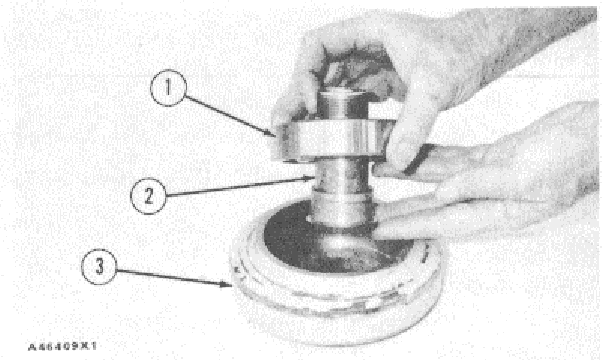


7. Remove bearing (12) from shaft.

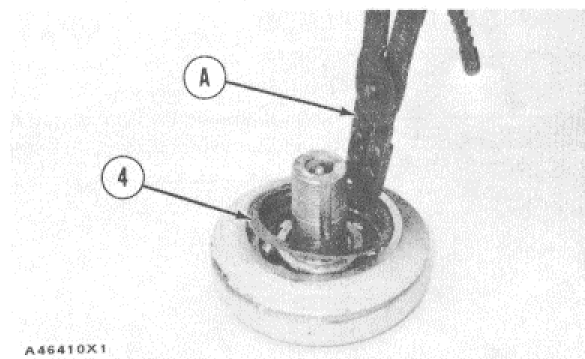
INSTALL SLIDING FLOOR ROLLER

	Tools Needed	A
5P4758	Snap Ring Pliers	1

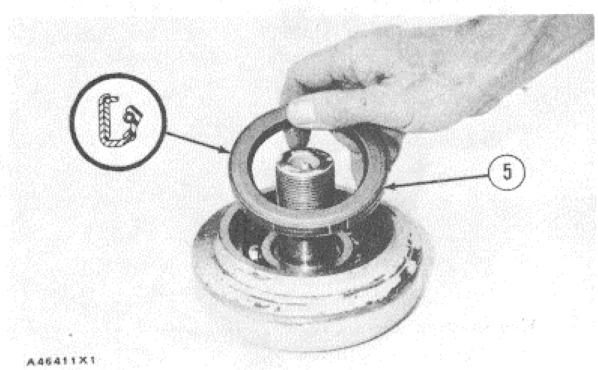
1. Install shaft (2) and bearing (1) in roller (3).



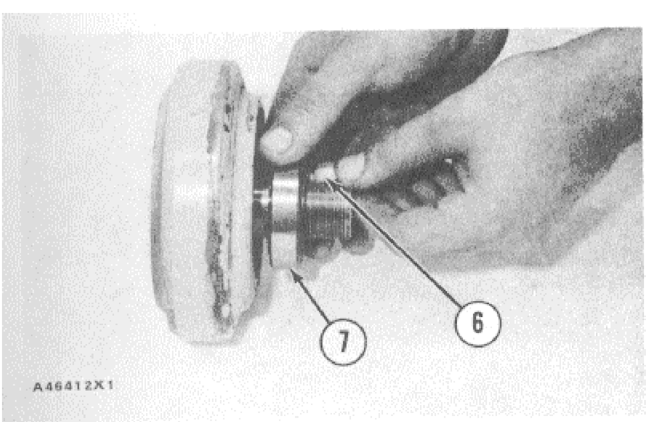
2. Install lockring (4) in the roller with tool (A).



3. Install seal (5) in the roller. Install the seal until it makes contact with the lockring in the roller and with the lip of the seal toward the outside of the roller.



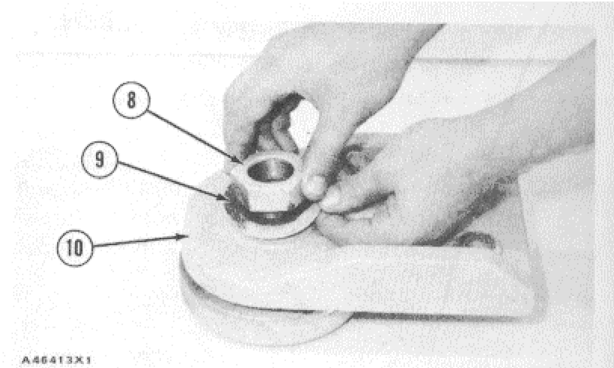
4. Install spacer (7) and key (6) on the roller.



SLIDING FLOOR ROLLER, SLIDING FLOOR

5. Install plate (10) on the roller shaft.

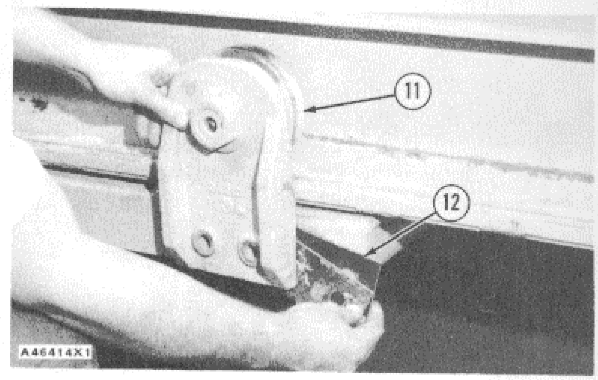
6. Install lock (9) and nut (8). Tighten the nut to a torque of 450 ± 70 lb. ft. (610 ± 95 N. m). Bend the lock on the nut.



7. Install the roller assembly (11) and shims (12) to the sliding floor. Use 5P960 Multipurpose Type Grease on the bolts before installation.

NOTE: Clearance between the door roller and bowl side is . 06 to . 18 in. (1. 5 to 4. 6 mm).

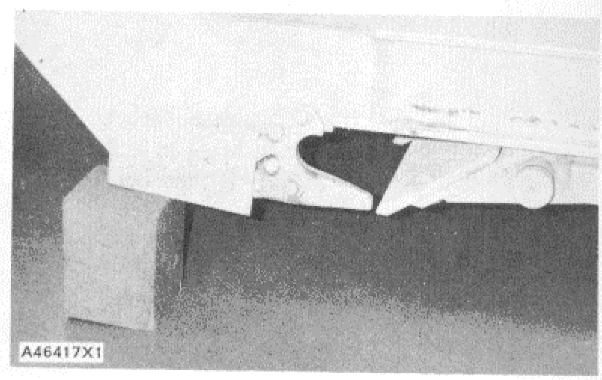
8. Fill the roller assembly with 5P960 Multipurpose Type Grease.



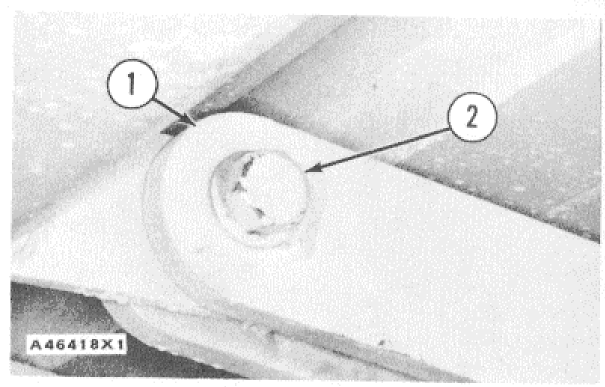
9. Lower the weight of the door assembly on roller assembly (11) and remove the floor jack.

REMOVE SLIDING FLOOR

	Tools Needed	A	B
1P510	Driver Group	1	
887560	Step Plate		1
1P2321	Puller Assembly		1



1. Put the sliding floor in position level with the ground and put wooden blocks on each side. Open the sliding floor to position shown.

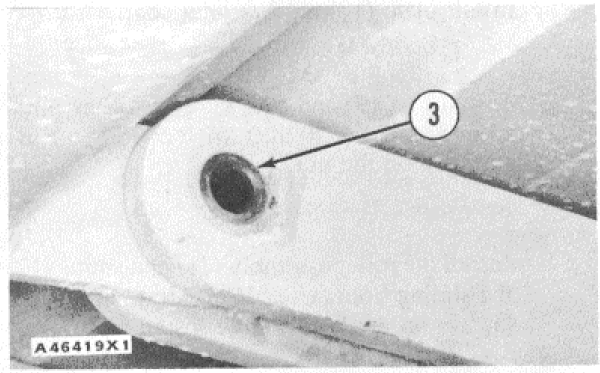


VIEW FROM UNDER MACHINE

2. Remove the nut and bolt (2) from both links (1) at the rear of the sliding floor.

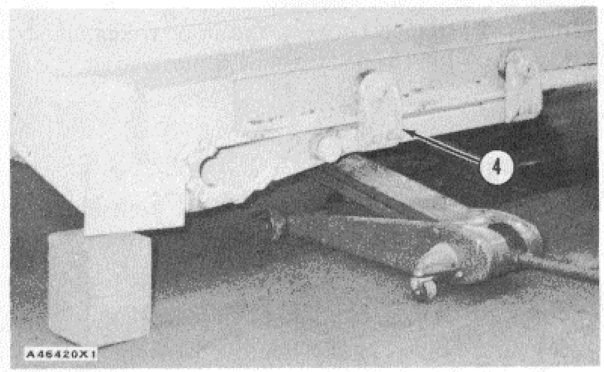
SLIDING FLOOR

3. Put a floor jack under a link and remove tube (3) with tooling (A). Lower the link to the floor and use the same procedure on the other link.

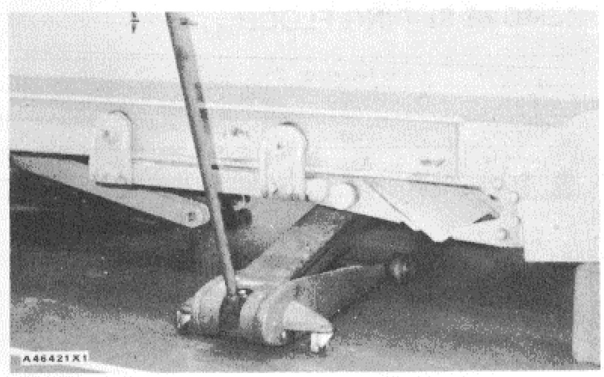


VIEW FROM UNDER MACHINE

4. Put a floor jack under the sliding floor as shown and remove the bolts from roller assemblies (4). Remove the roller assemblies and the shims.

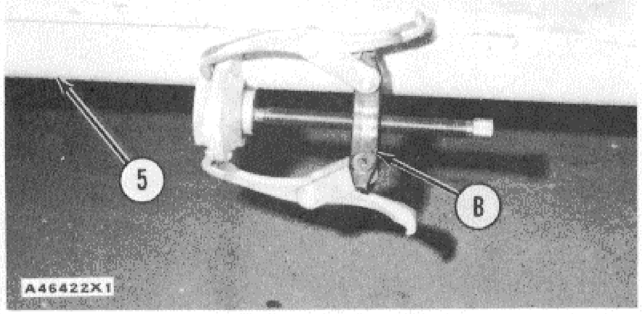


5. Put another floor jack on the other side of the sliding floor as shown. Remove the sliding floor from the opposite side. The weight of the sliding floor is 1, 300 lb. (585 kg).



⚠ WARNING: Use care when the sliding floor is removed. As soon as it is removed, put blocks under the floor so it will not fall off the jacks.

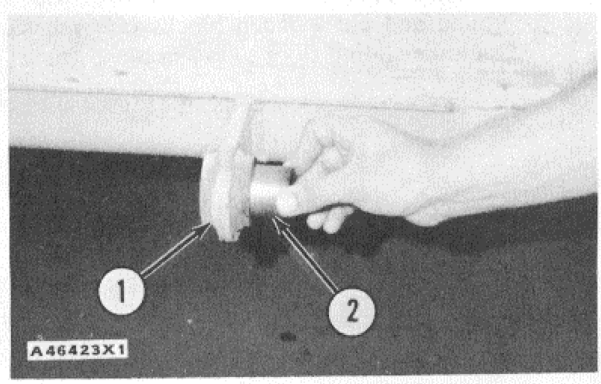
6. Install tooling (B) and remove the bushing from the bracket on the rear of sliding floor (5). Follow the same procedure to remove other bushing.



INSTALL SLIDING FLOOR

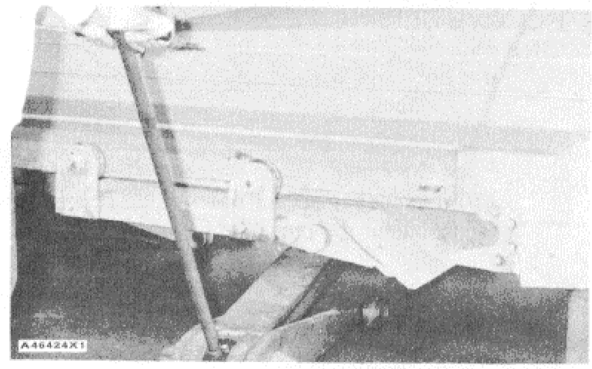
	Tools Needed	A
1P510	Driver Group	1

1. Install two bushings (2) in brackets (I) on the rear of the sliding floor.

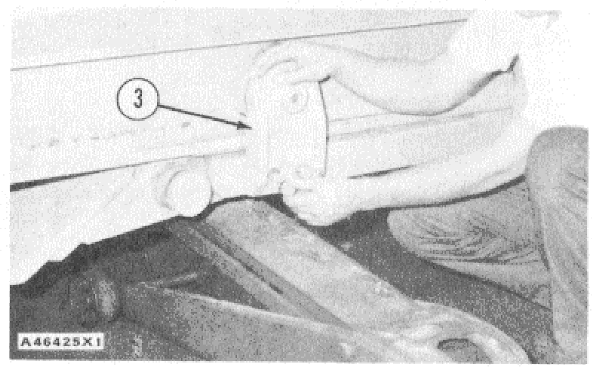


SLIDING FLOOR

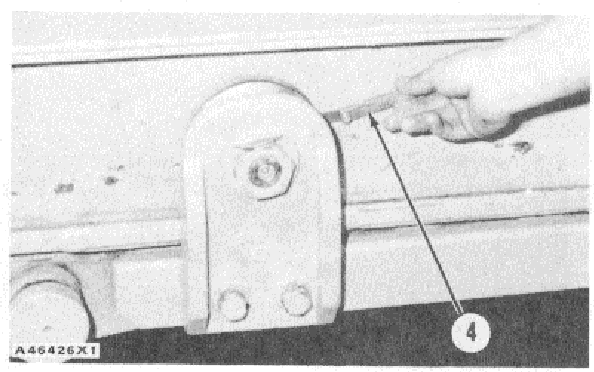
2. With the floor jacks installed on both sides of the sliding floor, slide the floor in position.



3. After floor is in position, install the shims and two roller assemblies (3).

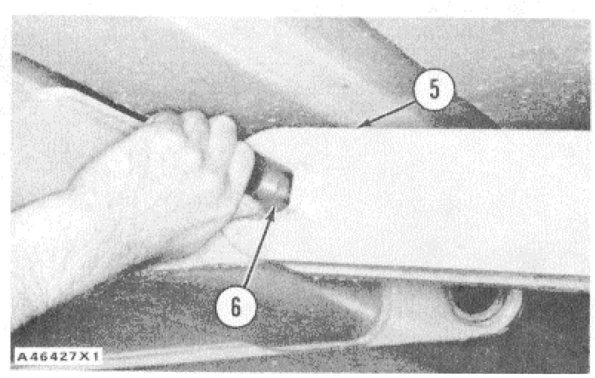


4. After rollers are installed, check the clearance with a feeler gauge (4). The clearance between floor roller and bowl sides is . 06 to . 18 in. (1. 5 to 4. 6 mm).



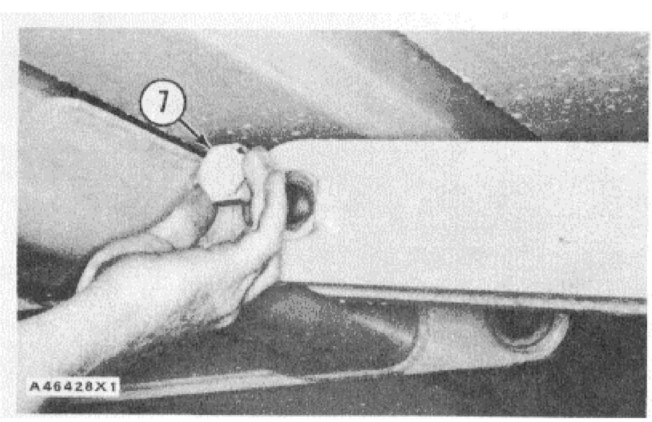
NOTE: When one side has . 18 in. (4. 6 mm) clearance, the other side must not have more than . 13 in. (3. 3 mm).

5. Put link (5) in position with a floor jack and install tube (6) with tooling (A).



6. Install bolt (7) and the nut in the tube.

7. Follow Steps 5 and 6 for assembly of the other link.



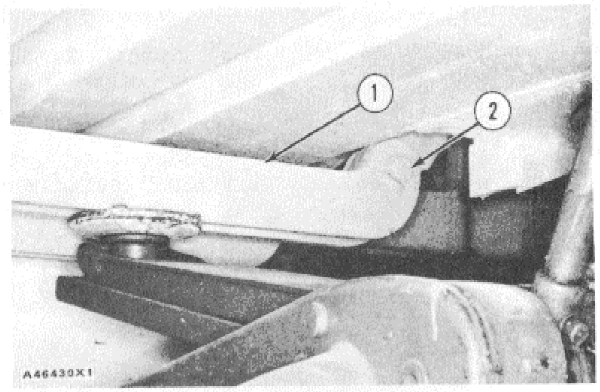
VIEW FROM UNDER MACHINE

SLIDING FLOOR LINK

REMOVE SLIDING FLOOR LINK

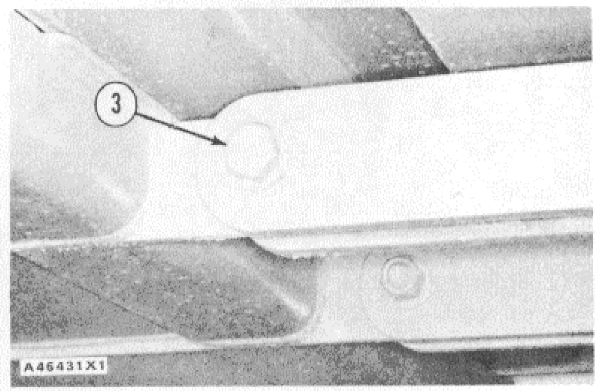
	Tools Needed	A
1P510	Driver Group	1

1. Lift the bowl and place blocks under each side of the bowl for support. _



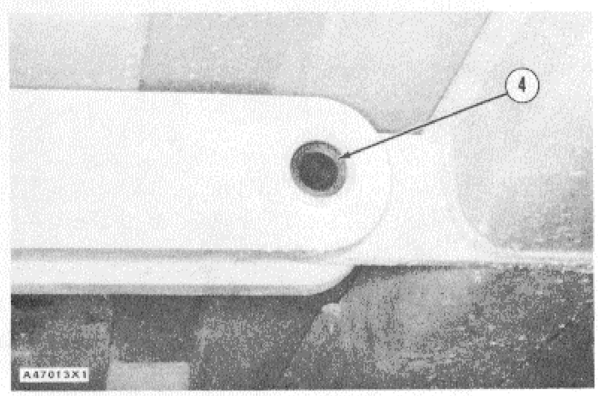
VIEW FROM UNDER MACHINE

2. Put the floor jack under link (I) as shown and remove nut and bolt (2) from the rear of the link.



VIEW FROM UNDER MACHINE

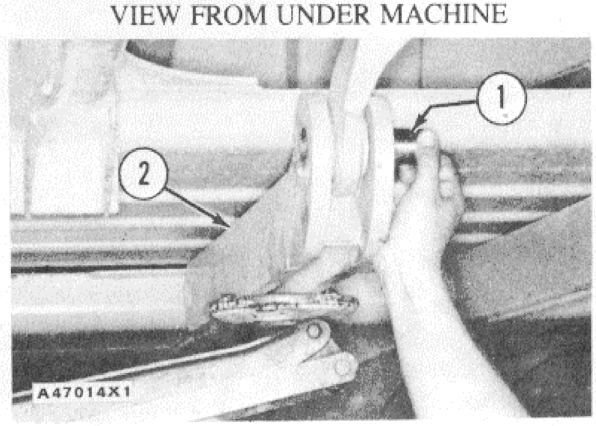
3. Remove nut and bolt (3) from the front of the link.



VIEW FROM UNDER MACHINE

4. Remove tube (4) from the front and the rear of the link with tooling (A). Remove the link with the floor jack. The weight of the link is 82 lb. (37 kg).

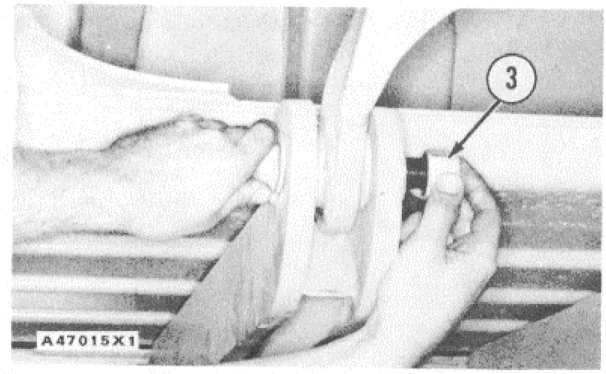
INSTALL SLIDING FLOOR LINK



1. Put the floor jack under the link and install in position as shown. Install tube (1) in link (2) on both ends.

SLIDING FLOOR LINK, SLIDING FLOOR ARM ASSEMBLY

2. Install bolt and nut (3) in both ends of the link. Remove wood blocks from the front of the scraper.



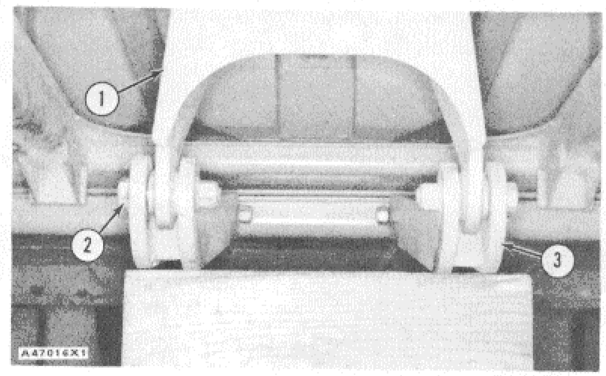
VIEW FROM UNDER MACHINE

REMOVE SLIDING FLOOR ARM ASSEMBLY

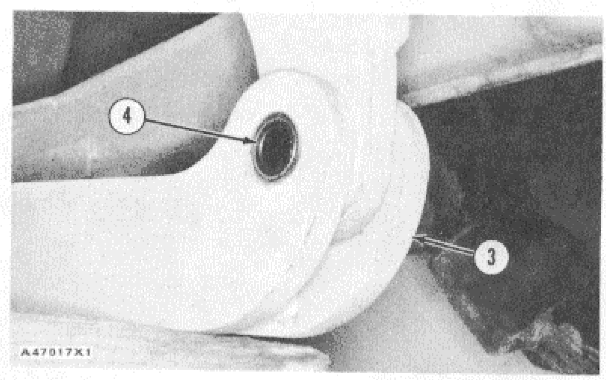
	Tools Needed	A
1P510	Driver Group	1

start by:
a) remove ejector cylinder

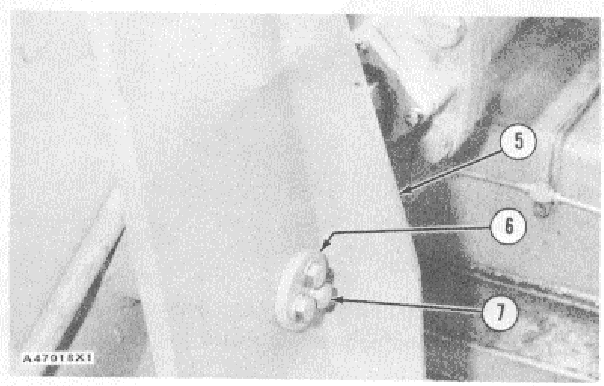
1. Make preparations to remove sliding floor arm assembly
   a) Lift the bowl and put supports under routing bits.
   b) Put a floor jack under the cutting edge.
   c) Put a wood block under the links.



2. Remove bolts (2) from links (3) where they connect to the arm (1).



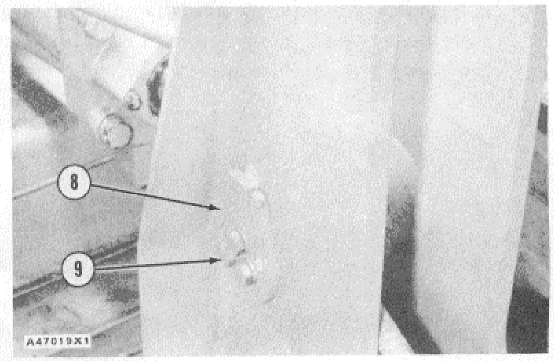
3. Remove tube (4) from both links (3) with tooling (A).



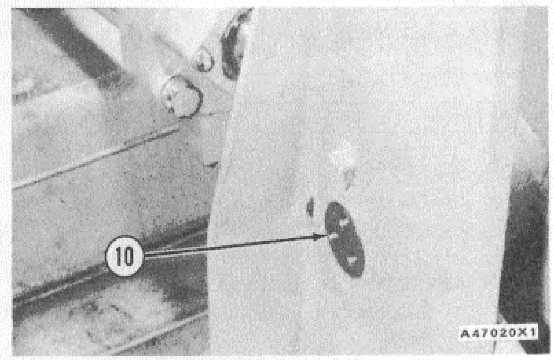
4. Remove bolts (7) and washer (6) from cylinder retaining pin which is installed in arm assembly (5).

SLIDING FLOOR ARM ASSEMBLY

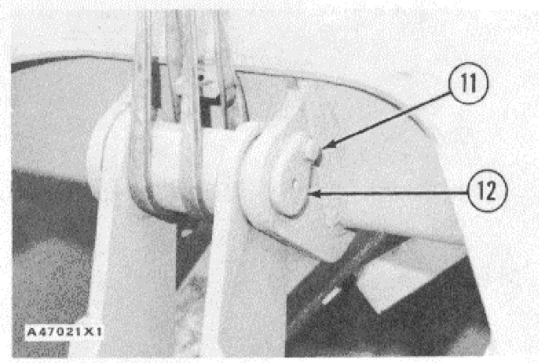
5. On the other side of the arm assembly, remove bolts (9) and plate (8) with the notch.



6. Put wooden blocks under the sliding floor cylinder for support and remove pin (10) with hammer and punch.

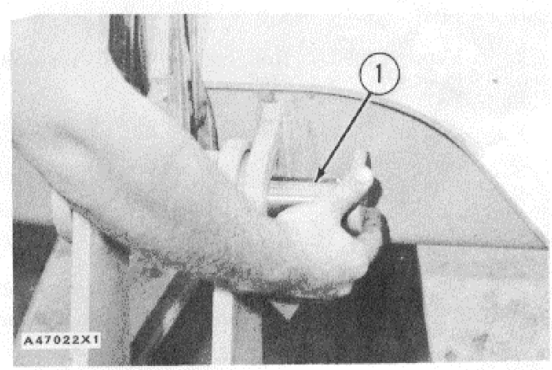


7. Fasten a hoist to the top of the arm assembly. Remove bolts (11) and slide pin (12) from the frame.



8. For the arm to clear the tube assembly, shown in Step 4, lift the arm slightly with hoist and move the lower portion of the arm toward the front of the scraper. The weight of the arm assembly is 175 lb. (79 kg).

