DEPARTMENT OF THE ARMY TECHNICAL MANUAL

OPERATOR'S, ORGANIZATIONAL

DS, GS AND DEPOT MAINTENANCE MANUAL

TRUCK; FORK LIFT

GASOLINE ENGINE DRIVEN

SOLID RUBBER TIRES, 4,000 LB CAPACITY

(HYSTER MODEL S40CP)

(ARMY MODEL MHE 203)

FSN 3930-935-7866 (100 IN)

FSN 3930-935-7865 (180 IN)

HEADQUARTERS, DEPARTMENT OF THE ARMY
9 SEPTEMBER 1969

This manual is published for the use of all concerned.

By Order of the Secretary of the Army:

W. C. WESTMORELAND,
General, United States Army,
Chief of Staff.

Official:
KENNETH G. WICKHAM
Major General, United States Army,
The Adjutant General.

Distribution:
To be distributed in accordance with DA Form 12-25, Section 1, (qty rqr block No. 194) organizational maintenance requirements for Trucks, Fork Lift, Gasoline.

CHANGE

NO. 4

HEADQUARTERS
DEPARTMENT OF THE ARMY
Washington D.C., 13 December 1990

OPERATOR'S ORGANIZATIONAL DS, GS AND DEPOT MAINTENANCE MANUAL

TRUCK; FORK LIFT GASOLINE ENGINE DRIVEN

SOLID RUBBER TIRES, 4,000 LB CAPACITY

(HYSTER MODEL S40CP)

(ARMY MODEL MHE 203)

NSN 3930-00-935-7866 (100 IN)

NSN 3930-00-935-7865 (180 IN)

TM 10-3930-607-15, September 1969 is changed as follows:
Page 2-1: APPENDIX 2, MAINTENANCE ALLOCATION CHART is superseded as follows:

APPENDIX 2.
MAINTENANCE ALLOCATION CHART
Section I. INTRODUCTION

2-1. General.

a. This section provides a general explanation of all maintenance and repair functions authorized at various maintenance categories.

b. 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 categories.

c. 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.

d. Section IV contains supplemental instructions and explanatory notes for a particular maintenance function.

2-2. Maintenance Functions. Maintenance functions will be limited to and defined as follows:

a. *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).

b. *Test.* To verify serviceability by measuring the mechanical, pneumatic, hydraulic, or electrical characteristics of an item and comparing those characteristics with prescribed standards.

c. *Service.* Operations required periodically to keep an item in proper operating condition, i.e., to clean (including decontaminate, when required). to preserve, to drain, to paint, or to replenish fuel, lubricants, chemical fluids, or gases.

d. *Adjust*. To maintain or regulate, within prescribed limits, by bringing into proper or exact position, or by setting the operating characteristics to specified parameters.

e. *Aline.* To adjust specified variable elements of an item to bring about optimum or desired performance.

f. 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.

g. *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 a space, repair part, or module (component or assembly) in a manner to allow the proper functioning of an equipment or system.

h. *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.

i. *Repair.* The application of maintenance service', including fault location/troubleshooting2, removal/installation, disassembly/assembly3 procedures, and maintenance actions4 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.

j. *Overhaul*. That maintenance effort (service/action) prescribed to restore an item to a completely serviceable/operational condition as required by maintenance standards in appropriate technical publication (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.

k. *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.

2-3. Explanation of Columns in the MAC Section II

a. *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".

b. *Column 2,* Component/Assembly. Column 2 contains the names of components, assemblies, subassemblies, and modules for which maintenance is authorized.

c. *Column 3, Maintenance Function*. Column 3 lists the function to be performed on the item listed in Column 2. (For detailed explanation of these functions, see paragraph 2-2).

d. *Column 4, Maintenance Category.* Column 4 specifies, by the listing of a work time figure in the appropriate subcolumns, the category 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 category of maintenance. If the number or complexity of the task within the listed maintenance function vary at different maintenance categories, appropriate worktime figures will be shown for each category. The worktime 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 specific tasks identified for the maintenance functions authorized in the mainte

---

[1]Service - inspect, test, service, adjust, aline, calibrate, and/or replace.

[2]Fault locating/troubleshooting - The process of investigating and detecting the cause of equipment malfunctioning; the act of isolating a fault within a system or unit under test (UUT).

[3] Disassembly/assembly - encompasses the step-by-step taking apart (or breakdown) of a spare/functional group coded item to the level of its least componency identified as maintenance significant (i.e., assigned an SMR code) for the category of maintenance under consideration.

[4]Action - welding, grinding, riveting, straightening, facing, remachining, and/or resurfacing.

nance allocation chart, The symbol designations for the various maintenance categories are as follows:

C - Operator or Crew
O - Organizational Maintenance
F - Direct Support Maintenance
H - General Support Maintenance
D - Depot Maintenance

e. *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.

f. *Column 6, Remarks.* This column shall, when applicable, contain a letter code, in alphabetical order, which shall be keyed to the remarks contained in Section IQ.

24. Explanation of Columns in Tool and Test Equipment Requirements, Section III

a. *Column 1, Reference Code*. The tool and test equipment reference code correlates with a code used in the MAC, Sec tion II, Column 5.

b. *Column 2, Maintenance Category.* The lowest category of maintenance authorized to use the tool or test equipment.

c. *Colunm 3, Nomenclature.* Name or identification of the tool or test equipment.

d. *Column 4, National Stock Number.* The National stock number of the tool or test equipment.

e. *Column 5, Tool Number.* The manufacturer's part number.

2-5. Explanation of Columns in Remarks, Section IV

a. *Column 1, Reference Code.* The code recorded in column 6, Section II.

b. *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) Maint. Function	(4) MAINTENANCE LEVEL Unit C	Unit O	Direct Support F	General Support H	Depot D	(5) Tools and Equipment	(6) Remarks
01	ENGINE								
0100	Engine Assembly	Inspect		0.1					
		Test		1.0					
		Service	0.4						
		Adjust		1.0					
		Replace			8.0				
		Repair				6.0			
		Overhaul				28.0			
0101	Crankcase, Block, Cylinder Head								
	Crankcase	Replace				2.5			
	Cylinder Head	Replace			1.5				
0102	Crankshaft	Replace				12.0			
	Repair					5.0			
0103	Flywheel Assy.	Replace		1.0					
	Repair				1.0				
0104	Pistons,								
	Connecting, Rods	Replace			4.0				
		Repair			2.0				
0105	Valves,Camshafts and Timing System								
	Valves,								
	Timing Gears	Adjust		1.0					
		Replace			5.0				
	Camshaft	Replace				5.0			

Maintenance Allocation Chart - Continued

(1) Group Number	(2) Component/ Assembly	(3) Maint. Function	(4) MAINTENANCE LEVEL Unit C	Unit O	Direct Support F	General Support H	Depot D	(5) Tools and Equipment	(6) Remarks
01	ENGINE - CONTINUED								
0106	Engine Lubrication System								
	Filter, Fluid, Pressure	Service		0.1					
		Replace		0.2					
	Body, Oil Pump	Test		0.5					
		Replace			1.0				
	Oil Pan	Replace			1.0				
	Air Cleaner, Element	Service		0.1					
		Replace		0.2					
0108	Manifolds								
	Manifold, Intake	Replace		1.0					
03	FUEL SYSTEM								
0301	Carburetor, Fuel Injector								
	Carburetor, Float	Adjust		0.5					
		Replace		1.0					
		Repair			2.0				
0302	Fuel Pumps	Test		0.3					
		Replace		0.5					
0304	Air Cleaner	Service		0.2					
		Replace		0.2					
0306	Tanks, Lines, Fittings, Headers								
	Tank, Fuel	Service	0.1						
		Replace			0.4				
0308	Engine Speed Governor and Controls								
	Governor, Gasoline	Adjust		0.2					
		Replace		0.5					

Maintenance Allocation Chart - Continued

(1) Group Number	(2) Component/ Assembly	(3) Maint. Function	(4) MAINTENANCE LEVEL Unit C	Unit O	Direct Support F	General Support H	Depot D	(5) Tools and Equipment	(6) Remarks
03	FUEL SYSTEM - CONTINUED								
0300	Fuel Filters								
	Filter Assembly, Fuel	Service		0.1					
		Replace		0.4					
0312	Accelerator, Throttle or Choke Controls								
	Pedal Control, Throttle	Adjust		0.6					
		Replace		0.8					
04	EXHAUST SYSTEM								
0401	Muffler and Pipes	Replace		1.0					
05	COOLING SYSTEM								
0501	Radiator	Test		0.2					
		Service	0.2						
		Replace		1.0					
		Repair				2.0			
0503	Water Manifold Headers, Thermostats and Housing Gasket								
	Thermostat	Test		0.5					
		Replace			0.5				
0504	Water Pump	Replace		1.0					
0505	Fan Assembly								
	Belt, V, Water Pump	Adjust		0.2					
	Pulley	Replace		0.5					

Maintenance Allocation Chart - Continued

(1) Group Number	(2) Component/ Assembly	(3) Maint. Function	(4) MAINTENANCE LEVEL Unit C	Unit O	Direct Support F	General Support H	Depot D	(5) Tools and Equipment	(6) Remarks
06	ELECTRICAL SYSTEM								
0601	Generator, Alternator								
	Generator, Engine AC	Test		0.5					
		Replace		0.5					
		Repair			2.0				
0602	Alternator Regulator	Test		0.3					
		Replace		0.3					
0603	Cranking Motor	Test		0.5					
		Replace		0.6					
		Repair			1.5				
0605	Ignition Components Distributor Assy.	Adjust		0.3					
		Replace		0.5					
		Repair			1.0				
0607	Instrument Panel or Engine Control Panel Panel, Instrument	Replace	1.0						
0609	Lights Headlight	Replace		0.4					
	Stoplight	Replace		0.4					
0610	Sending Units and Warning Switches Fuel, Oil, and Brake	Replace		0.4					
0611	Horn, Siren Horn, Electrical	Test	0.1						
		Replace		0.5					

Maintenance Allocation Chart - Continued

(1) Group Number	(2) Component/ Assembly	(3) Maint. Function	(4) MAINTENANCE LEVEL Unit C	Unit O	Direct Support F	General Support H	Depot D	(5) Tools and Equipment	(6) Remarks
06	ELECTRICAL SYSTEM - CONTINUED								
06121	Batteries, Storage (Wet or Dry)	Test		0.1					
		Service	0.3						
		Replace		0.3					
0613	Hull or Chassis Wiring Harness	Replace			3.0				
		Repair			0.5				
07	TRANSMISSION								
0705	Transmission Shifting Components Inching Controls	Replace							
0708	Torque Converter or Fluid Coupling Torque Converter	Replace			0.5				
0710	Transmission Assy.	Test			2.0				
		Service	1.2						
		Replace			8.0				
		Repair				14.0			
		Overhaul				12.0			
0713	Intermediate Clutch	Replace				4.0			
		Repair				6.0			
0714	Servo Unit Transmission Valve	Replace			1.0				
		Repair			1.0				
0721	Coolers, Pumps. Motors Filter. Fluid, Pressure	Service		0.1					
		Replace		0.2					
		Repair		0.2					

Maintenance Allocation Chart - Continued

(1) Group Number	(2) Component/ Assembly	(3) Maint. Function	(4) MAINTENANCE LEVEL Unit C	Unit O	Direct Support F	General Support H	Depot D	(5) Tools and Equipment	(6) Remarks
07	TRANSMISSION - CONTINUED								
0721	Coolers, Pumps Motors, Continued								
	Transmission,								
	Oil Pump	Replace			1.0				
08	TRANSFER AND FINAL DRIVE ASSEMBLIES								
0801	Power Transfer and Final Drive Assy.								
	Final Drive	Replace			2.5				
10	FRONT AXLE								
1002	Differential	Service		0.3					
		Replace			3.0				
		Repair				4.0			
11	REAR AXLE								
1100	Rear Axle Assy.								
	Frame, Steering								
	Axle	Replace			2.0				
1104	Steering, Side Shift and Wheel Leaning Mechanism								
	Rear Axle Steering								
	Mechanism	Replace			2.0				
12	BRAKES								
1201	Hand Brakes								
	Lever, Hand Brake	Adjust		0.1					
		Replace		0.7					
	Brake Shoe	Replace		1.0					

Maintenance Allocation Chart - Continued

(1) Group Number	(2) Component/ Assembly	(3) Maint. Function	(4) MAINTENANCE LEVEL Unit C	Unit O	Direct Support F	General Support H	Depot D	(5) Tools and Equipment	(6) Remarks
12	BRAKES-CONTINUED								
1202	Service Brakes								
	Drive Axle Brake Assembly	Replace		1.0					
1204	Hydraulic Brake System								
	Cylinder Assy.	Replace		1.0					
	Cylinder, Master Brake	Replace		1.0					
	Tube Assembly	Replace			1.0				
		Repair			1.0				
1206	Mechanical Brake System								
	Brake Pedal and Linkage	Adjust		0.2					
		Replace			0.7				
13	WHEEL AND TRACKS								
1311	Wheel Assembly								
	Wheel, Steer, Axle	Replace				0.7			
1313	Tires, Tubes, Tire Chains								
	Tires	Inspect	0.2						
		Replace				1.7			
14	STEERING								
1401	Mechanical Steering Gear Assembly								
	Steering Gear Assy.	Service		0.3					
		Adjust			0.5				
		Replace			4.0				
		Repair				2.0			

Maintenance Allocation Chart - Continued

(1) Group Number	(2) Component/ Assembly	(3) Maint. Function	(4) MAINTENANCE LEVEL Unit C	Unit O	Direct Support F	General Support H	Depot D	(5) Tools and Equipment	(6) Remarks
14	STEERING - CONTINUED								
1401	Mechanical Steering Gear Assy., Continued								
	Shaft Assembly, Steering	Replace				4.0			
		Repair				2.0			
	Tie Rod, Steering, Drag Link Steering	Service		0.4					
		Replace		2.0					
		Repair		0.5					
15	FRAME, TOWING ATTACHMENTS, DRAWBARS AND ARTICULATION SYSTEMS								
1501	Frame Assembly	Replace				4.0			
1502	Counterweights	Replace		0.7					
18	BODY, CAB, HOOD AND HULL								
1801	Body, Cab, Hood and Hull Assys.								
	Hood and Tank Cover	Replace		1.5					
	Overhead Guard	Replace		0.7					
1805	Floors, Subfloors and Related Components								
	Floor Pans	Replace		1.0					

Maintenance Allocation Chart - Continued

(1) Group Number	(2) Component/ Assembly	(3) Maint. Function	(4) MAINTENANCE LEVEL Unit C	Unit O	Direct Support F	General Support H	Depot D	(5) Tools and Equipment	(6) Remarks
18	BODY, CAB, HOOD AND HULL - CONTINUED								
1806	Upholstery Seats and Carpets								
	Seat Assembly	Adjust	0.1						
		Replace		1.0					
		Repair		2.0					
24	HYDRAULIC AND FLUID SYSTEMS								
2401	Pump and Motor	Test			0.5				
		Replace			1.0				
		Repair			2.0				
2402	Manifold and/or Control Valve								
	Valve Assembly	Replace			1.0				
		Repair			1.0				
	Valve Relief	Adjust			0.5				
		Replace			1.0				
		Repair			1.0				
2404	Tilt Cylinders and Tilt Crank								
	Cylinder, Tilt	Adjust		0.3					
		Replace		0.5					
		Repair			1.5				
2405	Mast Column								
	Cylinder, ft	Replace			2.0				
		Repair			2.0				
	Carriage Assy.	Service		0.3					
		Replace			2.0				
		Repair			2.0				
	Fork Assembly	Replace		1.0					
		Repair		1.0					

Maintenance Allocation Chart - Continued

(1) Group Number	(2) Component/ Assembly	(3) Maint. Function	(4) MAINTENANCE LEVEL Unit C	Unit O	Direct Support F	General Support H	Depot D	(5) Tools and Equipment	(6) Remarks
24	HYDRAULIC AND FLUID SYSTEMS - CONTINUED								
2406	Strainers, Filters Lines and Fittings								
	Filter, Element, Fluid	Replace		0.3					
	Lines and Fittings	Inspect	0.1						
		Replace		0.5					
	Hose Assembly, Tilt Cylinder	Replace			2.0				
		Repair			2.0				
2408	Liquid Tanks or Reservoirs								
	Tank, Hydraulic	Replace			0.7				

Section III. TOOL AND TEST EQUIPMENT REQUIREMENTS

(1) Tool or Test Equipmemt Ref. Code	(2) Maintenance Category	(3) Nomenclature	(4) National Stock Number	(5) Tool Number
		No Special Tools or Test Equipment Required		

Section IV. REMARKS

(1) **Reference** **Code**	**(2)** **Remarks**
	Not Applicable

By Order of the Secretary of the Army:

CARL E. VUONO
General, United States Army
Chief of Staff

Official:

PATRICIA P. HICKERSON
Colonel, United States Army
The Adjutant General

Distribution:

To be distributed in accordance with DA Form 12-25-E, block 2182, Operator and Unit, Direct and General Support maintenance requirements for TM 10-3930-607-15.

☆U S GOVERNMENT PRINTING OFFICE: 1991 - 543 - 025/40033

TM 10-3930-607-15
***C 3**

CHANGE
No. 3

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, DC, 5 April 1974

Operator, Organizational, Direct Support and General Support, and Depot Maintenance Manual

TRUCK, LIFT, FORK; GASOLINE ENGINE DRIVEN; SOLID RUBBER TIRES; 4,000 lb. CAPACITY (HYSTER MODEL S40CP, ARMY MODEL MHE-203) FSN 3930-935-7866, 100-IN LIFT; FSN 3930-935-7865, 180-IN LIFT

TM 10-3930-607-15, 9 September 1969, is changed as follows:

Page i. Add the following warning to the list of safety precautions:

WARNING

Operation of this equipment presents a noise hazard to personnel in the area. The noise level exceeds the allowable limits for unprotected personnel. Wear ear muffs or ear plugs which were fitted by a trained professional.

Page 1. Add the following:

Recommendation for Maintenance Publications Improvements

You can help to improve this manual by calling attention to errors and by recommending improvements. Your letter or DA Form 2028 (Recommended Changes to Publications and Blank Forms) should be mailed direct to: Commander, US Army Troop Support Command, ATTN: AMSTS-MPP, 4300 Goodfellow Blvd., St. Louis, MO 63120. A reply will be furnished direct to you.

Page A-5. Immediately after title, add the following warning:

WARNING

Operation of this equipment presents a noise hazard to personnel in the area. The noise level exceeds the allowable limits for unprotected personnel. Wear ear muffs or ear plugs which were fitted by a trained professional. (See TB MED 251).

Page 1-1. Appendix 1 is superseded as follows:

*This change supersede C 2,1 November 1972.

APPENDIX 1
BASIC ISSUE ITEMS LIST AND ITEMS
TROOP INSTALLED OR AUTHORIZED LIST

Section I. INTRODUCTION

1. Scope

This appendix lists items required by the operator for operation of the truck.

2. General

This list is divided into the following sections:

a. *Basic Issue Items List - Section II.* Not applicable.

b. *Items Troop Installed or Authorized List -Section III.* A list of items in alphabetical sequence, which at the discretion of the unit commander may accompany the truck. These items are NOT subject to turn-in with the truck when evacuated.

3. Explanation of Columns

The following provides an explanation of columns in the tabular list of Basic Issue Items List, Section II, and Items Troop Installed or Authorized, Section III.

a. Source, Maintenance, and Recoverability Code(s) (SMR).

(1) Source code. Indicates the source for the listed item. Source codes are:

Code	*Explanation*
P1	Repair parts, special tools, and test equipment supplied from GSAIDSA or Army supply system and authorized for use at indicated maintenance levels.
P2	Repair parts, special tools, and test equipment which are procured and stocked for insurance purposes because the combat or military essentiality of the end item dictates that a minimum quantity be available in the supply system.

(2) *Maintenance code*. Indicates the lowest level of maintenance authorized to install the listed item. The maintenance level code is:

Code	*Explanation*
C	Crew/Operator

(3) *Recoverability code.* Indicates whether unserviceable items should be returned for recovery or salvage. Items not coded are nonrecoverable. Recoverability codes are:

Code	*Explanation*
R	Applied to repair parts (assemblies anti components), special tools, and test equipment which are considered economically reparable at direct and general support maintenance levels.
S	Repair parts, special tools, test equipment and assemblies which are economlically reparable at DSU and GSU activities an(d which normally are furnished by supply on an exchange basis.

b. Federal Stock Number. This column indicates the Federal stock number assigned to the item and will be used for requisitioning purposes.

c. Description. This column indicates the Federal item name and any additional description of the item required.

d. Unit of Measure (U/M). A 2 character alphabetic abbreviation indicating the amount or quantity of the item upon which the allowances are based, e.g., ft, ea, pr, etc.

e. Quantity Furnished with Equipment (BIIL). Not applicable.

f Quantity Authorized (Items Troop Installed or Authorized). This column indicates the quantity of the item authorized to be used with the equipment.

Section III. ITEMS TROOP INSTALLED OR AUTHORIZED LIST

Federal stock number	Description	U/M	QTY auth
7510-889-3494	BINDER, Looseleaf	EA	1
7520-559-9618	CASE, Maintenance and Operation Manuals.....	EA	1
4210-888-2221	EXTINGUISHER, Fire	EA	1

By Order of the Secretary of the Army:

CREIGHTON W. ABRAMS
General, United States Army
Chief of Staff

Official:

VERNE L. BOWERS
Major General, United States Army
The Adjutant General

Distribution:
To be distributed in accordance with DA Form 12-25A (qty rqr block No. 894) organizational maintenance requirements for Warehouse Equipment.

☆ U.S. GOVERNMENT PRINTING OFFICE: 1974-768116/1368

SAFETY PRECAUTIONS

BEFORE OPERATION:

When servicing battery, do not smoke or use flame in the vicinity. Batteries generate hydrogen, a highly explosive gas.

Do not fill fuel tank while engine is running. Provide metallic contact between the fuel container and fuel tank to prevent a static spark from igniting fuel. Wipe or flush any spillage.

Make sure fire extinguisher (class B) is on the truck.

DURING OPERATION:

USE EXTREME CARE WHEN HIGH TIERING: Position elevated load, with slight back tilt of mast, directly over loading spot then tilt mast forward to stack.

Use caution when approaching doorways, aisles, intersections, or other workers.

Always travel with mast tilted back and forks raised just high enough to clear any uneven floor conditions.

Avoid sudden starting and stopping. Reduce speed on turns.

Know the rated capacity of the truck and do not overload it.

Never pick up a load until certain it can be carried safely. Make sure the load is steady before lifting and keep the load against the carriage back rest.

When transporting bulky loads, travel in reverse. Always descend ramps in reverse when carrying load.

Do not butt loads with the forks or with the rear of the truck.

AFTER OPERATION:

Do not remove the radiator cap from an overheated radiator; stop engine and allow radiator to cool before removing cap to avoid injury by scalding.

Make sure forks are lowered to the ground and handbrake is engaged firmly.

If the truck is parked on an incline, set brakes; and block at least two wheels in the event of hand brake failure.

MAINTENANCE FORMS AND RECORDS. Maintenance forms, records, and reports which are to be used by maintenance personnel at all maintenance levels are listed in and prescribed by TM 38-750.