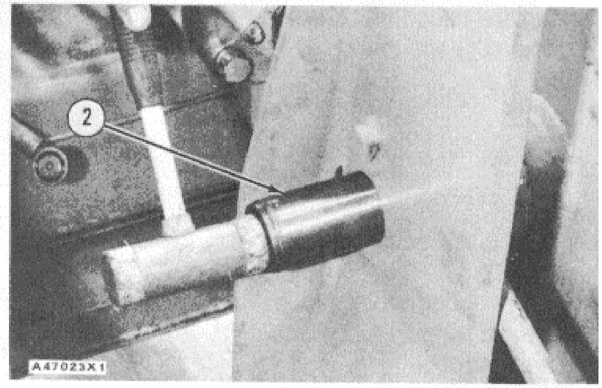
INSTALL SLIDING FLOOR ARM ASSEMBLY



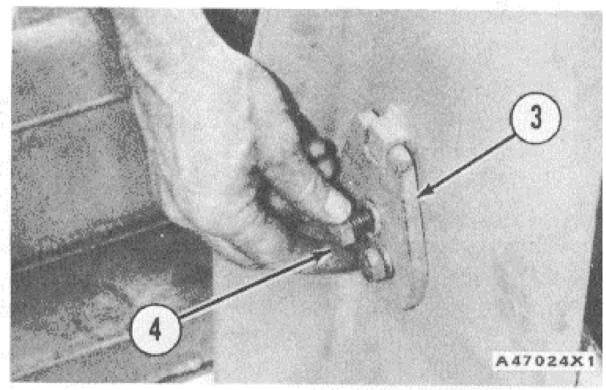
1. Fasten a hoist to the top of the arm and make sure the tube assembly is in correct position in the arm. Put the arm in position and install pin (1) and the bolt.

SLIDING FLOOR ARM ASSEMBLY

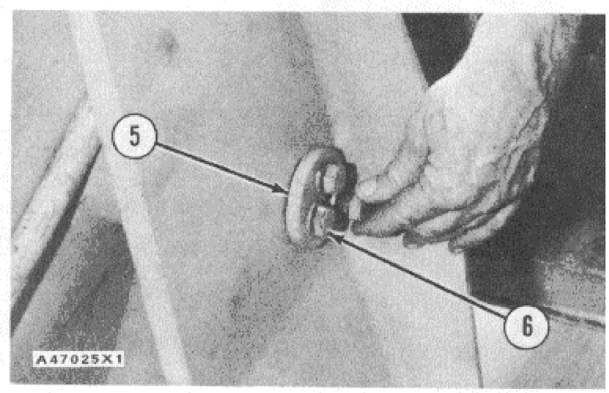
2. With the sliding floor cylinder and arm in alignment, install pin (2) with a soft faced hammer. Remove wood blocks from the cylinder.



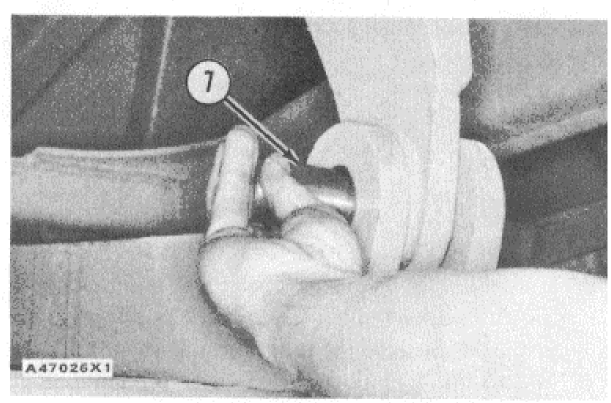
3. Install plate (3) and bolts (4) in the pin.



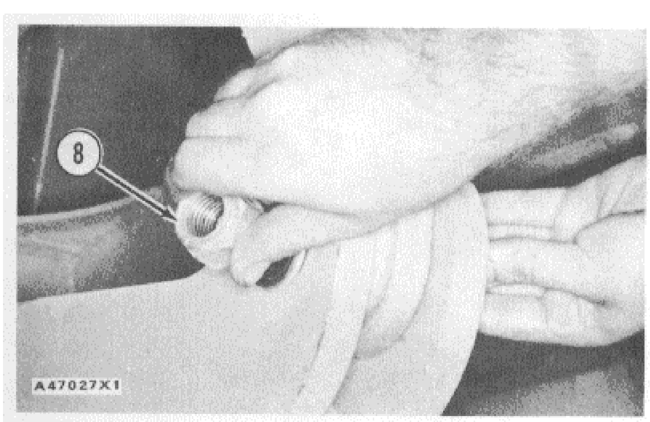
4. On other side of pin, install washer (5) and bolts (6).



5. Install tube (7) in link and arm on both sides.



6. Install bolt and nut (8) in both tubes.



7. Remove all wood blocks and the floor jack from the scraper.

end by:

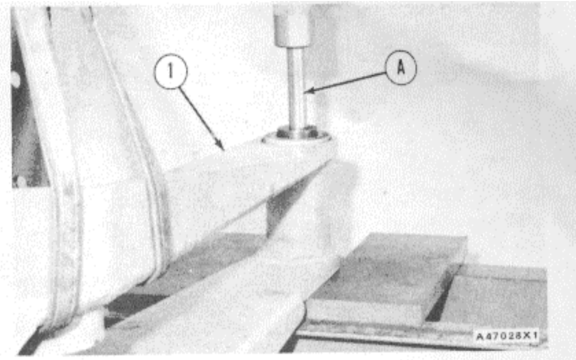
a) install ejector cylinder

SLIDING FLOOR ARM ASSEMBLY

DISASSEMBLE SLIDING FLOOR ARM ASSEMBLY

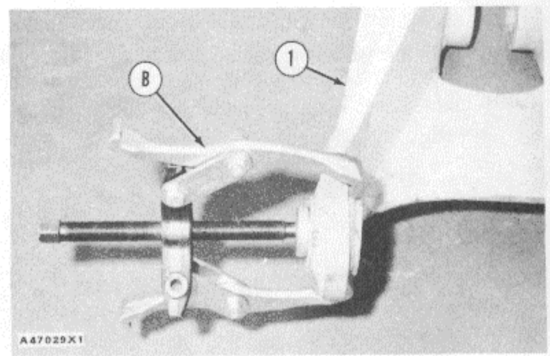
	Tools Needed	A	B
1P510	Driver Group	1	
1P2321	Puller Assembly		1
887560	Step Plate		1

start by:
a) remove sliding floor arm assembly



1. Fasten a hoist and put arm (1) in position in the press as shown.

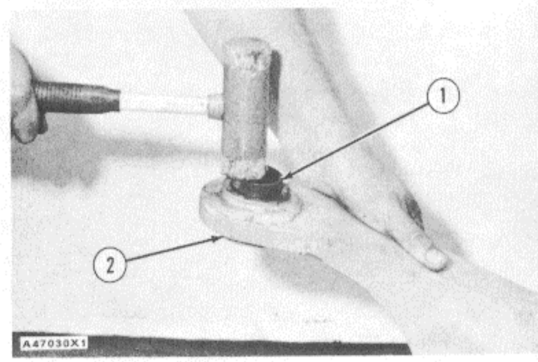
2. Remove bushing, spacer and bushing from the arm with tooling (A) and the press.



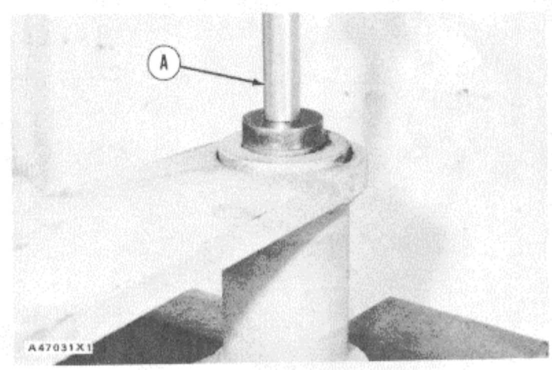
3. On the lower end of arm (I), remove bushing with tooling (B). Follow the same procedure for the other bushing.

ASSEMBLE SLIDING FLOOR ARM ASSEMBLY

	Tools Needed	A
1P510	Driver Group	1



1. Install bushing (1) in arm (2) with a soft faced hammer. Follow the same procedure for the other bushing.



2. Install bushing, spacer and bushing with tooling (A) in a press.

SLIDING FLOOR CYLINDER

REMOVE SLIDING FLOOR CYLINDER

	Tools Needed	A
1 P510	Driver Group	1

WARNING: Make sure all of the hydraulic pressure is released from the hydraulic system before any lines are disconnected.

1. Make preparations to remove sliding floor cylinders.
   a) Lift the bowl and place wood blocks under routing bits.
   b) Move the sliding floor to one-fourth open position and install floor jack under cutting edge.

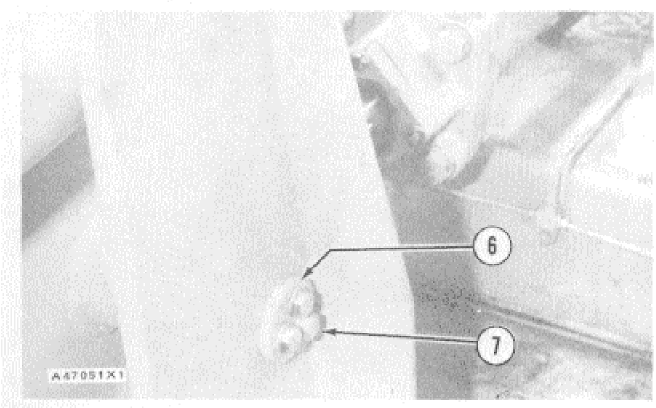
2. To remove the rear cover assembly, see REMOVE EJECTOR CYLINDER for details.

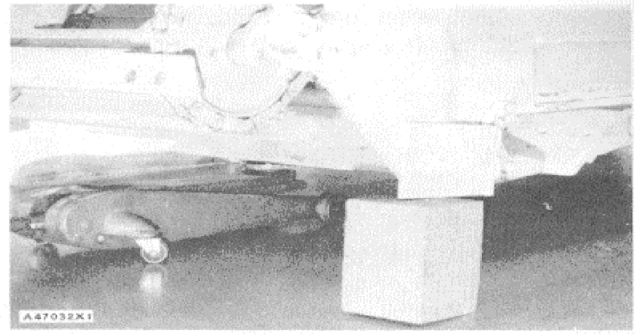
3. Remove top portion of clamp (1) from sliding floor cylinder (2).

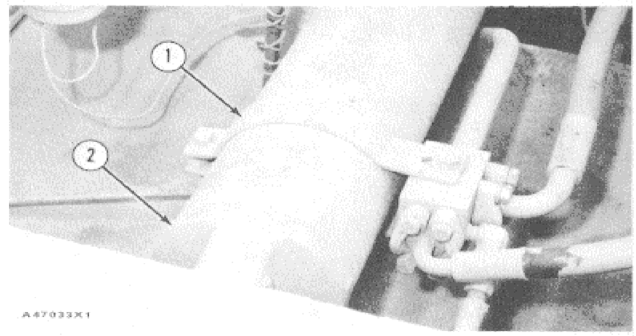
4. Remove bolts (3) from the tube assembly.

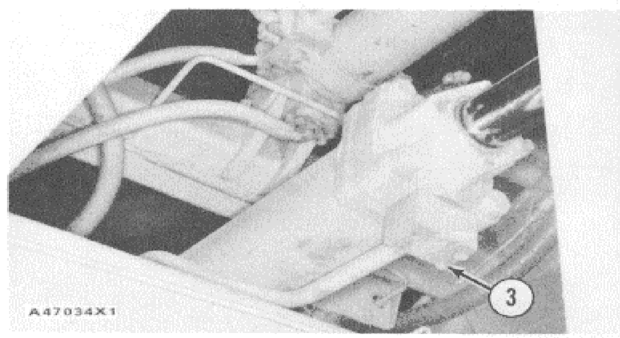
5. At the rod end of the cylinder, remove bolts (5) and plate (4) from the arm.

6. On other side of arm, remove bolts (7) and washer (6) from the arm.

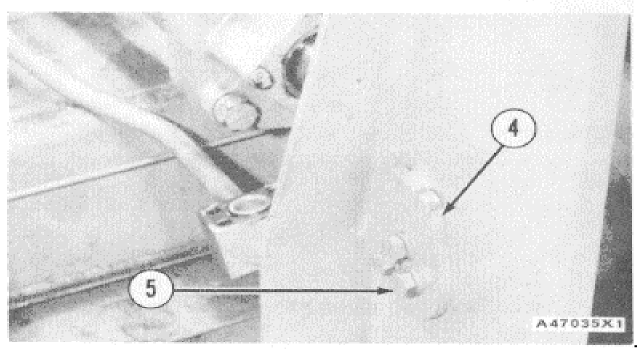








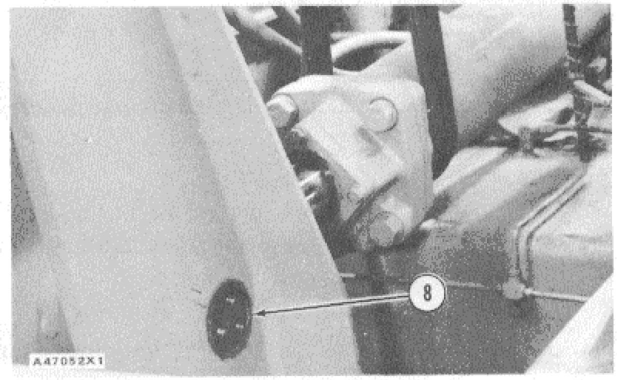
VIEW FROM UNDER MACHINE



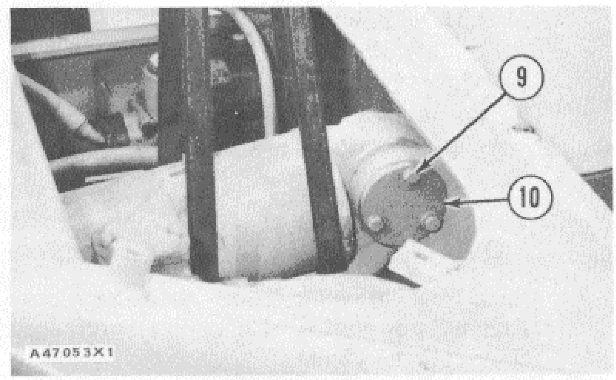
7

SLIDING FLOOR CYLINDER

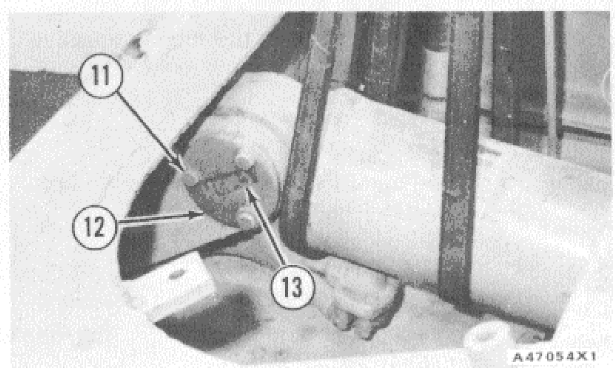
7. Fasten a hoist to the cylinder as shown and remove pin (8) with tooling (A).



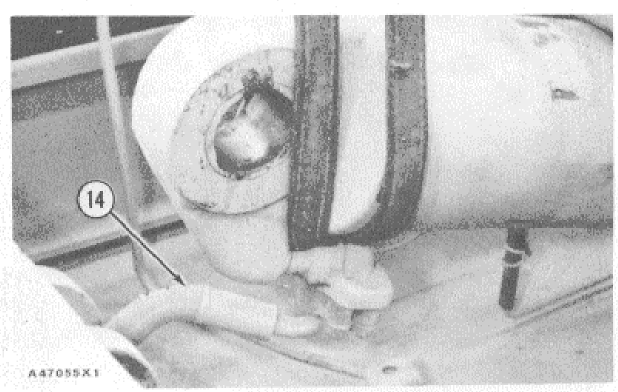
8. Remove the hoist from the rod end and install it on the head end of the cylinder. Remove bolts (9) and plate (10) from the frame.



9. Remove bolts (I) and plate (12) with a groove (slot) from the frame. Remove the pin (13) with tooling (A).



10. Lift the cylinder and remove hose (14) under the cylinder.



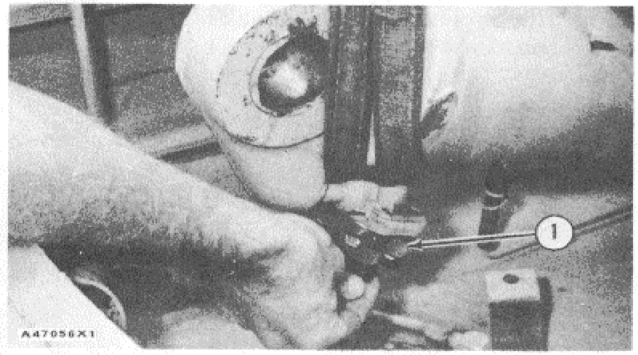
11. Remove the cylinder from the scraper. The weight of the sliding floor cylinder is 150 lb. (68kg).

SLIDING FLOOR CYLINDER

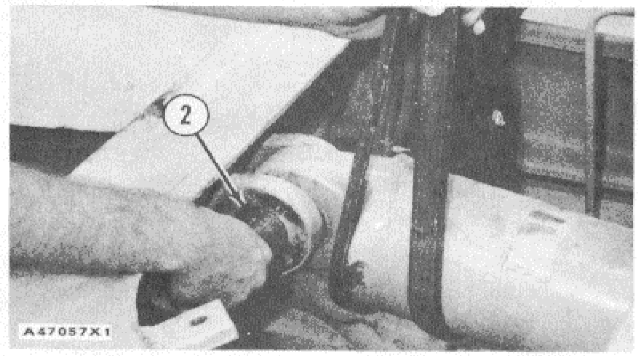
INSTALL SLIDING FLOOR CYLINDER

1. Fasten a hoist to the cylinder and put it in position shown.

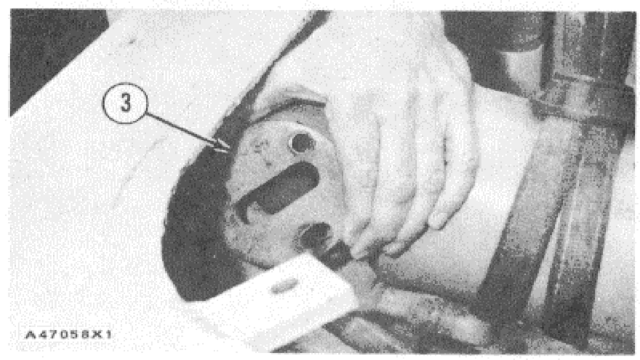
2. Install hose (1) under the cylinder.



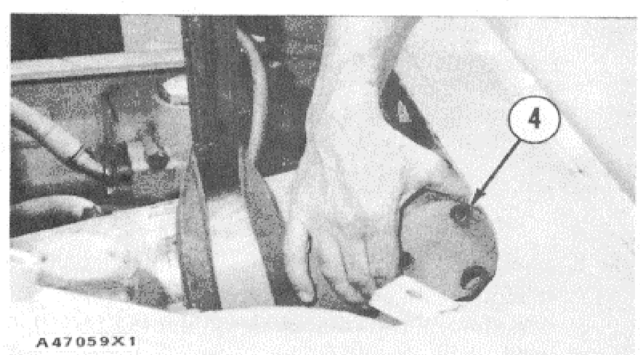
3. Lower the hoist and position cylinder so pin (2) can be installed. Install the pin.



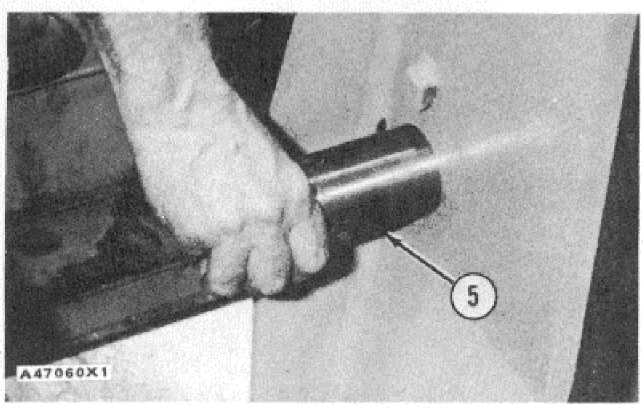
4. Install plate (3) on the frame. Make sure groove (slot) on pin and plate are in alignment.



5. Install plate (4) on the other side of the frame.

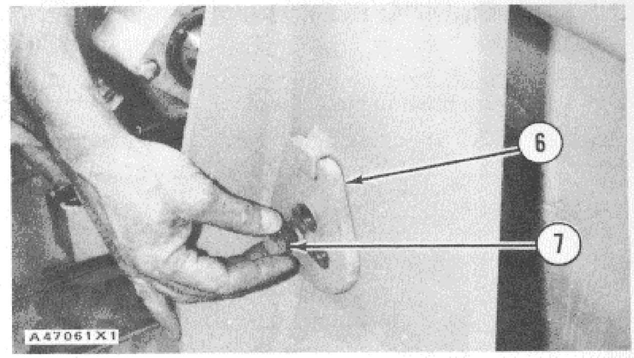


6. At the rod end of the cylinder, install pin (5) through the arm and the rod. The jack under the cutting edge can be used to move the arm for easier installation of the pin.

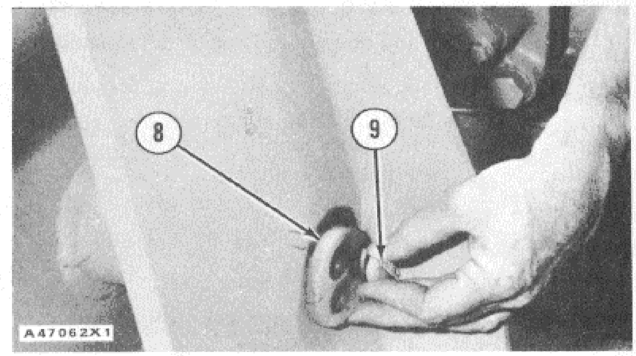


SLIDING FLOOR CYLINDER

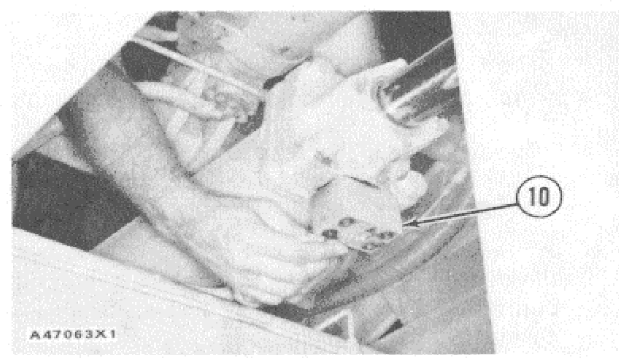
7. Install plate (6) with a notch and bolts (7) to the pin.



8. Install washer (8) and bolts (9) to the pin.

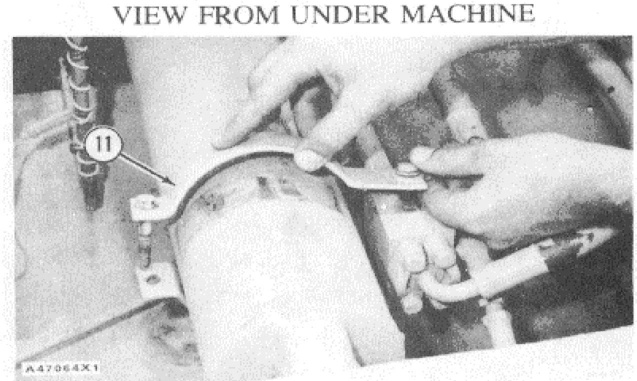


9. Install tube assembly (10) under the cylinder at the rod end.



VIEW FROM UNDER MACHINE

10. Install clamp (11) around the cylinder.



11. To install the rear cover assembly, see INSTALL EJECTOR CYLINDER for details.

12. Remove the floor jack and wood blocks from the front of the scraper.

SLIDING FLOOR CYLINDER

DISASSEMBLE SLIDING FLOOR CYLINDER

	Tools Needed	A	B
1 P1784	Hydraulic Cylinder Repair Stand	1	
5P3100	Pump Group	1	
1 P850	Torque Multiplier		1
2P2265	Mounting Assembly		1
5S6079	Socket		1

start by:

a) remove sliding floor cylinder

1. Fasten a hoist to the cylinder and put it in position on tooling (A) with the openings for the hydraulic lines down and the rod extended to the maximum position.

2. Remove four bolts (1) from the head of the cylinder.

3. Remove rod (2),head and piston from the cylinder.

4. Remove the nut from the rod with tooling (B).

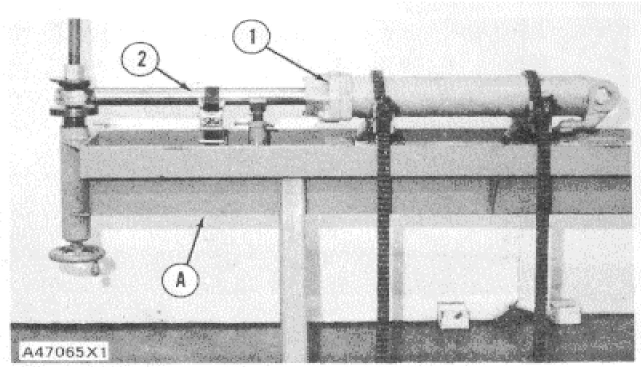
5. Remove piston (3) and head (4) from the rod.

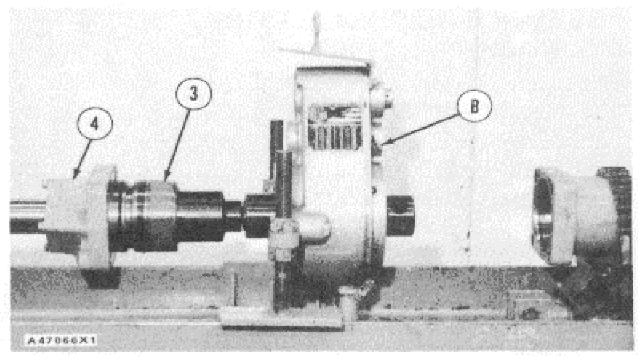
6. Remove ring (5) and seal assembly (6) from piston (3).

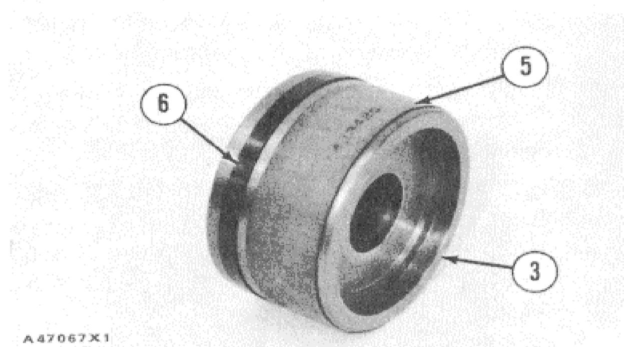
7. Remove bolts (7) from retainer (8). Remove the retainer and the shims. Keep the shims together for installation.

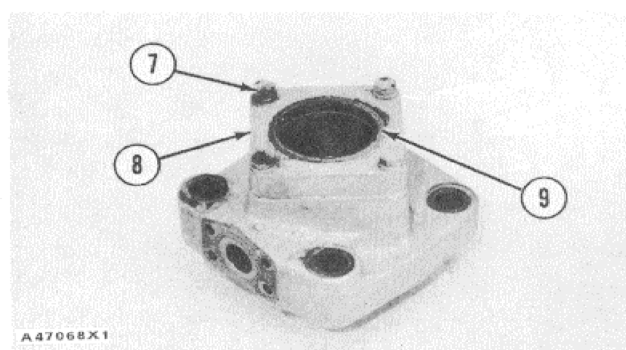
8. Remove seal (9) from the retainer.

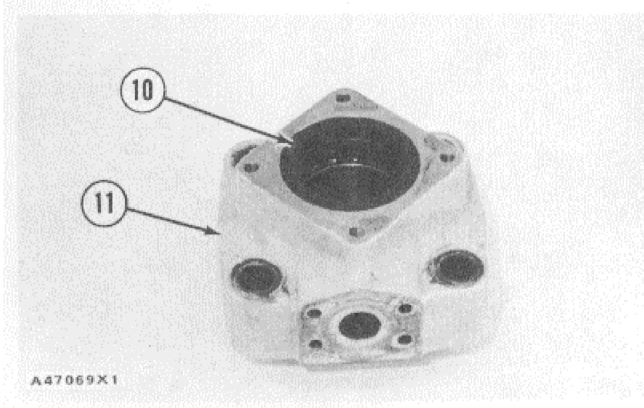
9. Remove packing (10) from head (11).





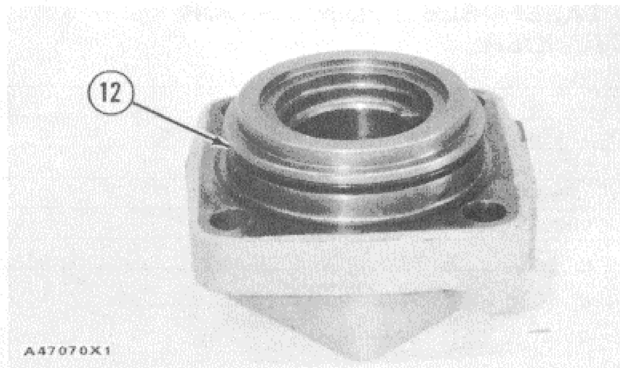






SLIDING FLOOR CYLINDER

10. Turn the head over as shown. Remove O-ring seal (12) and the ring from the head.

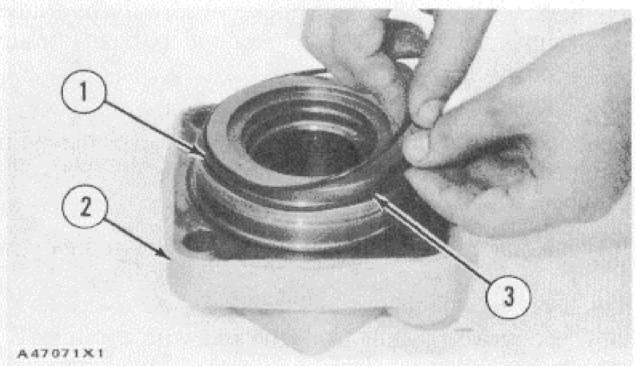


11. Check the condition of the parts of the cylinder. If the parts have damage, use new parts for replacement.

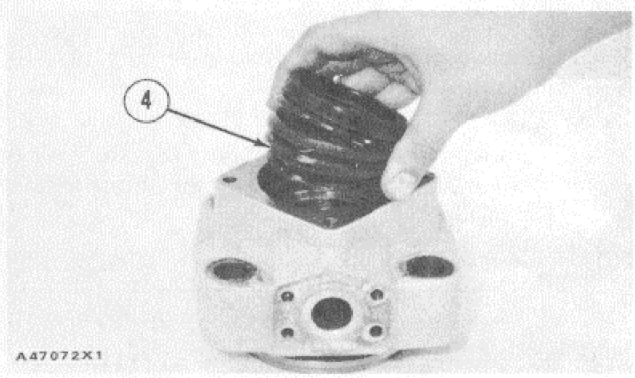
ASSEMBLE SLIDING FLOOR CYLINDER

	Tools Needed	A	B	C	D
1 P520	Driver Group	1			
2P8301	Seal Guide		1		
1P850	Torque Multiplier			1	
2P2265	Mounting Assembly			1	1
5S6079	Socket			1	
1P1784	Hydraulic Cylinder Repair Stand			1	1
5P3100	Pump Group				1

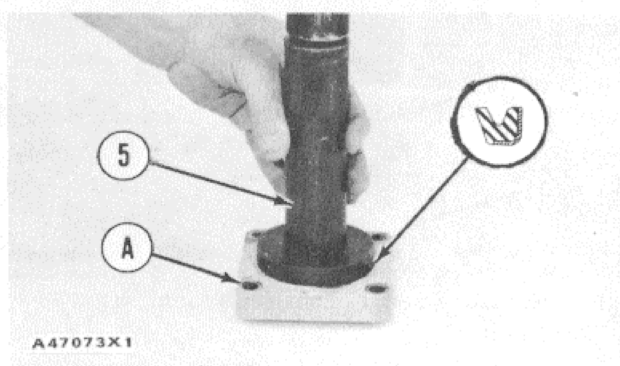
1. Make sure all of the parts are clean and free of dirt and foreign material. Put clean hydraulic oil on all of the parts of the cylinder.
2. Install ring (3) and O-ring seal (I) on head (2). The ring must be toward the outside of head when



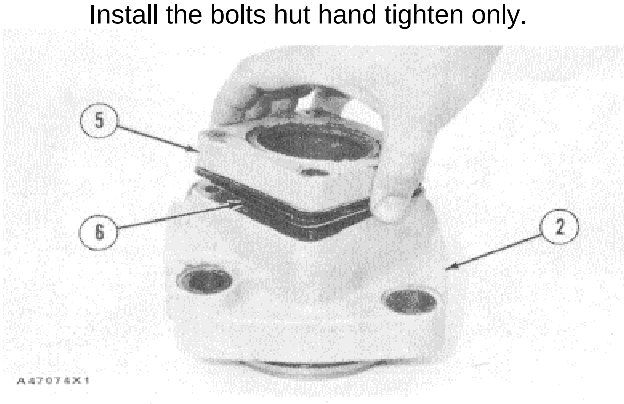
3. Turn the head over as shown. Install packing (4)



4. Install the seal in retainer (5) with tooling (A). Install the seal with the lip of the seal toward the outside of the retainer.

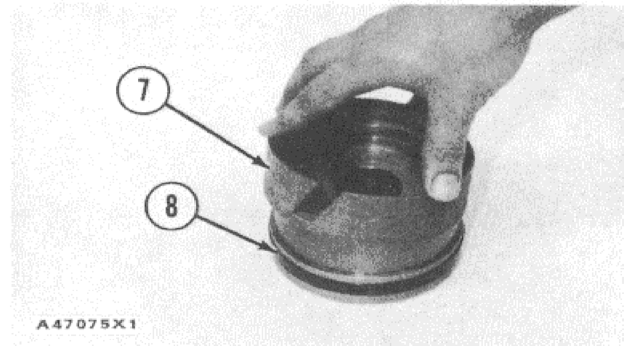


5. Install shims (6) and retainer (5) on head (2). Install the bolts hut hand tighten only.



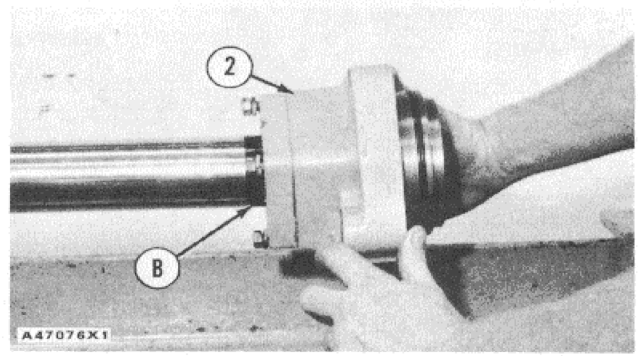
SLIDING FLOOR CYLINDER

6. Install seal assembly (8) and ring (7) on the pistons.

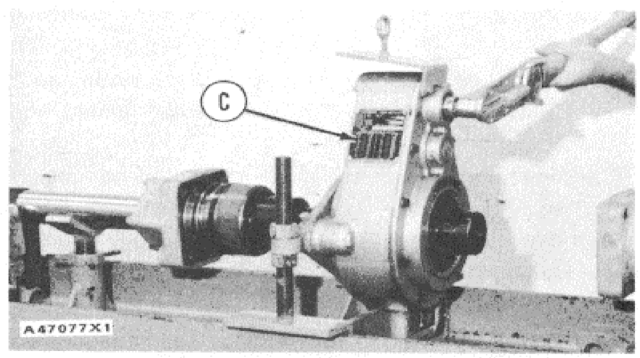


7. Install tool (B) on the rod and slide the head (2) over tool (B) on to the rod.

8. Install the piston and nut on the rod. Tighten the nut with tooling (C) to a torque of 1600 $\pm$ 160 lb. ft. (2160 $\pm$ 219 N·m).

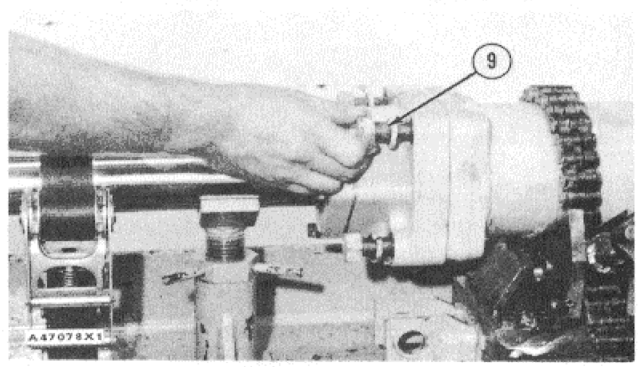


9. Install the piston in the cylinder. Slide the head against the cylinder and install four bolts (9).



NOTE: The rod must be fully extended when the bolts that hold the head and retainer in position are tightened. This will keep the cylinder, piston and head in better alignment with each other.

10. Tighten the bolts that hold the head and retainer.



11. Remove the cylinder from tooling (D).
end by:
install sliding floor cylinder.

CHAPTER 5
MODELS 613BSS AND 613BSS1
(SECTIONALIZED) UNIQUE INFORMATION

INTRODUCTION

All maintenance procedures, schedules, and information contained in the manuals for the Nonsectionalized Scrapers are applicable to the Sectionalized Scrapers. This section contains additional information required for the maintenance and overhaul of the steer axle and spring and cable assembly relative to the Sectionalized Scrapers. This section also contains a troubleshooting guide to help expedite any corrective actions these components might require to make the Sectionalized Scrapers fully operational.

All maintenance to the steering axle will be performed while either in its storage position or when removed. If the wheels need to be removed while the Sectionalized Scraper is sectionalized, then a hydraulic Jack must be used to lift the axle, and blocking should be installed.

Table of Contents

STEER AXLE ASSEMBLY

Lubricant Specifications

Lubricant Recommendations for Normal Operating Conditions [-18°C to 380C (0°F to 100°F)](')		
Compartment or System		**Lubricant Specifications**
Bearings - Steer	GAA	MI L-G-10924,Grease,Automotive and Artillery (GAA). This grease is suitable for all temperatures.

Lubrication and Maintenance Chart

Item	Service	Lube.
When Required		
Tires and Wheels	Inspect and check tire pressure.	
Wheel Lug Nuts	Measure torque.	
Every 50 Service Hours or Weekly		
Steering Mechanism	Lubricate - under severe operating conditions where mud, water and abrasive material may enter the bearings.	GAA
Every 250 Service Hours or Monthly		
Steering Mechanism	Lubricate 8 fittings.	GAA
Every 2000 Service Hours or One Year		
Steer Wheel Bearings	Check.	

Steer Axle Tires and Wheels

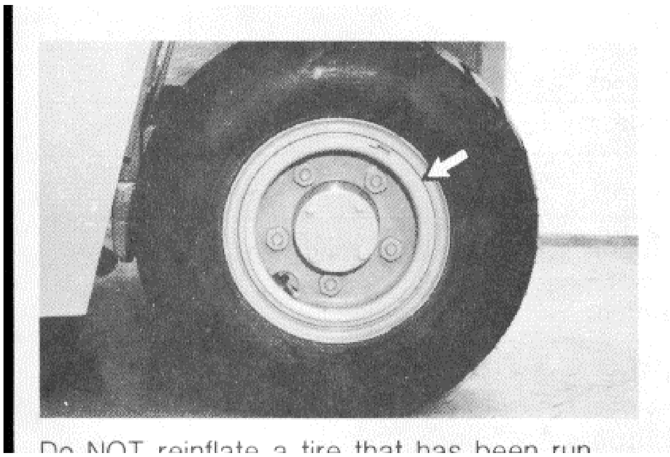
Inspect - Check

Inspect tires for wear, cuts, gouges and foreign objects. Look for bent rims and correct seating of locking ring.

Check tires for proper inflation. See "Tire Inflation Pressures."

To inflate tires always use a clip-on chuck with a minimum 60 cm (24 inches) length of hose to an in-line valve and gauge

Always stand behind the tread of the tire, NOT in front of the rim.



Do NOT reinflate a tire that has been run while flat or underinflated, without first checking to make sure the locking ring on the rim is not damaged and is in the correct position.

Warning

Servicing and changing tires and rims can be dangerous and should be done only by trained personnel using proper tools and procedures. If correct procedures are not followed while servicing tires and rims, the assemblies could burst with explosive force and cause serious physical injury or death. Follow carefully the specific information provided by your tire servicing man or dealer.

Warning

Side to side stability is affected by pneumatic tire type and inflation pressure.

Tire Inflation Pressure

Size	Ply Rating	kPa	psi
7.00 x 12 Steer	12 Ply 700	100	

NOTE: Fill tires to the recommended pressures listed ± 35 kPa (5 psi).

When tires are changed be sure to clean all rim parts and, if necessary, repaint to stop detrimental effects of corrosion. Sand blasting is recommended for removal of rust. Check all components carefully and replace any cracked, badly worn, damaged and severely rusted or corroded parts with new parts of the same size and type. If there is any doubt, replace with new parts. Do NOT ,under any circumstances, attempt to rework, weld, heat or braze any rim components.

Wheel Lug Nuts

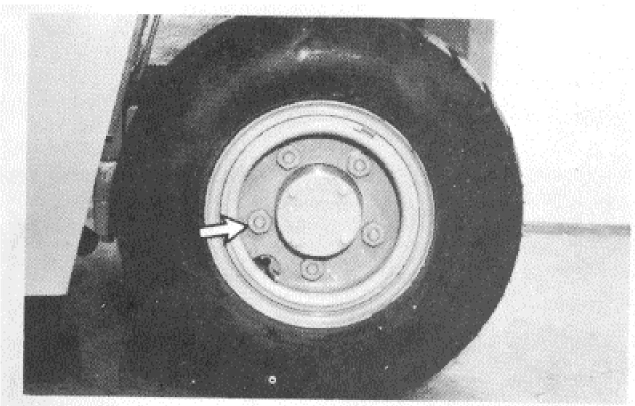
Measure Torque

NOTE

Do not lubricate ball seats of wheels or ball faces of wheel nuts.
Be sure mounting faces of hub, wheel nuts and flat mounting surfaces are clean.
Tighten wheel nuts again after 24 hours of operation.

NOTE: Always tighten wheel lug nuts in a sequence opposite (180°) each other.

Steer Wheels

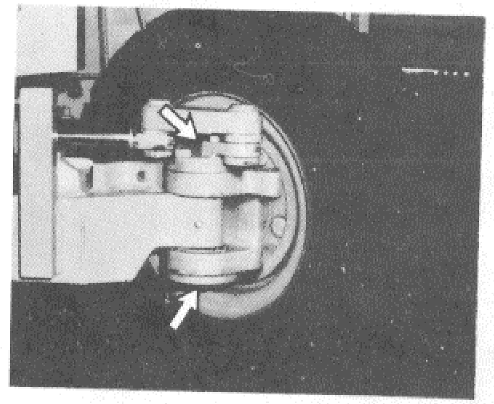


Install steer wheel. Put two nuts opposite (180°) each other. Tighten both.

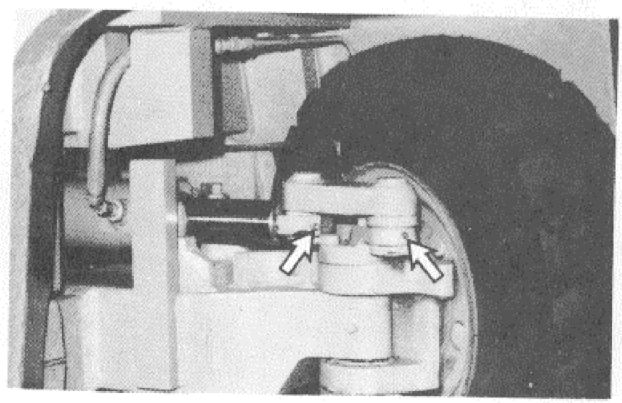
Install remaining nuts. Tighten all nuts in a sequence opposite (180°) each other. Tighten to 440 ± 35 N-m (325 ± 25 lb ft).

Steering Mechanism

Lubricate the Fittings
NOTE: Under severe operating conditions where mud, water and abrasive material may enter the bearings, lubricate the steering mechanism every 50 service hours or weekly.

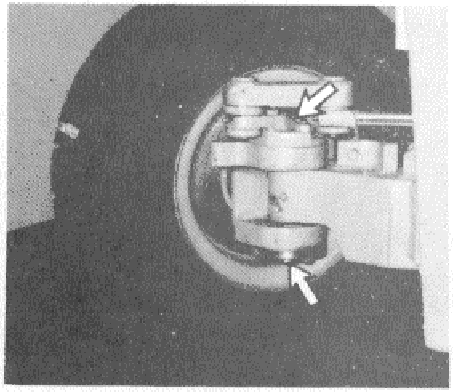


Right king pin. Lubricate 2 fittings.

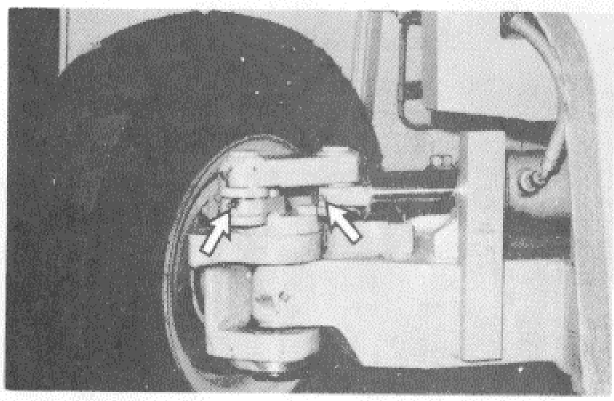


Right tie rod. Lubricate 2 fittings.

Every 250 Service Hours or Monthly



Left king pin. Lubricate 2 fittings.



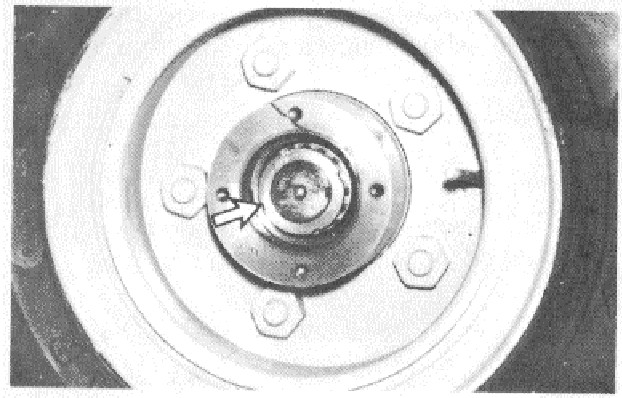
Left tie rod. Lubricate 2 fittings.

Every 2000 Service Hours or 1 Year

Steer Wheel Bearings

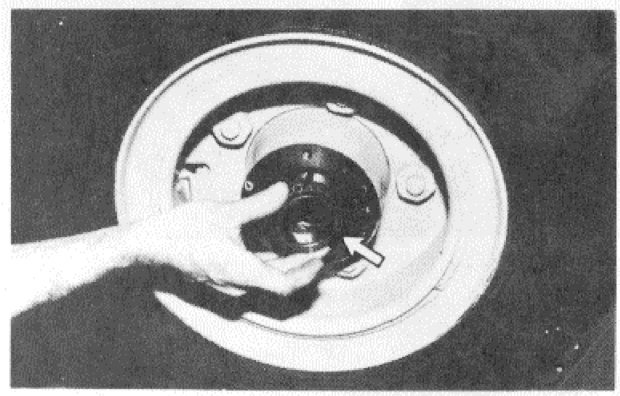
Pack

1. Remove the hub cap.



2. Straighten the lockwasher tangs.

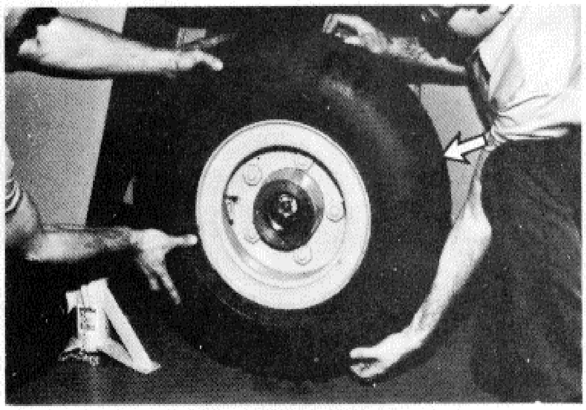
3. Remove the locknut, lockwasher and flat washer.



4. Remove the outer wheel bearing.

5. Remove the wheel.

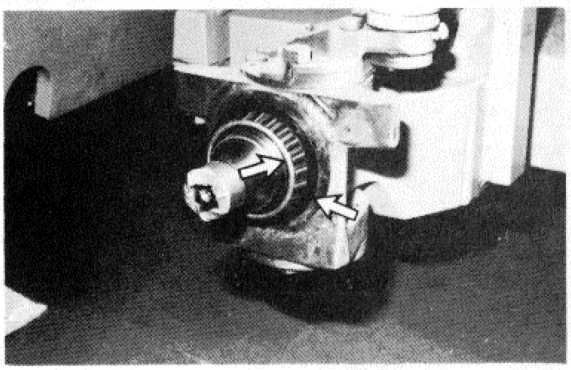
6. Clean the steering knuckle spindle shaft.



Every 2000 Service Hours or 1 Year

7. Remove the inner seal and bearing.

8. Repack the inner and outer bearings.



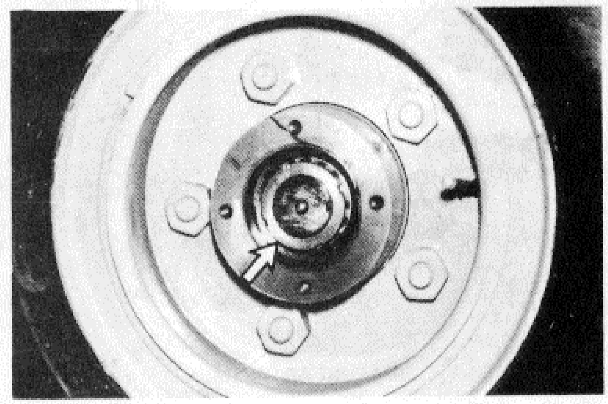
9. Install the inner bearing and seal.

10. Install the wheel on the spindle shaft.

11. Install the outer wheel

12. Install the outer washer, lockwasher and locknut.

13. Tighten the locknut to 135 N. m (100lb ft),while turning wheel hub, to seat bearing.



14. Loosen the locknut. Retorque it to 25 to 70 N. m (20 to 50 lb ft). Bend the lockwasher tang to secure locknut.

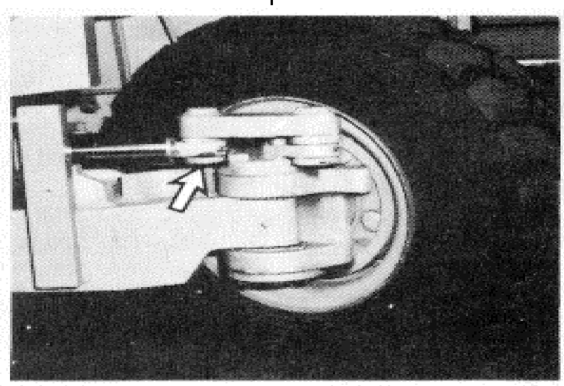
15. Install the hub cap.

Steering Mechanism

Inspect - Repair

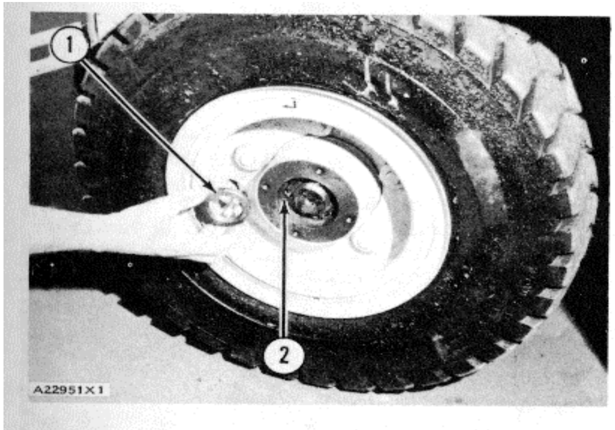
1. Inspect links for wear, loose pins and loose bolts. Repair or replace if necessary.

2. Secure a straight metal bar to the lift truck frame. When in a straight ahead position, both steer wheels must be parallel with the frame.



STEERING AXLE

STEER WHEEL BEARING ADJUSTMENT



BEARING ADJUSTMENT

1. Nut. 2. Lock.

I. Tighten nut (I) slowly to 70 N. m (50 lb. ft.) while turning the wheel to put the bearing into place.

2. Loosen nut (1I) completely. Tighten nut (1) again to 50 + 5 N. m (37 + 4 lb. ft.). 3. Bend lock (2) over nut (I) to hold the nut in position.

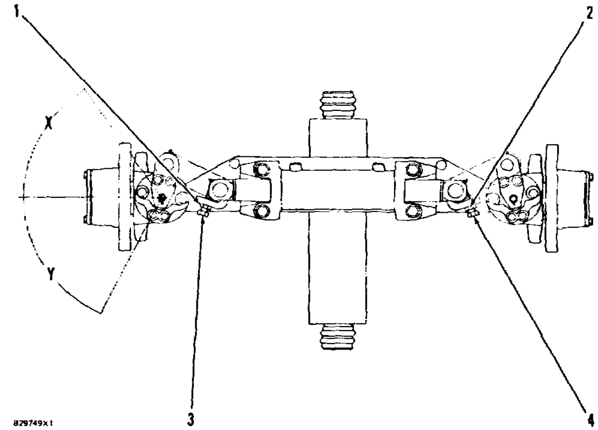
STEERING AXLE ADJUSTMENTS

Steer Axle Stops Adjustment

Use the procedure that follows to make an adjustment to the steer axle turning angle.

I. Loosen locknut (I) and make an adjustment to bolt (3) to give angle (Y) 760%.

2. Tighten locknut (I) to hold this adjustment.



STEER AXLE

1. Locknut. 2. Locknut. 3. Bolt. 4. Bolt. X. 56% Angle. Y. 76% Angle.

3. Turn the steer axle hubs the opposite direction and loosen locknut (2).

4. Make an adjustment to bolt (4) to give angle (X) 560.

5. Tighten locknut (2) to hold this adjustment.

Steering Knuckle Bearing Preload Adjustment

Use the procedure that follows to adjust the steering knuckle bearing preload.

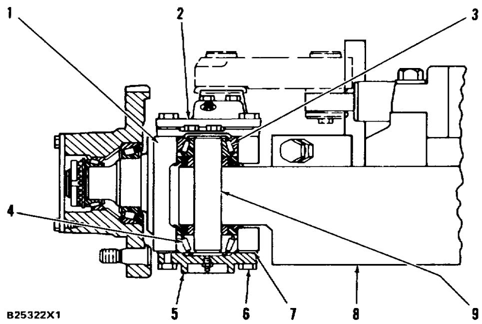
1. Install the upper and lower seals in steering knuckle (1) and put GAA Multi-purpose Grease on the lips of the seals that face the axle beam assembly

2 Put steering knuckle (1) in position on axle beam assembly (8). Put GAA Multi-purpose Grease on kingpin (9) and install the kingpin through the knuckle and axle beam assembly. Install and tighten the lockscrew to hold the kingpin in position.