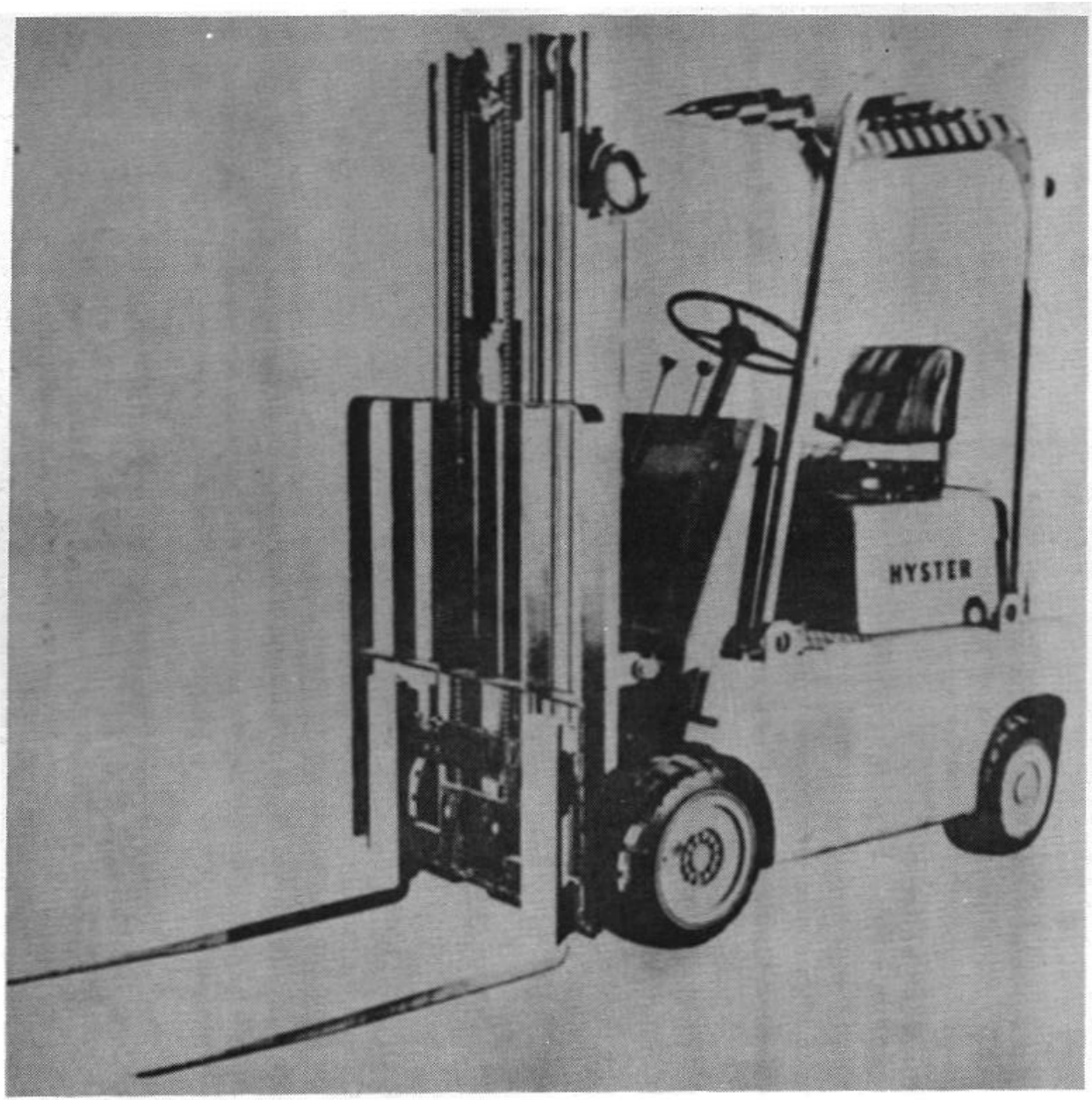

HYSTER

TABLE OF CONTENTS

INTRODUCTION AND GENERAL DESCRIPTION

INTRODUCTION

This manual contains operation and service instructions for the Model S-40C-P Fork Lift Trucks manufactured by Hyster Company, Portland, Oregon. Unit serial numbers covered by the material in this manual are as Follows:

C2D-5928N through C2D-6125N.
C2D-6542N through C2D-6556N.

The Federal Stock Number for the model with a three-stage upright assembly is 3930-935-7865; the Federal Stock Number for the model with a free-lift upright assembly is 3930-935-7866. The model identification number, the unit serial number, and the Federal Stock number appear on the specification plate under the instrument panel of the fork lift truck.

PURPOSE

The fork lift truck is used for loading, lifting, transporting and stacking cargo and bulk articles packaged, on pallets, or in bins.

GENERAL CHARACTERISTICS AND PERFORMANCE

The fork lift trucks operate efficiently on floors, docks, and other paved surfaces. The three-stage models provide lifting heights up to 180 inches, the free-lift models provide lifting heights to 100 inches. Both models have a working capacity of 4000 pounds. The load center of gravity is 24 inches from the front face of the lifting arms.

ENGINE AND POWER TRAIN

Power is provided by a four-cylinder, four cycle, internal combustion gasoline engine. A hydraulic torque converter provides fluid coupling of power from the engine to the transmission. The transmission is a hydraulically operated unit which provides one range of speed in forward and one in reverse.

DRIVE AXLE AND BRAKES

Motive power from the drive shaft is transferred to the drive wheels through a heavy duty spiral bevel differential and wheel mounted reduction gearing. The brakes are hydraulically actuated.

DESCRIPTION OF COMPONENTS

ENGINE. The engine is a four-cylinder inline, side valve (L-head), four-cycle internal combustion gasoline engine, producing 45 SAE horsepower at 2600 rpm. The construction is of the main frame (integral cylinder and crankcase) unit power plant type. The crankshaft has three precision replaceable type main bearings. Each of the four connecting rods is fitted with a precision replaceable type rod bearing. The connecting rods are of heat-treated steel and the pistons are of the cylindrical rib type using two compression rings and two oil control rings. Intake and exhaust valves are one-piece forgings. The cylinder block and cylinder head are waterjacketed for cooling. The major part of the combustion space is over the valves and the L-head type cylinder head is completely water-jacketed.

FUEL PUMP AND FILTER. The mechanical fuel pump, located on the engine, is a diaphragm type unit actuated by a rocker arm displaced by an eccentric lobe on the engine camshaft. A fuel filter is located in the fuel pump inlet line.

HYDRAULIC BRAKE SYSTEM. The automotive type brakes are mounted on the front axle only. The brake system consists of

brake pedal and linkage, master cylinder, hydraulic fluid lines, wheel cylinders, and brake shoe assemblies attached to brake backing plates, The brake backing plates are mounted on the front axle, Brake drums are attached to the front wheel hubs,

HANDBRAKE. The handbrake, or parking brake, consists of a hand operated lever in the driver's compartment and a cable that connects the handbrake lever to the eccentric arm and brake shoes,

STEERING SYSTEM. The steering system consists of a single stud, recirculating ball worm gear and lever,

HYDRAULIC TANK, The hydraulic tank, with & capacity of eight gallons, provides an hydraulic fluid reservoir for the hydraulic system, It includes an hydraulic fluid filter,

HYDRAULIC FLUID FILTER. The hydraulic fluid filter, located in the hydraulic tank, contains a replaceable filter element which filters all foreign material from the hydraulic fluid used in the hydraulic system, The filter is located in the return aide of the hydraulic system,

HYDRAULIC CONTROL VALVE. The hydraulic control valve is mounted on the cowl of the fork lift truck, It consists of a body, operating spools, a check valve for each spool, an adjustable relief valve, and the necessary seals and plugs,

TILT CYLINDERS. The double acting tilt cylinders, located between the upright assemblies and the driver's compartment, are equipped with self-adjusting packings, These cylinders tilt the upright assemblies forward and backward.

HOIST CYLINDER. The cylinder is located between the uprighted and is attached to the inner upright at the top and outer uptight at the bottom, This cylinder is equipped with self-adjusting packing and a flow control valve,

UPRIGHT ASSEMBLY. The upright assembly consists of outer upright, intermediate upright, and an inner upright, or on the free-lift model, an outer and inner upright only, Assembled on each are canted rollers which provide the necessary rolling and sliding surfaces needed to obtain upright rigidity, Rolling surfaces for two load chains are provided by eight flanged rollers, Four of the rollers are part of the Inner upright assembly and four are attached to the hoist cylinder, One end of each load chain is anchored on the hoist cylinder and the other is attached to the load carriage, The upright assembly id supported at the front of the fork lift truck by two pivots on the drive axle.

CARRIAGE ASSEMBLY. The carriage assembly is supported by the upright assembly and supports the lifting arms.

HORN. Electrical current to the horn is obtained through the horn relay that is energized by the horn button on the steering wheel, The horn is an electrical vibrator type,

STARTING SWITCH. Actuation of the starting switch energizes the starter motor solenoid which, in sequence, moves the starting motor pinion gear into engagement with the engine flywheel, and makes electrical contact to energize the starting motor.

CARBURETOR. The carburetor is a single throat, down-draft unit, A fast idle mechan

ism aids in cold weather starting by preventing over-choking. An idle bowl vent aids in hot starting. The carburetor also contains a mechanically operated accelerator pump and a power jet system.

GOVERNOR. A fly-ball type governor is mounted on the engine, and under preset over-speed conditions, a spring-balanced throttle arm closes the carburetor throttle valve, restricting fuel-air mixture to the engine, until the engine speed stabilizes at governed speed setting.

AIR CLEANER. The air cleaner is an oilbath type, mounted next to the carburetor.

ENGINE OIL FILTER. The engine oil filter, located on the engine, removes foreign material from the engine lubricating oil. The filter is a replaceable type.

STARTING MOTOR AND SOLENOID. The starting motor is a high-torque, low-speed, direct current motor with a solenoid switch. The starting motor is located on the flywheel housing of the engine.

DISTRIBUTOR AND IGNITION COIL. The distributor and ignition coil are located on top of the engine. The distributor is an automatic, 12-volt grounded type, gear driven by the engine camshaft. The ignition coil is a hermetically-sealed unit that transforms low voltage to high voltage for the engine ignition system.

ALTERNATOR. The alternator produces an out-put of 12 volts dc to the electrical system.
The generator is bracket-mounted on the engine and is belt-driven by the engine.

BATTERY. The battery is a lead-acid, 12-volt, six cell, 53 amp-hour capacity unit mounted in the engine compartment.

COOLING SYSTEM. The cooling system for the engine consists of a radiator, radiator fan, fan driving belt, water pump, water hoses, and thermostat.

CRANKCASE VENTILATION SYSTEM. The engine ventilation system minimizes emission of noxious vapors into the atmosphere by drawing fumes from the crankcase into the intake manifold.

TRANSMISSION. The power shift transmission is mounted on the engine. It consists of an hydraulic torque converter, two hydraulically actuated clutches, and constant mesh gearing. Directional selection is made manually, with actual clutch engagement within the transmission done hydraulically.

INCHING CONTROL. An "inching" system in the transmission provides accurate control of the forward or backward movement of the fork lift truck when engaging the lifting arms with a load. The inching control foot pedal is located on the left side of the driver's compartment floor boards.

AXLES. The front axle of the fork lift truck transmits motive power from the engine and transmission to the driving wheels. Brake assemblies and cushion-tire wheels are mounted at both ends of the front axle. The rear axle provides wheel articulation for steering. Single wheels without brakes are mounted at each end of the rear axle.

DIFFERENTIAL. The differential gearing, and a heavy-duty spiral bevel pinion-and gear, are contained within a one-piece housing. They transmit motive power to the front axles. The straddle-mounted pinion has three bearings to carry thrust and radial load. Further torque multiplication is provided by reduction gears within the drive wheel assemblies.

HOUR METER. The hour meter is a device that records the total amount of time that the engine has operated. The meter is connected with an oil switch on the engine, ensuring that the meter will operate only when the engine is running.

COUNTERVWEIGHT. A cast iron counterweight is located at the rear of the fork lift truck to counter-balance heavy loads on the loading arms at the front.

WHEELS AND TIRES. The wheels are demountable. Tires are cushion type.

GENERAL

The safe and efficient use of a lift truck requires skill and alertness on the part of the operator. To develop the skill required for safe, efficient truck operation the operator should become familiar with the make-up of this truck, understand its capabilities and limitations, and see that it is maintained in good mechanical condition. He should become familiar with the various instruments and acquire a feel for the control levers and foot pedals. He should read and understand the safe driving and load handling techniques and the safety rules contained in this manual. And, most important, a qualified person experienced in operating the truck should guide him through at least several driving and load handling operations before he attempts to operate the truck on his own.

ENGINE BREAK-IN PROCEDURE

The recommended break-in procedure is as follows:

1. Check all liquid levels,

2. Start engine and run at just above idle with no load for one-half hour, During this time, check for external oil leaks and correct oil pressure.

3. Put the unit to work using rated capacity loads. It is important that engine operating temperatures be maintained from 180 to 200 degrees during the first few hundred hours of service. Avoid prolonged periods of idling as this will lower crankcase temperatures and may cause cylinder wall glazing, preventing the piston rings from seating properly.

4. If the unit cannot be put to work immediately or the operation is slow and light, a simulated work condition should be initiated. Operate the unit from two to four hours with rated load, accelerate the truck from low idle to high idle at full throttle and decelerate to low idle. Avoid prolonged high idle operation during first 50 hours. This may cause cylinder wall scuffing and scoring.

5. After 50 hours operating adjust valve clearances and retorque cylinder head units, Correct break-in is important for maximum oil economy and long engine life. It should be noted that industrial engines are designed to work at higher RPM ranges than stationary installations. The piston rings used exert normal wall pressures at higher RPM's. This is one of the reasons light operations or prolonged periods of engine idling may result in smoking and excessive oil consumption.

6. Follow the Recommended Preventive Maintenance schedule in this manual.

CONTROLS AND INSTRUMENTS (Fig. 1)

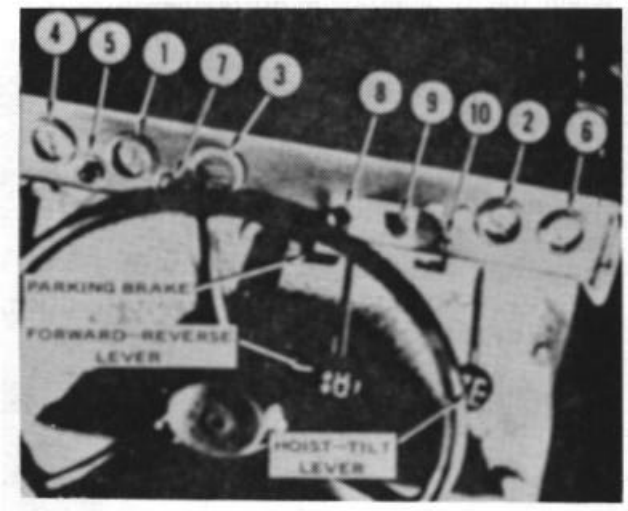


Figure 1.

A. INSTRUMENT PANEL

The instrument panel is arranged with various gauges and indicators for checking the performance of the various truck components.

1. Generator, or alternator, operation is

checked by an Ammeter gauge. The Ammeter may show a slight discharge at engine idle, but should indicate charging when the engine speed is increased.

2. Engine oil pressure is indicated by a pressure gauge. The gauge may register high pressure when the engine is first started in cold weather, but the pressure should drop to its normal level as the engine warms up. Always stop the engine immediately if the gauge indicates no pressure when the engine is running.

3. The hour meter, designated ENGINE HOURS, registers the accumulated operating hours of the engine. Periodic maintenance recommendations are based on these engine hours.

4. The TEMP gauge indicates the engine coolant temperature.

5. The transmission oil temperature is indicated by a TRANS TEMP warning light. When the transmission oil temperature is too high for safe operation the light will come on.

6. The fuel gauge indicates the level of fuel in the tank.

7. Pulling the CHOKE knob facilitates starting the engine on gasoline powered trucks.

8. The Ignition Switch is a two position, ON-OFF, unit.

9. The Starter control is a push-button.

10. The Light Switch is a pull-on type.

B. CONTROL LEVERS

1. Shifting Levers

a. The single-speed power shift transmission has one lever mounted on the right side of the steering column for Forward - Neutral - Reverse selection.

2. Upright Control Lever. The hoist and tilt functions of the upright are controlled by one lever. The shift pattern for this lever is shown on the lever knob.

3. Parking Brake Lever. All trucks are equipped with a parking brake handle to the right of the steering column. Pulling up on the lever sets the brake.

C. FOOT PEDAL LOCATION (Fig. 2)

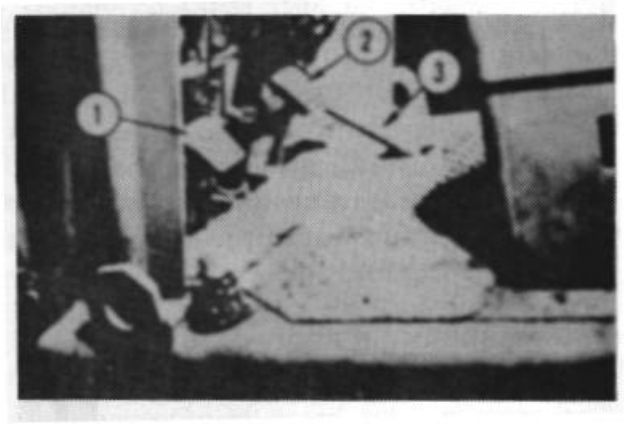


Figure 2.

1. The Inching pedal, sometimes referred to as left brake pedal, is located to the left of the steering column. By adjusting the pedal position with the left foot the operator can control the truck movement in small increments (inching) at high engine speed. Complete application of the pedal places the transmission in neutral and sets the service brakes,

2. Brake pedal. This pedal is located to the right of the steering column and is operated by the right foot. The brake pedal is independent of the inching pedal and has no connection with the transmission. The brake pedal should be used for braking only and not for inching.

3. The Accelerator pedal is located to the right of the brake pedal. Truck speed is controlled with the right foot.

CAUTION: Do not operate a powershift

equipped truck with the "TRANS. TENIP" warning light on. Trucks equipped with a powershift transmission should not be operated with oil temperatures of 2500F, or above.

DRIVING THE TRUCK

A. STARTING THE ENGINE

Set the parking brake and place the direction control lever in Neutral to close the starter circuit. Turn the ignition switch clockwise and depress the starter button. Allow the starter to turn over the engine until it starts, then release the button. Do not crank the engine longer than 30 seconds. If it does not start within this time, something is wrong and should be corrected. When the engine is cold, it may be necessary to choke it. If the engine is hot, choking should not be necessary, but depress the accelerator about half-way to aid starting.

B. DRIVING AND DIRECTION CHANGING

Place the direction control lever in the desired position and release the parking brake. Step down on the Accelerator pedal for the desired travel speed,

To change direction, remove foot from the Accelerator pedal and apply the brakes sufficiently to stop or nearly stop the truck, Move the direction control lever to the desired position.

C. STEERING

A lift truck is unique from most other types of vehicles in that it is steered by the rear wheels and powered by the front wheels. The main reason for this is that it allows the truck to turn much sharper than if it were steered by the front wheels.

Exaggerated tail swing is characteristic of lift trucks. This is a result of being steered by the rear wheels. A driver needs to become accustomed to tail swing,

For example, when turning a sharp corner, it is necessary to start from the inside corner rather than from the middle of the aisle as attempted by many new drivers.

When turning from a wide aisle into a narrow one, start turning as close to the opposite stock pile as tail swing will allow. Thus, the lift truck enters the narrow aisle going straight ahead.

In exceptionally narrow aisles, it is usually permissable to carry the load at an angle toward the direction you wish to swing in order to shorten the turning radius. (Fig. 3)

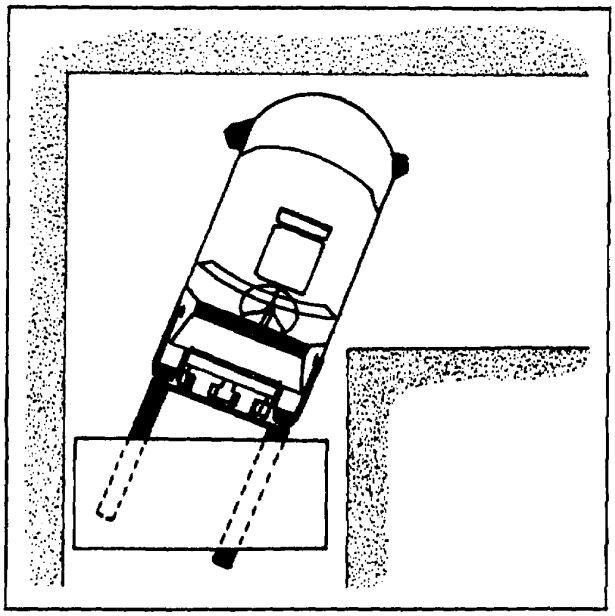


Figure 3.

Rail cars or similar openings can be entered easiest at an angle. This eliminates having to turn sharply inside.

During most operations, an operator steers with his left hand only. This leaves his right hand free to operate the hoist and directional controls.

D. STOPPING

Lift trucks should be brought to a halt gradually. Wheel sliding and hard braking is dangerous as well as unnecessary and harmful to the truck. After the truck is stopped, lower the forks flush with the ground, put the truck in neutral, set the parking brake and shut off the engine.

If the truck has been working hard, allow the engine to idle a few minutes before shutting it off.

LOAD HANDLING

The capacity of a lift truck is given by weight and distance to the load center. For example, a capacity of 4000 pounds at 24 inches means that the truck can lift 4000 pounds, if the center of the load is 24 inches forward from the face of the load carriage.

Before attempting to lift a load make sure its weight is within the capacity of the truck at the load center involved. To do this, measure from the side of the load which will be against the carriage to the center of the load. This is the load center. Now refer to the rated capacity chart on the truck name plate to determine if the truck will safely lift the load at the load center found above.

Keep in mind too, that, unless the name plate indicates otherwise, the rated capacity shown is for a standard truck equipped with standard load carriage, forks, and upright and having no special load handling equipment. Also the rated capacity presumes that the center of the load is no further from the top of the forks than it is from the face of the carriage. If these conditions do not exist then the operator may have to reduce his safe operating load because the truck's resistance to tipping may be reduced,

A. STABILITY - LIFT TRUCKS

The rated capacity of a lift truck applies to a condition where the truck is on level ground with the upright vertical. When the upright is tilted forward or back, or the truck is on an incline, stability of the truck is affected.

It should be remembered that any lift truck can be tipped over if one is careless when raising a load.