3. Install the upper spacer on the kingpin. Install upper bearing (3) against the spacer.

4. Install upper cover assembly (2) and tighten four bolts(10) and (12) to a torque of 135 + 14 N. m (100 + 10 lb. ft.). Tighten two bolts (I) to a torque of 270 + 20 N. m (200 + 15 lb. ft.).

5. Install the lower spacer on the kingpin. Install lower bearing (4) against the spacer.



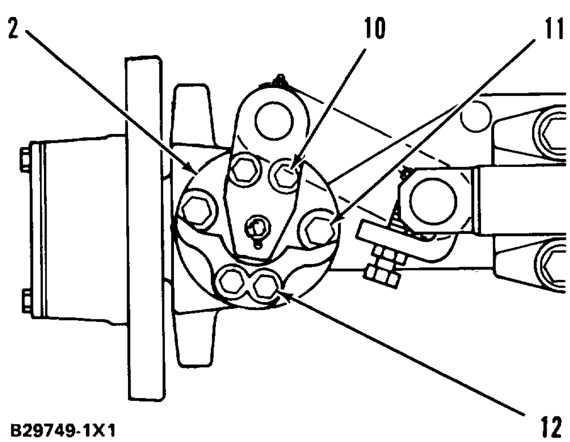
STEERING KNUCKLE (SIDE VIEW)

1. Steering knuckle. 2. Upper cover assembly. 3. Upper bearing. 4. Lower bearing. 5. Lower cover. 6. Bolts. 7. Shims. 8. Axle beam assembly. 9. Kingpin.

6. Install lower cover (5) without shims and install and tighten two opposite bolts (6) to a torque of 5. 7 N. m (50 lb. in.).

7. Use a feeler gauge to check the gap between the cover and knuckle (I) at each bolt location.

8. Find the average of the two measurements and subtract 0. 10 mm (. 004 in.) from this average. This is the thickness of shims (7) that must be installed between lower cover (5) and the steering knuckle.



STEERING KNUCKLE (TOP VIEW)

2. Upper cover assembly. 10. Bolts. 11. Bolts. 12. Bolts.

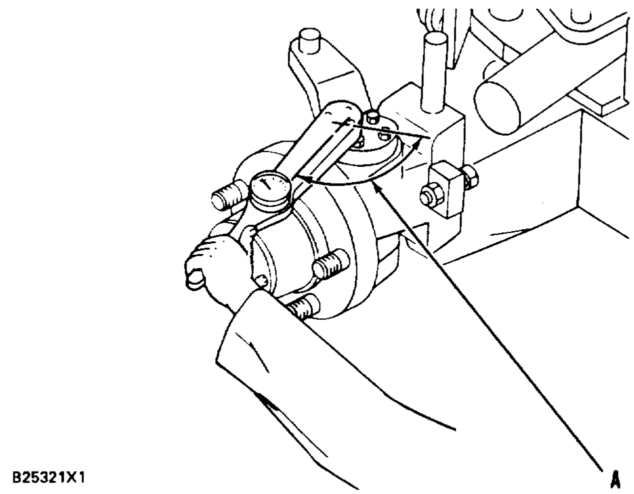
9. Remove the cover, install the shims, install cover (5) and the bolts. To check the preload adjustment of the bearings, use the procedure that follows:

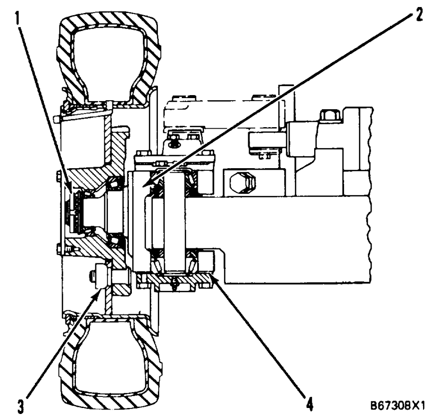
1. Put a pound-inch torque wrench on one of the upper cover bolts so that the handle of the wrench is angle (A) 900 from the center of the bolt directly opposite the bolt that the torque wrench is on.

2. Check the torque required to turn the steering knuckle.

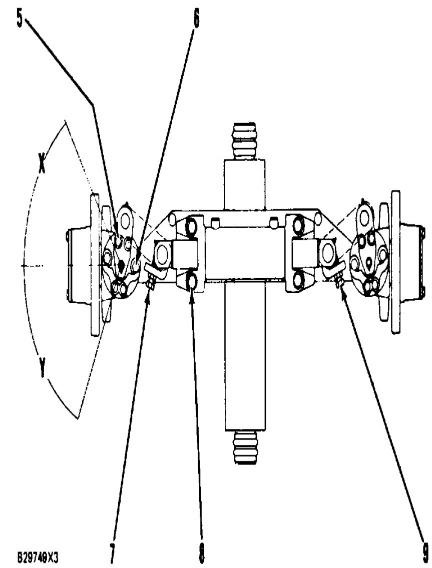
NOTE: The steer wheel and steering link must be removed before the check is made.

3. The indication must be 4. 5 to 6. 8 N. m (40 to 60 lb. in.). If the indication is too high, add shims between the lower cover and knuckle. If the indication is too low, shims must be removed.





STEER AXLE AND WHEEL



(1). Do the steps that follow for steer wheel bearing adjustment:

a. Tighten nut (1) slowly to 70 N m (50 lb. ft.) while turning the wheel.
b. Loosen nut (1) completely. Tighten it again to 50 ± 5 N-m (37 ± 4 lb. ft.)
c. Bend the lock over nut (1).

(2) Add or remove shims (4) until torque required to turn knuckle assembly is. .... 4. 5 to 6. 8 N-m (40 to 60 lb. i n.)

(3) Torque for nut that holds wheel to hub440 + 35 N-m (325 + 25 lb. ft.)

(5) Torque for cover bolts (four). ....135 ± 14 Nm (100 ± 10 b. ft.)

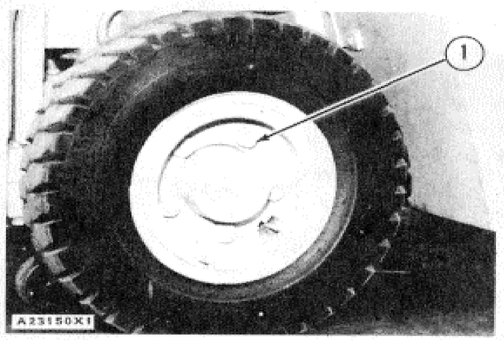
(6) Torque for cover bolts two ....270 ±2 0 N-m (200 ± 15 lb. ft.)

(7) Adjust stop bolt to get angle (Y) of ....76°

(8) Torque for steering cylinder mounting bolts .... 470 ±45 Nm (350 ± 35 b. ft.)

(9) Adjust stop bolt to get angle (X) of ....56°

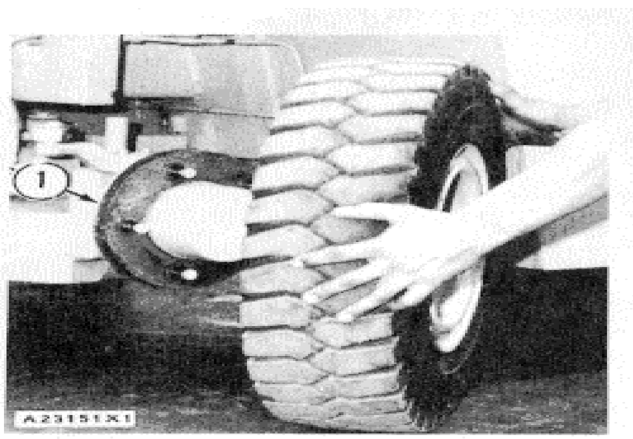
Remove Tires And Rims
4202-11



1. Loosen nuts (1) that hold the tire and rim to the hub.

2. Remove the nuts. Remove the tire and rim. Weight of the tire and rim is 38. 6 kg (85lb.).

Install Tires And Rims

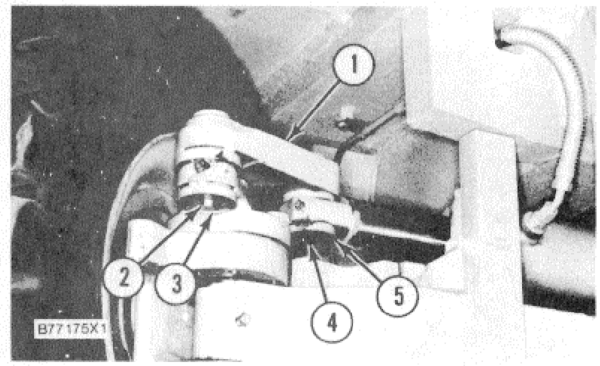


1. Put the tire and rim in position on hub (1)

2. Install the nuts that hold the tire and rim. Tighten the nuts to a torque of 447 t 25 N. m (330 ± 20 lb ft) while the tire and rim are ± turned

Tie Rods

Remove Tie Rods



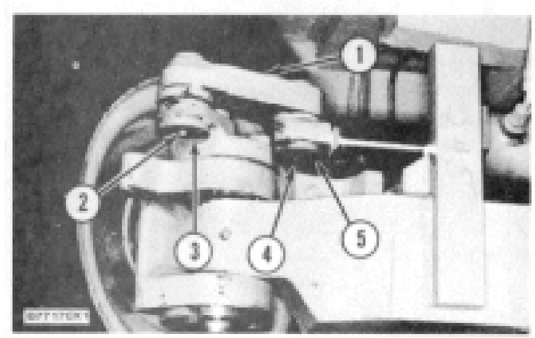
1. Turn the steer wheels for access to the tie rods.

2. Remove bolt (2) and retainer (3) from the steering knuckle.

3. Remove bolt (4) and retainer (5) from the steering cylinder.

4. Remove tie rod (1) from the steering knuckle and cylinder

Install Tie Rods



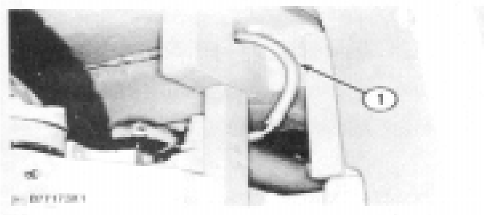
1. Install tie rod (1) on the steering knuckle and cylinder.

2. Install retainer (5) and bolt (4) in the cylinder. Tighten the bolt to a torque of 54 +4. N m (40 ± 3 lb. ft.).

3. Install the retainer (3) and bolt (2) to the cylinder. Tighten the bolt to a torque of 54 +4 N m (40 ± 3lb. ft)

Steering Cylinder

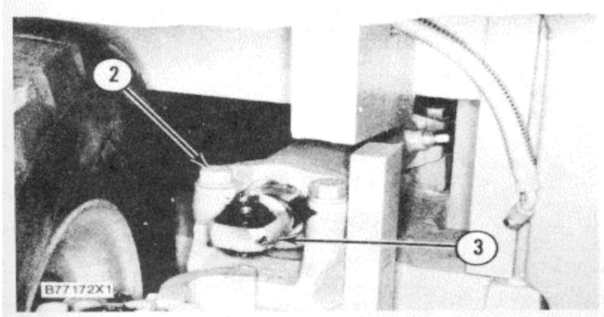
Remove Steering



Cylinder

1. Disconnect two hydraulic lines (1) from the steering cylinder. Put caps on the lines and the fitting on the cylinder to keep dirt out of the hydraulic system

2. Remove four bolts (2) that hold the



steering cylinder in place
3. Remove steering cylinder (3).

Install Steering Cylinder

1. Put steering cylinder (2) in position and install four bolts (1) that hold the cylinder in place.

2. Tighten the bolts to a torque of 470 + 45 N m (350 ± 35 lb ft).

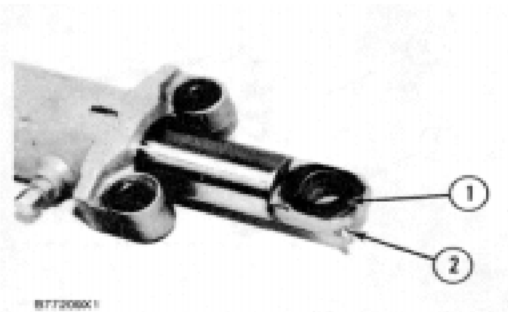
3. Remove caps from the lines and steering cylinder. Connect two hydraulic lines (3) to the cylinder.

4. Remove the air from the steering system.

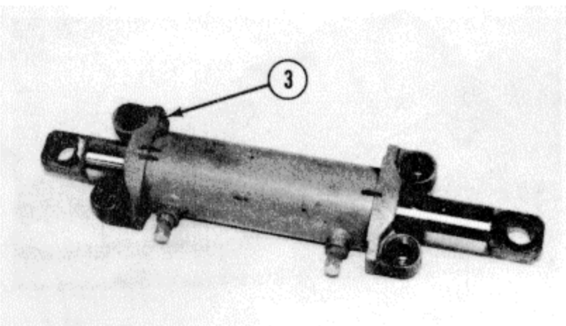
Disassemble Steering Cylinder

START BY:

a) remove steering cylinder

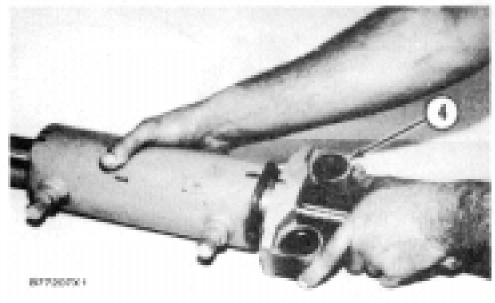


1. Remove grease fitting (2) and seals (1) from the cylinder shaft.

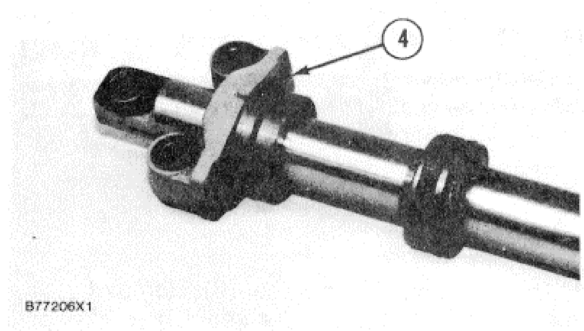


2. Put identification marks on the cylinder body and caps.

3. Use a soft hammer to remove end cap(3) from the cylinder rod. Be careful not to damage the finished surface of the cylinder rod



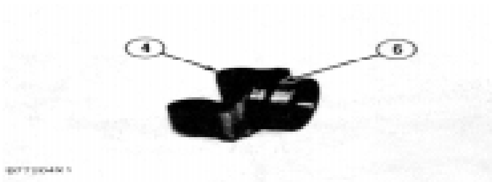
4. Remove shaft and cap (4) from the cylinder body.



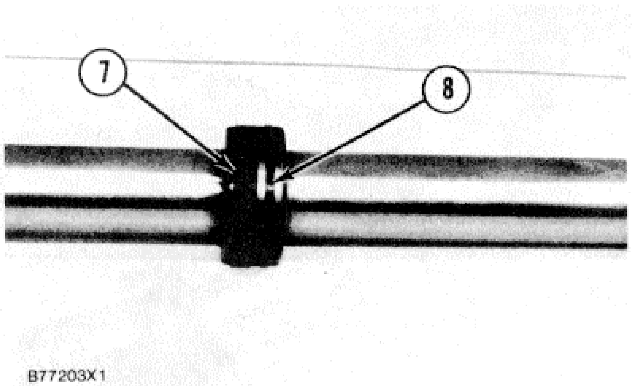
5. Remove cap (4) from the cylinder rod.

6. Remove all seals (5) from the inside bore of cap (4)

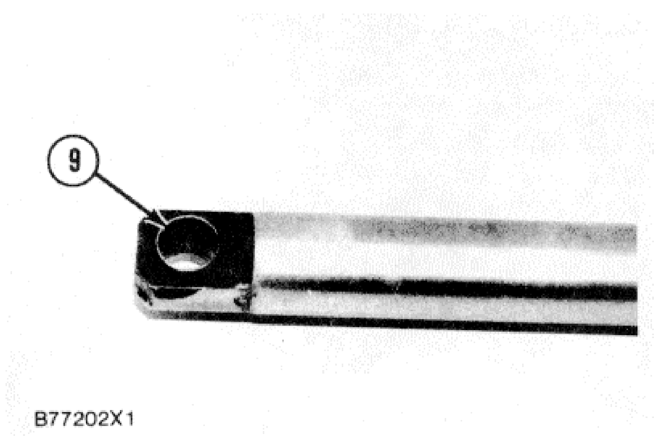
Steering Cylinder



7. Remove O-ring seal (6) and the backup ring from cap (4).



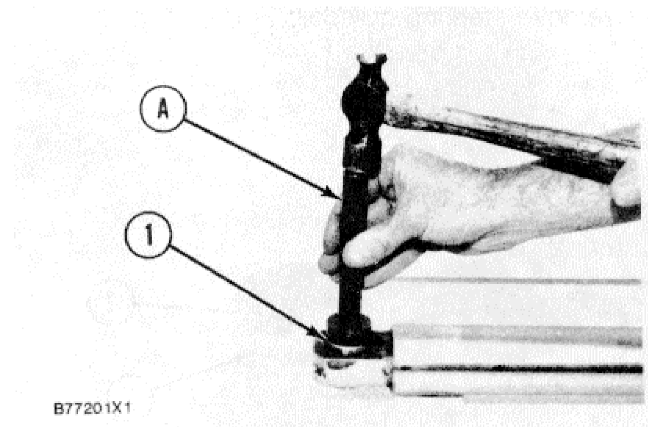
8. Remove ring (7) and seal (8). Remove the backup ring from under seal (8).



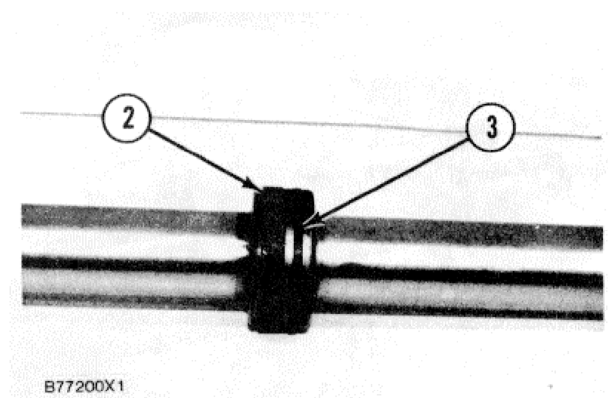
9. Remove bearing (9) from the cylinder rod if damaged.

Assemble Steering Cylinder

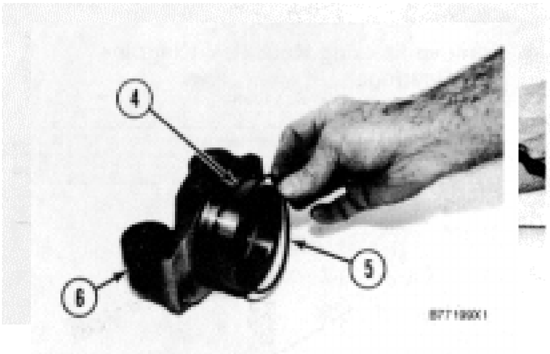
Tools NeededAB 1P510Driver Group1	
1P520Driver Group1	



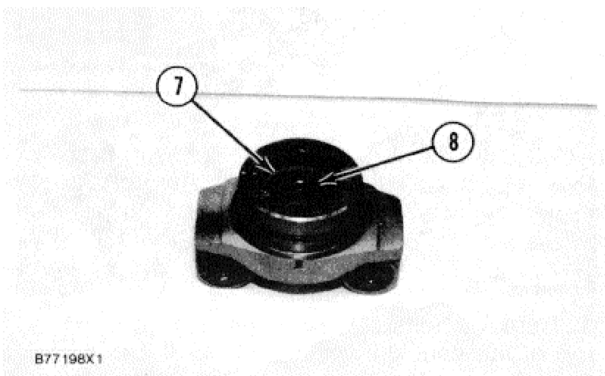
1. install bearing (1) in cylinder rod with tool group (A). Install the bearing with the hole in the bearing in alignment with the hole for the grease fitting.



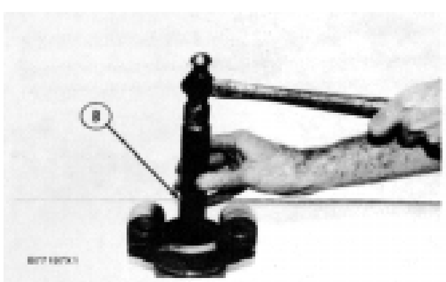
2. Install the backup ring, seal (3) and ring (2) on the cylinder rod.



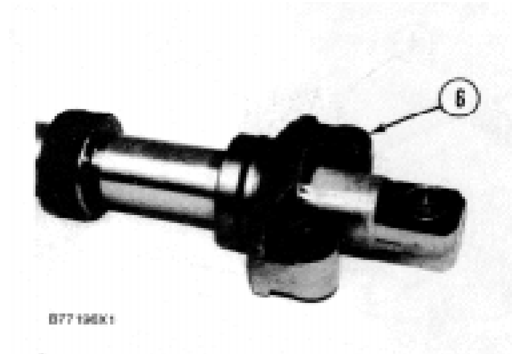
3. Install backup ring (4) and O-ring seal (5) on cap (6).



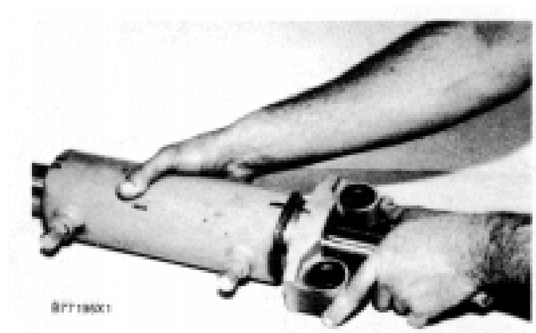
4. Install wiper seals (7) and (8). Install seal (8) with the lip toward the inside.



5. Install the lip seal in the top of the cap with tool group (B). Install the seal with the lip of the seal toward the outside.



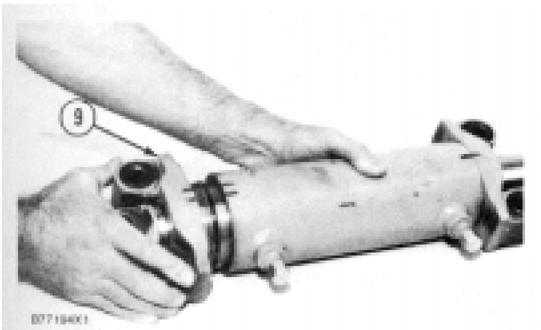
6. Install cap (6) on the cylinder rod.



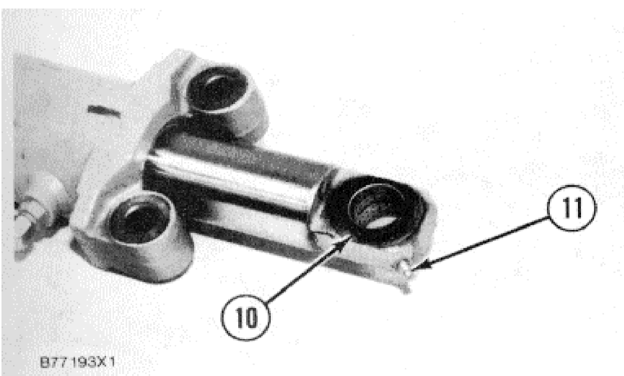
7. Install cap and shaft in the cylinder body as shown.

]

Steering Cylinder



8. Install cap (9) on the cylinder rod.



9. Install seal (10) and grease fitting (11).

END BY:
a)install steering cylinder

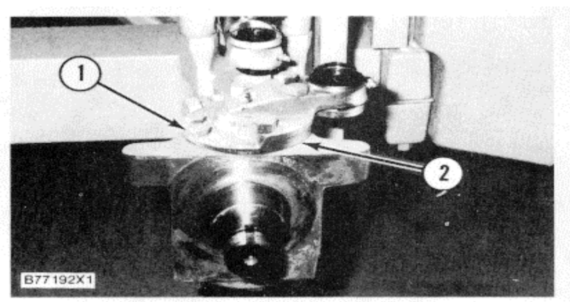
Steering Knuckles, Kingpins And Bearings

Remove Steering Knuckles, Kingpins And Bearings

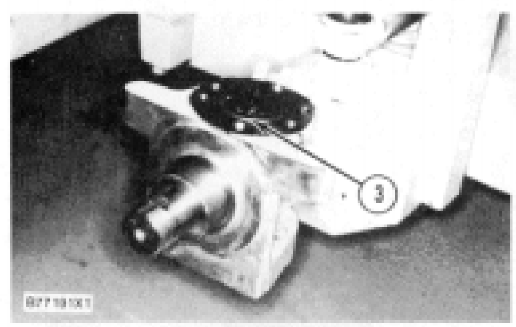
Tools Needed	A
1P520 Driver Group	1

START BY:

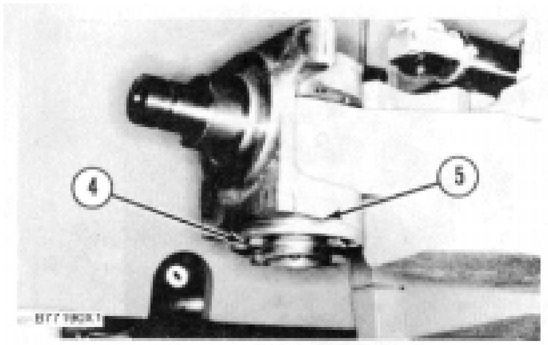
a)remove wheel bearings (steer)
b)remove tie rods



1. Remove bolts (1) and cover (2) from the top of the knuckle.

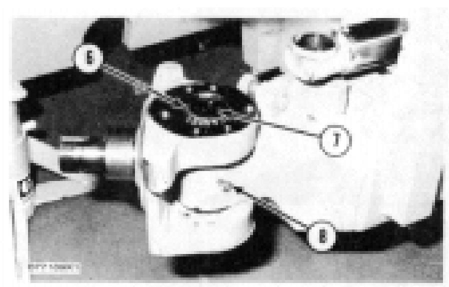


2. remove upper Dearing cup (;) from tone knuckle.

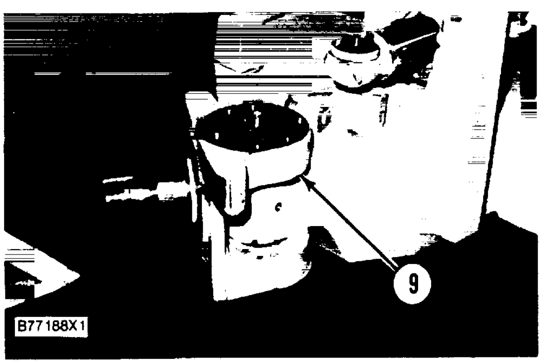


3. Remove bolts (4), cover (5) and the shims from the bottom of the knuckle.

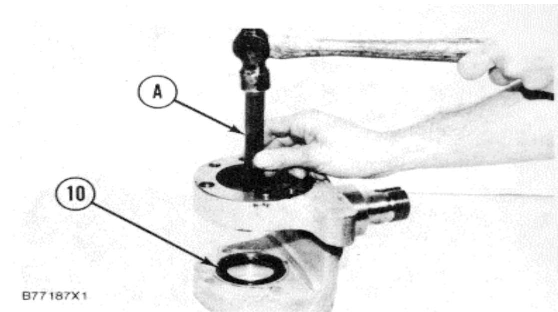
4. Remove the lower bearing cup, cone and spacer from the kingpin.



5. Remove bolt (8), upper bearing cone (6), Kingpin (7) and the spacer from the knuckle.



6. Remove knuckle (9) from the axle.



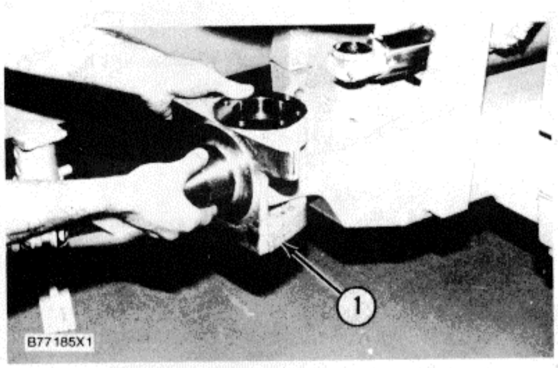
7. Remove the upper and lower lip seals10) from the knuckle with tool group (A).

Install Steering Knuckles, Kingpins And Bearings

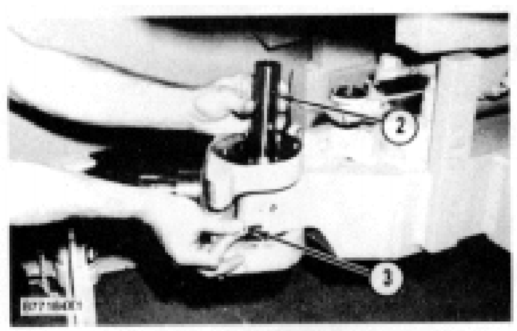
Tools Needed	A
P520Driver Group	I|

1. Install the upper and lower lip seals in the knuckle with tool group (A). Install the seals with the lips toward the inside. Put 5P960, Multipurpose Grease on the lips of the seals that face the axle beam assembly.

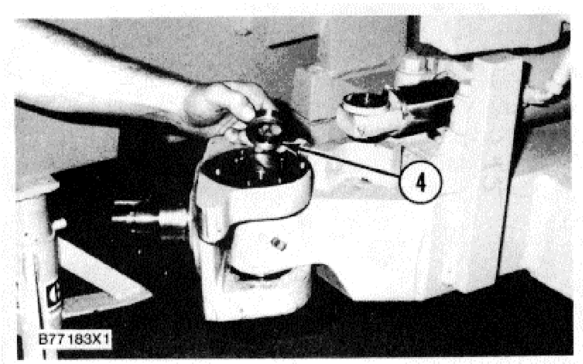
Steering Knuckles, Kingpins And Bearings



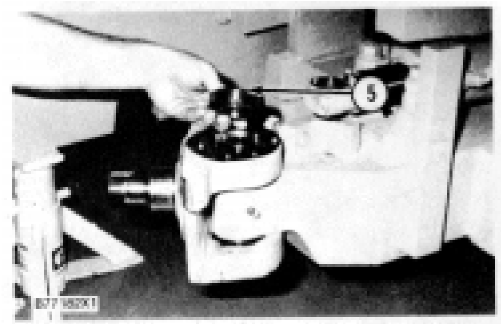
2. Put steering knuckle (1) in position on the axle beam assembly.



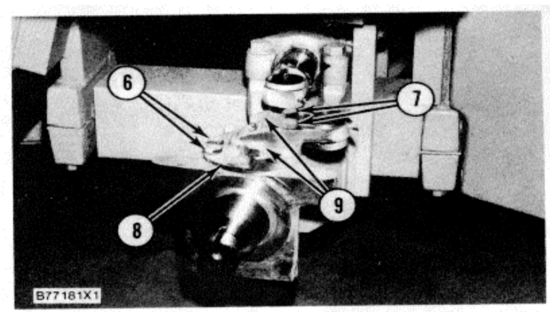
3. Put GAA Multipurpose Grease on the kingpin. Install kingpin (2) through the knuckle and axle beam assembly. Install and tighten bolt (3) to hold the kingpin in position.



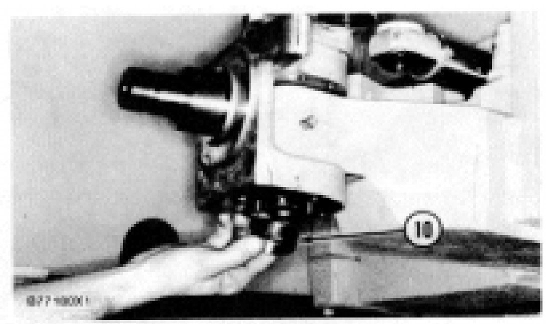
4. Install upper spacer (4) on the kingpin.



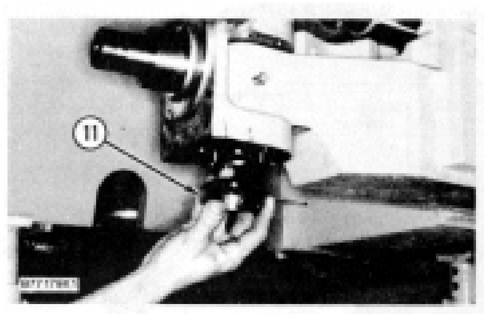
5. Install upper bearing (5) against the spacer.



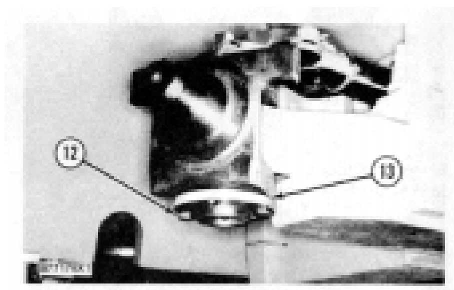
6. Install upper cover assembly (8) and tighten four bolts (6) and (7) to a torque of135 ±1 4 N-m (100 ± 10 lb,ft.). Tighten two bolts (9) to a torque of 270 + 20 N-m(200 ± 15 lb. ft.).



7. Install lower spacer (10) on the kingpin.

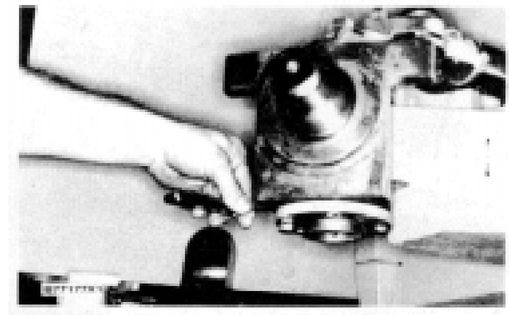


8.Install lower bearing (11) against the spacer.



9. Install lower cover assembly (13) without shims

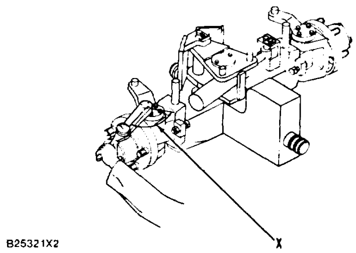
10. Install and tighten two bolts (12) opposite each other to a torque of 5.7 N.m (50 lb in.).



11. Use a feeler gauge to check the gap between the cover and knuckle at each bolt location.

12. Find the average of the two measurements and add 0.10 mm (.004 in) to this average This is the thickness of shims that must be installed between the lower cover and the knuckle. Remove cover (13) and install the shims. Install cover (13) and all of bolts (12).

Steering Knuckles, Kingpins And Bearings



13. To check the preload adjustment of the bearings, use the procedure that follows:

a) Put a pound-inch torque wrench on one of the upper cover bolts so that the handle of the wrench is angle (X) 90° from the center of the bolt directly opposite the bolt that the torque wrench is on.

b) Check the torque required to turn the steering knuckle

NOTE: The steer wheel and steering link must be removed before the check is made.

c) The indication must be 4 5 to 6.8 N m (40 to 60 lb in.) If the indication is too high, add shims between the lower cover and knuckle. If the indication is too low, shims must be removed.

END BY

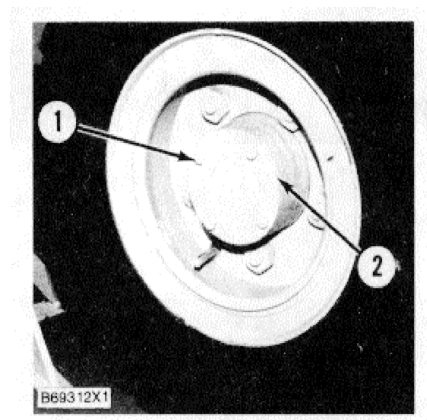
a) install tie rods

b) Install wheel bearings

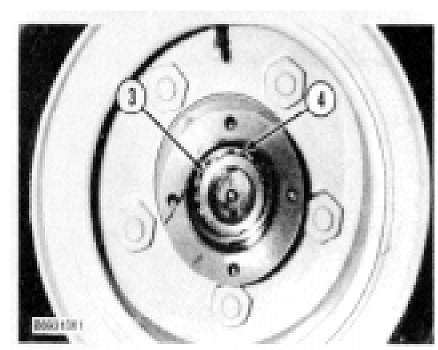
Wheel Bearings

Remove Wheel Bearings

Tools Needed	A	B
5P4756 Spanner Wrench		1

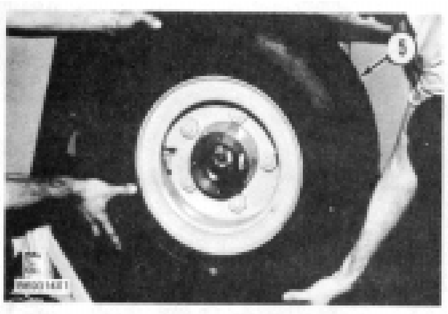


1. Remove bolts (1), cover (2) and the gasket from the steer wheel



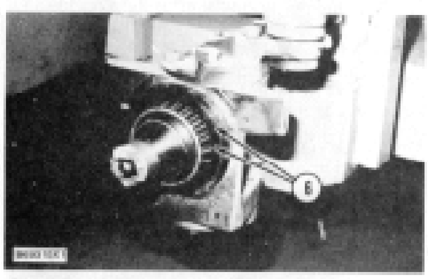
2. Bend (tab) lock (4) out of the groove in the nut.

3. Remove nut (3) with tool (B), the two washers and outer bearing cone from the steering knuckle



4. Put tape around the threads of steering knuckle to give protection to the threads when the steer wheel is removed.

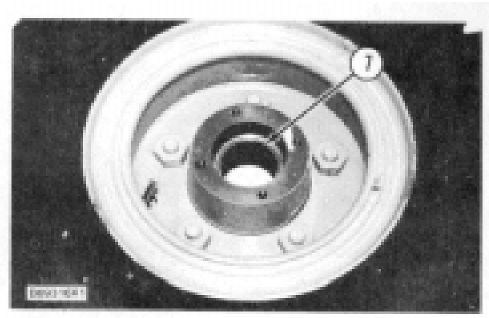
5. Remove steer wheel (5) with two persons. Weight of the steer wheel is 54.4 kg (120 lb.).



NOTICE

Be extra careful not to cause damage to the threads on the steering knuckle.

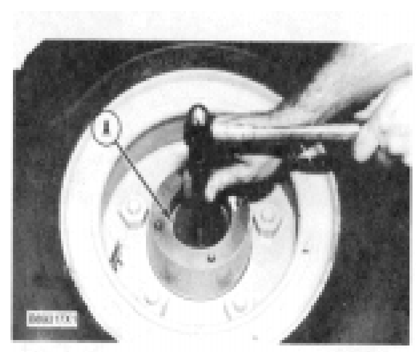
6. Remove inner bearing cone (6) with the seal from the steering knuckle.



7. Make an inspection of the inner and outer bearing cups (7). If a replacement of the bearing cups is necessary, remove the bearing cups from the hub

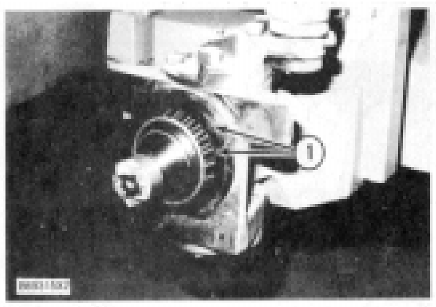
Install Wheel Bearings

	Tools Needed	A	B
1P520	Driver Group	1	
5P4756	Spanner Wrench		1



1. If the bearing cups were removed from the hub, lower the temperature of the cups and use tool group (A) to install them in the hub.

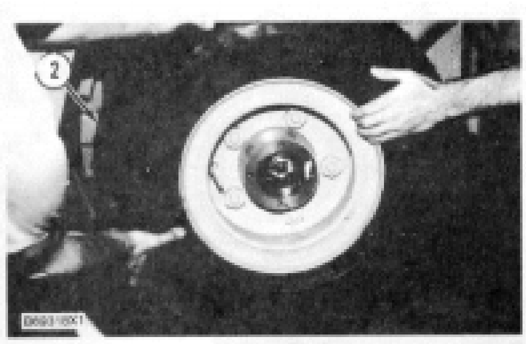
Wheel Bearings



2. Put tape around the threads of the steering knuckle to give protection to the threads when the steering wheel is installed.

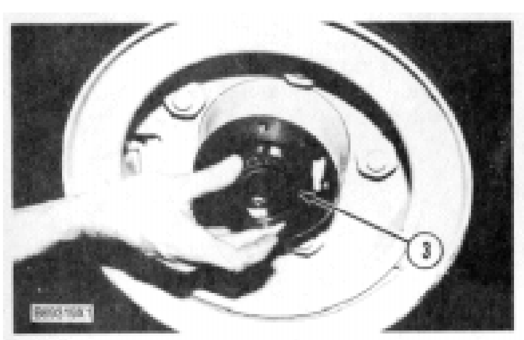
3. Put (pack) GAA Multipurpose Grease in the inner and outer bearing cones.

4. Install inner bearing cone and seal (1) on the steering knuckle.



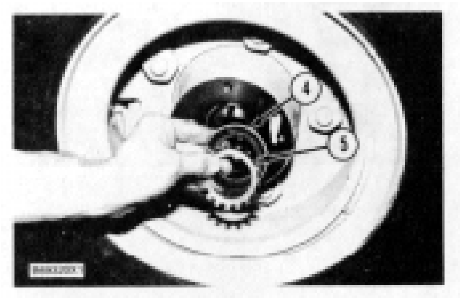
5. Use two persons and install steer wheel (2) on the steering knuckle.

Disassembly and Assembly



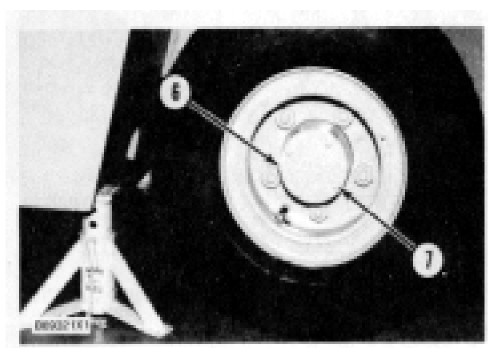
6. Remove the tape from the threads on steering knuckle.

7. Install outer bearing (3) on the steering knuckle.



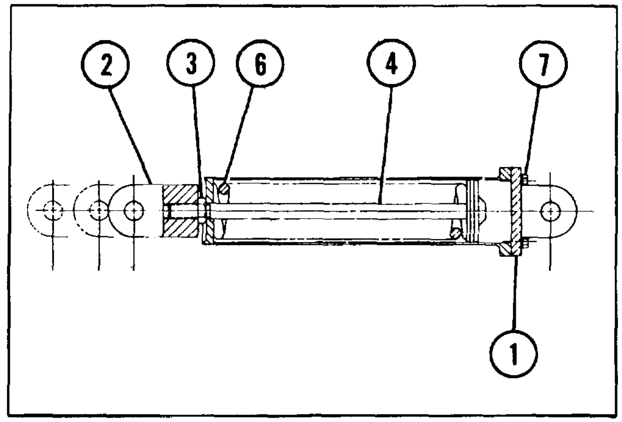
8. Install washer (4) and locking washer (5) on the steering knuckle.

9. Install the nut on the end of the knuckle. Use tool (B) to tighten the nut slowly to 70 N•m (50 Ib.ft.) while the wheel is turned. Loosen the nut completely. Tighten it again to a torque of 50 $\pm$ 5 N.m (37 $\pm$ 4 Ib.ft.). Bend one of the tines (tab) of locking washer (5) into one of the notches in the nut.



10. Put the gasket and cover (6) in position on the hub and install bolts (7) that hold the cover in place.

DRAWBAR SPRING ASSEMBLY WITH CABLES



1. The cables are attached to lugs on the cap assembly (1) and clevis (2). Inspect for wear and replace if necessary.

2. Remove clevis (2) and nut (3) from rod assembly (4).

3. Remove four bolts (5) from cap assembly (1), remove cap assembly.

4. Rod (4) and spring (6) can now be removed from body (7).

   Any parts showing wear must be replaced.

5. Install rod (4) and spring (6) into body.

6. Install nut (3) and clevis (2) to rod assembly.

7. Attach cap assembly (1) to body (7) and install four bolts (5).

TROUBLESHOOTING

The following guide covers the steering axle, spring and cable assembly, and draftframe. All other systems of the Sectionalized vehicles are similar to the Nonsectionalized Tractor-Scraper, and are covered in Chapters 1 through 4.

PROBLEM
PROBABLE CAUSE
RECOMMENDED ACTION

STEERING AXLE

Too much force needed to turn steering wheel.

1. The pump operation is not correct.
2. Dirt in the steering system.
3. Steering gear operation is not correct.
   (a) Check pump, repair or replace as necessary.
   (b) Bleed the steering system.
   (c) Check steering gear, repair or adjust as necessary.

Tractor does not turn when steering wheel is slowly turned.

1. The oil level of the tank is low.
2. There is air In the steering system.
3. The pump operation is not correct.
4. Dirt in the steering system.
5. Steering gear operation is not correct.
   (a) Fill oil tank as necessary.
   (b) Bleed the steering system.
   (c) Check pump, repair or replace as necessary.
   (d) Bleed the steering system.
   (e) Check the steering gear, repair or replace as necessary.

The temperature of the oil is too hot.

1. The viscosity of the oil is wrong.
2. The steering relief valve Is not set correctly. See SPECIFICATIONS, page 1-55.

PROBLEM
PROBABLE CAUSE
RECOMMENDED ACTION

3. There is a restriction in an oil passage.
4. The pump has too much wear.
   (a) Replace with oil of the proper viscosity.
   (b) Adjust valve.
   (c) Bleed the steering system.
   (d) Check pump, repair or replace as necessary.

The output of the steering pump is low.

1. The oil level of the tank is low.
2. The viscosity of the oil is wrong.
3. The pump has too much wear.
   (a) Fill oil tank as necessary.
   (b) Replace with oil of the proper viscosity.
   (c) Check pump, repair or replace as necessary.

The pressure of the oil is low.

1. The steering relief valve opens at an oil pressure that is lower than the pressure in SPECIFICATIONS, page 1-55.
2. The pump has too much wear.
   (a) Adjust valve.
   (b) Check pump, repair or replace as necessary.

PROBLEM
PROBABLE CAUSE
RECOMMENDED ACTION

SPRING AND CABLE ASSEMBLY

Cable breaks or releases at point of attachment during sectionalization procedure.

1. Cable catches on battery housing and/or fuel tank and snaps.

2. Pin at clevis or cap assembly breaks releases cable.

3. Lug at ejector or steer axle assembly breaks and releases cable.

(a) Replace cable.

(b) Replace pins as necessary.

(c) Replace lugs as necessary.

PROBLEM
PROBABLE CAUSE
RECOMMENDED ACTION

Spring assembly will not fully extend, or does not retract.

1. Rod assembly is bent.

2. Spring assembly body is dented.

(a) Replace rod assembly.

(b) Replace body.

DRAFT FRAME BEARINGS

Draft frame bearing is damaged.

Pin may have caused damage during reconnection.
Inspect pin and bearings, replace as necessary.

APPENDIX A
REFERENCES

SCOPE

This appendix lists Army regulations, forms, field manuals, technical manuals and other publications referenced in this manual and which apply to maintenance of the Tractor-Scraper.

ARMY REGULATIONS

Reporting of Transportation Discrepancies in Shipments	AR 55-38
Dictionary of United States Army Terms	AR 310-25
Authorized Abbreviations and Brevity Codes	AR 310-50
Department of the Army Information Security Program	AR 380-5
Accident Reporting and Records	AR 385-40
Prevention of Motor Vehicle Accidents	AR 385-55
Logistic Assistance Program	AR 700-4
Army Material Maintenance Handling	AR 750-1

DEPARTMENT OF THE ARMY PAMPHLETS

Consolidated Index of Army Publications and Blank Forms	DA Pam 25-30
The Army Maintenance Management System (TAMMS)	DA Pam 738-50

FORMS

U.S. Army Accident Investigation Report	DA Form 285
Equipment Operator's Qualifications Record (Except Aircraft)	DA Form 34E
Recommended Changes To Publications and Blank Forms	DA Form 202E
Recommended Changes To Equipment Technical Publications	DA Form 2028
Organizational Control Record for Equipment	DA Form 2401
Equipment Inspection and Maintenance Worksheet	DA Form 2402
Maintenance Request	DA Form 240
Preventive Maintenance Schedule and Record	DD Form 31
Processing and Deprocessing Record for Shipment, Storage, and Issue of Vehicles and Spare Engines	DD Form 139
DOD Fire Incident Report	DD Form 2324
U.S. Government Motor Vehicle Operator's Identification Card	OF Form 341
Operator's Report on Motor Vehicle Accident	SF Form 9
Transportation Discrepancy Report	SF Form 36
Report of Discrepancy (ROD)	SF Form 36
Product Quality Deficiency Report (NSN 7540-00-105-0078)	SF Form 36

FIELD MANUALS

NBC Contamination Avoidance	FM 3-
NBC Protection	FM 3-
NBC Decontamination	FM 3-
Field Behavior of NBC Agents (Including Smoke and Incendiaries)	FM 3-
Camouflage	FM 5-20
Vehicle Recovery Operations	FM 20-22
First Aid for Soldiers	FM 21-11
Visual Signals	FM 21-60

Manual for the Wheeled Vehicle Driver ....FM 21-305
Basic Cold Weather Manual ....FM 31-70
Northern Operations ....FM 31-71
Metal Body Repair and Related Operations ....FM 43-2
Desert Operations ....FM 90-3
Mountain Operations (How To Fight) ....FM 90-6

TECHNICAL BULLETINS

Occupational and Environmental Health: Hearing Conservation .... TB MED 501
Solder and Soldering .... TB SIG 222
Hand Portable Fire Extinguishers Approved for Army Users .... TB 5-4200-200-10
Equipment Improvement Report and Maintenance Digest (U.S. Army Tank-Automotive Command) Tank-Automotive Equipment ....TB 43-0001-39 Series
Color, Marking, and Camouflage Painting of Military Vehicles, Construction Equipment, and Materials Handling Equipment .... TB 43-0209
Non-Aeronautical Equipment Army Oil Analysis Program (AOAP) .... TB 43-0210
AOAP Army Oil Analysis Program for Leaders and Users .... TB 43-0211
Maintenance in the Desert .... TB 43-239
Preservation of USAMECOM Mechanical Equipment for Shipment and Storage .... TB 740-97-2
Use of Antifreeze Solutions and Cleaning Compounds in Engine Cooling Systems .... TB 750-651

TECHNICAL MANUALS

Operator's Manual: Training Set, Chemical Agent Identification: Simulants, M72A2 (6910-01-043-2090) .... TM 3-6910-227-10
Operator's Manual: Scraper, Tractor: Elevating, Self-propelled, 11 Cubic Yard, Sectionalized and Nonsectionalized, Models 613BSS and 613BSS1 (NSN 3805-01-144-8837 and NSN 3805-01-267-4177) and Models 613BSNS and 613BSNS1 (NSN 3805-01-144-2992 and NSN 3805-01-267-4178) .... TM 5-3805-260-10
Unit, Direct Support, and General Support Maintenance Repair Parts and Special Tools Lists for Scraper, Tractor: Elevating, Self-propelled, 11 Cubic Yard, Sectionalized and Nonsectionalized, Models 613BSS and 613BSS1 (NSN 3805-01-144-8837 and NSN 3805-01-267-4177) and Models 613BSNS and 613BSNS1 (NSN 3805-01-144-2992 and NSN 3805-01-267-4178) ....TM 5-3805-260-24P
Inspection, Care, and Maintenance of Antifriction Bearings ....TM 9-214
Operator's Manual for Welding Theory and Application .... TM 9-237
Materials Used for Cleaning, Preserving, Abrading, and Cementing Ordnance Materiel and Related Items Including Chemicals .... TM 9-247
Organizational, Direct Support, and General Support Maintenance Care, Maintenance, and Repair of Pneumatic Tires and Inner Tubes .... TM 9-2610-200-24
Operator and Organizational Maintenance Manual, Including Repair Parts and Special Tools List, Simplified Test Equipment for Internal Combustion Engines (STE-ICE) (4910-00-124-2554) .... TM 9-4910-571-12&P
Operator's, Organizational, Direct Support and General Support Maintenance Manual for Lead-Acid Storage Batteries: 4HN, 24V (6140-00-069-3528) MS75047-1; 2HN, 12V (6140-00-057-2553) MS 35000-1; 6TN, 12V (6140-00-057-2554) MS 35000-3 .... TM 9-6140-200-14
Principles of Automotive Vehicles ....TM 9-8000
Organizational Maintenance Manual: Night Vision Goggles, AN/PVS-5 and AN/PVS-5A (5855-00-150-1820) .... TM 11-5855-238-20
Organizational, Direct Support and General Support Maintenance Manual, Including Repair Parts and Special Tools Lists (Including Depot Maintenance Repair Parts and Special Tools), Night Vision Goggles AN/PVS-5 and AN/PVS-SA (5855-00-150-1820) .... TM 11-5855-238-24&P

Army Equipment Data Sheets: Chemical Defense Equipment (Reprint
with INCL-1) .... TM 43-0001-26-1
Painting Instructions for Field Use .... TM 43-0139
Administrative Storage of Equipment .... TM 740-90-1
Procedures for Destruction of Tank-Automotive Equipment to Prevent
Enemy Use .... TM 750-244-6

OTHER PUBLICATIONS

Army Medical Department Expendable/Durable Items .... CTA 8-100
Expendable/Durable Items (Except Medical, Class V, Repair Parts, and
Heraldic Items) .... CTA 50-970
Catalog of Audiovisual Productions, Army Productions, Volume I (PA) DOD5040.2-C-1

APPENDIX B
SUPPLEMENTAL MAINTENANCE INSTRUCTIONS

Table of Contents

GENERAL

DESCRIPTION

The Tractor-Scraper is a commercial elevating model with diesel engine, pneumatic tires, two axles, articulated steering, two single driving front wheels and two single non-driving rear wheels. The Tractor- Scraper has a minimum heaped capacity of eleven cubic yards and is equipped with power shift trans- mission.

OPERATIONAL CONCEPT

The Tractor-Scraper shall withstand the usage encountered in military operations such as: self-loading, handling, dumping and spreading soil, crossing rough terrain, fording streams, and negotiating steep longitudinal and slidehill slopes, without damage. The Tractor-Scraper shall be capable of driving at maximum travel speed in transport, being towed by another vehicle, limited towing of other equipment, and for airborne and air assault operations. The Tractor-Scraper shall be capable of self-loading undistributed or recompacted soil to a heaped capacity in less than one minute.

EQUIPMENT PUBLICATIONS

Department of the Army publications available in support of the Tractor-Scraper, in addition to this manual, are TM 5-3805-260-10 and TM 5-3805-260-24P.

PERSONNEL

1. Operator. MOS 62E (Heavy Construction Equipment Operator).

2. Unit Maintenance. MOS 62B (Construction Equipment Repairer).

3. Direct/General Support (DSIGS) Maintenance. MOS 62B (Construction Equipment Repairer).

LOGISTICS ASSISTANCE

1. Tank-Automotive Command Field Maintenance Technicians stationed at the receiving Installations will be fully qualified and available to furnish on-site training and/or assistance concurrent with receipt of the Tractor-Scraper.