While a lift truck is mounted on four wheels, it is actually supported at three points. This is because the steering axle is free to pivot at the center. The three points of suspension, then, are the two drive wheels and the center of the steering axle. These are labeled A, B and C in the following figure. (Fig. 4)

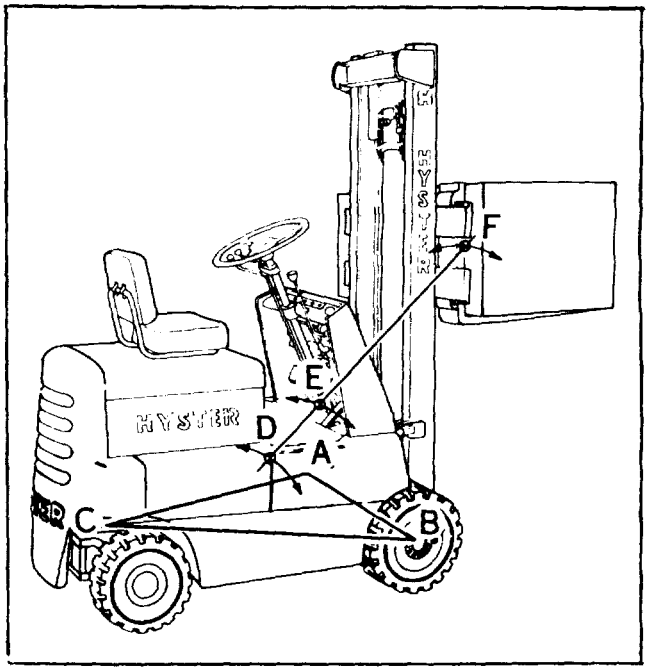


Figure 4.

Point D is the center of gravity of the empty truck. The load has its center of gravity in its own center, marked F in the illustration. When the load is on the truck, the truck and load become one mass weight and have a combined center of gravity shown at point E.

If the truck is to tip over forward, it will do so

about the drive axle A-B. If it tips over sideways, it will do so at about the line A-C or B-C.

The combined center of gravity, E, is within the boundaries of the triangle formed by A, B and C, when the upright is vertical. The farther E is from lines A-B, A-C or B-C the more stable is the truck. As the load and upright is tilted forward, E moves forward also. This brings point E closer to line A-B and the truck is less stable forward. If the load is tilted forward far enough to move E ahead of line A-B (provided the load does not slip off the forks), the truck will tip over forward.

As the load is tilted backward, E moves backward and gets closer to lines A-C and B-C. In this condition side stability is impaired.

The most stable condition, therefore, is when the upright is vertical. It is very important then, when raising a load, to keep the upright nearly vertical. ONLY BACKTILT ENOUGH TO KEEP THE LOAD FROM SLIPPING OFF THE FORKS.

B. LIFTING, LOWERING, TILTING

The hoist and tilt mechanisms are both actuated by the same lever. Pull the lever back and the hoist lifts. Push it forward and it lowers. The tilt mechanism is operated by pushing the lever to the extreme right, then pulling it back to tilt the uprights back and push it forward to tilt the uprights forward.

C. LOADING AND STACKING

When the control lever is released, it will automatically return to neutral and stop the hoist or tilt operation.

Lifting speed is controlled by: 1) the speed of the engine, and 2) the extent the control lever is pulled. Engine speed has no effect on lowering speed.

1. Move the truck forward until the load arms are entirely under the load to be lifted. Make certain that the load is centered on the arms and that it is well-seated against the face of the lifting carriage.

When picking up round objects, first tilt the uprights so that the forks slide along the floor under the object to be lifted. (Fig. 5)

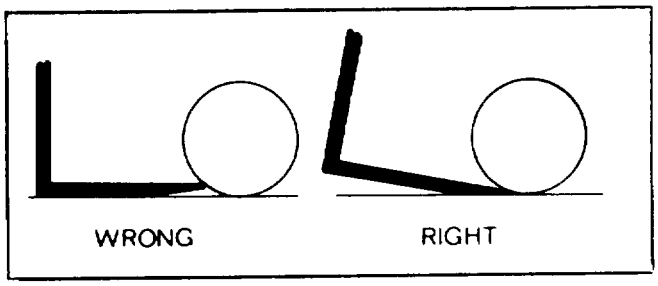


Figure 5.

2. Depress the inching pedal. Accelerate the engine with the accelerator pedal.

3. When sufficient backward tilt of the uprights is obtained to allow safe handling of the load, move the hydraulic lever back to neutral and then move it to the left position and pull back. At the same time accelerate the engine until the desired hoist speed is obtained.

Never race the engine while hoisting a load. Engine speeds above 2200 RPM will not increase speed of the hoisting mechanism and will only result in excessive wear and damage to the engine. With a little practice the operator will learn by sound, observation and "feel" the maximum efficient hoisting speed.

4. When the load has been raised to the desired height, ease the hoist lever to the neutral position and move the truck to the base of the stack on which the load is to be placed.

Although a load may be placed on or removed

from a stack by using the hoist hand lever, the operator will discover that with practice the loads can be placed or removed entirely with the tilting mechanism, which is designed to raise the load arms slightly as the uprights are tilted backwards.

Practice raising the load as the truck is nearing the stack while coasting into position. This reduces strain on engine and on the brakes.

5. The operator is urged to study the problem of load handling, at all times being aware that carefully planned operations will produce the maximum amount of work with the minimum of fatigue to himself and to the lift truck.

D. TRANSPORTING LOADS

1. To transport a load, tilt the uprights as far back as the nature of the load will permit and raise the load only high enough to clear obstructions. In moving the load, follow the instructions previously outlined under "driving the lift truck." Always reduce speed gradually as sudden stops will cause excessive brake wear and will cause the load to fall forward.

2. Know the underclearance of the truck, and the surface upon which you are traveling at all times.

3. When operating a lift truck on a steep incline, back down with the load.

SAFE DRIVING AND LOAD HANDLING TECHNIQUES

1. Operators must be trained and qualified. First, this means the operator must be authorized to drive the truck. Second, it means that he must thoroughly understand these safety techniques. And third, it means that he must make sure a qualified person experienced in operating the truck guides him through at least several driving and load handling operations before he attempts to operate the truck on his own. This basic education in safe driving and load handling techniques is absolutely necessary to prepare the operator for proper defensive driving and enable him to anticipate the unexpected.

2. "Avoid lifting or hitting anything if it appears that it could fall on the operator or a bystander. Remember that a truck equipped with a overhead guard and load backrest provides reasonable protection to the operator from falling objects, but cannot protect against every possible impact."

This means that an operator should never attempt to pick up any loose, unstable, or stacked load if it appears that any part of the elevated load might topple through or over the top of the upright, or fall on any person who happens to be standing nearby. It also means that to avoid hitting certain objects such as stacked material which could become dislodged and fall, the operator must exercise extreme care while working near such objects and must not move his truck around with his load carriage elevated.

3. Have no riders, and use a secured safety platform when lifting personnel. A fork lift is built only for one rider -- the operator. It is a safety hazard for anyone to ride the forks of a truck or hitch a ride in any manner. If a truck is used to elevate workmen, a safety platform must be secured to prevent its slipping from the forks, and it should have a solid floor and hand rail.

4. Keep arms, legs, etc., inside the driver's compartment. Arms and legs outside the machine, coupled with narrow aisles, can be extremely dangerous.

5. Keep yourself and all others clear of the hoisting mechanism, Particularly, never put hand, arms, head or legs through the up

right or near the carriage or hoisting chains. This applies not only to the driver but also to his helper. A helper should not be near the load or hoisting mechanism while the driver is attempting to pick up, hoist, or deposit a load.

6. Allow no one under the load or carriage. Even if the operator has an overhead guard his helper does not. Therefore, absolutely no one should be allowed underneath an elevated load or carriage.

7. Report damage or faulty operation immediately -- Do not operate the truck until it is corrected. A lift truck will only do its job safely when it is in proper working order. A truck should absolutely never be operated when a malfunction exists.

8. Avoid bumps, holes, slick spots, and loose materials that may swerve or tip the truck. Different models of lift trucks are designed to operate under different conditions. Cushion tire models are designed to operate on relatively smooth, firm surfaces. Bumps, holes and loose materials have the same affect as if part of the floor dropped out from underneath the truck. Always make sure you pick the smoothest road for your truck.

9. Travel slowly around corners. Narrow aisles and blind corners are fine scenes for collisions. To avoid them drive slowly and sound the horn in advance.

10. Shut off the engine, lower the carriage completely, and set the parking brake when leaving the truck. Block the wheels when on an incline or working on the truck.

11. Do not turn on an incline. For stability reasons a lift truck should not be driven along the side of an incline so that the truck is leaning sideways. Always keep the front and rear ends of the truck pointed in the direction of slant.

12. Do not fill the fuel tank while the engine is running. Fires and explosions can result from failure to follow this simple rule.

13. Avoid sudden starts or stops. Unsuspecting bystanders or close-by material can be damaged by a truck suddenly jumping into motion and possibly going out of control. Sudden starts can hurt the truck too. Tires are worn, axles can be snapped, and gears stripped. Sudden stops can also cause you to lose a load. Remember -- skid marks are a sign of bad driving.

14. Watch clearances, especially forks, upright, overhead guard and tail swing. Because a lift truck is designed to perform such a wide variety of functions within limited space, there are certain clearance situations which the driver must anticipate. The driver must be aware that his forks sometimes protrude beyond the front of the load. Because of this he may strike objects or unintentionally lift or nudge other palletized loads.

15. Strictly observe the following load handling techniques:

a. Handle only loads within rated capacity. The truck name plate rating represents the maximum safe load that can be lifted. This maximum rating should never be exceeded. However, such factors as weak floors, uneven terrain, or loads having a high center of gravity may mean that the safe working load is considerably below the rated capacity. When special conditions do exist the operator must reduce his load so that his truck will remain stable.

b. Handle only stable loads. Many loads are made up of unstable items that can be easily dislodged. They can either upset a truck or fall on someone.

c. Center the weight of wide loads between the forks. Otherwise the load may topple off the forks when you turn a corner or hit a bump.

d. Watch "swing" when handling long loads. Failure to watch clearance at the ends of your load can cause you to strike persons or objects.

e. Keep the load against the carriage. This is most easily accomplished by maintaining a slight backward tilt.

f. Do not travel with load raised. When loads are carried in an elevated position the stability of the truck is reduced. There is also a possibility that the load or part of it can fall on someone or something.

g. For better vision with bulky loads travel in reverse, but always keep a proper lookout in the direction of travel and always keep the load upgrade on grades of 10% or more. Normally, direction of travel should be determined by the best visibility available to the operator. However, when grades of 10% or more are encountered both truck and load stability demand that the load be kept upgrade.

h. Lift and lower with the mast vertical or tilted slightly back. Tilt elevated loads forward only when directly over the unloading place. If the load or lifting mechanism is elevated to pickup or deposit a load, keep the tilt in either direction to a minimum.

MAINTENANCE AND LUBRICATION

GENERAL

Preventive maintenance is a planned maintenance program whereby machine failures and costly downtime are generally prevented due to periodical performed services and adjustments. The following maintenance guide is designed to provide services that can be performed, in most cases, at the job site with the simplest of tools. Following this guide will do much to obtain a long and efficient truck life.

Below are truck components requiring periodic attention. See the Maintenance and Lubrication Schedule for recommended intervals.

A. ENGINE OIL

The lubricating oil in the crankcase should be kept up to the full mark on the dipstick. Stop the engine before checking the oil level. Withdraw the dipstick; wipe it clean, then insert it all the way and again withdraw it to take the reading.

B. RADIATOR

Fill the radiator with clean, soft water and ethylene-glycol anti-freeze according to the directions on the can.

CAUTION:

When checking a hot radiator, place a rag over the cap and loosen the cap to the first notch to relieve the pressure. If the cap is completely removed without the pressure being relieved, severe scalding may result. Never add cold water to an overheated engine.

C. FAN BELT

The fan belt tension should be checked periodically. Refer to appropriate service publications for correct fan belt tensions. The belt should be replaced when it "bottoms" in the pulley grooves or cannot be tightened enough to prevent slipping.

D. HYDRAULIC OIL

With the hoist lowered to the ground, check the hydraulic oil level with the bayonet gauge. The level should be kept between the upper (full) and lower marks on the gauge with the oil hot.

CAUTION:

Never operate the engine without oil in the hydraulic system. A few revolutions without oil can ruin the hydraulic pump.

E. AIR CLEANER

Service the air cleaner according to the instructions on the filter bowl. Wash the element in solvent or kerosene. Fill the oil cup with SAE 30 engine oil.

F. TRANSMISSION

Maintain fluid level to the full mark on the bayonet gauge, Check the level with the engine running, the transmission in neutral, and the oil at operating temperature.

G. DRIVE AXLE AND DIFFERENTIAL

Oil should be level with the level plug.

H. BRAKE PEDAL

The brake pedal should always have 1/4 inch free travel before the pressure stroke starts. This is necessary to prevent blocking of the

bypass port in the master cylinder. The master cylinder should always be kept filled to within 3/8 inch from top with heavy duty brake fluid.

I. BATTERY

Water level should be 1/2 inch above separators and plates. Use pure distilled water only. Specific gravity of a fully charged battery is 1.250 to 1.275.

J. REFUELING

CAUTION:

Never fill the tank near open flame or when the engine is running. Keep the funnel or fuel hose nozzle in contact with the metal of the tank when filling to avoid the possibility of an electric spark igniting the fuel.

GENERAL LUBRICATION

Refer to L0O-3930-607-12 ./,

GASOLINE ENGINE - FS162

GENERAL

This section covers the FS162 engine.

REMOVAL

1. Tilt the hood back and remove it from the truck. Unscrew the counterweight mounting bolt from the rear of the truck.

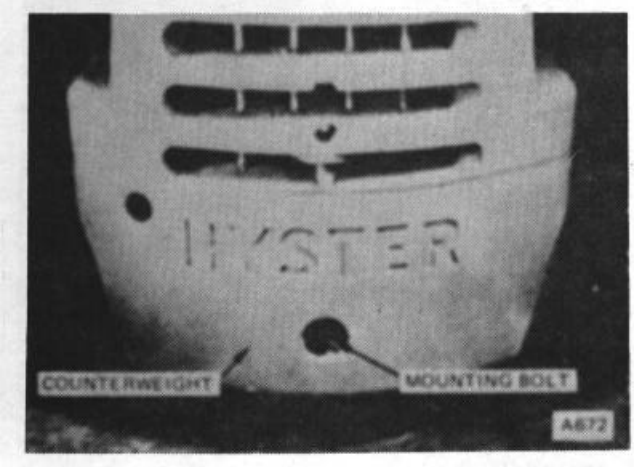


Figure 1.

2. Loosen the two mounting nuts, one on each side, in the engine compartment, (Fig. 2)

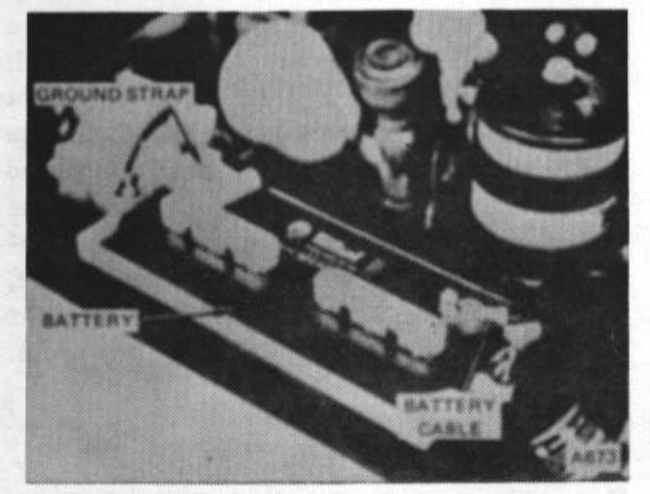


Figure 2.

Attach a hoist to the counterweight and lift it from the truck. Remove the floor plates.

3. Drain the radiator. Disconnect the upper and lower radiator hoses. Disconnect the hoses from the oil cooler in the bottom of the radiator, Unscrew the radiator mounting bolts and lift the radiator out.

4. Disconnect the ground strap and cable from the battery. Unscrew the battery holddown wing nuts. Remove the battery holddown and lift the battery out, Disconnect the wires from alternator. (Fig. 2)

5. Disconnect: the wire from the oil pressure sender; the high and low tension wires from the ignition coil; the wire from the temperature sender. (Fig. 3)

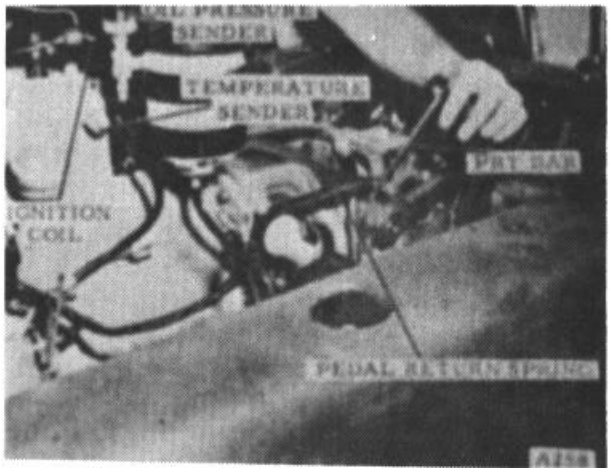


Figure 3

6. Disconnect: the cable from the starter; the wires from the solenoid; fuel gauge mender; alternator regulator.

7. Disconnect the fuel line from the fuel pump; the exhaust elbow at the muffler; the hydraulic lines from the oil pump. (Fig. 4) Cap all hydraulic openings.

8. Remove the foot pedal return springs, at the foot pedals. (Fig. 5) Index mark the torque converter and flywheel. Remove the converter mounting capscrews from the engine flywheel through the access holes located on the top of the converter housing. Remove the

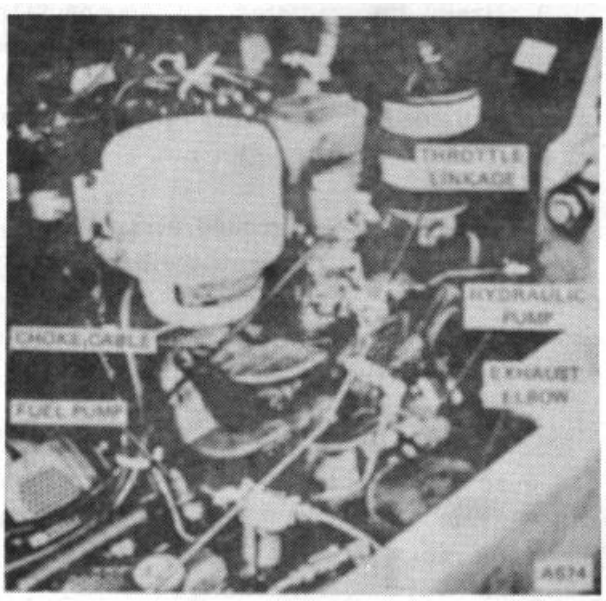


Figure 4.

Figure 5.

oil cooling hoses at the valve and cap. Remove the two front engine mounts nuts. Attach a hoist and support the engine weight. Place a block beneath the converter housing and remove the capscrews holding it to the engine converter housing adaptor plate. Lift the engine from the truck.

CYLINDER HEAD

A. REMOVAL

NOTE:
To aid in obtaining correct ignition timing, remove distributor cap and record rotor position.

Remove the distributor, the coil mount bracket, the governor spring bracket, and the spark plugs. Loosen and remove the nuts holding the cylinder head to the block. Remove the head from the engine.

B. CLEANING AND INSPECTION

1. Remove all carbon from combustion areas, using a scraper and wire brush. (Fig. 6)

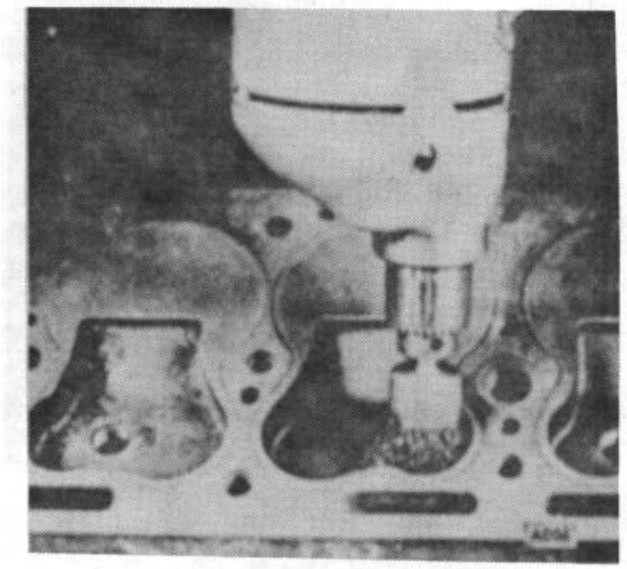


Figure 6.

Clean the cylinder head thoroughly with a solvent or degreasing solution and blow it off with compressed air. Make sure the gasket contact surface of the head is clean, smooth and flat. Check flatness with straightedge and feeler gauge in three positions lengthwise and five crosswise. The maximum permissible is .004" low in the center lengthwise, gradually decreasing toward the ends, or .003" crosswise or in localized low spots. (Fig. 7 and Fig. 8)

2. Inspect for cracks. Wipe planed surface with a rag saturated with kerosene, wipe head dry then tap lightly throughout entire surface. Cracks will be indicated by the kerosene being vibrated out of the crack and appearing on the planed surface.

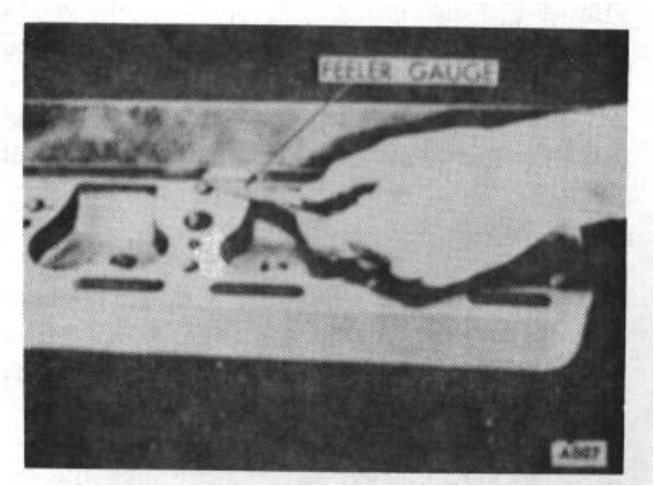


Figure 7.

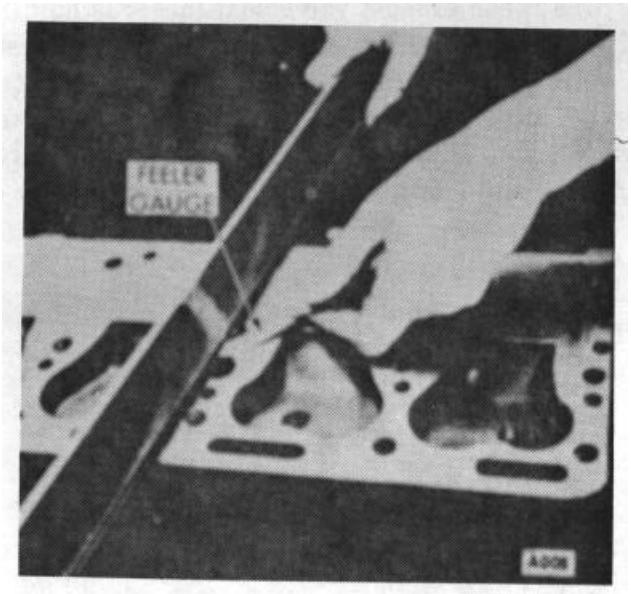


Figure 8.

3. Clean and check cylinder block, being careful not to allow carbon to enter intake and exhaust ports.

4. Clean threads of the head studs and nuts.

C. INSTALLATION

Use the reverse of removal procedure.

Tighten with torque wrench in recommended sequence to the correct torque by going over the head nuts two times before pulling them down to the final torque specification on the third round. (Fig. 9 and Fig. 10)

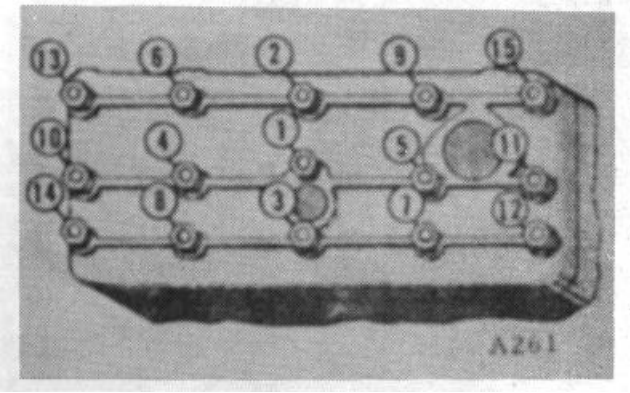


Figure 9.

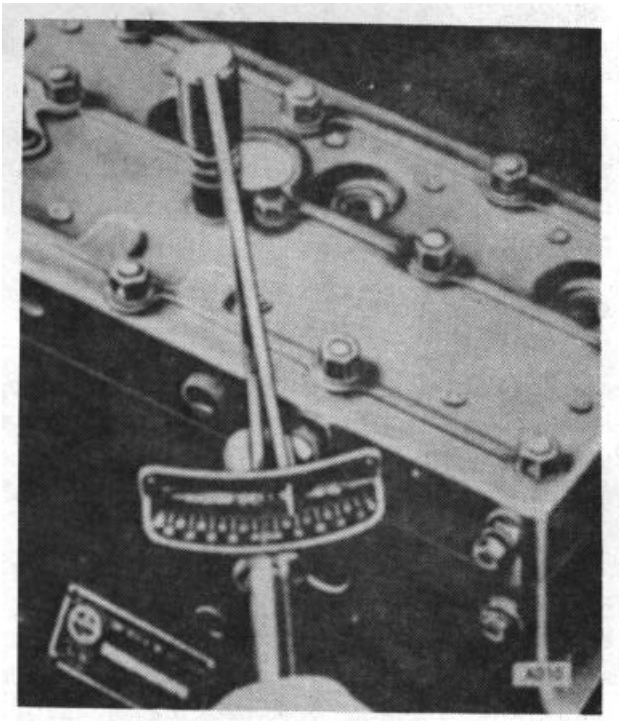


Figure 10.

VALVE ASSEMBLIES

A. VALVE REMOVAL

Remove head and tappet cover. With a valve spring lifter, compress the springs and remove the keepers from the valve stems which are in a closed position. (Fig. 11) Close the other valves by rotating the crankshaft and

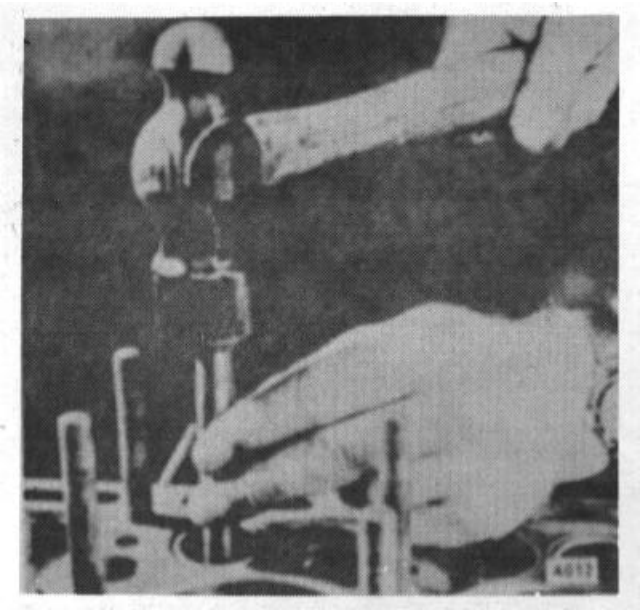


Figure 71.

remove the keepers from these valves in the same manner. Remove all valves and place in correct order to prevent mixing while handling.

B. VALVE GUIDES

1. Clean the valve stem guides, removing lacquer or other deposits by running a valve guide cleaner or wire brush through the guides.

2. Check guides for wear by using a "go and no-go" plug gauge or a telescope gauge and 1" micrometer. Replace all guides that are worn bellmouthed and have increased .0015" in diameter, See Specification Listing for maximum diameter permissible to determine actual amount the diameter has increased.

3. Remove all valve guides when necessary by driving them out from the combustion chamber side with a driver slightly smaller than the O.D. of the valve guide. (Fig. 11)

4. Install new guides as required by driving from the combustion side to the correct depth below the valve seat as given in the Specification Listing.

5. Ream new valve stem guides to size given in the Specification Listing, using a straight reamer ground to correct size and having a pilot which will properly locate it and keep it from wandering from the original reamed hole.

CAUTION:

When replacing with guides that are ferrox coated, do not ream since these are all pre-reamed before being ferrox coated. Further reaming will remove the coating.

C. VALVE SEAT INSERTS

1. The exhaust valve seat insert is held in place by a shrink fit. Inspect all exhaust valve seat inserts in the block and replace any that are loose, cracked or otherwise damaged. Use a puller for removing a faulty insert as shown in Figure 12. When replace

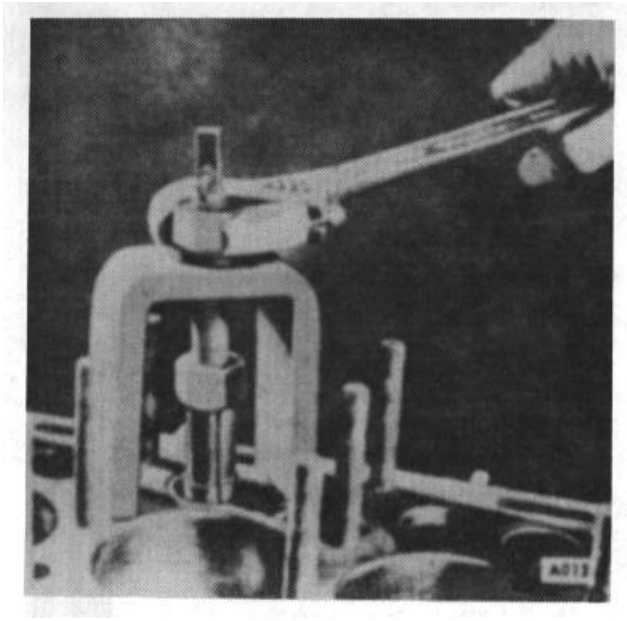


Figure 12.

ment of a new insert is required, clean and counterbore for .010" larger insert using a counterbore tool with a correct fitting pilot. When machining the counterbore, be sure to go deep enough with the tool to clean up the bottom so that the insert will have full contact to carry away the heat. Do not install new inserts having the same outside diameter as

the one removed. Dimensions of standard inserts and counterbores are given in the Specification Listing.

2. When oversize inserts are used, dimensions of the insert and counterbore increase proportionately (.010", .020", .030", depending on the oversize). New insert installation should have a press fit. Chill insert with dry ice for 20 minutes before assembling. Insert may then be installed in the counterbore using a piloted driver, tapping in place with very light hammer blows, without shearing the side walls. (Fig. 13) This assures a firm seating in the bottom of the counterbore, after which it should be rolled in place.

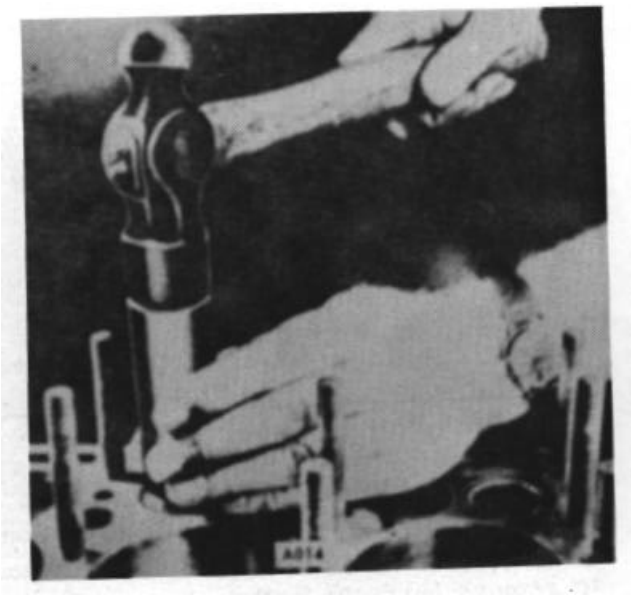


Figure 13.

3. Grind the intake and exhaust valve seats (Fig. 14) in the block in accordance with Specification Listing. Before removing the arbor, check seat for runout. Total indicator reading of the run-out must not be more than .002". Use a solid stem pilot with a long taper, as all valve seats must be ground concentric and square with either new or worn valve stem guide holes. (Fig. 15)

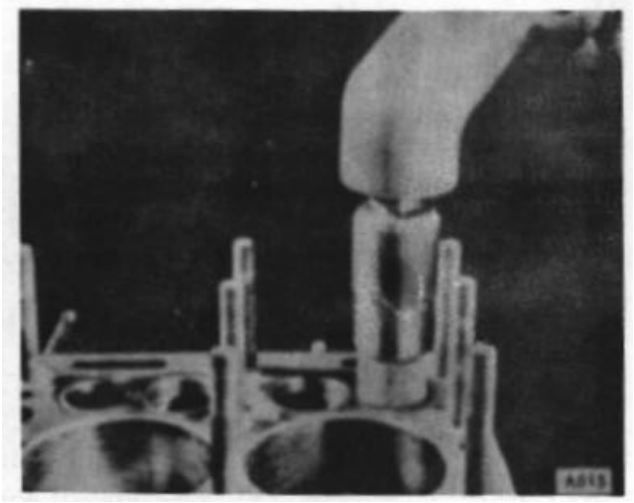


Figure 14.

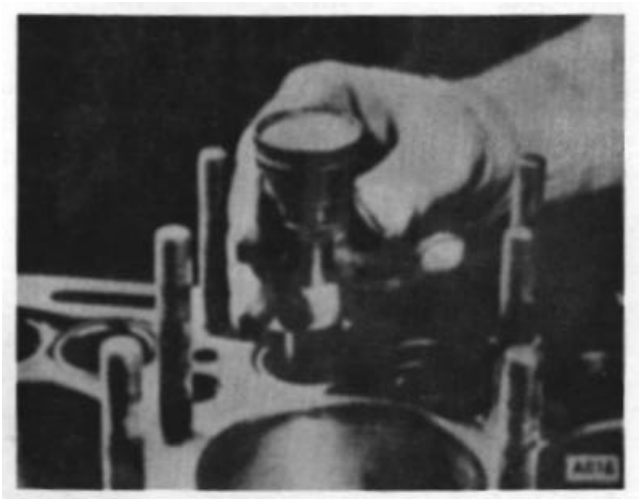


Figure 15.

D. VALVES

1. Inspect valves and replace any that are cracked, burned or which have stems that are bent or worn more than .002" over the maximum allowable limits. Reface or replace all valves.

2. All valves having less than 50% margin thickness (outer edge of valve head) after refacing has been completed, should be replaced. To check this dimension, compare the refaced valve with a new valve. (Fig. 16)

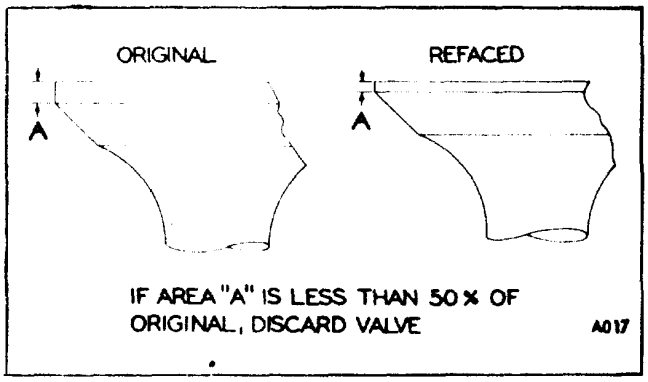


Figure 16.

3. Check all refaced or new valves in V-blocks with indicator to determine if the contact face is true with the stem within .002". (Fig. 17) If not, repeat the refacing operation.

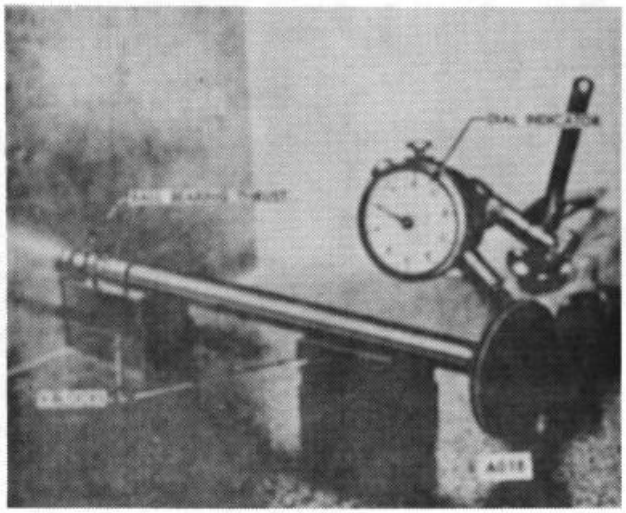


Figure 17.

4. After the valves and seats have been refaced and reground, coat the seat lightly with "Prussian Blue" and drop the valve into position, oscillating it slightly to transfer the blue pattern to the valve face. This should show a contact width of 1/16" to 3/32" and should fall well within the width of the valve face, leaving at least 1/64" on either side where the blue does not show. If the valve contact is over 3/32" wide, the seat in the block may be narrowed by using a 15 stone to reduce the outside diameter or using a 60° or 75° stone to increase the inside diameter. (Fig. 18) Never allow valves to sit down inside the seat. (Fig. 19)

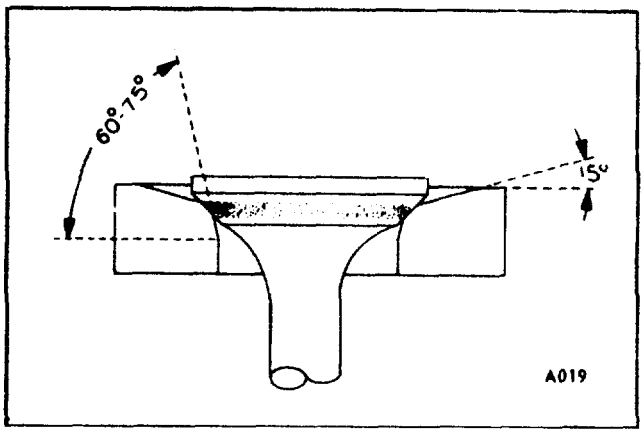


Figure 18.

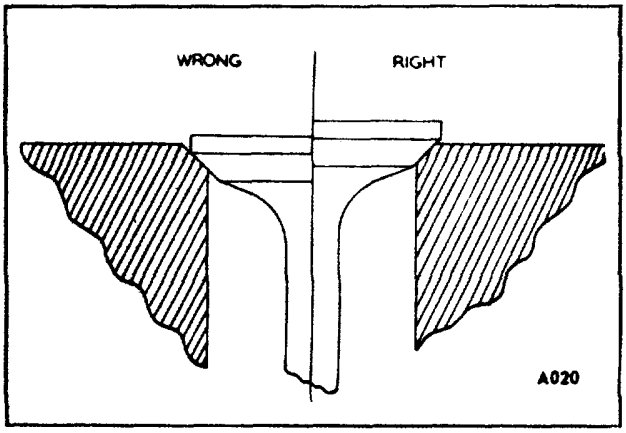


Figure 19.

5. After the narrowed-down seat is brought within specifications, the seat should be retouched lightly with the original stone to remove burrs or feathered edge. Coat the valve stem with a light film of engine oil.

E. VALVE SPRINGS

Check all valve springs on the spring tester to make sure they meet specifications regarding force and length. (Fig. 20) Springs, when compressed to the "valve open" or "valve closed" length, must fall within correct specifications when new, and must not show more than 10% loss in order to re-use. Reassemble the valves and springs in the block with the retainer and retainer pin.

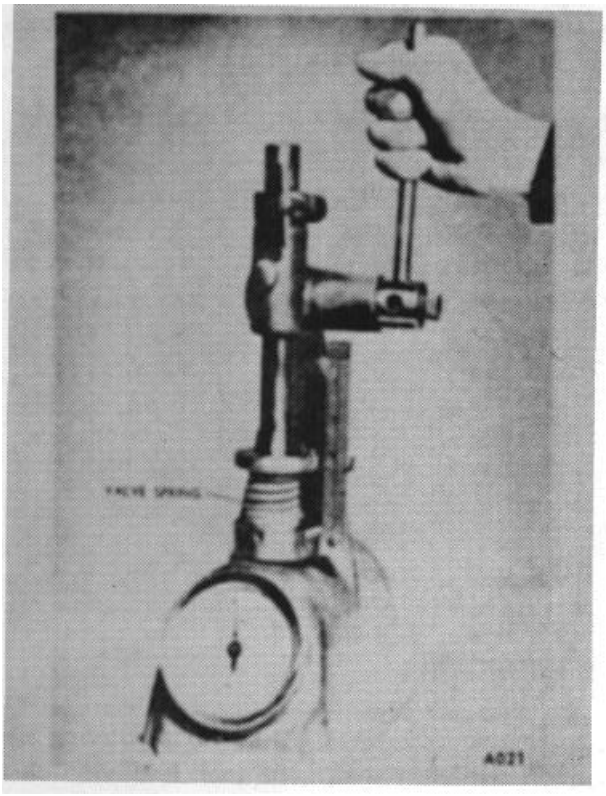


Figure 20.

CHECKING BORE WEAR

A. Clean the ring of carbon from around the top of the cylinder formed above the travel of the top ring.

B. Determine the original diameter of the cylinder by checking the unworn area with inside micrometer at intervals of approximately 45 . (Fig. 21)

C. Check in same manner the top of the ring travel area approximately 1/4" below the shoulder.

D. The maximum difference in the above checks, indicates the amount of cylinder wear. If less than .008" reringing will be suitable; and if over .008", rebore.

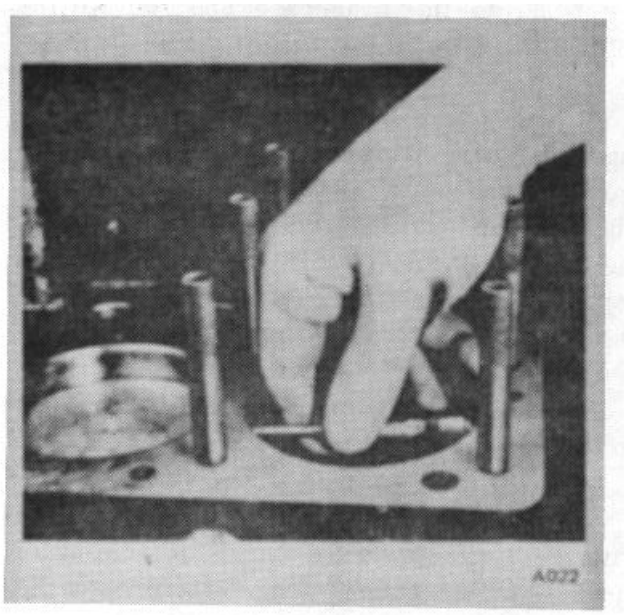


Figure 21.

PISTONS AND RODS

A. REMOVAL

1. Ridge ream the cylinders to remove the unworn area at the top so that the new rings when assembled will not bump and distort both themselves and the piston lands. (Fig. 22)

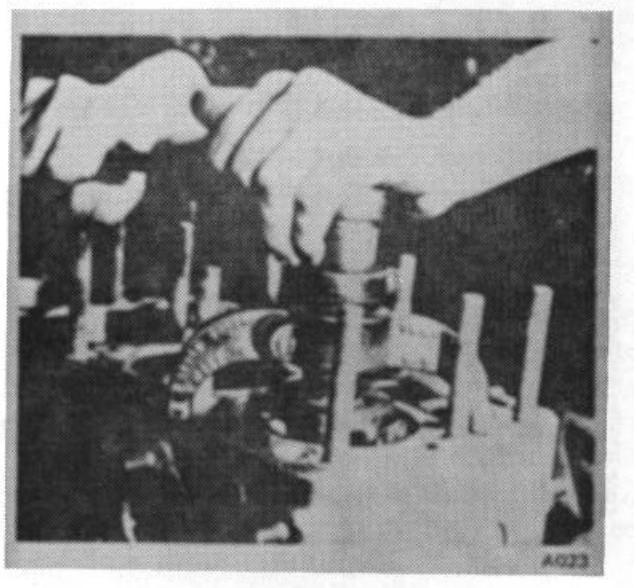


Figure 22.

2. Drain the crankcase and remove the oil pan.

3. Remove capscrews from the connecting rods, permitting removal of caps. Keep the caps and bolts in numerical order so that when the pistons and rods are removed from the engine, the cap can be reassembled and kept with its mating part. If not already numbered, do so at this time.

4. Push the pistons and connecting rods up through the top of the cylinders.

5. Cut the glaze on the cylinder bores with a de-glazer to assure quick seating of the new piston rings. (Fig. 23) Protect the crankshaft with oily (not dirty) rags during the deglazing operation.

NOTE:

The de-glazer, fitted with 220 grit stones, may be run up and down the cylinder bore while being turned with an electric drill until the shiny surface (glaze) is removed. These surfaces must then be throughly cleaned by wiping with a clean, oiled rag which will pick up the small particles. of dust that are embedded in the pores of the iron.

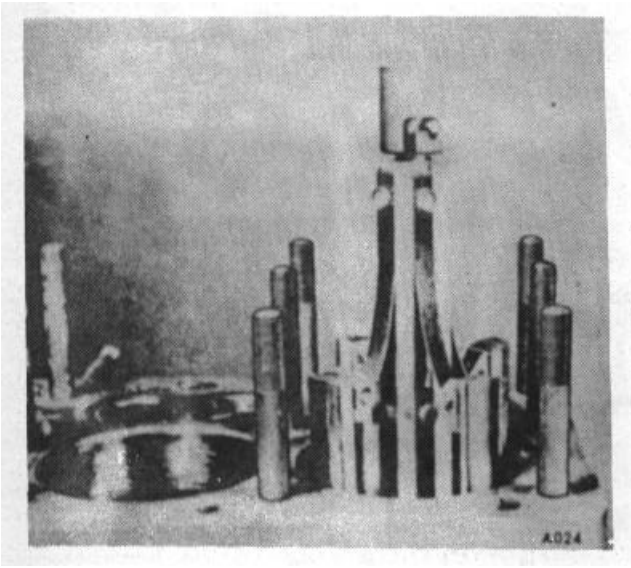


Figure 23.