2. Assistance can be obtained by contacting the Logistics Assistance Office listed in Appendix B of AR 700-4, Logistics Assistance Program.

MAINTENANCE

MAINTENANCE AND OPERATING SUPPLY LIST

A listing of maintenance and operating supplies required for initial operation is supplied on page B-24.

TOOL AND TEST EQUIPMENT REQUIREMENTS

See Section III of the Maintenance Allocation Chart (MAC).

MAINTENANCE FORMS AND RECORDS

Refer to DA Pam 738-750, The Army Maintenance Management System (TAMMS).

REPORTING EQUIPMENT IMPROVEMENT RECOMMENDATIONS (EIRs)

If your Tractor-Scraper needs improvement, let us know. Send us an EIR. You, the user, are the only one who can tell us what you don't like about your equipment. Let us know what you don't like about the design or performance. Put it on an SF 368 (Quality Deficiency Report). Mail it to us at: Commander, U.S. Army Tank-Automotive Command, ATTN: AMSTA-MP, Warren, MI 48397-5000. We will send you a reply.

EQUIPMENT IMPROVEMENT REPORT AND MAINTENANCE DIGEST

The quarterly Equipment Improvement Report and Maintenance Digest, TB 43-001-39-1 series, contains valuable information on the equipment covered in this manual. The information in the TB 43-001-39-1 series is compiled from some of the Equipment Improvement Recommendations that you prepared. This TB contains information on equipment improvement, minor alterations, proposed Modifications Work Orders (MWO), warranties (if applicable), actions taken on some of your submitted DA Forms 2028 and 2028-2, and advanced information on proposed changes that may affect this manual. The information will help you in doing your job better and will help in keeping up to date on the latest changes to this and related publications. Also refer to DA Pam 25-30, Consolidated Index of Army Publications and Blank Forms, and Appendix A, References, in this manual.

MAINTENANCE CONCEPT

The Tractor-Scraper will not require any new or special maintenance consideration. All maintenance functions can be accomplished within the current maintenance concepts established for construction equipment.

1. Operator/Crew Maintenance. Operator and crew maintenance is limited to daily preventive maintenance checks and services.
2. Organizational Maintenance. Organizational maintenance consists of scheduled preventive maintenance services, minor repairs, and adjustments.
3. Direct Support (DS) Maintenance. Direct support maintenance consists of repairs on-site or in direct support unit's shop. Repairs are accomplished with a minimum of tools and test equip-

ment. Maintenance is performed on a repair-and-return-to-user basis, and organizational maintenance repair parts are supplied to using units.

4. General Support (GS) Maintenance. General support maintenance units receive equipment for repair and overhaul from direct support units, collection points, supply units, and other activities for which they are assigned maintenance support responsibilities. GS units operate on a repair/ overhaul and return to supply system principle.
5. Depot Maintenance. The primary purpose of Depot maintenance is to augment stocks of serviceable assets which require maintenance that is beyond the capability of General Support Maintenance Activities. Depot maintenance is usually accomplished in fixed shops and facilities that are government owned and operated, government owned and contractor operated, or contractor owned and operated.

MAINTENANCE ALLOCATION CHART (MAC)

Maintenance will be performed as necessary by the category indicated in the Maintenance Allocation Chart to retain or restore serviceability. All authorized maintenance within the capability of a using organization will be accomplished before referring the item to support maintenance. Higher categories will perform the maintenance functions of lower categories when required or directed by the appropriate commanders. Using and support units may exceed their authorized scope and functions in the MAC when approval is granted by the next higher support Maintenance Commander. The Maintenance Allocation Chart (MAC) is on page B-9.

MODIFICATIONS

Modifications will not be made without the approval of U.S. Army Tank-Automotive Command (TACOM), AMSTA-MVB, Warren, Ml 48397-5000.

QUALITY DEFICIENCY REPORT (QDR)

Standard Form 368 (Quality Deficiency Report) was adopted for Equipment Improvement Recommendations (EIRs) reporting. This action was taken to standardize reporting within all governmental services. Submissions to be in accordance with DA Pam 738-750.

MAINTENANCE EXPENDITURE LIMITS

The average life expectancy for the Tractor-Scraper is 14 years. After last date shown, use 25% repair limit until type classified obsolete.

REPAIR LIMIT	YEAR
50%	4
45%	6
40%	8
35%	10
30%	12
20%	14

SHIPMENT AND STORAGE

1. Refer to TB 740-97-2, Preservation of USAMECOM Mechanical Equipment for Shipment and Storage.

2. Refer to TM 740-90-1, Administrative Storage of Equipment.

DESTRUCTION TO PREVENT ENEMY USE

Refer to TM 750-244-6, Procedures for Destruction of Tank-Automotive Equipment to Prevent Enemy Use.

FIRE PROTECTION

1. A hand operated fire extinguisher may be installed at the discretion of the using unit.
2. Refer to TB 5-4200-200-10, Hand Portable Fire Extinguishers Approved for Army Users.

REPAIR PARTS, SPECIAL TOOLS, TMDE AND SUPPORT EQUIPMENT

Common Tools and Equipment

For authorized common tools and equipment, refer to the Modified Table of Organization and Equipment (MTOE) applicable to your unit.

Special Tools, TMDE and Support Equipment

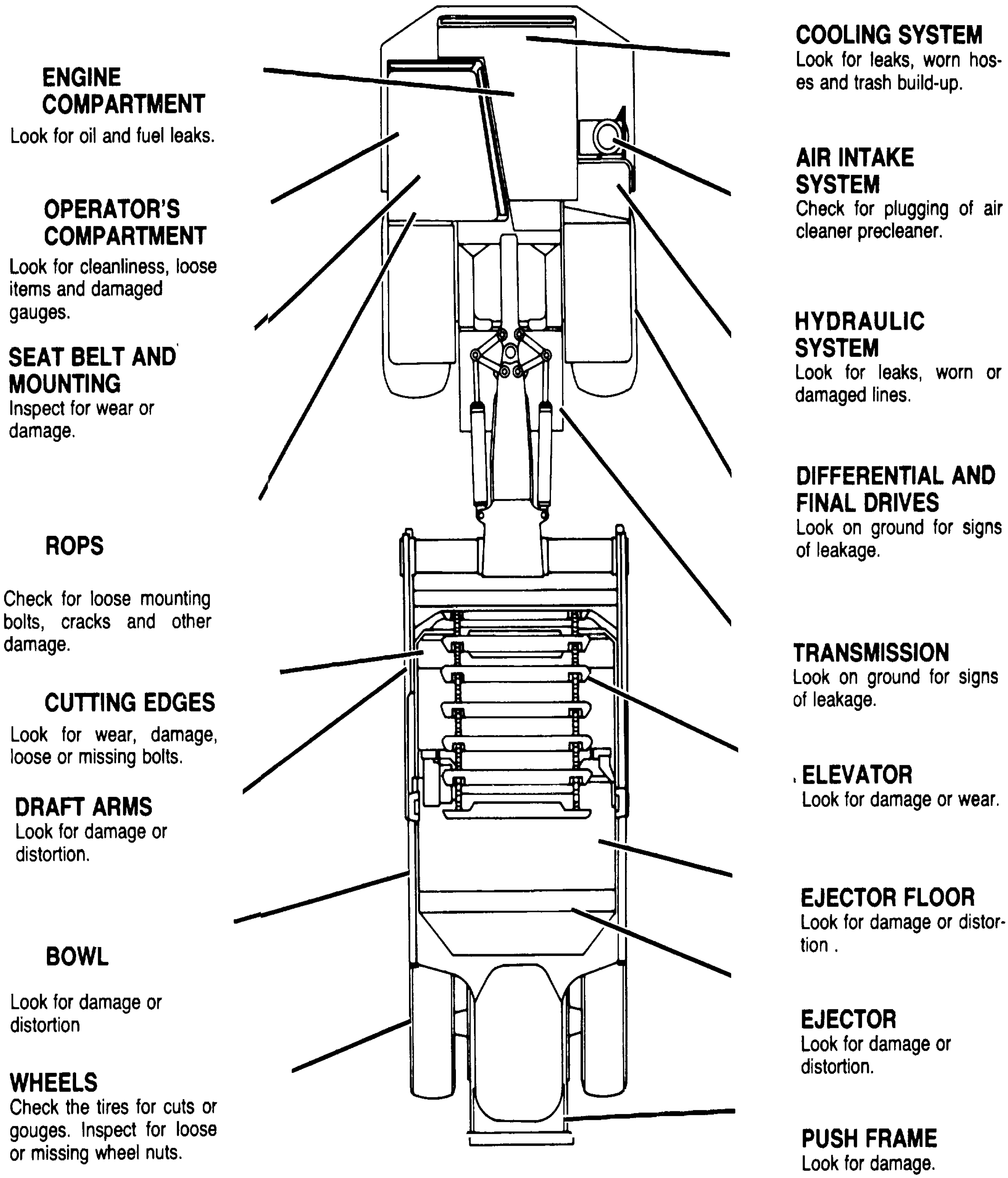
Refer to Section 11 of the Maintenance Allocation Chart (MAC) for special tools and TMDE you will need to maintain this vehicle. No support equipment is required.

Repair Parts

Repair parts are listed and illustrated in TM 5-3805-260-24P.

Walk-Around Inspection

For maintenance and operator personnel safety, and maximum service life of the machine, make a thorough walk-around inspection when doing lubrication and maintenance work. Look under and around the machine for such items as loose bolts, trash build-up, oil or coolant leaks, condition and inflation of tires and condition of the cutting edge and cutting edge teeth. Have faulty condition repaired.



Tire Inflation Information

CONDITION	MANUFACTURER	PLY RATING	PRESSURE
SHIPPING	FIRESTONE	12	35 PSI (2.5 kg/cm2)
	GENERAL	12	40 PSI (2.8 kg/cm2)
	FIRESTONE	16	45 PSI (3.2 kg/cm2)
	GENERAL	16	45 PSI (3.2 kg/cm2)
OPERATION	FIRESTONE	12	35 PSI (2.5 kg/cm2)
	GENERAL	12	40 PSI (2.8 kg/cm2)
	FIRESTONE	16	45 PSI (3.2 kg/cm2)
	GENERAL	16	45 PSI (3.2 kg/cm2)
ROADING	FIRESTONE	12	35 PSI (2.5 kg/cm2)
	GENERAL	12	40 PSI (2.8 kg/cm2)
	FIRESTONE	16	45 PSI (3.2 kg/cm2)
	GENERAL	16	45 PSI (3.2 kg/cm2)
STORAGE	FIRESTONE	12	20 PSI (1.4 kg/cm2)
	GENERAL	12	15 PSI (1.1 kg/cm2)
	FIRESTONE	16	25 PSI (1.8 kg/cm2)
	GENERAL	16	20 PSI (1.4 kg/cm2)

Adjusted Inflation Pressure

Use this chart when inflating tires indoors at 65°F (18°C) if the machine is to be operated at a cooler outside temperature.

Recommended Inflation Pressure		**Adjusted Inflation Pressure For Ambient Operating Temperature of:**							
		30°F (- 1°C)		O°F (- 18°C)		-20°F (-29°C)		-40°F (-40°C)	
psi	kPa	psi	kPa	psi	kPa	psi	kPa	psi	kPa
30	205	33	230	36	250	39	270	41	285
35	240	38	260	42	290	45	310	47	325
40-	280	44	305	48	330	51	350	54	370
45	310	49	340	53	365	57	395	60	415
50	345	55	380	59	405	62	430	66	460
55	380	60	415	65	450	68	470	72	500
60	415	65	450	71	490	74	510	79	550
65	450	71	490	76	520	80	550	85	590
70	480	76	520	82	570	86	590	91	630
75	520	81	560	88	610	92	630	97	670
80	550	87	600	93	640	98	680	104	720

TORQUE REQUIREMENTS

Coarse Threads	SAE GRADE 5  Dry	Lubricated or Plated	SAE GRADE 8  Dry	Lubricated or Plated
	(IN LB)	(IN LB)	(IN LB)	(IN LB)
10-24	43-47	32-35	60-66	45-49
¼-20	96-106	75-83	144-158	108-119
	(FT LB)	(FT LB)	(FT LB)	(FT LB)
5/16-18	17-19	13-14	25-28	18-20
⅜-16	31-34	23-25	44-48	33-36
7/16-14	49-54	37-41	70-77	52-57
½-13	75-83	57-63	106-117	80-88
9/16-12	109-120	82-90	153-168	115-127
⅝-11	150-165	113-124	212-233	159-175
¾-10	266-293	200-220	376-414	282-310
⅞-9	394-433	296-326	606-667	455-501
1-8	591-649	443-489	909-1000	682-750
1⅛-7	794-873	596-656	1288-1417	966-1063
1¼-7	1120-1232	840-924	1817-1999	1360-1496
Fine Threads				
	(IN LB)	(IN LB)	(IN LB)	(IN LB)
10-32	49-54	36-40	68-75	51-56
¼-28	120-132	86-95	168-185	120-132
	(FT LB)	(FT LB)	(FT LB)	(FT LB)
5/16-24	19-21	14-15	25-28	20-22
⅜-24	35-39	26-29	49-54	37-41
7/16-20	55-61	41-45	78-86	58-64
½-20	85-94	64-70	120-132	90-99
9/16-18	121-133	91-100	171-188	128-141
⅝-18	170-187	128-141	240-264	180-198
¾-16	297-327	223-245	420-462	315-347
⅞-14	434-477	326-359	668-735	501-550
1-12	646-711	485-534	995-1096	746-821
1⅛-12	891-980	668-735	1445-1590	1083-1191
1¼-12	1240-1364	931-1024	2012-2213	1509-1660

MAINTENANCE ALLOCATION CHART

Section I. INTRODUCTION

GENERAL

1. This section provides a general explanation of all maintenance and repair functions authorized at the various maintenance levels.
2. The Maintenance Allocation Chart (MAC) in Section II designates overall authority and responsibility for the performance of maintenance functions on the identified end item or component. The application of the maintenance functions to the end item or component will be consistent with the capacities and capabilities of the designated maintenance levels.
3. Section III lists the tools and test equipment (both special tools and common tool sets) required for each maintenance function as referenced from Section II.
4. Section IV contains supplemental instructions and explanatory notes for a particular maintenance function.

MAINTENANCE FUNCTIONS

Maintenance functions will be limited to and defined as follows:

1. Inspect. To determine the serviceability of an item by comparing its physical, mechanical, and/or electrical characteristics with established standards through examination (e.g., by sight, sound, or feel).
2. Test. To verify serviceability by measuring the mechanical, pneumatic, hydraulic, or electrical characteristics of an item and comparing those characteristics with prescribed standards.
3. Service. Operations required periodically to keep an item in proper operating condition, i.e., to clean (includes decontaminate, when required), to preserve, to drain, to paint, or to replenish fuel, lubricants, chemical fluids, or gases.
4. Adjust. To maintain or regulate, within prescribed limits, by bringing into proper or exact position or by setting the operating characteristics to specified parameters.
5. Align. To adjust specified variable elements of an item to bring about optimum or desired performance.
6. Calibrate. To determine and cause corrections to be made or to be adjusted on instruments or test, measuring, and diagnostic equipments used in precision measurement. Consists of comparisons of two instruments, one of which is a certified standard of known accuracy, to detect and adjust any discrepancy in the accuracy of the instrument being compared.
7. Remove/Install. To remove and install the same item when required to perform service or other maintenance functions. Install may be the act of emplacing, seating, or fixing into position spare, repair part, or module (component or assembly) in a manner to allow the proper functioning of an equipment or system.
8. Replace. To remove an unserviceable item and install a serviceable counterpart in its place "Replace" is authorized by the MAC and is shown as the third position of the SMR code.
9. Repair. The application of maintenance services, including fault location/troubleshooting, removal/installation, and disassembly/assembly procedures, and maintenance actions to identify troubles and restore serviceability to an item by correcting specific damage, fault, malfunction or failure in a part, subassembly, module (component or assembly), end item, or system.
10. Overhaul. That maintenance effort (service/action) prescribed to restore an item to a complete serviceable/operational condition as required by maintenance standards in appropriate technical publications (i.e., DMWR). Overhaul is normally the highest degree of maintenance performed by the Army. Overhaul does not normally return an item to like new condition.

11. Rebuild. Consists of those services/actions necessary for the restoration of unserviceable equipment to a like new condition in accordance with original manufacturing standards. Rebuild is the highest degree of materiel maintenance applied to Army equipment. The rebuild operation includes the act of returning to zero those age measurements (hours/miles, etc.) considered in classifying Army equipment/components.

EXPLANATION OF COLUMNS IN THE MAC, SECTION II

1. Column 1, Group Number. Column 1 lists functional group code numbers, the purpose of which is to identify maintenance significant components, assemblies, subassemblies, and modules with the next higher assembly. End item group number shall be "00."
2. Column 2, Component/Assembly. Column 2 contains the names of components, assemblies, subassemblies, and modules for which maintenance is authorized.
3. Column 3, Maintenance Function. Column 3 lists the functions to be performed on the item listed in Column 2. (For a detailed explanation of these functions, see paragraph C-2.)
4. Column 4, Maintenance Level. Column 4 specifies, by the listing of a work time figure in the appropriate subcolumn(s), the level of maintenance authorized to perform the function listed in Column 3. This figure represents the active time required to perform that maintenance function at the indicated level of maintenance. If the number or complexity of the tasks within the listed maintenance function vary at different maintenance levels, appropriate work time figures will be shown for each level. The work time figure represents the average time required to restore an item (assembly, subassembly, component, module, end item, or system) to a serviceable condition under typical field operating conditions. This time includes preparation time (including any necessary disassembly/assembly time), troubleshooting/ fault location time, and quality assurance/quality control time in addition to the time required to perform the specific tasks identified for the maintenance functions authorized in the Maintenance Allocation Chart. The symbol designations for the various maintenance levels are as follows:

   C.......................Operator or Crew
   0 ....Unit Maintenance
   F ....Direct Support Maintenance
   H.......................General Support Maintenance
   D.......................Depot Maintenance

5. Column 5, Tools and Equipment. Column 5 specifies, by code, those common tool sets (not individual tools) and special tools, TMDE, and support equipment required to perform the designated function.
6. Column 6, Remarks. This column shall, when applicable, contain a letter code, in alphabetic order, which shall be keyed to the remarks contained in Section IV.

EXPLANATION OF COLUMNS IN TOOL AND TEST EQUIPMENT REQUIREMENTS, SECTION III

1. Column 1, Tool or Test Equipment Reference Code. The tool and test equipment reference code correlates with a code used in the MAC, Section II, Column 5.
2. Column 2, Maintenance Level. The lowest level of maintenance authorized to use the tool or test equipment.
3. Column 3, Nomenclature. Name or identification of the tool or test equipment.
4. Column 4, National/NATO Stock Number. The National or NATO Stock Number of the tool or test equipment.
5. Column 5, Tool Number. The manufacturer’s part number.

EXPLANATION OF COLUMNS IN REMARKS, SECTION IV

1. Column 1, Reference Code. The code recorded in Column 6, Section II.
2. Column 2, Remarks. This column lists information pertinent to the maintenance function being performed as indicated in the MAC, Section II.

Section II. MAINTENANCE ALLOCATION CHART

(1) GROUP NUMBER	(2) COMPONENT ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE LEVEL UNIT C	UNIT O	DIRECT SUPPORT F	GENERAL SUPPORT H	DEPOT D	(5) TOOLS AND EQUIPMENT REF CODE	(6) REMARKS CODE
01	ENGINE								
0100	Engine Assembly	Inspect	0.2						A
		Test		1.5				1	B, G
		Service	0.5	1.0				1	C
		Replace			14.0			2, 3	
		Repair				40.0		2, 6, 7 9-12	D
		Overhaul					80.0	2, 6, 7 9-12	
0101	Crankcase, Block, Cylinder Head								
	Head Assembly	Replace			8.0			2	
		Repair				16.0		2, 6	
0103	Flywheel Assembly								
	Flywheel	Replace			4.3			2	
		Repair				3.0		2.6	
	Housing	Replace				12.0		2	
		Repair				2.2		2	
0105	Valves, Camshafts, and Timing System								
	Valve Mechanism	Adjust			1.5			1	E
		Replace				2.0		2	
	Covers, Front Housing	Replace				11.5		2	
		Repair				1.5		2	
0106	Engine Lubrication System								
	Filter Assembly, Oil	Service		0.4				1	
		Replace		0.4				1	
		Repair		2.0				1	
	Pump Assembly , Oil	Replace				3.0		3	F
		Repair				2.0		3	
	Breather, Crankcase	Service	0.2					1	
		Replace	0.6					1	

Section II. MAINTENANCE ALLOCATION CHART - Continued

(1) GROUP NUMBER	(2) COMPONENT ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE LEVEL UNIT C	UNIT O	DIRECT SUPPORT F	GENERAL SUPPORT H	DEPOT D	(5) TOOLS AND EQUIPMENT REF CODE	(6) REMARKS CODE
03	FUEL SYSTEM								
0301	Carburetor, Fuel Injector	Test			1.0			8	I
		Replace			1.0			2, 10	
		Repair			1.0			6, 8	
0302	Fuel Pumps								
	Pump, Transfer	Test			1.0				
		Replace			1.0			2	
		Repair			3.0			3	
	Pump, Fuel Injection	Adjust		0.5				2, 7	
		Replace			6.0			3	J
		Overhaul					7.5	2, 4, 6, 7	
	Pump Primer	Replace		1.5				1	
		Repair		0.3				1	
0304	Air Cleaner	Replace		1.0				1	
		Repair		0.5				1	
	Elements	Service		0.2				1	
		Replace		0.3				1	
	Prescreener	Service		0.2				1	H
		Replace		0.4				1	
0306	Tanks, Lines, Fittings, Headers								
	Tank, Upper	Inspect	0.2						A
		Service	0.5					1	
		Replace			3.5			1	
		Repair			2.0			1	
	Tank, Lower	Inspect	0.2						
		Service	0.5					1	
		Replace			3.0			3	
		Repair			2.0			3.5	
	Auxiliary Fuel Tank	Replace		0.5				1	
		Repair			1.0			1.5	
0308	Engine Speed Governor and Controls								
	Governor Assembly	Inspect		0.3					
		Adjust			1.0			3, 7	L
		Replace			6.0			3	L
		Repair				3.0		2, 4	

Section II. MAINTENANCE ALLOCATION CHART - Continued

(1) GROUP NUMBER	(2) COMPONENT ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE LEVEL UNIT C	UNIT O	DIRECT SUPPORT F	GENERAL SUPPORT H	DEPOT D	(5) TOOLS AND EQUIPMENT REF CODE	(6) REMARKS CODE
0308	Engine Speed Governor and Controls (Con't)								
	Linkage, Control	Inspect	0.2						
		Service		0.3				2	
		Adjust		0.5				2	
		Replace		1.7				2	
0309	Fuel Filters								
	Fuel Filter Assembly	Service		0.5				1	
		Replace		0.3					
	Water Separator	Service		0.3				1	
		Replace		0.5				1	
		Repair		1.0				1	
04	EXHAUST SYSTEM								
0401	Muffler and Pipes	Replace		0.7				1	
05	COOLING SYSTEM								
0501	Radiator, Evaporative Cooler, or Heat Exchanger								
	Radiator	Inspect	0.5						K
		Test		1.0				3	
		Service		0.5					
		Replace			3.2			3	
		Repair			4.4			3.5	
	Cap, Radiator	Replace		0.1					
		Repair		0.5				1	
0503	Water Manifold, Headers, Thermostats and Housing Gasket								
	Regulator	Test		1.0				3	
		Replace		1.0				1	
0504	Water Pump								
	Pump Assembly	Replace		2.0				2	
		Repair			2.0			2, 3	M
	Fan Drive	Replace		1.5				2	
		Repair			0.5			2,3	
	Belts, Vee	Inspect	0.1						
		Replace		0.5				1	
		Adjust		0.2				1	

Section II. MAINTENANCE ALLOCATION CHART - Continued

(1) GROUP NUMBER	(2) COMPONENT ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE LEVEL UNIT C	UNIT O	DIRECT SUPPORT F	GENERAL SUPPORT H	DEPOT D	(5) TOOLS AND EQUIPMENT REF CODE	(6) REMARKS CODE
06	ELECTRICAL SYSTEM								
0601	Generator, Alternator								
	Alternator	Test		0.5				3	
		Replace		0.5				3	
		Repair			0.3			3,6	N
0603	Starting Motor								
	Motor, Starter	Test		0.2				3	
		Replace		1.5				3	
		Repair			3.0			3,6	O
	Relay	Test		0.3				3	
		Replace		0.5				2	
0607	Instrument or Engine Control Panel								
	Instrument Panel	Replace		7.0				1	
		Repair		3.0				1	
0608	Miscellaneous Items								
	Disconnect Switch	Replace		1.0				1	
0609	Lights								
	Flood Light	Replace		0.5				1	
	Running Light	Replace		0.5				1	
0611	Horn, Siren								
	Back-up Alarm	Inspect	0.1						
		Replace		0.3				1	
0612	Batteries, Storage								
	Battery	Inspect	0.5						
		Service		0.5				3	r
		Test		0.5				3	
		Replace		1.5				1	
0613	Hull or Chassis Wiring Harness								
	Harness, Tractor	Inspect	0.1						
		Test		0.1				3	
		Replace			4.2			2	
		Repair		0.1				2	
	Harness Scraper	Inspect	0.1						
		Test		0.1				3	
		Replace			3.5			2	
		Repair		1.0				2	

Section II. MAINTENANCE ALLOCATION CHART - Continued

(1) GROUP NUMBER	(2) COMPONENT ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE LEVEL UNIT C	UNIT O	DIRECT SUPPORT F	GENERAL SUPPORT H	DEPOT D	(5) TOOLS AND EQUIPMENT REF CODE	(6) REMARKS CODE
07	TRANSMISSION								
0705	Transmission Shifting Components	Inspect		0.2					
		Adjust		1.0				2	
		Service	0.2					2	
		Replace		3.0				2	
0708	Torque Converter or Fluid Coupling								
	Torque Converter	Replace			16.0			2	
		Repair				8.0		2.3	
0710	Transmission Assembly and Associated Parts								
	Transmission	Inspect	0.2						P
		Service		0.5				1	Q
		Test			2.5			3	
		Replace			19.5			2	
		Repair				16.0		2	
		Overhaul					36.0	2,4,6	
0714	Servo Unit								
	Valves, Control	Inspect		0.2					
		Test			1.0			2,4	
		Adjust			1.5			2,4	
		Replace			3.5			2	
		Repair				2.5		2,6	
	Linkage, Valve Control	Adjust		1.0				2	
		Replace		1.5				2	
0719	Reduction or Transfer Gears, Shafts, and Bearings								
	Input Transfer Gears	Replace				4.0		2,4	
		Repair				3.0		2,4	
	Output Transfer Gears	Replace				4.0		2,4	
		Repair				3.0		2,4	
0721	Coolers, Pumps, Motors								
	Pump Assembly, Oil	Test			1.3			3	
		Repair			4.3			2,3	
		Replace			2.1			2	
	Filter Assembly, Oil	Service		0.2				1	
		Replace		0.8				1	
		Repair		0.4				1	

Section II. MAINTENANCE ALLOCATION CHART - Continued

(1) GROUP NUMBER	(2) COMPONENT ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE LEVEL UNIT C	UNIT O	DIRECT SUPPORT F	GENERAL SUPPORT H	DEPOT D	(5) TOOLS AND EQUIPMENT REF CODE	(6) REMARKS CODE
0721	Coolers, Pumps, Motors (Con't)								
	Magnetic Strainer	Service		1.0				1	
		Replace			0.5			1	
09	PROPELLER, PROPELLER SHAFTS, UNIVERSAL JOINTS, COUPLER AND CLAMP ASSEMBLY								
0900	Propeller Shafts								
	Upper Drive Shaft	Replace		1.0				2	
		Repair		1.5				2	
	Lower Drive Shaft	Replace		1.0				2	
		Repair		1.5				2	
10	FRONT AXLE								
1000	Front Axle Assembly								
	Axle Assembly	Service		0.5				1	
		Replace			5.0			2,4	
		Repair			4.0			2,4	
1002	Differential								
	Differential and Carrier Assembly	Service		0.5				1	
		Replace			4.0			2,4	
		Repair				4.0		2,4	
1003	Planetary or Final Drive								
	Final Drives	Service		0.5				1	
		Replace			4.0			2,4	
		Repair				4.0		2,4	
1004	Steering and Leaning Wheel Mechanism								
	Auxiliary Steering Axle	Replace		1.0				2	
		Repair			2.0			2	
11	REAR AXLE								
1100	Rear Axle Assembly								
	Scraper Axles	Replace			3.0			2,4	
		Repair			2.0			2,4	

Section II. MAINTENANCE ALLOCATION CHART - Continued

(1) GROUP NUMBER	(2) COMPONENT ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE LEVEL UNIT C	O	DIRECT SUPPORT F	GENERAL SUPPORT H	DEPOT D	(5) TOOLS AND EQUIPMENT REF CODE	(6) REMARKS CODE
12	BRAKES								
1201	Handbrakes								
	Parking and Emergency Brakes	Test	0.2					1	
		Adjust		0.4				1	
1202	Service Brakes								
	Brake Head Assemblies	Replace			6.0			2	
		Repair			2.0			2,4	S
1204	Hydraulic Brake System								
	Master Cylinder	Service		0.5				1	
		Replace			1.5			2	
		Repair			2.5			2,4	
1208	Air Brake System								
	Air Tanks	Service	0.5					1	
		Replace		2.0				2	
	Brake Control Valve	Replace		2.0				1	
		Repair			2.0			2,4	
1209	Air Compressor Assembly	Service		0.3				1	
		Replace		1.0				2	
		Repair			3.0			2,4	
13	WHEELS AND TRACKS								
1311	Wheel Assembly	Replace		1.0				1	
		Repair		1.5				2,3	
1313	Tires, Tubes, Tire Chains								
	Tires	Inspect	0.1						
		Service		0.3					
		Replace		1.0				1	
		Repair		2.0				1,4	
14	STEERING								
1401	Mechanical Steering Gear Assembly								
	Steering Column	Replace			1.0			2,3	
		Repair			1.5			2,3	
	Mechanical Linkage	Replace		2.0				2	
		Repair		1.0				2	

Section II. MAINTENANCE ALLOCATION CHART - Continued

(1) GROUP NUMBER	(2) COMPONENT ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE LEVEL UNIT C	UNIT O	DIRECT SUPPORT F	GENERAL SUPPORT H	DEPOT D	(5) TOOLS AND EQUIPMENT REF CODE	(6) REMARKS CODE
1402	Tractor Hitch Steering								
	Hitch	Replace			3.0			1	
		Repair			2.0			1	
	Steering Link Pins	Replace			2.0			1	
		Repair			1.5			1	
1410	Hydraulic Pump or Fluid Motor Assembly								
	Hydraulic Pump	Test			0.7			2,3	
		Replace			2.0			2	
		Repair				4.0		2,6	
1412	Hydraulic or Air Cylinders								
	Steering Cylinders	Replace			1.0			2	
		Repair			1.5			2,4	
1414	Steering System Valves								
	Steering Control Valve	Test			1.0			2,3	
		Replace			2.0			2	
		Repair			1.5			2.6	
15	FRAME, TOWING AT-TACHMENTS, DRAW BARS, AND ARTICULA-TION SYSTEMS								
1501	Frame Assembly								
	Draft Frame	Replace			4.0			2,4	
		Repair				8.0		5	
18	BODY, CAB, HOOD AND HULL								
1801	Body, Cab, Hood and Hull Assemblies								
	Canopy (ROPS Frame)	Replace		1.0				1	
	Hood	Replace		1.0				1	
		Repair			0.5			5	
1802	Fenders, Running Boards with Mounting and Attaching Parts, Windshield, Glass, etc.								
	Fenders	Replace		1.5				1	
		Repair			3.0			5	

Section II. MAINTENANCE ALLOCATION CHART - Continued

(1) GROUP NUMBER	(2) COMPONENT ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE LEVEL UNIT C	UNIT O	DIRECT SUPPORT F	GENERAL SUPPORT H	DEPOT D	(5) TOOLS AND EQUIPMENT REF CODE	(6) REMARKS CODE
1806	Upholstery, Seats, and Carpets								
	Seat Assembly	Replace		1.0				1	
		Repair			1.5			2	
22	BODY CHASSIS, AND HULL ACCESSORY ITEMS								
2202	Accessory Items								
	Horn	Inspect	0.1						
		Replace		1.0				1	T
		Repair		1.0				1	
	Mirror, Rear View	Replace		0.5				1	
24	HYDRAULIC AND FLUID SYSTEMS								
2400	Scraper Hydraulic System								
2401	Pump and Motor								
	Hydraulic Pump	Test			1.3			2,3	
		Replace			2.0			2	
		Repair				2.0		2	
	Hydraulic Motor	Test			1.3			2,3	
		Replace			4.0			2	
		Repair			2.0			2	
2402	Manifolds and/or Control Valves								
	Elevator Control Valve	Test			0.2			2,3	
		Replace			2.0			2	
		Repair			2.0			2	
	Elevator Speed Control Valve	Test			0.2			2,3	
		Replace			1.0			2	
		Repair			1.5			2	
	Bowl and Ejector Control Valve	Test			0.2			2,3	
		Replace			0.5			2	
		Repair			0.5			2	
2403	Hydraulic Controls and/ or Manual Controls								
	Control Levers and Linkage	Adjust			1.2			1	
		Replace			2.1			1	
		Repair			2.2			1	

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Section II. MAINTENANCE ALLOCATION CHART - Continued

(1) GROUP NUMBER	(2) COMPONENT ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE LEVEL UNIT C	UNIT O	DIRECT SUPPORT F	GENERAL SUPPORT H	DEPOT D	(5) TOOLS AND EQUIPMENT REF CODE	(6) REMARKS CODE
2407	Hydraulic Cylinders								
	Bowl Lift Cylinders	Inspect	0.1						
		Replace		1.3				2	
		Repair			3.0			2,4	
	Ejector Cylinder	Inspect	0.1						
		Replace		2.0				2	
		Repair			2.5			2,4	
	Floor Cylinder	Inspect	0.1						
		Replace		3.0				2	
		Repair			2.5			2,4	
2408	Liquid Tanks or Reservoirs								
	Hydraulic Tank	Inspect	0.1						
		Service		0.3				1	
		Replace			4.5			2	
		Repair				6.0		2,5	
30	ELEVATORS, SPECIAL PURPOSE								
3000	Hydraulic Elevator Assembly								
	Elevator Assembly	Inspect	0.2						
		Replace			4.0			2	
	Guard Assembly	Inspect	0.2						
		Replace			0.5			1	
	Chain Assembly	Replace			2.0			2	
		Repair			3.0			2,6	
	Elevator Flights	Replace		1.0				1	
		Repair			1.0			5	
	Drive Sprockets	Inspect		0.5					
		Replace			3.0			2	
		Repair			1.5			2	
	Speed Reducer	Replace			4.0			2	
		Repair			3.0			2	
	Upper Shaft	Replace			1.0			2	
		Repair			3.0			2	
	Chain Adjustment Roller	Replace			1.5			2	
		Repair			0.5			2	
	Chain Roller	Replace			1.0			2	
		Repair			0.5			2	

Section II. MAINTENANCE ALLOCATION CHART

(1) GROUP NUMBER	(2) COMPONENT ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE LEVEL UNIT C	UNIT O	DIRECT SUPPORT F	GENERAL SUPPORT H	DEPOT D	(5) TOOLS AND EQUIPMENT REF CODE	(6) REMARKS CODE
3000	*Hydraulic Elevator Assembly (Con't)*								
	Lower Shaft	Replace			1.02			2	
		Repair			2.5			2	
33	**SPECIAL PURPOSE KITS**								
3307	*Special Purpose Kits*								
	Load Transfer Axle, Wheel, and Cylinders	Replace	1.5					2	
		Repair		2.0				2	
	Load Transfer Axle Control Valve	Replace	1.2					2	
		Repair		1.5				2, 6	
47	**GAGES (NONELECTRICAL), WEIGHING AND MEASURING DEVICES**								
4702	*Gages, Mountings, Lines, and Fittings*								
	Lines and Fittings	Inspect		0.3					
		Replace		1.6				2	
		Repair			0.5			13, 14	
	Oil Pressure Gage	Inspect		0.2					
	Replace				0.5			2	
	Air Pressure Gage	Inspect	0.2						
		Replace		0.5				2	
4703	*Hourmeter*								
	Service Meter	Inspect	0.2						
		Replace		0.6				2	
74	**CRANES, SHOVELS, AND EARTHMOVING EQUIPMENT COMPONENTS**								
7448	*Bowl and Discharge Components*								
	Ejector Assembly	Inspect		0.1					
		Replace			0.6			2	
		Repair				8.0		2	
	Sliding Floor	Inspect		0.2					
		Replace			4.0				
		Repair				5.0		2, 5	

Section II. MAINTENANCE ALLOCATION CHART - Continued

(1) GROUP NUMBER	(2) COMPONENT ASSEMBLY	(3) MAINTENANCE FUNCTION		(4) MAINTENANCE LEVEL UNIT O	UNIT F	DIRECT SUPPORT H	GENERAL SUPPORT D	DEPOT	(5) TOOLS AND EQUIPMENT REF CODE	(6) REMARKS
		C		O	F	H	D	CODE	CODE	
7448	*Bowl and Discharge Components (Con't)*									
	Cutting Edges	Inspect		0.2						
		Replace			2.0				1	
	Router Bits	Inspect		0.2						
		Replace			1.0				1	

Section III TOOL AND TEST EQUIPMENT REQUIREMENTS

(1) TOOL OR TEST EQUIPMENT REF CODE	(2) MAINTENANCE CATEGORY	(3) NOMENCLATURE	(3) NATIONAL/ NATO STOCK NUMBER	(4) TOOL NUMBER	(5) FSCM
1	O	Tool Kit, Auto Mechanics SC5180-90-CL-N26	5180-00-177-7033	#W33004	50980
2	O, F	Tool Kit, Master Mechanics SC51 80-90-CL-N05	5180-00-699-5273	#W45060	50980
3	O	Shop Equipment, Automotive4 Maintenance and Repair, Common #1 Less Power SC49 1 0-95-CL-A74	910-00-754-0654	#W32593	19204
4	O	Shop Equipment, Automotive Maintenance and Repair, Common #2 Less Power SC49 1 0-95-CL-A72	4910-00-754-0650	#W32730	19204
5	F	Shop Sets, Welding SC3470-95-CL-A08		#T16714	19204
6	F, H	Shop Equipment, General Purpose Repair, Semi-Trailer Mounted SC4940-95-CL-B02	4940-00-287-4894	#T10549	19204
7	F	Pin, Timing		3P1544	11083
8	F, H	Test Set, Diesel Injector: SC4910-IL	4910-00-317-8265	#V73742	19207
9	F	Wrench, Injector Pump	5120-01-124-1773	8S2243	11083
10	F	Extractor, Injector	5120-00-178-1267	8S2244	11083
11	H	Distorter, Wear Sleeve	5120-01-119-1748	5P7312	11083
12	H	Ring, Distorter, Rear		5P7338	11083

SECTION IV. REMARKS

(1) REFERENCE CODE	(2) REMARKS
A	Inspect by checking lubricating oil level, and checking for leaks.
B	Test includes operation and compression.
C	Service by changing engine oil.
D	Complete engine gasket kit is available.
E	Valve mechanism adjustment consists of measuring clearance between rocker arm and valve turning adjustment screw. This procedure also indicates how to locate top dead center for no. 1 piston.
F	Includes the removal of the suction ball.
G	Return to depot maintenance when unserviceable economically repairable.
H	Service by cleaning.
I	Test nozzle prior to disassembly to determine if nozzle can be reused.
J	Fuel injection pump timing checks can be performed on or off engine.
K	Inspect by checking coolant level and by checking for leaks.
L	Setting high and low idle.
M	Water pump overhaul kit is available.
N	Alternator repair kits are available.
O	Starter motor repair kits are available.
P	Inspect by checking transmission fluid level, and checking for leaks.
Q	Service by cleaning screen.
R	Battery maintenance instructions are provided in TM 9-6140-200-14.
S	Master cylinder repair kits are available.
T	Horn repair kit is available.

USER MAINTENANCE SUPPORT PLAN

MAINTENANCE AND OPERATING SUPPLY LIST

NOMENCLATURE:	MAKE:	MODEL:
Scraper, Tractor, Elevating, Self-Propelled	Caterpillar Tractor Company	613BSNS/613BSS

MFR PART NO.:	NSN:	SERIAL NO. RANGE:	DATE
613BSNS: 5R5488 613BSS: 5R5489	613BSNS: 3805-01-267-2992 613BSS: 3805-01-144-8837		March 1984

(1) COMPONENT APPLICATION	(2) MFR PART NO OR NAT'L STOCK NO.	(3) DESCRIPTION	(4) QTY REQ F/INITIAL OPN	(5) QTY REQ F/8 HRS OPN	(6) NOTES
ENGINE		OIL, LUBRICATING (MIL-L-2104C)			
	9150-00-188-9858	OE/HDO 30	3.0 GAL	AR	Above +15°F (Above -9°C)
	9150-00-186-6668	OE/HDO 10	3.0 GAL	AR	+40°to-15°F (+4° to -26°C)
	9150-00-402-2372 (MIL-L-46167)	OEA (ARCTIC)	3.0 GAL	AR	+40° to -65°F (+4° to -54°C)
FUEL, SYSTEM	DIESEL FUEL OIL				
	9140-00-286-5296	DIESEL DF-2 (2)	65 GAL	(1)39GAL	(1) 4.9 GAL/HR @ MED LOAD FAC
	9140-00-286-5286	DIESELI DF-I (3)	65 GAL	39 GAL	(2) REGULAR GRADE.
	9140-00-286-5282	DIESEL, DF-A (4)	65 GAL	39 GAL	(3) WINTER GRADE (4) ARCTIC GRADE
COOLING SYSTEM		COOLANT ANTIFREEZE (5) (MIL-A-46153)			(5) FOR PROTECTION AGAINST FREEZING IN AMBIENT TEMPERA-TURE AS LOW AS -55°F.WHEN DILUTED TO **60%** BY VOLUME WITH WATER.
	6850-00-181-7933	AFC	10 GAL	AR	
TRANSMISSION		OIL, LUBRICATING			
	9150-00-188-9858	OE/HDO 30	6.5 GAL	AR	Above +15°F (Above -9°C)
	9150-00-186-6668	OE/HDO 10	6.5 GAL	AR	+40° to -15°F (+40 to -26°C)
	9150-00-402-2372	OEA (ARCTIC)	6.5 GAL	AR	+40° to -65°F (+4 to -54°C)

USER MAINTENANCE SUPPORT PLAN

MAINTENANCE AND OPERATING SUPPLY LIST

(1) COMPONENT APPLICATION	(2) MFR PART NO OR NAT'L STOCK NO.	(3) DESCRIPTION	(4) QTY REQ F/INITIAL OPN	(5) QTY REQ F/8 HRS OPN	(6) NOTES
SPEED REDUCER, DIFFERENTIALS AND FINAL DRIVES		LUBRICANT, MULTIPURPOSE GEAR			(6) SPEED REDUCER - 1 GAL DIFFERENTIAI - 5 GAL FINAL DRIVES (EA) - 1.5 GAL
	9150-01-035-53	GO 80/90 (6) 1 QT CAN	9.0 GAL	AR	
	9150-01-035-5393	.5 GAL CAN			
	9150-01-035-5394	55 GAL DRUM			
HYDRAULIC SYSTEM		OIL, LUBRICATING			
	9150-00-191-2772	OE/HDO 10	24 GAL	AR	
LUBE POINTS		GREASE, AUTOMOTIVE GAA, (MIIL-G-10924C)			
	9150-00-190-0904	1 LB CAN			
	9150-00-190-0905	5 LB CAN			
	9150-00-190-0907	35 LB CAN			
CLEANING	7920-00-148-9666	RAGS, WIPING OIL 50 LB BALE	1	1	USE AS REQUIRED
		SOLVENT, DRY CLEANING SD-2 (P-D680)			
	6850-00-664-5685	1 QT CAN			
	6850-00-281-1985	I GAL CAN			
	6850-00-264-9038	5 GAL DRUM			
	6850-00-285-8012	55 GAL DRUM			

USER MAINTENANCE SUPPORT PLAN

MAINTENANCE AND OPERATING SUPPLY LIST

(1) COMPONENT APPLICATION	(2) MFR PART NO OR NAT'L STOCK NO.	(3) DESCRIPTION	(4) QTY REQ F/INITIAL OPN	(5) QTY REQ F/8 HRS OPN	(6) NOTES
BRAKES		BRAKE FLUID SILICONE BFS (MIL-B-46176)			
	9150-01-102-9455	1 GAL		AR	
	9150-01-123-3152	5 GAL		AR	
	7690-01-111-2265	DECAL FOR MASTER CYLINDER Part Number 12302516 (19207)		1 EA	Reference: TB43-0002-87
AIR COMPRESSOR		OIL LUBRICATING (MIL-L-2104C)			
		OE/HDO 30	0.5 QTS	AR	Above +15°F (Above -9°C)
		OE/HDO 10	0.5 QTS	AR	+40° to -15° F (+4° to 26°C)
		OEA (ARCTIC) (MIL-L-46167)	0.5 QTS	AR	+40° to -65°F (+4° to -54°C)

UNIT PREVENTIVE MAINTENANCE CHECKS AND SERVICES (PMCS)

General

To make sure that your equipment is ready for operation at all times, inspect it systematically so you can discover any defects and have them corrected before they result in serious damage or failure. The charts on the next few pages contain your unit PMCS. The item numbers indicate the sequence of minimum inspection requirements. If you're operating the equipment and notice something wrong which could damage the equipment if you continue operation, stop operation immediately.

Record all deficiencies and shortcomings, along with the corrective action taken, on DA Form 2404. The Item Number column is the source for the numbers used on the TM Number column on DA Form 2404.

Unit Preventive Maintenance Checks and Services

1. The item numbers of the table indicate the sequence of the PMCS. Perform at the intervals shown below:

   a. Do your QUARTERLY (Q) preventive maintenance every three months.

   b. Do your SEMIANNUALLY (S) preventive maintenance every six months.

   c. Do your ANNUALLY (A) preventive maintenance once every year.

   d. Do your BIENNIALLY (B) preventive maintenance once every two years.

   e. Do your HOURLY (H) preventive maintenance at the hour interval listed.

   f. Do your MILE (MI) preventive maintenance at the mile interval listed.

2. If something doesn't work, troubleshoot it according to the instructions in this manual or notify your supervisor.

3. Always do your preventive maintenance in the same order so it gets to be a habit. Once you've had some practice, you'll spot anything wrong in a hurry.

WARNING

• Dry cleaning solvent P-D-680 is toxic and flammable. Always wear protective goggles and gloves, and use only in a well-ventilated area. Avoid contact with skin, eyes, and clothes, and DO NOT breathe vapors. DO NOT use near open flame or excessive heat. The solvent's flash point is 1000F-138°F (38°C-59°C). If you become dizzy while using cleaning solvent, immediately get fresh air and medical help. If solvent contacts eyes, immediately wash your eyes with water and get medical aid.

• Compressed air used for cleaning purposes will not exceed 30 psi. Use only with effective chip guarding and personnel protective equipment (goggles/ shield/gloves, etc.).

4. If anything looks wrong and you can't fix it, write it down on your DA Form 2404. If you find some- thing seriously wrong, report it to direct support maintenance RIGHT NOW.

5. When you do your preventive maintenance, take along the tools you need to make all the checks. You always need a rag or two.

   a. **Keep it clean.** Dirt, grease, oil and debris only get in the way and may cover up a serious problem. Clean as you work and as needed. Use dry cleaning solvent (P-D-680) on all metal surfaces. Use soap and water when you clean rubber or plastic material.

   b. **Bolts, nuts and screws.** Check them all for obvious looseness, missing, bent or broken condition. You can't try them all with a tool, of course, but look for chipped paint, bare metal, or rust around bolt heads. Tighten any bolt, nut, or screw that you find loose.

c. **Welds.** Look for loose or chipped paint, rust, or gaps where parts are welded together. If you find a bad weld, report it to direct support.

d. **Electric wires and connectors.** Look for cracked or broken insulation, bare wires, and loose or broken connectors. Tighten loose connections and make sure the wires are in good shape.

e. **Hoses and fluid lines.** Look for wear, damage, and leaks, and make sure clamps and fittings are tight. Wet spots show leaks, of course. But a stain around a fitting or connector can also mean a leak. If a leak comes from a loose fitting or connector, tighten the fitting or connector. If something is broken or worn out, either correct it or report it to direct support (refer to the Maintenance Allocation Chart).

6. It is necessary for you to know how fluid leakage affects the status of your equipment. The following are definitions of the types/classes of leakage you need to know to be able to determine the status of your equipment. Learn and be familiar with them and REMEMBER - WHEN IN DOUBT, NOTIFY YOUR SUPERVISOR!.

LEAKAGE DEFINITIONS FOR UNIT PMCS

Class I Seepage of fluid (as indicated by wetness or discoloration) not great enough to form drops.

Class II Leakage of fluid great enough to form drops, but not enough to cause drops to drip from the item being checked/inspected.

Class III Leakage of fluid great enough to form drops that fall from the item being checked/inspected.

CAUTION

• Equipment operation is allowable with minor leakages (Class I or II). Of course, consideration must be given to the fluid capacity in the item/system being checked/inspected. When in doubt, notify your supervisor.

• When operating with Class I or II leaks, continue to check fluid levels as required in your PMCS.

• Class III leaks should be reported to your supervisor.

UNIT PREVENTIVE MAINTENANCE CHECKS AND SERVICES

Q = Quarterly S - Semiannually A - Annually B - Biennially H - Hours MI - Miles

ITEM NO	INTERVAL Q	S	A	B	H	MI	ITEM TO BE INSPECTED PROCEDURE: CHECK FOR AND HAVE REPARIED, FILLED OR ADJUSTED AS NEEDED Perform All Operator PMCS First
							Perform Operator/Crew PMCS prior to or in conjunction with unit PMCS if: 1. There is a delay between the daily operation of equipment and the unit PMCS. 2. Regular operator is not assisting/participating. **NOTE** • For Army Oil Analysis Program (AOAP), refer to TB 43-0210. The AOAP laboratory recommendation to change oil and filter will apply; however, oil and filter changes will not exceed the change interval (calendar, miles, or hours) established by the manufacturer during the warranty period. • The AOAP sampling interval for the hydraulic system is scheduled to be published in the next change to TB 43-0210, Appendix F.
1					250		TIRES **WARNING** • Explosions of air inflated earthmoving tires have resulted from heat induced gas combustion inside the tires. The heat generated by welding or heating rim components, external fire, or excessive use of brakes can cause gaseous combustion. A tire explosion is much more violent than a blowout. The explosion can propel the tire rim and final drive components as far as 460 meters (1500 feet) or more from the machine. Both the force of the explosion and the flying debris can cause personal injury or death and property damage. All personnel should be aware of this danger and the actions to take to minimize the risk. • Proper air inflation equipment and training in its use are necessary to avoid possible over-inflation. A tire blowout or rim failure can result from improper or misused equipment. Check and service (see TM 5-3805-260-10 and TM 9-2610-200-24). Proper inflation pressure is 40 psi for the tractor and the scraper.

UNIT PREVENTIVE MAINTENANCE CHECKS AND SERVICES

Q = Quarterly **S - Semiannually** **A - Annually** **B - Biennially** **H - Hours** **MI - Miles**

ITEM NO	INTERVAL						ITEM TO BE INSPECTED PROCEDURE: CHECK FOR AND HAVE REPARIED, FILLED OR ADJUSTED AS NEEDED Perform All Operator PMCS First
	Q	S	A	B	H	MI	
2					250		**FAN ASSEMBLY** Check and adjust fan/alternator belts (see page 1-21). Apply a 25 lb force midway on the belt. Deflection should b3 9/16 to 13/16 inch (14 to 20 mm).
3					250		**BATTERIES** **WARNING** Never disconnect any charging unit circuit or battery cable from battery when the charging unit is being operated. A spark can cause an explosion from the flammable vapor mixture of hydrogen and oxygen that is released from the electrolyte through the battery outlets. Injury to personnel may result. Check and perfrom battery maintenance (see TM 5-3805-260-10 and TM 9-6140-200-14).
4					250		**HEADLAMPS, TAILLAMPS, BLACKOUT LIGHTS, FLOODLIGHTS** Inspect for operation.
5					250		**HYDRAULIC CONTROL VALVES** Inspect valves and linkages. Look for bent levers and control arms and worn bushings.
96					250		**CARRIER ROLLERS** Adjust and service.

A

UNIT PREVENTIVE MAINTENANCE CHECKS AND SERVICES

Q = Quarterly **S - Semiannually** **A - Annually** **B - Biennially** **H - Hours** **MI - Miles**

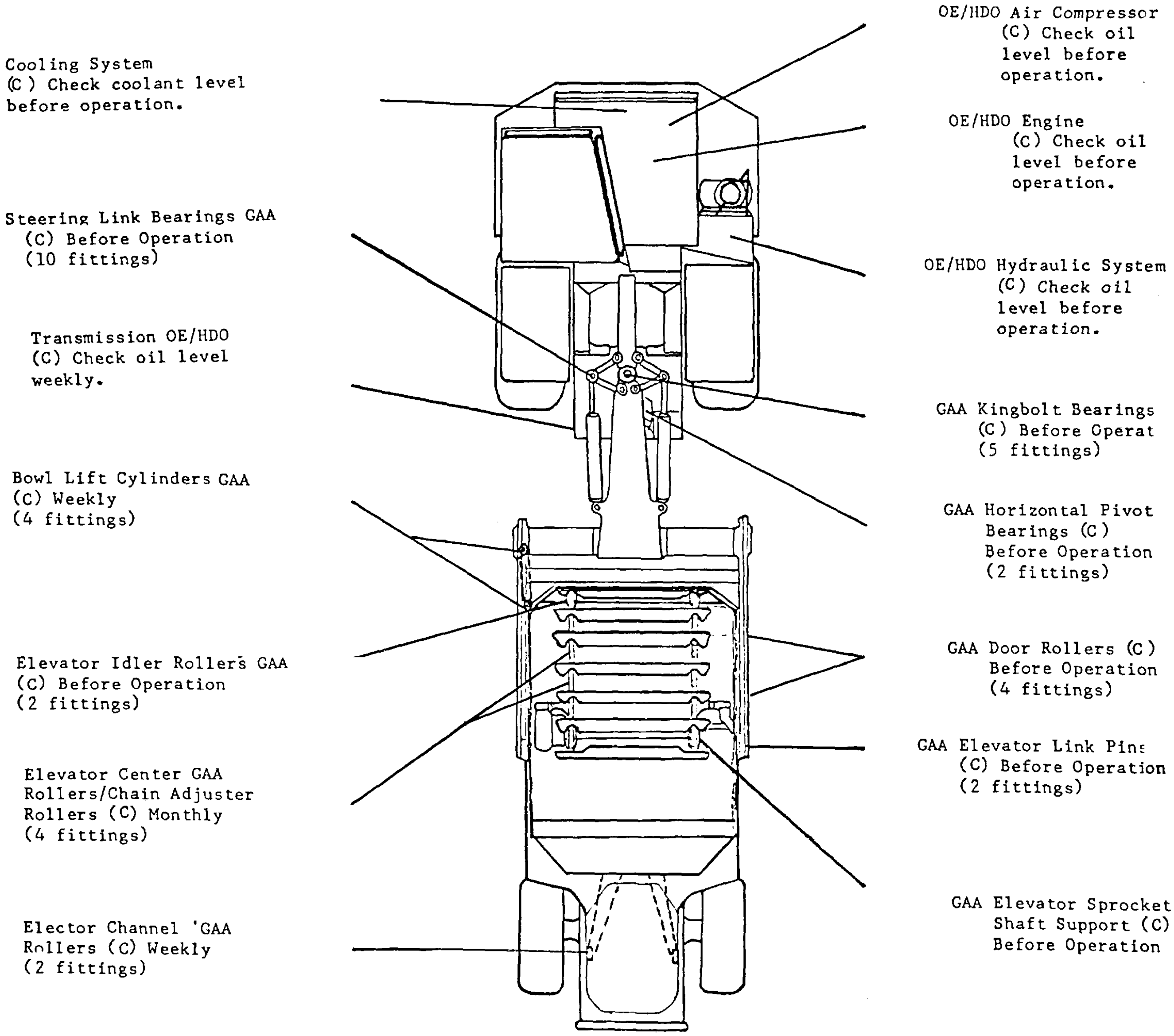
ITEM NO	INTERVAL Q	S	A	B	H	MI	ITEM TO BE INSPECTED PROCEDURE: CHECK FOR AND HAVE REPARIED, FILLED OR ADJUSTED AS NEEDED Perform All Operator PMCS First
							WARNING Block the bowl and apron when performing maintenance in the bowl area. Support the cutting edges before removing the mounting bolts. Failure to follow this warning may result in serious injury to personnel.
7					**250**		**EJECTOR, DRAFT ARMS, GOOSENECK/CROSSTUBE FRAME** Check for damage or distortion.
8					**500**		**HYDRAULIC TANK** **WARNING** Hot oil can cause burns. At operating temperature, the hydraulic tank is hot and under pressure. Remove the fill cap ONLTY when the engine is stopped and the cap is cool enough to touch with your hand. Remove the fill cap slowly to relieve pressure. Inspect and service tank for leaks, broken fittings, cracked welds, or missing parts. Replenish fluid level if needed . Take oil sample (see TB 43-0210)
9					**500**		**TRANSMISSION** Take oil sample (see page 2-68 of TM 5-3805-260-10 and TB 43-0210.
10					**500**		**COOLING SYSTEM** WARNING The cooling system is pressurized. Personal injury may result when removing the radiator cap after operati9ng temperature is reached. If it becomes necessary to check the coolant level during operation, use proper protection when removing radiator cap. Check and replace thermostat or antifreeze, if required (see pages 1-20 and TB 750-651.