6. Cross hatches should be clearly visible after glaze breaking operations. (Fig. 24)

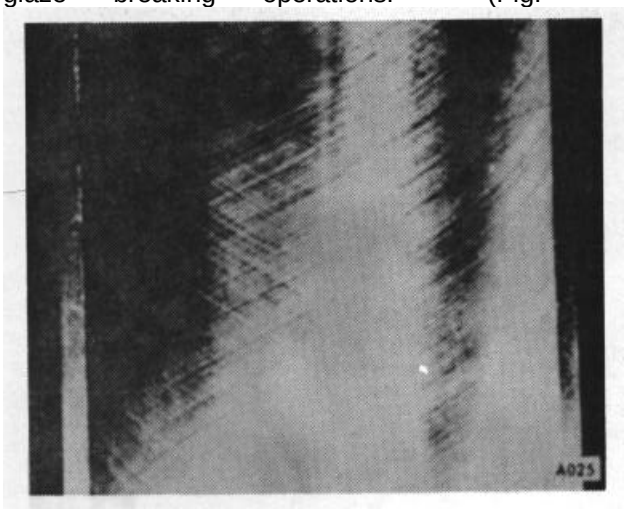


Figure 24.

B. PISTON FIT

1. Check the piston fit in the bore using a half-inch wide strip of .003 inch feeler stock attached to a small scale of approximately 15 lbs. capacity.

2. Insert the feeler between the piston and the cylinder, midway between the piston pin bosses. When the correct fit is obtained, a pull of 5-10 pounds on the scale will be needed to withdraw the feeler. (Fig. 25) The pistons must be fitted with the block and pistons at room temperature (68°-70°F).

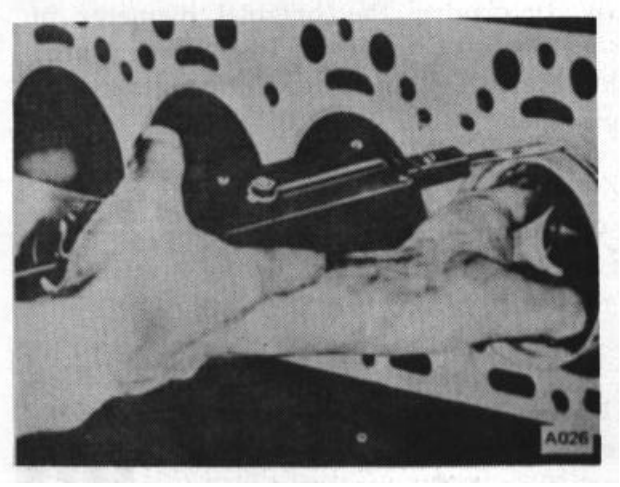


Figure 25.

3. Check the fit of the piston when it is approximately 2" down in the cylinder bore in an inverted position.

C. PISTON RINGS

1. Check all piston rings in the cylinders for gap whether using a re-ring set of piston rings in cylinder bores which have been ridge reamed or an oversize set for rebored cylinders.

2. To do this, insert a piston in the cylinder in an inverted position and then insert each ring, one at a time, about 2" down in the bore. Bring the bottom edge of the piston up against the ring to square it up in the cylinder bore.

3. Check the gap between the ends of the ring with a feeler gauge in accordance with specifications. If any of the rings do not have enough gap, they may be filed by clamping the file in a vise and holding the ends against opposite sides of the file as shown in Figure 26.

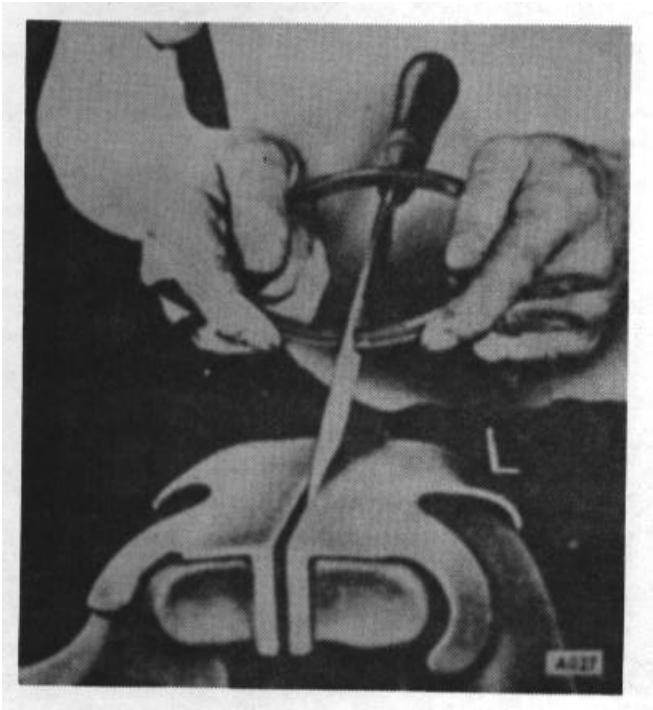


Figure 26.

D. PISTON PINS

1. Check the bushing in the upper end of the connecting rod for wear. If worn, and the original pistons are to be used with a service set of rings, an oversize piston pin may be installed.

2. The piston pin hole in the piston and the bushing in the connecting rod maybe honed to increase their diameter to obtain the desired fit. Replace the bushing in the connecting rod, if new pistons are used. Using an arbor press, press out the old bushing and press in the new one. (Fig. 27) Then the bushing must be honed to obtain the correct fit of the pin in the bushing.

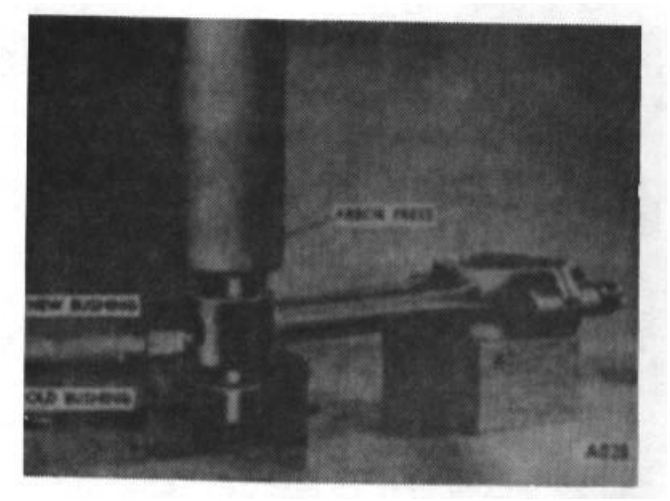


Figure 27.

3. If there is an excess of stock in the piston pin bushing, it may be reamed first, then honed. In any event, the final operation should be done with a hone to obtain the desired fit with better than 75% bearing area on the pin.

NOTE:
For bearing inspection refer to Main Bearing Section.

E. ASSEMBLY AND ALIGNING

1. Assemble the pistons on the connecting rod by first heating them in some form of

oven or in hot water to a minimum temperature of 160°.F.

2. With the piston heated, the pin will enter the piston easily and can be pushed on through the connecting rod and into place, without distorting the piston.

3. The snap rings must be assembled in the grooves. Make sure they are fully seated.

4. The piston pin hole in the connecting rod must be parallel to, and in the same plane as, the large bore in the bearing end of the connecting rod. This may be checked on a fixture with the piston. Figure 28 (Parallelism) and Figure 29 (Twist).

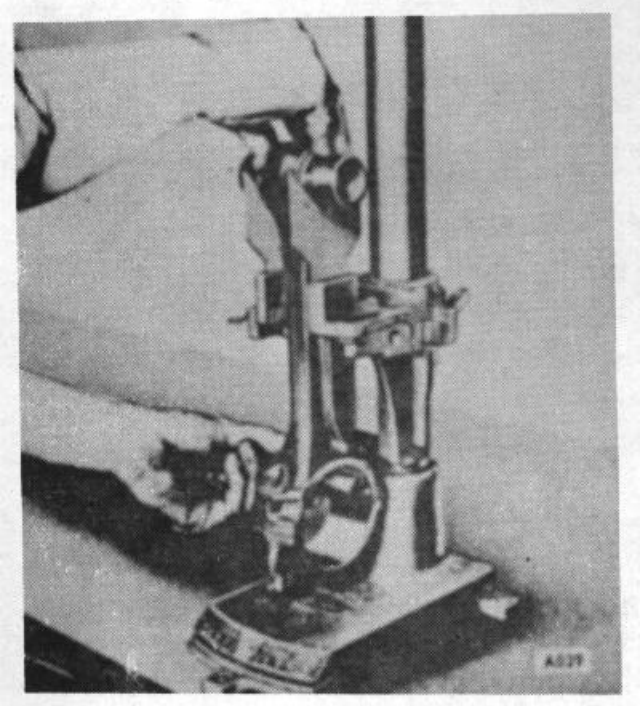


Figure 28.

5. The completed piston and rod assembly must be rechecked and there must not be more than .002" twist or out-of-squareness checked over a spread of approximately 4 inches. The connecting rod can be bent or twisted to meet this specification. (Fig. 30)

NOTE:
Pistons are cam and taper ground.

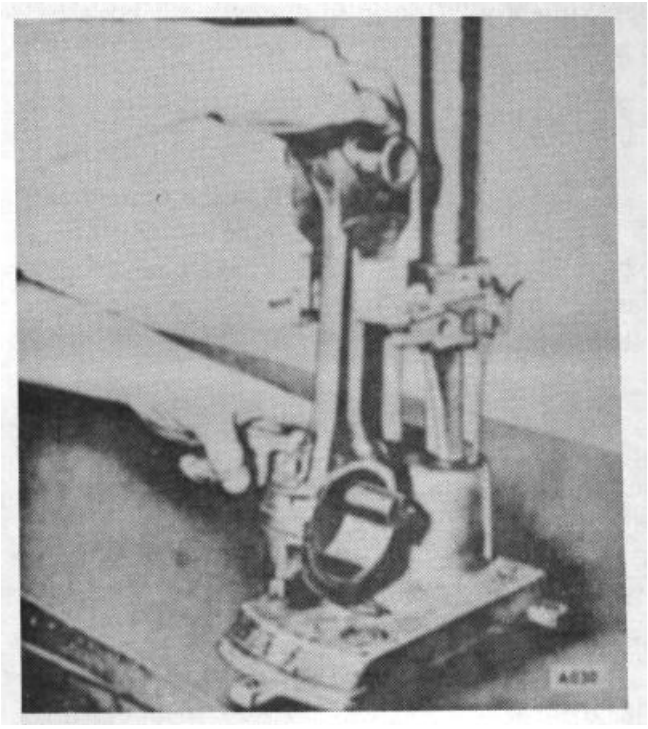


Figure 29.

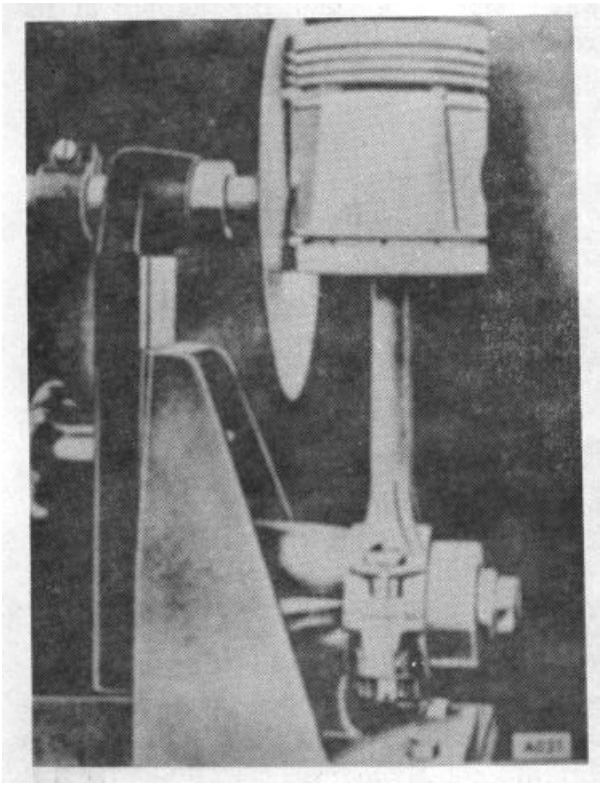


Figure 30.

This must be taken into consideration when checking alignment of the assembly, since the diameter in line with the piston pin would be less at the top of the skirt than at the bottom.

F. RECOMMENDED METHOD OF INSTALLING RINGS

1. Grip the connecting rod in a vise with lead lined jaws. Roll each of the straight side rings in its groove to be sure there are no burrs or other interference with the free action of the ring in the groove.

2. Check the ring side clearance at various positions with a feeler in accordance with the tolerances. (Fig. 31) If any of the rings lack clearance in the grooves they can be removed and lapped on a flat plate. Use crocus cloth to narrow them down to the desired clearance.

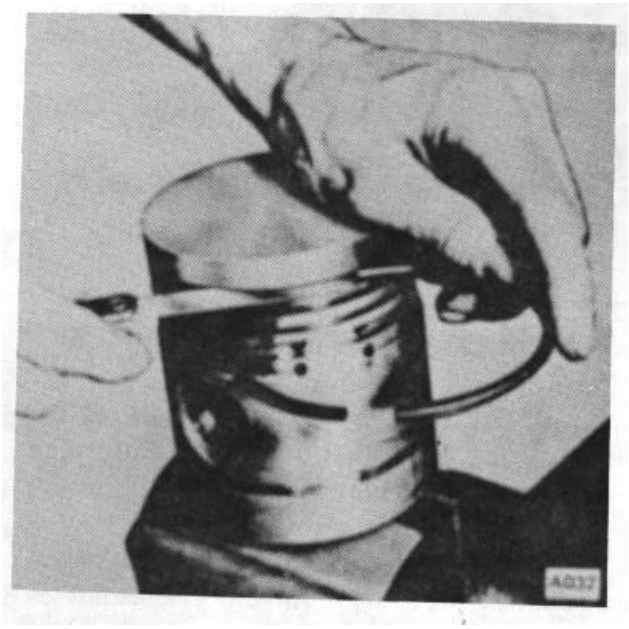


Figure 31.

3. Hold the ring tool with recess side up and place the ring in the groove with the bottom side up. (Fig. 32) Start with the lowest ring first. Some piston rings are taper-faced. These are clearly marked "TOP" on the side to be up when assembled on piston. (Fig. 33)

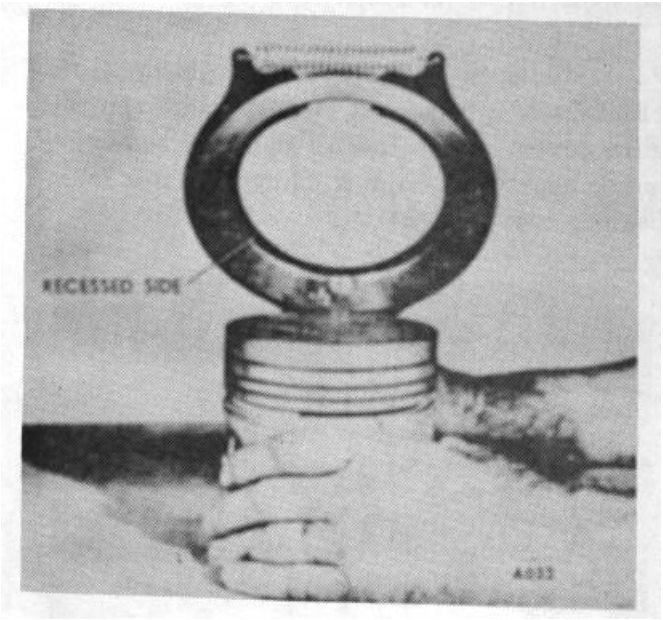


Figure 32.

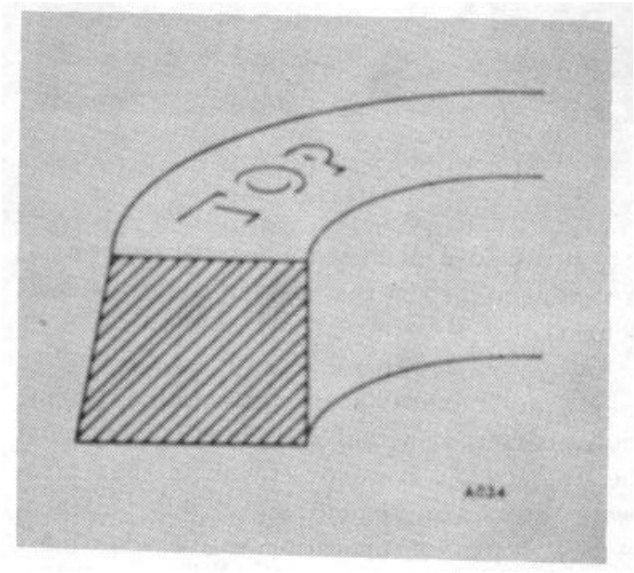


Figure 33.

4. Position ring in the tool so the expanding fingers will fully engage both ends.

5. Apply pressure on handles so ring is completely expanded. Pass the expanded ring and tool, recessed side down, over the piston to the proper groove.

CRANKSHAFT AND BEARINGS

1. Using a puller, remove pulley from crankshaft. Take out screws and remove gear cover. Drop the oil pump by removing nut or capscrews holding pump to center main bearing cap, (Fig. 34)

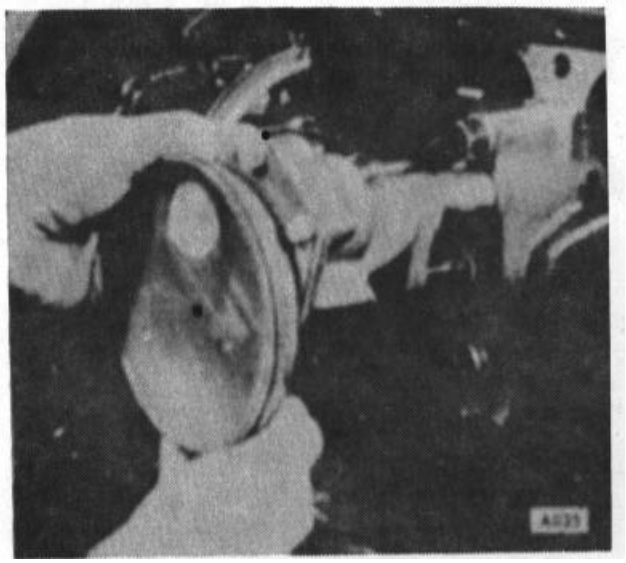


Figure 34.

2. Remove each main bearing cap, one at a time, and inspect the bearing and crankshaft Journal.

a. If there is any indication of flaking out, scoring or actual wear, the bearing must be replaced. However, tri-metal bearings, when new, are smooth and highly polished. A few hours of operation will change their appearance completely. The bearing surface becomes a leaden gray in color and develops minute craters, almost cellular in appearance as indicated in Figure 35. This appearance is a natural characteristic of this type bearing and in no way indicates failure.

3. If the visual inspection appears satisfactory, the bearings should be removed and checked for thickness using a ball micrometer. (Fig. 36)

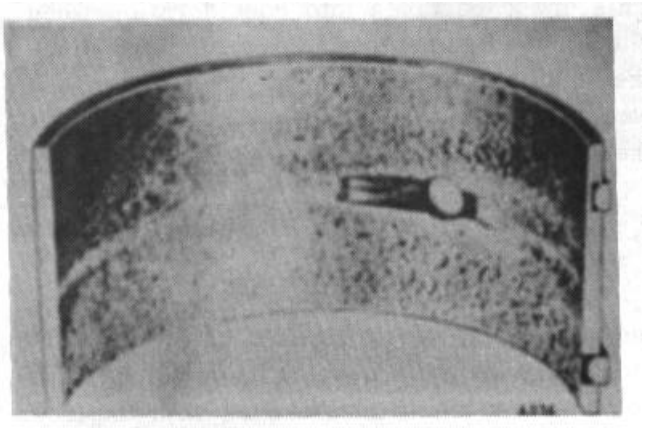


Figure 35.

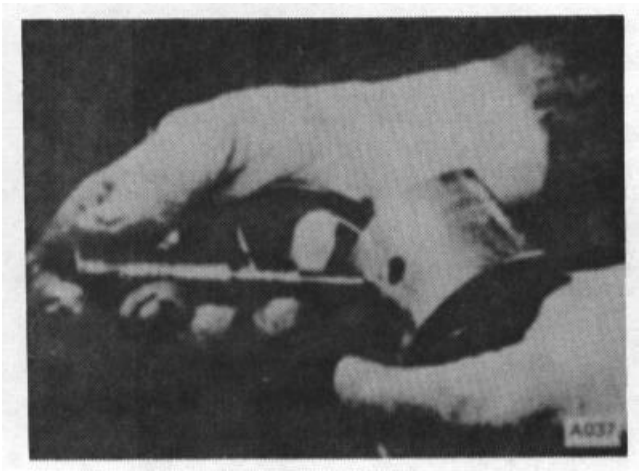


Figure 36.

NOTE:
Bearing thickness wear must not exceed more than ,0005 inch.

a. To remove the upper half of the main bearing shell, use a special tool which is a pin with an angular head.

b. Insert the pin in the oil hole of the crankshaft. (Fig. 37) As the crankshaft is turned in a clockwise direction, the head of the pin will pick up the bearing shell and force it out of the bore in the block. The bearing can be replaced by reversing this removal procedure. (Fig. 38)

4. If visual inspection of the crankshaft shows no indication of excessive wear or scoring, the clearance of the bearing should

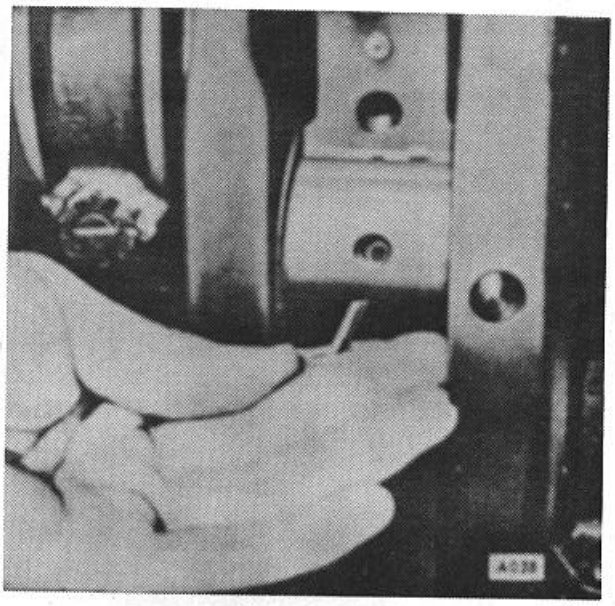


Figure 37.

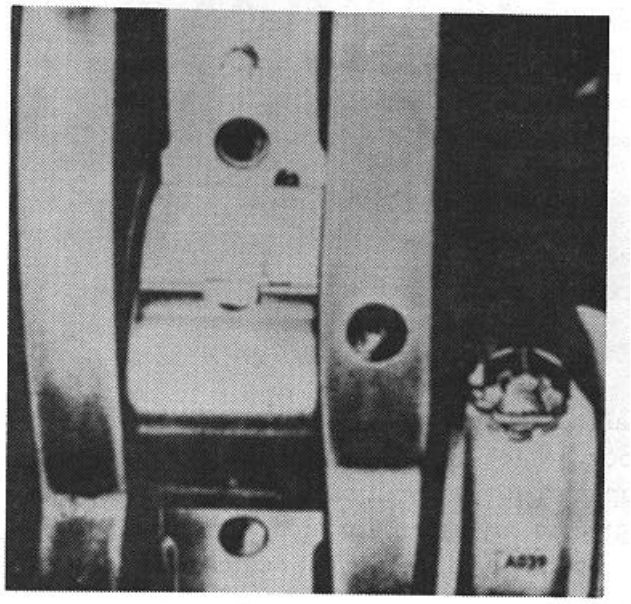


Figure 38.

be checked. Use a piece of feeler stock 1/2" wide and approximately 1/8,' shorter than the length of the bearing. Dress all edges carefully to be sure there are no burrs to mark the bearing.

5. Check each bearing, one at a time, by placing the feeler stock (the thickness of which should be equivalent to the maximum clearance permissible in the bearing lengthwise, in the bearing shell, on a film of oil. (Fig. 39) Assemble the bearing cap and tighten the screws, torquing them to specifications. Try to turn the crankshaft by hand to determine whether or not there is any drag.

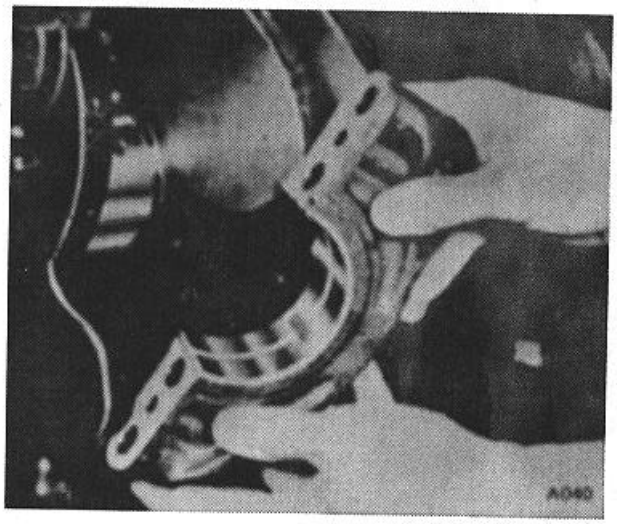


Figure 39.

6. If a definite drag is felt and the piece of feeler stock is equivalent to, but no more in thickness than the maximum clearance specified, neither the crankshaft or bearing is worn excessively as far as clearance is concerned. When using new bearings and the crankshaft is not worn, checking with a piece of feeler stock as outlined above should lock up the crankshaft, making it possible to turn only by use of a bar or wrench.

7. The same check can be made by using a piece of Plastigage.

CAUTION:
When using this method, do not turn the crankshaft as that would destroy the Plastigage. Compare the width of the plastic material with the gauge printed on the Plastigage envelope (Fig. 40) to determine the bearing clearance.

8. If crankshaft is scored, or worn enough so that new bearings will not fit with the

required clearance, it should be removed and reground. Crankshaft main bearing journals may be reground to decrease the diameter a maximum of .040 inch.

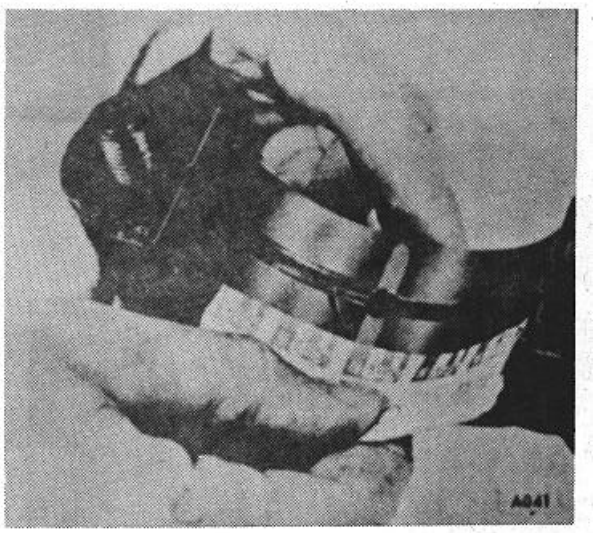


Figure 40.

9. Connecting rod bearings and crankpins may be checked in the same manner with one exception; instead of trying to turn the crankshaft when the connecting rod bearing is tightened on it with a piece of feeler gauge assembled, try to move the connecting rod from side to side. When the connecting rod is perfectly free, it will have from .006" to .010" side play and can be moved by a light touch of the fingers. With feeler stock assembled having a thickness equal to the maximum specified clearance, enough drag should be felt to require pressure to move the rod from side to side.

CAMSHAFT, TAPPETS AND TIMING-GEARS

A. REMOVAL

1. Remove valve cover. Then, using a puller, remove the cam and crank gears.
(Figs. 41 and 42)

2. Remove the screws holding the cam

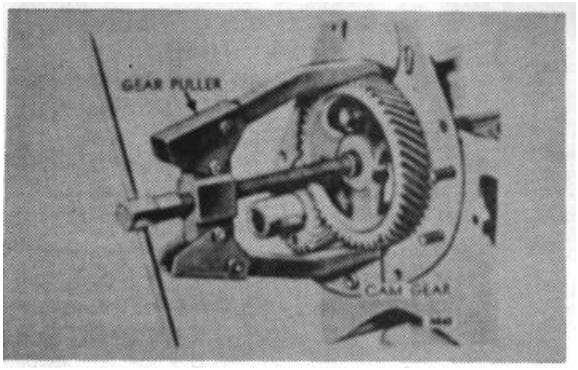


Figure 41.

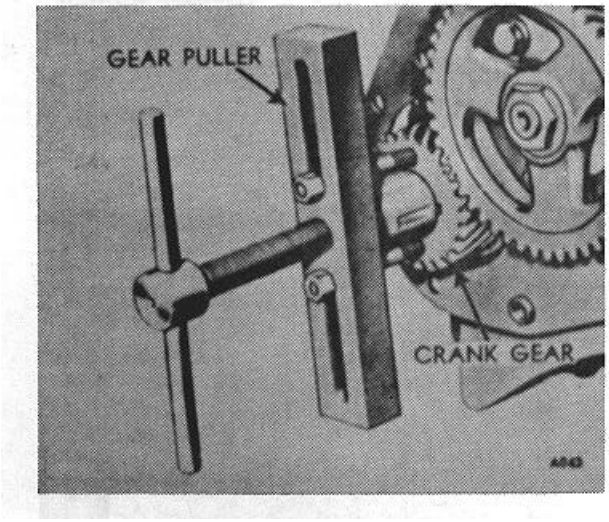


Figure 42.

shaft thrust plate to the front of the cylinder block, which makes it possible to pull the camshaft forward out of the bearings. Unless engine is laying on its side, tappets must be removed or lifted before camshaft can be pulled.

3. Remove tappet cover. Tappets can then be lifted out and lined up in sequence, for installation in the same location, less inspection shows that they require replacement.

4. Before pulling the camshaft completely, check the clearance of the bearing journals in the bushing. To do this, use strips of feeler stock 1/4" wide with edges dressed with a stone to eliminate any burrs or feathered edges.

5. If clearance is equal to or greater than the amount indicated under wear limits, check the diameter of the camshaft journals to determine the next step. Exessive wear at these positions requires replacement of the shaft.

NOTE

If wear is found to be in the bushings instead, these must be replaced using precision service bushings which require no reaming. Figure 43 illustrates bushing installation.

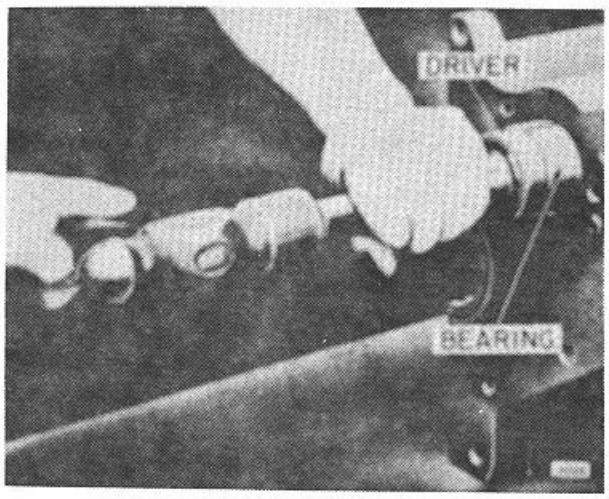


Figure 43.

B. INSPECTION AND ASSEMBLY

1. Tappets must be inspected visually for scores or damage to the contact face. Two or three small pits in the latter is acceptable.
More than that calls for replacement of the tappets. (Fig. 44)

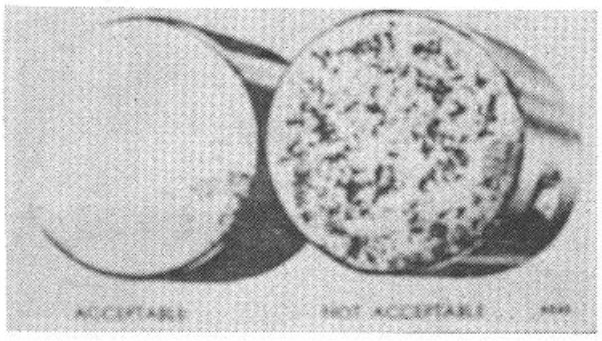


Figure 44.

2. Check the outside diameter with a micrometer to determine if replacement is necessary.

3. Tappet guides or guide bushings may be checked for wear with a plug gauge or preferably with a telescope gauge and micrometers.

4. Timing gears and timing gear fits must be checked carefully while the engine is being overhauled. To check the fit, use a screw driver to force the mating teeth as far apart as possible. Check the clearance with a feeler gauge. (Fig. 45) If the clearance is .002" or greater, or if the gear teeth are badly scuffed and worn, the gear must be replaced. Timing gears must be replaced in pairs.

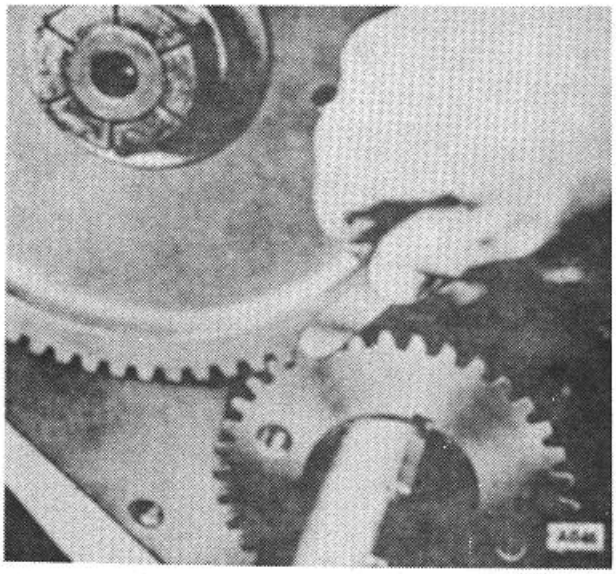


Figure 45.

5. Crankshaft gears and camshaft gears are furnished in standard, undersize, and oversize. Gears marked "S" are standard; if they are marked with figures "1" or "2" in a letter "U", they are undersize. If they are marked with figures in the letter "O" they are oversize.

6. Examine the camshaft thrust plate Figure 46, carefully for scoring and wear.

If there is evidence of either, a new thrust plate should be installed.

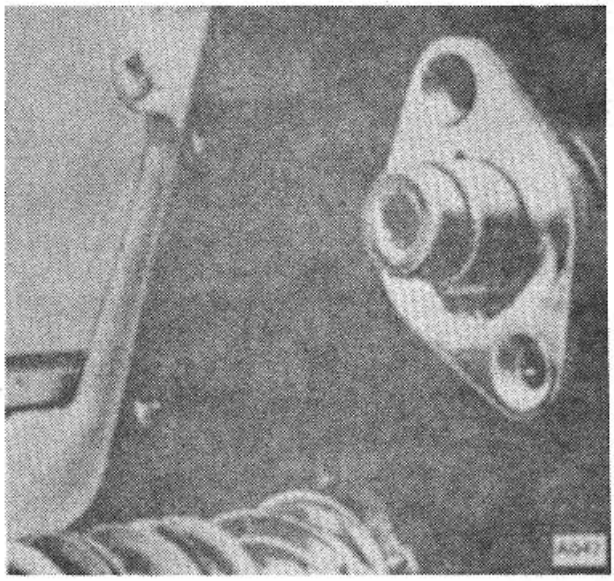


Figure 46.

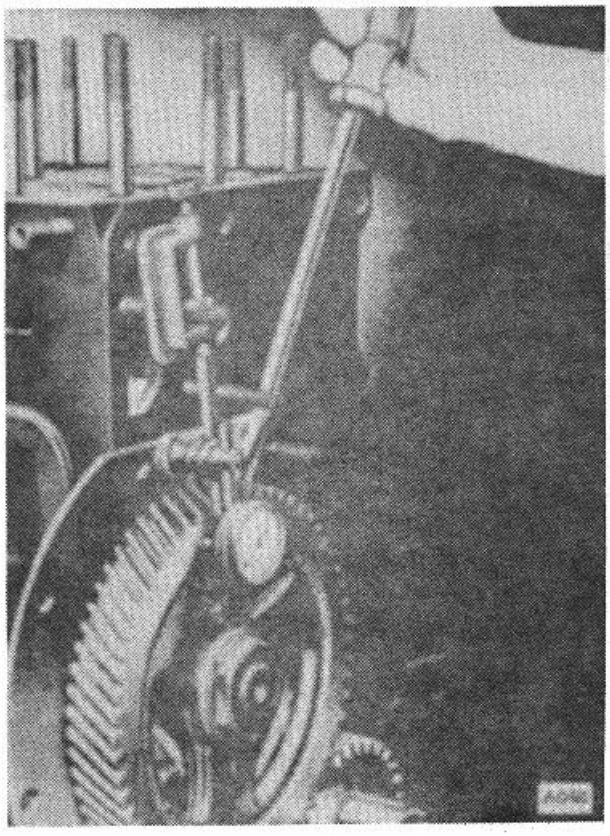


Figure 47.

7. Assemble the cam gear to the camshaft. Hold the camshaft forward so there is no possibility of its bumping the expansion plug at the rear end, forcing it out of position, and causing an oil leak. Check end play. (Fig. 47)

8. Inspect crankshaft thrust washers (Fig. 48) for wear and scoring. Replace if necessary before reassembling gear.

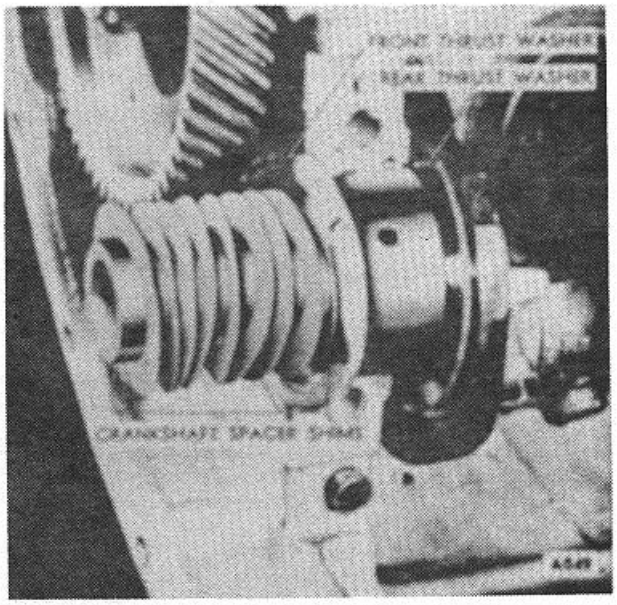


Figure 48.

9. Drive the crank gear on to the shaft (Fig. 49) making sure that the marked teeth on the cam gear straddle the marked tooth on the crank gear. (Fig. 50)

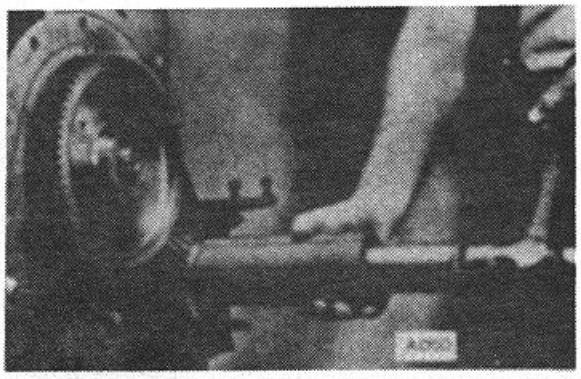


Figure 49.

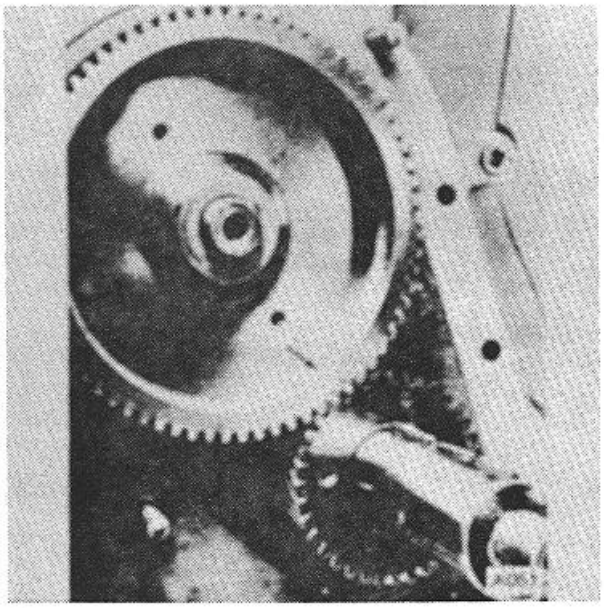


Figure 50.

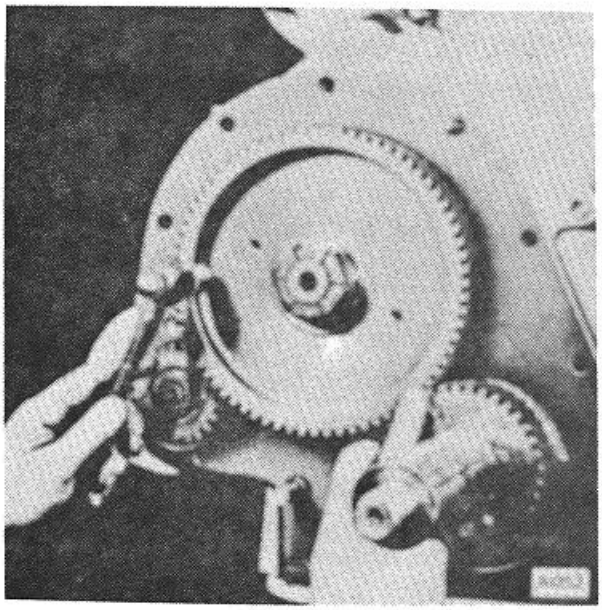


Figure 51.

10. Check the clearance with the above gears assembled in place. Using a screwdriver, pry the teeth as far apart as possible and check the clearance with a feeler gauge.
If a .0015" feeler will not enter the gap, the clearance is not excessive.

11. To be certain that there is enough clearance, hold your finger at the junction of the two gears and, with a light hammer, tap the rim of the cam gear and note if there is vibration felt at this point. (Fig. 51) If there is vibration and a .0015" feeler gauge will not enter the gap between the two gear teeth, the gear fit is within specifications.

12. Check crankshaft end play before replacing the gear cover.

NOTE:
A shim pack containing shims of .002" and .008" thickness is incorporated in the assembly between the front end of the main bearing journal and crankshaft gear. (Fig. 48) Removal or addition of shims will bring the end play to correct specifications.
The crankshaft gear must be tightened firmly against the shim pack when checking end play.

This can be done by using a sleeve or the regular pulley. Slip it over the crankshaft and use the standard assembly parts to tighten the pulley and gear in place.

13. After end play is adjusted, remove pulley. Replace crankshaft seal in the gear cover. Cement gasket to cover with quick drying cement. Install cover and pulley.

REAR CRANKSHAFT SEAL

A. GENERAL

To replace this packing and reassemble this rear seal, follow instructions carefully.

B. REMOVAL AND INSTALLATION

1. Remove the filler block and oil guard, the latter being the semi-circular die casting which fits in the cylinder block, in a groove machined just to the rear of the rear main bearing.

2. Clean all surfaces and grooves thoroughly. If a scraper or wire brush is used, be

very careful not to scratch or gouge the sealing surfaces. All dried cement or other material must be removed from these surfaces. Check filler block contact faces for flatness. Replace if warped.

3. The jute packing, as it is received, has a diameter approximately one-third greater than the width of the grooves. This must be crushed in a vise, or otherwise flattened narrow enough to be inserted in the grooves.

4. Press it into the grooves of both the filler block and oil guard as well as possible by hand. Then, using a piston pin, smooth hammer handle or some other tool with a smooth, rounded surface, iron the packing into the groove so that it is seated firmly and expanded to grip the sides. (Fig. 52) In its present condition the packing is long enough to protrude from the groove at both ends.

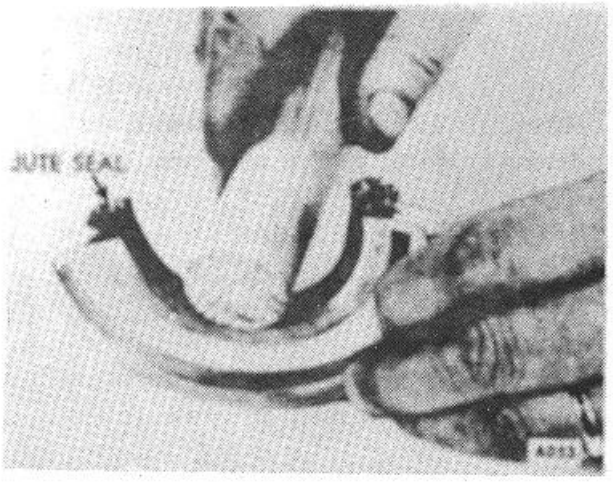


Figure 52.

5. With a sharp knife or razor blade, cut this off parallel to the surface of the casting, allowing it to protrude 1/32 inch.

C. INSTALLATION

1. Coat the outer or sealing surface of the oil guard with a non-hardening cement.

2. Slide into place around the crankshaft if engine is still assembled; or directly into the recess, if crankshaft is out.

3. Apply a light coat of non-hardening cement to hold the oil pan to filler block seal. (Fig. 53)

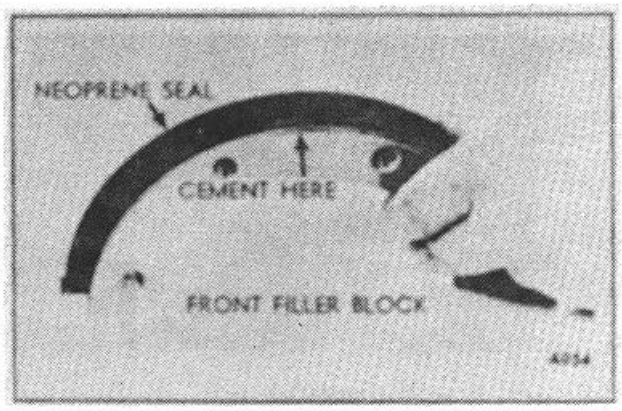


Figure 53.