UNIT PREVENTIVE MAINTENANCE CHECKS AND SERVICES

Q = Quarterly **S - Semiannually** **A - Annually** **B - Biennially** **H - Hours** **MI - Miles**

ITEM NO	INTERVAL						ITEM TO BE INSPECTED PROCEDURE: CHECK FOR AND HAVE REPARIED, FILLED OR ADJUSTED AS NEEDED Perform All Operator PMCS First
	Q	S	A	B	H	MI	
11							**ENGINE OIL** Take oil sample (see page 2-68 of TM 5-3805-260-10 and TB 43-0210).
12					500		**CYLINDERS, STEERING/BOWL/APRON AND EJECTORS** Test cylinders for worn piston seals. Reference: Maintenance Manual, pages 1-56, 1-62 thru 1-64, and 2-112, 4-9, and 4-25.
13					2000		**ROPS** Check for cracks, loose nuts/bolts. Tighten and torque as required (see page 3-318 and B-8).

LUBRICATION REQUIREMENTS



By Order of the Secretary of the Army:

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General, United States Army
Chief of Staff

Official:

PATRICIA P. HICKERSON
Brigadier General, United States Army
The Adjutant General

Distribution:

To be distributed IAW DA Form 12-25-E (Block No. 5720) Unit, Direct Support and General Support maintenance requirements for TM 5-3805-260-24.

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AIR SYSTEM

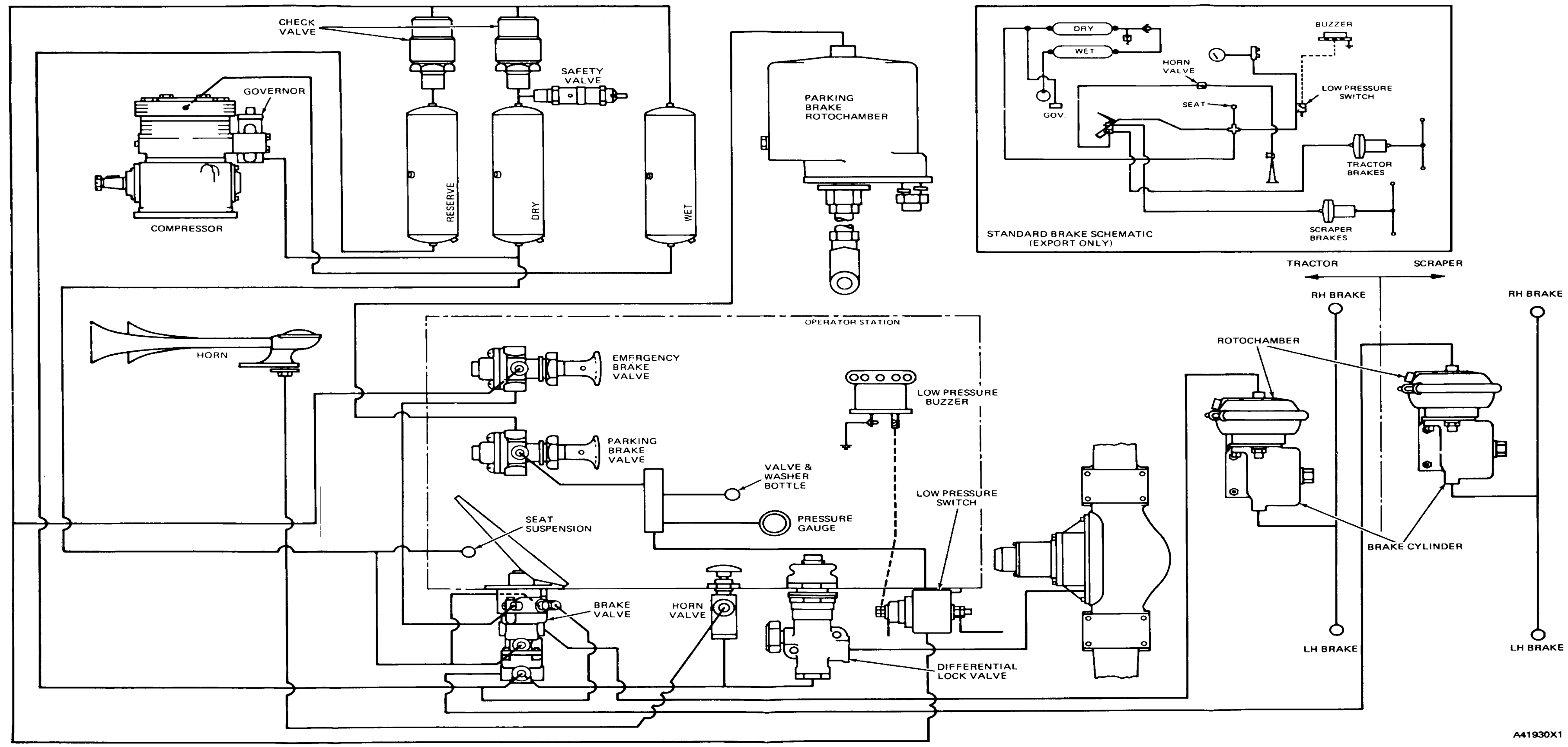


Figure FO-1

ELECTRICAL SYSTEM

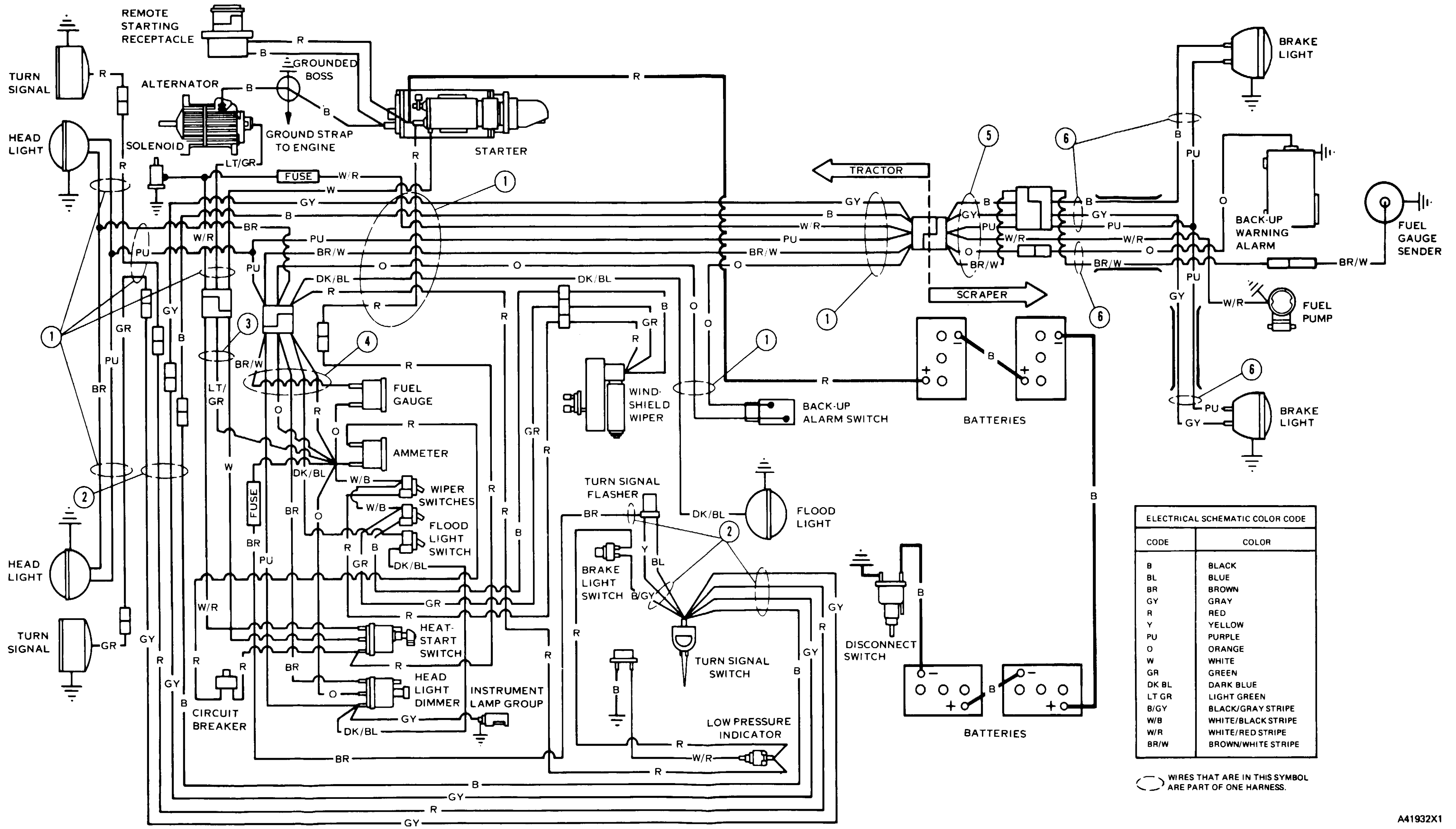


Figure FO-2.

HYDRAULIC SYSTEM

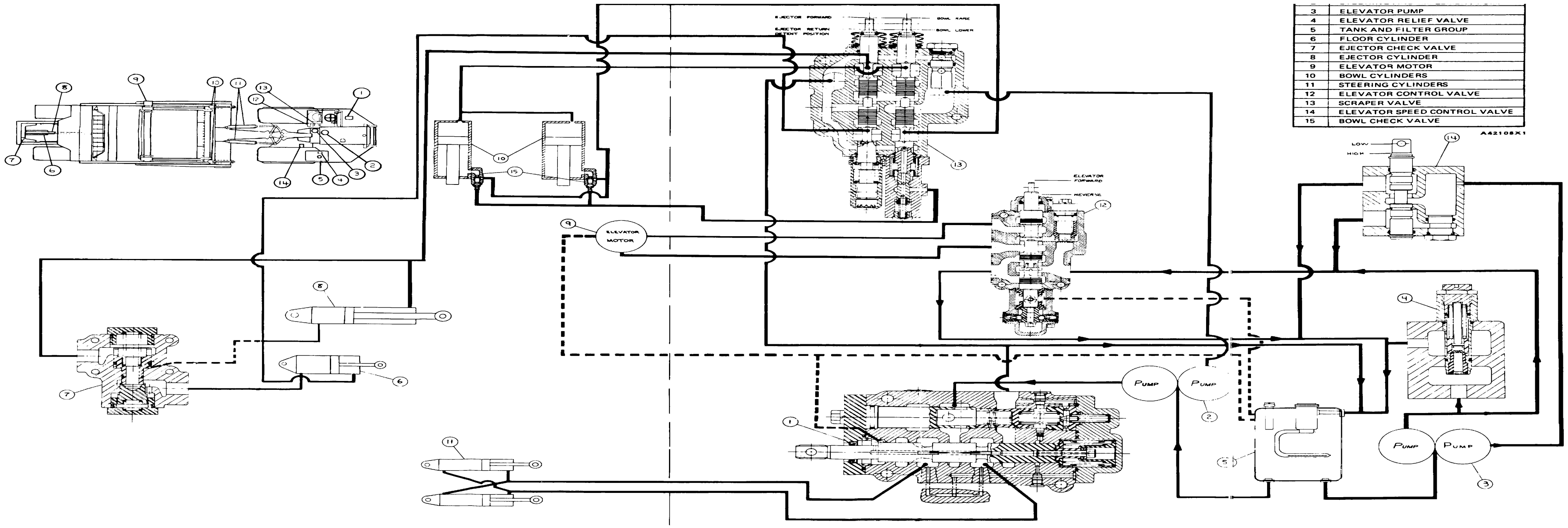


Figure FO-3.

BLACKOUT LIGHTING (MODELS 613BSS1 & 613BSNS1)

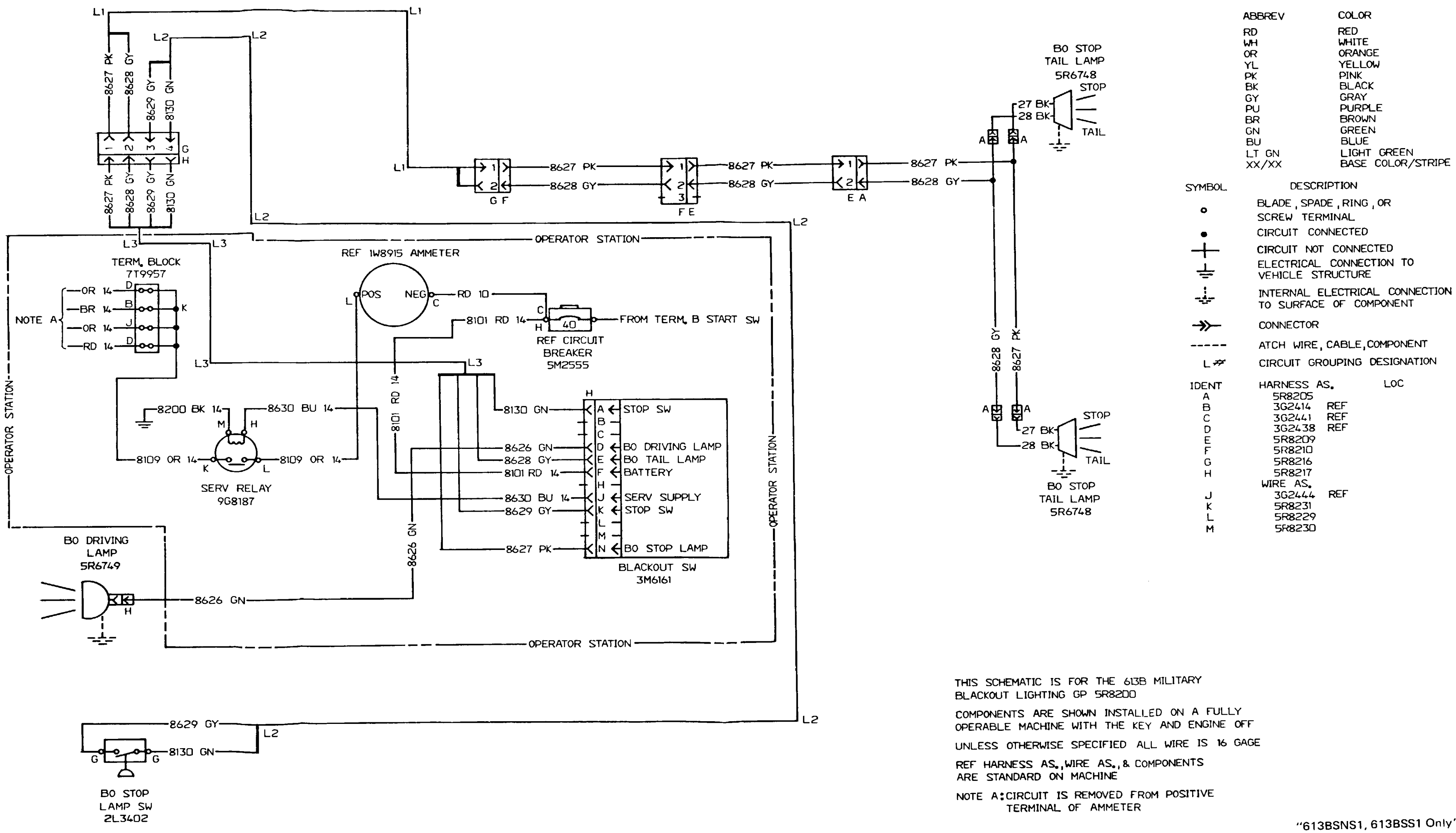


Figure FO-4.

AIR SYSTEM AND BRAKES

TRACTOR-SCRAPER SCHEMATIC

1. Air compressor.
2. Air compressor governor.
3. Reserve tank.
4. Check valve.
5. Relief valve.
6. Dry tank.
7. Wet tank.
8. Rotochamber for parking brake.
9. Tractor air chamber and master cylinder.
10. Right tractor brake.
11. Residual pressure valve. (check valve).
12. Quick release valve.
13. Scraper air chamber and master cylinder.
14. Right scraper brake.
15. Left tractor brake.
16. Air pressure gauge.
17. Junction block.
18. Control valve for window washer.
19. Reservoir for window washer.
20. Warning buzzer.
21. Control valve for seat suspension.
22. Shock absorber for seat.
23. Emergency pilot valve.
24. Horn.
25. Control valve for horn.
26. Differential lock valve.
27. Double check valve.
28. Brake control valve.
29. Low air pressure indicator.
30. Control valve for emergency brakes.
31. Control valve for parking brake.
32. Residual pressure valve (check valve).
33. Left scraper brake.
34. Air Dryer (613BSNS1, 613BSS1)

613BSNS, 613BSS

613BSNS1, 613BSS1

All Models

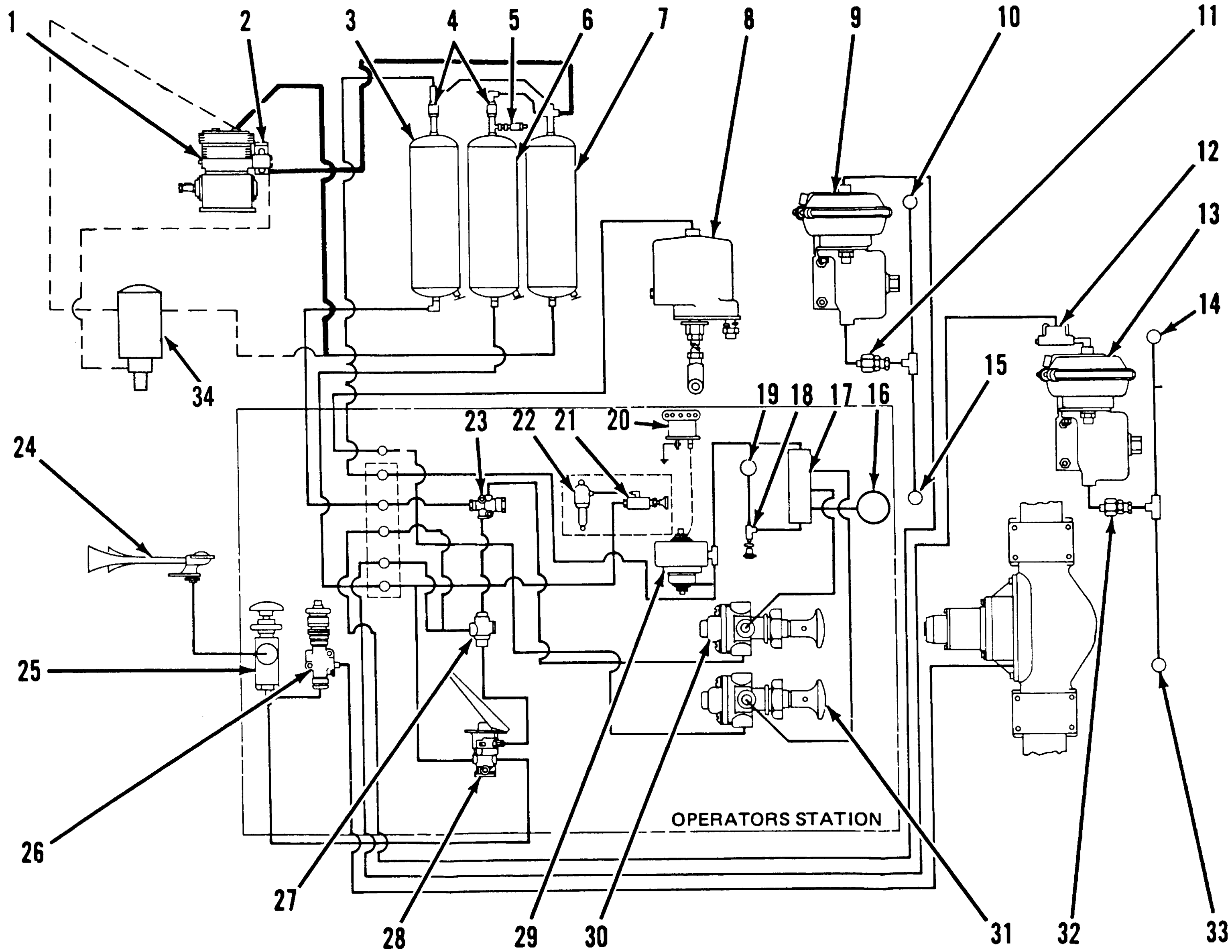
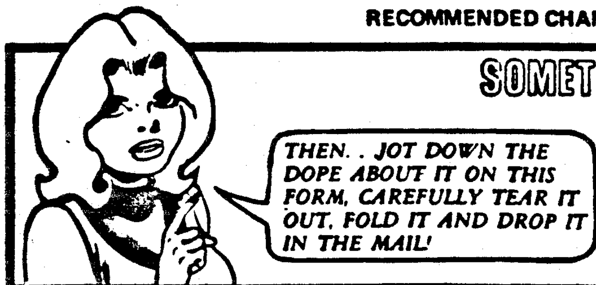


Figure FO-5.

TEAR ALONG PERFORATED LINE

RECOMMENDED CHANGES TO EQUIPMENT TECHNICAL PUBLICATIONS



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TM 11-5825-270-10	23 Jul 81	Radio Frequency R-2176/FRN

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THE METRIC SYSTEM AND EQUIVALENTS

LINEAR MEASURE

1 Centimeter = 10 Millimeters = 0.01 Meters = 0.3937 Inches

1 Meter = 100 Centimeters = 1,000 Millimeters = 39.37 Inches

1 Kilometer = 1,000 Meters = 0.621 Miles

SQUARE MEASURE

1 Sq Centimeter = 100 Sq Millimeters = 0.155 Sq Inches

1 Sq Meter = 10,000 Sq Centimeters = 10.76 Sq Feet

1 Sq Kilometer = 1,000,000 Sq Meters = 0.386 Sq Miles

CUBIC MEASURE

1 Cu Centimeter = 1,000 Cu Millimeters = 0.06 Cu Inches

1 Cu Meter = 1,000,000 Cu Centimeters = 35.31 Cu Feet

LIQUID MEASURE

1 Milliliter = 0.001 Liters = 0.0338 Fluid Ounces

1 Liter = 1,000 Milliliters = 33.82 Fluid Ounces

TEMPERATURE

5/9 (°F -32) = °C

212° Fahrenheit is equivalent to 100° Celsius

90° Fahrenheit is equivalent to 32.2° Celsius

32° Fahrenheit is equivalent to 0° Celsius

9/5 C° +32 = F°

WEIGHTS

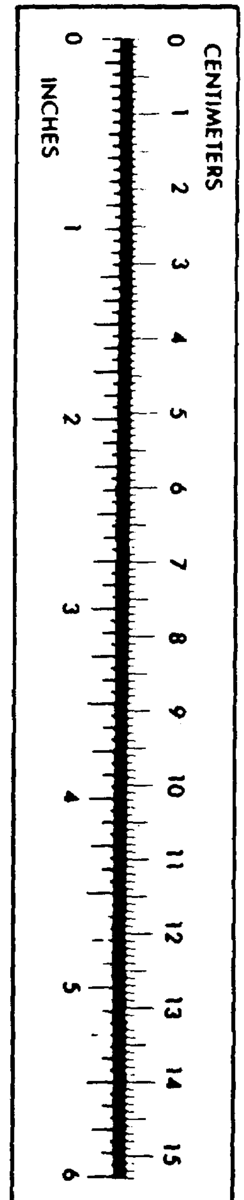
1 Gram = 0.001 Kilograms = 1,000 Milligrams = 0.035 Ounces

1 Kilogram = 1,000 Grams = 2.2 Lb.

1 Metric Ton = 1,000 Kilograms = 1 Megagram = 1.1 Short Tons

APPROXIMATE CONVERSION FACTORS

TO CHANGE	TO	MULTIPLY BY
Inches	Centimeters	2.540
Feet	Meters	0.305
Yards	Meters	0.914
Miles	Kilometers	1.609
Square Inches	Square Centimeters	6.451
Square Feet	Square Meters	0.093
Square Yards	Square Meters	0.836
Square Miles	Square Kilometers	2.590
Acres	Square Hectometers	0.405
Cubic Feet	Cubic Meters	0.028
Cubic Yards	Cubic Meters	0.765
Fluid Ounces	Milliliters	29.573
Pints	Liters	0.473
Quarts	Liters	0.946
Gallons	Liters	3.785
Ounces	Grams	28.349
Pounds	Kilograms	0.454
Short Tons	Metric Tons	0.907
Pound-Feet	Newton-Meters	1.356
Pounds Per Square Inch	Kilopascals	6.895
Miles Per Gallon	Kilometers Per Liter	0.425
Miles Per Hour	Kilometers Per Hour	1.609
TO CHANGE	**TO**	**MULTIPLY BY**
Centimeters	Inches	0.394
Meters	Feet	3.280
Meters	Yards	1.094
Kilometers	Miles	0.621
Square Centimeters	Square Inches	0.155
Square Meters	Square Feet	10.764
Square Meters	Square Yards	1.196
Square Kilometers	Square Miles	0.386
Square Hectometers	Acres	2.471
Cubic Meters	Cubic Feet	35.315
Cubic Meters	Cubic Yards	1.308
Milliliters	Fluid Ounces	0.034
Liters	Pints	2.113
Liters	Quarts	1.057
Liters	Gallons	0.264
Grams	Ounces	0.035
Kilograms	Pounds	2.205
Metric Tons	Short Tons	1.102
Newton-Meters	Pound-Feet	0.738
Kilopascals	Pounds Per Square Inch	0.145
Kilometers Per Liter	Miles Per Gallon	2.354
Kilometers Per Hour	Miles Per Hour	0.621



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