OIL PUMP (Fig. 34)

A. GENERAL

The oil pump is assembled to the center main bearing and held in vertical position against a machined pad by studs. The extended portion of the body acts as a pilot, fitting closely in a reamed hole in the main bearing web, maintaining a definite relationship between the camshaft and the oil pump drive shaft. A gear assembled to the upper end of this shaft is driven by a mating gear cut on the camshaft, and drives the oil pump gear which is assembled to the lower end of the pump shaft.

The pump shaft is carried in two bronze bushings assembled in the cast iron housing, which is also a part of the oil distributing system. The capacity is well in excess of that required by the engine.

B. SERVICE (Fig. 54)

1. Note distributor rotor position before

removing the pump. When the pump is removed, examine the drive gear carefully for wear. Inspect the gear on the camshaft at the same time. The camshaft and pump gear must be replaced, if scored or badly worn,

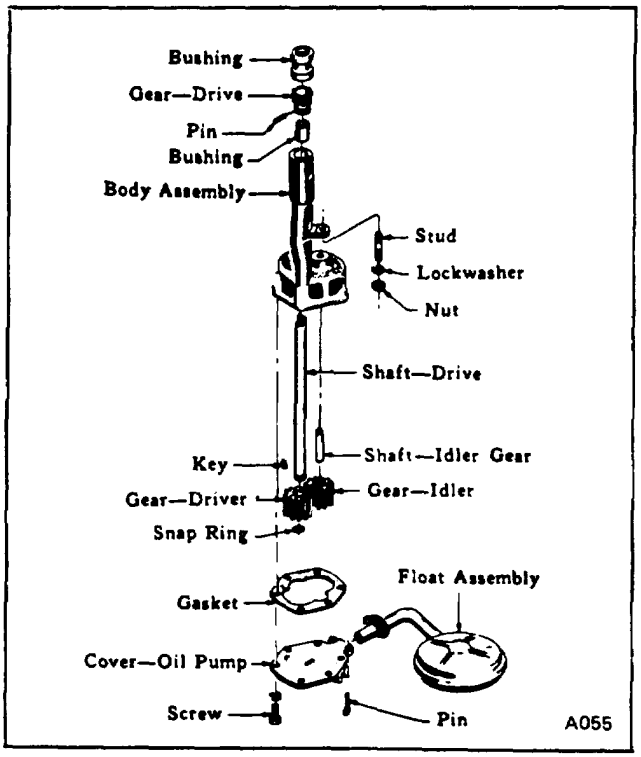


Figure 54.

2. Examine the pick-up screen for clogging or damage. Remove the cover. Be careful not to damage the lead gasket which acts as a spacer as well as a gasket. Examine the gears and pump body for any sign of wear indicating lack of clearance. The gears should have from .001" to .003" clearance in the chamber and should make no contact with the walls. (Fig. 55) Inspect the gear, cover and faces for excessive wear or scoring. With the gasket assembled in the body, there should be .0015" - .006" clearance between the gears and the cover. Worn or scored gears and a worn cover may be replaced. If the body shows wear in the chamber, it can be replaced, but complete pump replacement would be more economical.

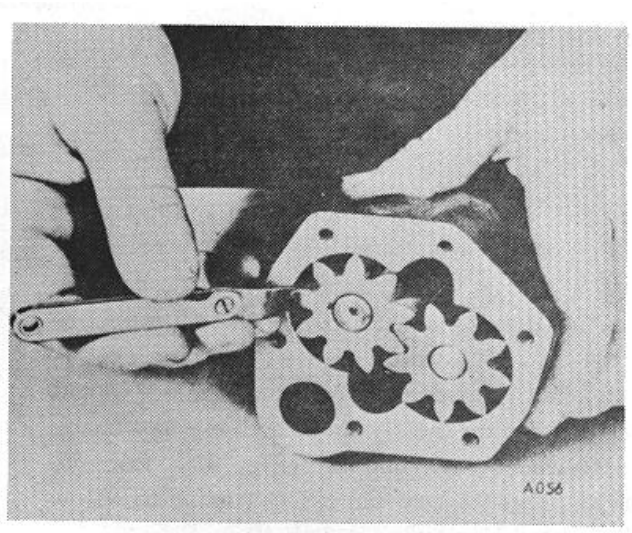


Figure 55.

3. Engine oil pressure must be maintained at 20 PSI at engine governed speed for satisfactory engine life. Pressure relief is located externally on the right-hand side, near the oil pan flange, at the center. (Fig. 56) Pressure is controlled by a plunger and spring, the latter specifically for a certain range. The only adjustment variation is either to change springs or add or remove washers from behind the present spring. Up to four washers are permissible. When replacing oil pump drive gear, it is necessary to line up the hole in the gear with the hole in the shaft.

NOTE:
Pressure check can be made at the oil-filter-inlet-line and block junction,

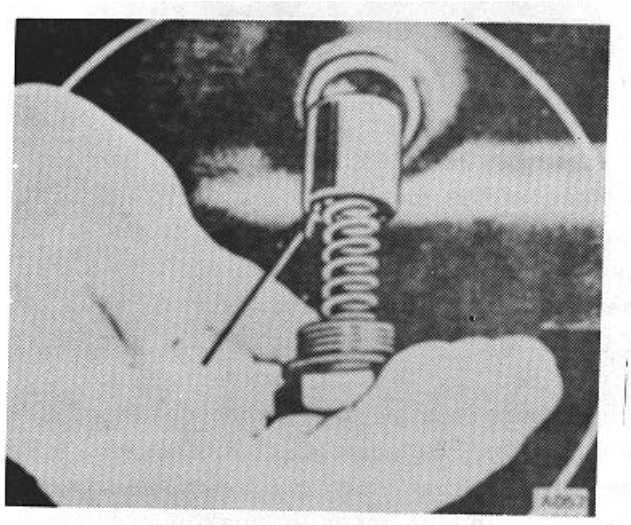


Figure 56.

FLYWHEEL AND FLYWHEEL HOUSING (Runout)

A. FLYWHEEL

1. The flywheel is machined and balanced so that the clutch face and locating counterbore will run true with its axis. To be sure that the crankshaft flange, or the counterbore in the flywheel which locates it on the crankshaft, has not been sprung or damaged, mount an indicator on the flywheel housing and check the flywheel for runout. (Fig. 57) Remove spark plugs before checking runout to allow free engine turnover.

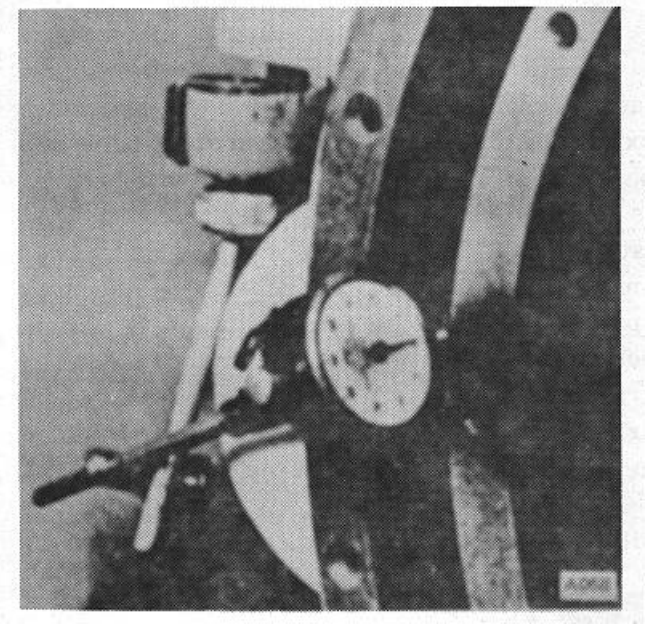


Figure 57.

2. The indicator should be set up so that it contacts the clutch face on the vertical surface of the clutch counterbore, then turn the flywheel one full revolution, at the same time holding against the crankshaft to offset the possibility of end play. Excessive runout of the flywheel in either position will probably be caused by dirt in, or damage to, the counterbore locating the flywheel on the crankshaft flange. Relocate the indicator to check the inside diameter of the counterbore.
(Fig. 58) In both cases the maximum indicator reading must not be more than .008".

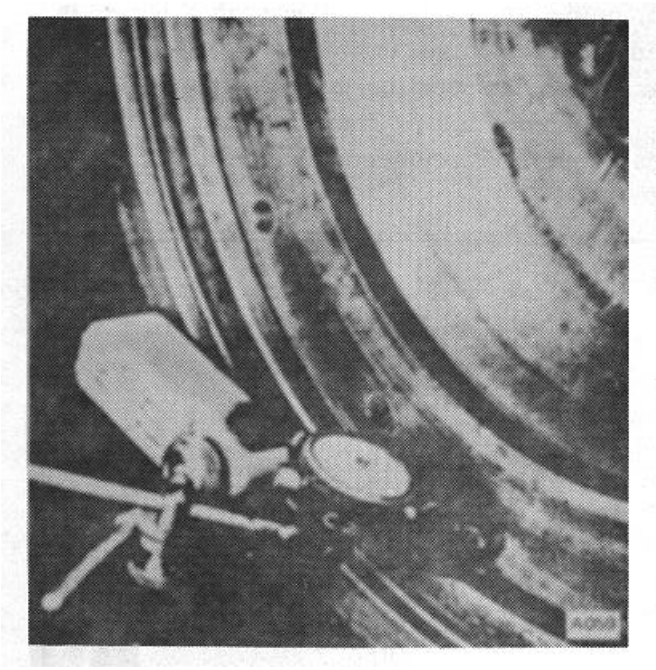


Figure 58.

B. HOUSING

When assembled, mount the indicator on the flywheel so that it contacts the housing face and turn the crankshaft, at the same time holding against it to counteract end play.
The maximum indicator reading must not exceed .008". (Fig. 59) Relocate the indi

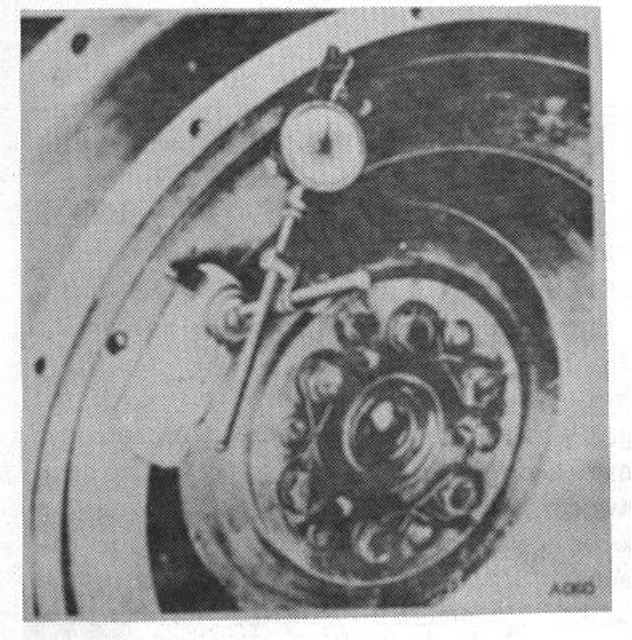


Figure 59.

cator to contact the housing bore and check in the same manner. The same runout limit prevails. (Fig. 60)

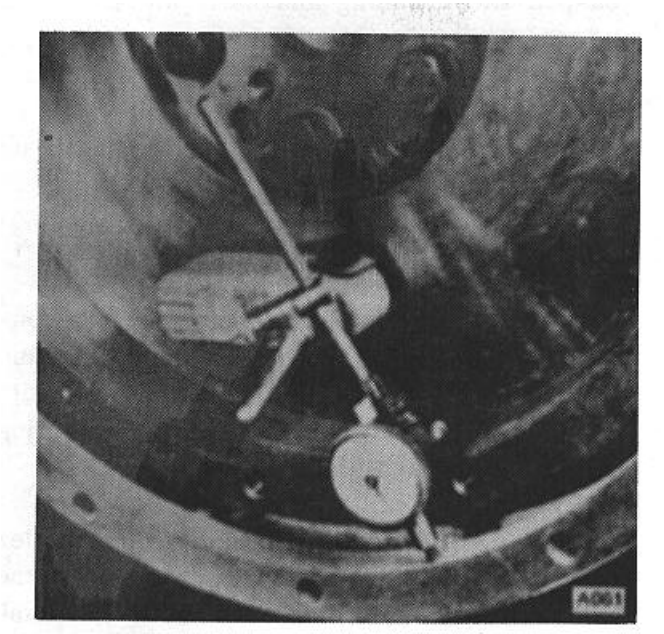


Figure 60.

GOVERNOR

A. GENERAL (Fig. 61)

This governor differs from conventional centrifugal governors principally in that round steel balls are used as the motivating force producer instead of masses of weight. The balls move out and in radially from the gov

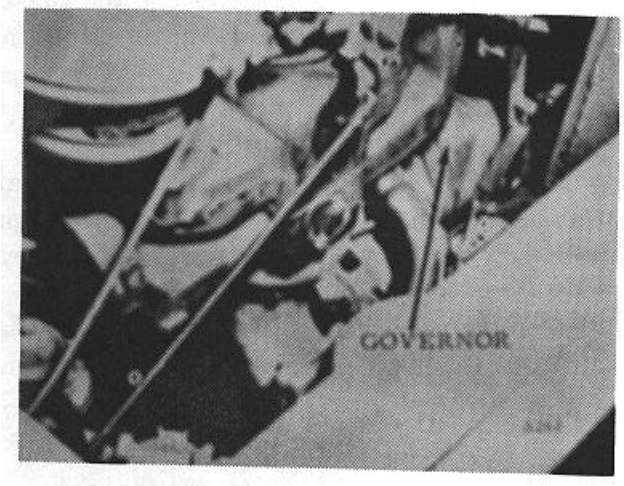


Figure 61.

ernor shaft on two hardened steel races. One race is a flat surface, the other conical in shape. As the balls move in and out they tend to raise or lower the conical shaped race, the motion of which is transferred through a fork or finger to the governing lever on the outside of the governor housing. The force created by the balls in their centrifugal movement is opposed by a spring on the governing lever, the other end of which is hooked to the speed adjusting screw lever, The balls move in a slotted driver which is pinned to the governor shaft; the two races are free floating on the shaft. When the engine is running at a fixed speed, all parts go around with the governor shaft and the thrust is taken on the thrust bearing between conical shaped race and fork base. When a change in speed due to change in load takes place, the relative speed between the balls and races is changed. Consequently, wear is distributed over the entire operating surface of the races and balls. Since the surfaces are hardened, little or no wear other than a polish should ever take place on the parts.

B. ADJUSTMENT

\

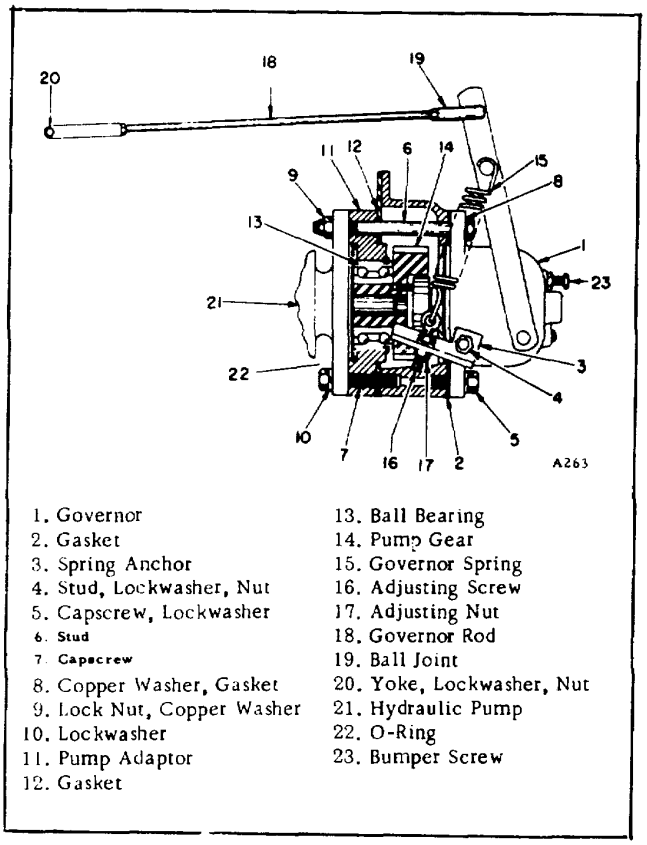
The hook-up of governor lever to carburetor lever should be done in the following manner:

1. Make sure carburetor shaft does not stick nor bind.

2. With governor lever in its normal position under spring tension, with engine shut-off, with carburetor lever in wide open throttle position, a rod of exact length to connect the two levers is inserted.

3. Make sure there is no bind nor sticking in the assembly of rods and levers. This is very important

4. The spring tension is adjusted by repositioning the spring anchor nuts. (Fig. 62)



1. Governor
2. Gasket
3. Spring Anchor
4. Stud, Lockwasher, Nut
5. Capscrew, Lockwasher
6. Stud
7. Capscrew
8. Copper Washer, Gasket
9. Lock Nut, Copper Washer
10. Lockwasher
11. Pump Adaptor
12. Gasket
13. Ball Bearing
14. Pump Gear
15. Governor Spring
16. Adjusting Screw
17. Adjusting Nut
18. Governor Rod
19. Ball Joint
20. Yoke, Lockwasher, Nut
21. Hydraulic Pump
22. O-Ring
23. Bumper Screw

Figure 62

Turning the nuts clockwise increases the spring tension thus raising the engine speed.
Turning the nuts counterclockwise decreases the spring tension. After making the adjustment, be sure to tighten the two locknuts.

5. Should governor surge at no-load high idle, screw bumper screw (Fig. 62) in until surge is eliminated. Do not run bumper screw in far enough to increase speed.

C. SERVICE

The driver must always be tight to the shaft.
The races must be free on the shaft. In assembly of the governor a space of .004" to .006" is provided between the driver and the flat race. This is to assure freedom for movement of the flat race. When servicing the governor, make sure that both races revolve freely on the shaft. When the balls are "in", that is, in the bottom of the driver slots, the space between the top of the conical shaped race bushing and hair pin clip should be .230" - .240". Use .010" spacer washers to obtain required space. The governor shaft is pressed into the gear and secured with a screw that is partially in the shaft and partially in the gear.

ASSEMBLY

1. When reassembling pistons and connecting rods, use a good ring compressor and oil the bores thoroughly. A hammer handle may be used to tap the pistons out of the ring compressor into the cylinder bore.

2. Use care to prevent damage to cylinder bore finish by the connecting rods when the connecting rods are assembled over the crank pin. Locate them carefully to prevent damage to the bearing surface, and crankshaft journals.

3. Always lubricate the bearings with clean engine oil when assembling. Tighten the bearings to specified torque. Use lockwires as required to prevent loosening of nuts and screws.

4. Clean the cylinder head and block surfaces thoroughly before installing the gasket.
Tighten all cylinder head capscrews evenly and in specified sequence. Torque to specification.

5. Make certain the gasket surfaces are flat and clean, before assembling the oil pan with new gaskets. Tighten screws in accordance with specified limits. When engine is assembled and filled with proper oil, set tappets. (Fig. 63) See Specification Listing.

INSTALLATION

After engine is placed in the chassis and major components are installed, perform the following:

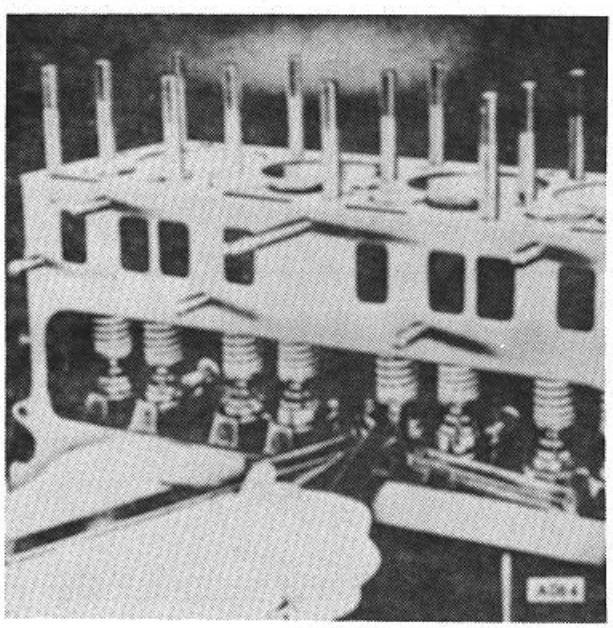


Figure 63.

1. Connect hydraulic lines. Torque enough to prevent vacuum and pressure leaks. Clean all electrical terminals and connect wires. Connect vacuum lines with sufficient torque to prevent leaks.

2. Fill hydraulic tank, engine and transmission, with specified oils.

3. Connect and tighten fuel lines. Check fuel supply and replace battery.

4. Re-check installation. If all is in order, start engine. As soon as engine is running, oil pressure should rise as lubricating system is charged. This takes several seconds.

CAUTION

Shut-down engine if oil pressure does not rise within a reasonable length of time.

5. Run engine at a fast idle while installing the hood and checking installation for leaks.

6. After engine and transmission are at operating temperature, re-check oil levels, and power-shift transmission linkage.

MAINTENANCE

A. DAILY INSPECTION

Perform the following daily, or according to operating conditions.

1. Over-all visual inspection of engine. Look for evidence of fluid leakage on floor, cylinder head and block, indicating loose fuel, oil or water connections - tighten if found.

2. Check oil level.

3. Fill with clean fuel. This should be done at end of day's operation to prevent condensation forming in tank. Clean filler cap and area around spout before filling to prevent entrance of dust into fuel system.

4. Check air cleaner. (Fig. 64) 5. Check oil pressure.

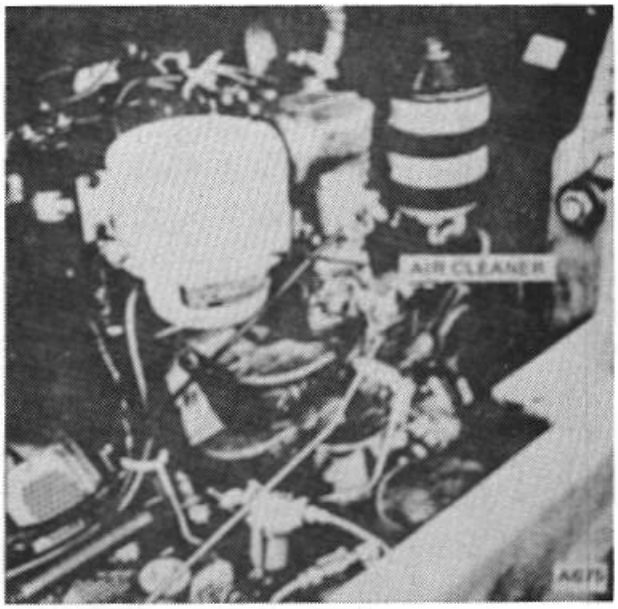


Figure 64.

B. RADIATOR

Drain the radiator every 1000 hours and flush with fresh water to remove rust and other foreign deposits. To completely drain the

cooling system, open the drain cocks on the bottom of radiator and left side of cylinder block. Chemical mixtures should not be used to attempt to stop radiator leaks. Use only permanent-type anti-freeze in winter. If water only is used in the system, add a good commercial rust inhibitor in the proportion recommended by the inhibitor manufacturer.

C. REVERSE FLUSH THE RADIATOR (Fig. 65) AS FOLLOWS

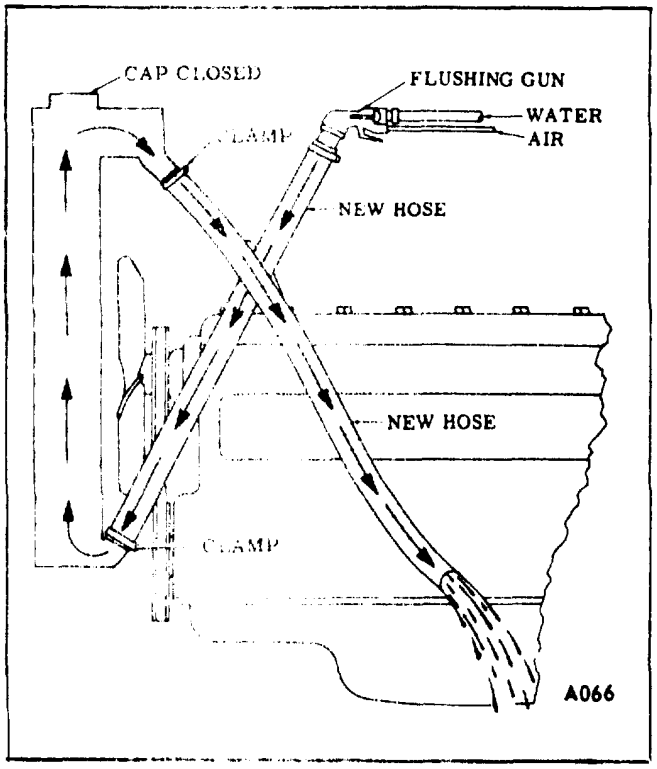


Figure 65.

1. Disconnect the hoses at the engine.
2. Tighten radiator cap.
3. Clamp the flushing gun in the lower hose with a hose clamp.
4. Turn on the water and let it fill the radiator.
5. Apply air pressure gradually, to avoid radiator damage. (Not -more than 10 PSI)
6. Shut off air, again fill the radiator with water and apply air pressure - repeat until the flushing stream runs clear.
7. Clean and inspect radiator cap.

D. TO REVERSE FLUSH THE ENGINE. (Fig. 66)

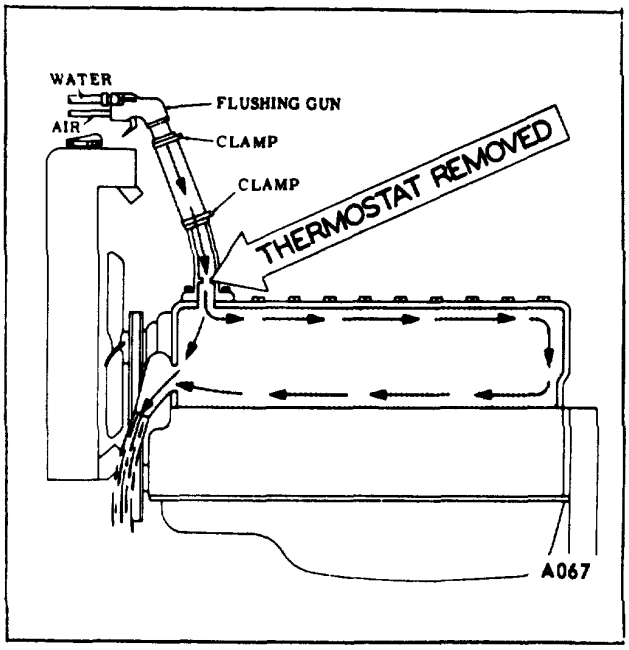


Figure 66.

1. Remove the thermostat.
2. Clamp the flushing gun in the upper hose.
3. Partly close the water pump inlet to fill the engine water jacket before applying the air.
4. Follow the same procedure outlined above for the radiator by alternately filling the water jacket with water and blowing it out with air (80 PSI) until the flushing stream is clear.

E. TESTING THERMOSTAT

1. Remove thermostat housing cover and thermostat. Before testing, clean and examine

the bellows for rupture or distortion. If the valve can be pulled or pushed off its seat with only a slight effort when cold or it does not seat properly, the unit is defective and must be replaced.

2. The thermostat can be tested by the following method:

a. Hang thermostat by its frame in a container of water so that it does not touch the bottom.
b. Heat the water and check temperature with a thermometer.
c. If the valve of a 180° thermostat does not start to open at temperature of 165-1750F, or if it opens well before the 1650 point is reached, the thermostat should be replaced. Thermostat should be fully open between 1800 and 1850. When checking thermostats of different rating, the foregoing temperatures will vary accordingly. When replacing the thermostat, be sure seal is in place and seal seat, as well as counterbore, is clean. Assemble new gasket to housing contact surface. Thermostat flange must seat in counterbore with gasket sealing contact between it and the cover.

F. FAN BELT

When tightening fan belts, loosen the alternator mounting and adjusting bolts and pull out on the alternator by hand until the belt is just snug. Under no consideration should a pry bar be used on the alternator to obtain fan belt tension or damage to the bearings will result. When adjusted correctly, the fan belt should have between 1/2 inch deflection on the long side. Tighten alternator mounting and adjusting bolts when adjustment is completed.

G. COMPRESSION

Warm up engine to operating temperature. Remove all spark plugs and block throttle wide open. Insert compression gauge in first spark plug hole and hold it firmly. (Fig. 67)

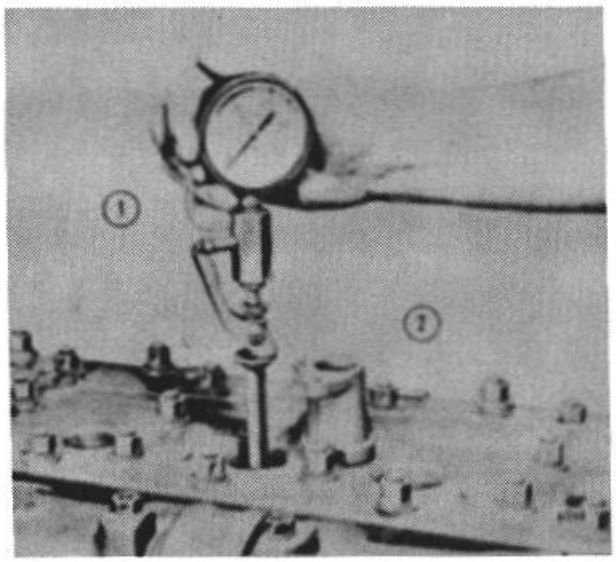


Figure 67.

Crank engine until the highest gauge reading is obtained. Check all cylinders in this manner. If readings are low in two adjacent cylinders, a blown head gasket is indicated. If readings are low and vary widely (more than 10 PSI), pressure is being lost either at the pistons, rings or valves. To determine where pressure loss is occurring, insert about one tablespoon of SAE 30 engine oil through the spark plug hole. Take a new reading. If this reading is higher than the initial reading, the piston rings are faulty. If reading is the same as the initial reading, the valves may be leaking or the cylinder head gasket is damaged.

H. ADJUST VALVE TAPPET CLEARANCE

Check and adjust if necessary to specified clearance both intake and exhaust valves after the engine has warmed up to running temperature. Turn the adjusting screws in or out until the correct feeler gauge clearance is obtained.

TROUBLESHOOTING

CAUSE	REMEDY
Engine Will Not Crank	
1. Dead or weak battery	1. Recharge or replace battery.
2. Poor ground connections, poor connections at battery terminals	2. Disconnect battery cable. Clean battery terminals and cable ends. Inspect and replace cable if necessary.
3. Faulty ignition switch	3. Replace switch.
4. Defective starter	4. Replace or repair starter as necessary.
5. Internal engine seizure	5. If unable to turn engine manually, check for damaged flywheel gear and starter pinion, foreign matter on top of piston or piston seizure.
Engine Cranks But Will Not Start	
1. Out of fuel	1. Fill tank. Open shut-off valve.
2. Slow cranking speed	2. Recharge or replace battery. Check starter, repair if necessary. Clean, inspect and replace battery cable if necessary.
3. Low compression	3. Re-seat valves, install rings or rebore block. Install oversize pistons as necessary.
4. No ignition	4. Check and repair ignition system if necessary. Refer to ELECTRICAL Section.
5. No fuel at the carburetor	5, Fill fuel tank. Check and repair fuel pump. Inspect fuel lines, repair and tighten connections as necessary.
6. Defective choking mechanism	6. Make sure the cable is free to operate and that the cable opens and closes the carburetor choke valve completely.
Engine Misses Intermittently	
1. Spark plugs dirty, cracked or shorted by moisture on electrodes	1. Clean, replace or dry spark plugs as necessary.
2. High tension wires broken or shorted	2. Replace wires.

TROUBLESHOOTING

CAUSE	REMEDY
3. High tension wires corroded in distributor cap	3. Clean or replace terminals if necessary. Replace distributor cap if necessary.
4. Faulty distributor points, condenser or coil	4. Clean, adjust, or replace parts as necessary.
5. Valve tappets adjusted too close	5. Adjust to specified clearance.
6. Worn valve guides	6. Ream guides and replace valves with ones having larger stems.
7. Leaking head gasket	7. Tighten cylinder head nuts to proper tension and adjust valves. Replace head gasket if necessary.
8. Cracked cylinder head	8. Replace head.
9. Cracked valve seat or water jacket	9. Install valve seat insert. Replace block if necessary.
10. Air leak in intake manifold	10. Tighten intake manifold capscrews, carburetor mounting nuts, vacuum advance line or vacuum hose. Replace gaskets and other parts as necessary.
<u>Loss Of Power</u>	
1. Engine missing intermittently	1. Refer to "Engine Misses Intermittently".
2. Engine ignition out of time	2. Check distributor advance mechanism. Adjust or replace parts as necessary. Adjust timing to specifications.
3. Valves or valve seats worn and leaking	3. Re-seat valves or replace.
4. Piston rings worn, stuck in grooves or broken	4. Replace rings. Bore cylinders oversize and install new piston assemblies if necessary.
5. Tappets set too close or sticking	5. Adjust to specified clearance. Remove and clean tappets.
6. Power leakage past spark plugs	6. Install new spark plug gaskets, and tighten spark plugs.
7. Worn cylinders	7. Bore cylinders to oversize and install new piston assemblies.

TROUBLESHOOTING

CAUSE	REMEDY
8. Valve springs weak or broken	8. Replace valve springs.
9. Incorrect valve timing	9. Reset timing. Install new gears or camshaft as necessary.
10. Water or sediment in fuel tank of fuel filter.	10. Drain and clean fuel tank. Replace fuel filter element.
11. Air cleaner clogged	11. Service air cleaner.
12. Exhaust pipe or muffler restricted	12. Replace parts as necessary. Free-up heat control valve.
Engine Knocking	
1. Loose or worn main bearings (heavy, dull knock when accelerated under load)	1. Replace main bearings. Grind crankshaft and install undersize bearings if necessary.
2. Loose connecting rod bearings (condition noted at idling speed or light load and knock diminishes as load is increased)	2. Replace rod bearings. Grind crankshaft and install undersize bearings if necessary.
3. Loose piston pins (sharp metallic rap at idling speed or when starting cold engine)	3. Install oversize pins or piston assembly.
4. Loose pistons (noted at low speeds, especially with a cold engine)	4. Bore cylinders and install oversize piston assemblies.
5. Overheated engine	5. Refer to "Overheating."
6. Insufficient lubricating oil	6. Drain oil., and refill to "Full" mark on gauge.
7. Loose flywheel	7. Replace flywheel if mounting holes are elongated or pilot hole is out-of-round. Tighten mounting nuts to correct tension. Replace crankshaft if flywheel mounting flange is out-of-round.
8. Excessive crankshaft end play (indicated by an intermittent knock which will come and go when clutch is operated or load is released and engaged.)	8. Install new crankshaft thrust bearing.
9. Excessive camshaft end play (noise usually occurs at half engine speed)	9. Install new camshaft thrust bearing.

TROUBLESHOOTING

CAUSE	REMEDY
10. Bent connecting rod	10. Straighten or, if necessary, replace the connecting rod. Replace the piston assembly if necessary.
Operating Knocks	
1. Pre-ignition	1. Clean spark plugs. Install spark plugs of a lower heat range.
2. Ignition timed too early	2. Adjust timing to specifications.
3. Low octane fuel	3. Fill tank with fuel of higher octane rating.
4. Overloading	4. Use lower gear or reduce load.
5. Excessive accumulation of carbon in combustion chamber	5. Clean or remove carbon deposits.
6. Hot spot in combustion chamber due to carbon deposit or clogged water passage	6. Remove carbon and open water passage.
7. Engine operating too hot	7. Refer to "Overheating."
8. Carburetion or fuel mixture incorrect	8. Check carburetor. Reset, repair or replace as necessary.
9. Spark plug gaps too wide	9. Adjust gaps correctly.
Explosion In Muffler	
1. Ignition too late	1. Correct ignition timing.
2. Weak spark	2. Check condenser, distributor, coils and wires. Adjust and replace parts as necessary.
3. Exhaust valves holding open	3. Check tappet clearance, springs and guides. Clean and replace parts as necessary.
4. Exhaust valves warped	4. Reface or replace.
Explosion In Carburetor Or Air Cleaner	
1. Fuel mixture too lean	1. Clean carburetor, check fuel level in bowl.
2. Intake valves holding open	2. Check tappet clearance, springs, guides, etc.

TROUBLESHOOTING

CAUSE	REMEDY
3. Intake manifold leaking	3. Tighten manifold nuts. Replace gaskets if necessary.
Excessive Fuel Consumption	
1. Carburetor worn or improperly adjusted	1. Repair carburetor as necessary.
2. Fuel leaks	2. Repair fuel system as necessary.
3. Sticking controls	3. Oil controls and eliminate binding.
4. Excessive idling	4. Shut engine off when not in operation.
5. Excessive use of choke	5. Push choke button in when engine is warm. Adjust choke cable so choke valve will open completely.
6. Dirty air cleaner	6. Service air cleaner.
7. Engine over heating	7. Refer to "Overheating."
8. Engine running too cold	8. Refer to "Overcooling."
9. Engine in poor condition	9. Repair engine as necessary.
10. Defective or mis-adjusted ignition system	10. Adjust spark plug gaps. Adjust distributor point gap. Adjust timing to specifications. Repair ignition system as necessary.
Over Heating	
1. Lack of coolant	1. Add coolant.
2. Fan belt improperly adjusted	2. Adjust fan belt deflection to 1/2 inch.
3. Carburetor choke valve partly closed	3. Adjust choke cable so that the choke valve will open completely.
4. Thermostat sticking in the closed position	4. Clean, test and, if necessary, replace thermostat.
5. Cooling system dirty	5. Clean and flush cooling system. Refill with clean coolant containing rust inhibitor.
6. Hoses deteriorated	6. Replace hoses.

TROUBLESHOOTING

CAUSE	REMEDY
7. Inlet hose collapsing, especially during acceleration	7. Replace hoses.
8. Defective water pump	8. Rebuild or replace water pump.
9. Dirt or insects in radiator air passages	9. Remove foreign particles.
10. Exhaust system restricted	10. Replace muffler and exhaust pipes as necessary. Make sure the heat control valve is functioning.
Over Cooling	
1. Thermostat sticking open thermostat.	1. Clean, check, and, if necessary, replace
2. Low ambient temperature temperature into operating range.	2. Cover radiator sufficiently to bring water
Excessive Exhaust Smoke	
1. Too much oil in the crankcase (blue smoke)	1. Drain oil to "Full" mark on gauge.
2. Worn rings, pistons, cylinders or intake valves guides (blue smoke)	2. Install new rings. Bore cylinders and install oversize piston assemblies. Ream valve guides and install valves with oversize stems.
3. Too much fuel entering the combustion chamber (black smoke)	3. Install new needle and seat and adjust carburetor float level. Install new fuel pump if pump pressure is too high.
4. Oil leaks at screws, gaskets and oil seals	4. Tighten screws. Replace gaskets and oil seals as necessary.
5. Inferior grade of oil (blue smoke)	5. Drain crankcase and refill with good grade of oil.
6. Over heating	6. Refer to "Overheating."
7. Ring gaps too great or not staggered (blue smoke)	7. Install new rings, with gaps staggered.
8. Main or connecting rod bearings loose (blue smoke)	8. Replace bearings as needed.

TROUBLESHOOTING

CAUSE	REMEDY
9. Air cleaner clogged (blue smoke)	9. Service air cleaner.
10. High oil pressure	10. Free-up relief valve in the oil pump. Replace spring if necessary.
Bearing Failures	
1. Continuous overspeeding of the engine	1. Continuous operation at maximum speed or close to it is to be avoided. Exercise caution when going down grade. Do not allow vehicular speed to exceed same speed obtainable in same gear on level terrain.
2. Lack of oil	2. Keep oil level at "Full" mark on bayonet gauge.
3. Inferior grade of oil or oil of improper viscosity	3. Use good quality oil of proper viscosity.
4. Low oil pressure	4. Check oil level. Fill to "Full" mark on gauge. Check oil pump and relief valve spring. Replace parts as necessary.
5. Bent connecting rod	5. Replace connecting rod.
6. Crankshaft rough or out-of-round	6. Regrind or replace shaft.
7. Restricted oil passages	7. Clean oil lines and passages. Replace oil filter element.
8. Bearings loose or improperly fitted	8. Replace main or connecting rod bearings.
9. Dirt or other matter in lubricating oil	9. Drain crankcase and refill with clean oil. Service breather air filter regularly. Replace oil filter element.
Low Oil Pressure	
1. Oil pressure gauge defective	1. Replace gauge.
2. Oil pump strainer screen in oil pan clogged	2. Clean screen.
3. Oil too hot, resulting in low viscosity	3. Correct cause of overheating.
4. Pressure regulator piston worn or clogged	4. Clean or replace piston or spring if necessary.

TROUBLESHOOTING

CAUSE	REMEDY
5. Excessive main and connecting rod bearing clearance	5. Check shaft, regrind if necessary, and replace bearings.
6. Oil pressure gauge line bent or clogged	6. Clean, straighten or replace line.
7, Loose camshaft bearings	7. Replace bearings and/or camshaft as necessary.
Rapid Cylinder Or Piston Wear	
1, Breather and air cleaner not properly serviced	1. Clean frequently and at regular intervals,
2. Leaking air cleaning system. Inferior grade of lubricating oil	2. Tighten connections. Replace ruptured element and hoses. Use good quality oil.
3. Lack of oil	3. Keep oil at "Full" mark on bayonet gauge.
4. Dirty oil	4. Change oil and replace oil filter element.
5. Piston rings not properly fitted to cylinders or rings too severe	5. Replace piston rings. Rebore cylinders if necessary.
6. Carburetor fuel mixture too rich	6. Replace worn jets. Replace needle and seat. Adjust float level. Check fuel pump pressure.
7. Cold operation of engine	7. Refer to "Over Cooling".
Valves Sticking	
1, Incorrect valve tappet clearance	1. Adjust clearance.
2, Valve springs weak or broken	2. Replace springs.
3. Valve stems or guides scored, dirty or gummy	3. Clean or replace.
4, Incorrect clearance between valve stem and guide	4. Fit valve stems to correct clearance in guides. Ream valve guides and install valves with oversize stems.
Burnt Valves Or Valve Seats	
1. Valve tappet clearance adjusted too close	1. Adjust clearance.

TROUBLESHOOTING

CAUSE	REMEDY
2. Weak valve springs	2. Replace springs.
3. Excessive carbon	3. Remove carbon deposits.
4. Camshaft not timed correctly	4. Retime camshaft.
5. Lean fuel mixture	5. Clean and adjust carburetor. Check for vacuum leaks and repair as necessary.
6. Valve seats too narrow	6. Cut seats to correct width.
7. Low grade fuel	7. Use good quality fuel.
8. Valve heads cut too thin	8. Replace valve.

SPECIFICATION LISTING

GASOLINE ENGINE	**FS162**
General Specifications	
Number of Cylinders	4
Bore	3.4375 in.
Stroke	4.375 in.
Displacement	162 cu. in.
Horsepower	45
at RPM	2600
Idle Speed	550-600 RPM
Governed Speed:	
Powershift Trans.	2450 RPM
Stall Speed	1275-1325 RPM
Valve Lash (Hot):	
Intake	.014
Exhaust	.016
Timing:	
Firing Order	1-3-4-2
No. 1 Fires (at 600 PRM)	2 BTDC
Compression:	
Ratio	7.25:1
Normal at 150 RPM	125 PSI
Oil Pressure:	
Normal at 2000 RPM	20-30 PSI
Minimum at Idle	7 PSI
Lubrication:	
Capacity (includes filter)	4.5 U.S. Qts.
Oil Type*	SAE 30

* Oil type given is for average atmospheric temperatures. Refer to Miscellaneous Section for the type of oil used in trucks operating in various atmospheric temperatures.

Dimensions (In Inches)	
Valve Guide, Intake and Exhaust:	
Length	2.3125
Outside Diameter	.6565/.6575
Stem hole diameter	.3422/.3432
Wear limits - max. dia.	.3447
Contact face to guide	1.4687
Intake Valves:	
Stem diameter	.3406/.3414
Wear limits - min. dia.	.3386
Seat angle	30
Stem clearance limits	.0008/.0026
Wear limits - max. cl.	.0046
Desired stem clearance	.0015

SPECIFICATION LISTING (Con't)	
Exhaust Valves:	
Stem diameter	.3377/.3385
Wear limits - min. dia.	.3357
Seat angle	45°
Stem Clearance	.0037/.0055
Wear limits- max. cl.	.0075
Desired stem clearance	.0045
Valve Springs, Intake and Exhaust:	
Outside diameter	.9687
Length - valve closed	1.7031
Load - valve closed	47-53 lbs.
Wear limit - min. wgt.	42 lbs.
Length - valve open	1.4218
Load - valve open	96-104 lbs.
Wear limit - min. wgt.	86 lbs.
Valve Seat Inserts:	
Standard outside dia.	1.3485/1.3475
Press fit	.003/.005
Camshaft:	
Brg. journal dia. No. 1	1.8715/1.8725
Wear limits - min. dia.	1.8705
Brg. journal dia. No. 2	1.7455/1.7465
Wear limits - min. dia.	1.7445
Brg. journal dia. No. 3	1.2465/1.2475
Wear limits - min. dia.	1.2455
Bush inside diameter	
No. 1	1.8745/1.8755
No. 2	1.7495/1.7502
No. 3	1.2495/1.2505
Bush, clearance limits	.002/.004
End play	.005/.009
Connecting Rods:	
Bush. hole dia.	.9130/.9140
Brg. hole dia.	2.0615/2.0620
Brg. thickness	.061651/.06190
Wear limits - min. thk.	.06115
Dia. - crank pin	1.9365/1.9375
Wear limits - min. dia.	1.9355
Clearance limits	.0002/.0022
Desired clearance	.001
Wear limits - max. cl.	.0032
Side play	.006/.010
Desired Side play	.006
Main Bearing:	
Dia. of brg. bore in blk.	2.4365/2.4372
Brg. shell thickness	.09290/.09315
Wear limits - min. thk.	.u924
Dia. of main brg. journ.	2.2490/2.250
Wear limits - min. dia.	2.248
Clearance limits	.0002/.0024
Desired clearance	.001
C/S end play	.003/.008
Piston Pin:	
Length	2.489/2.504
Diameter	.8591/.8593
Wear limits - min. dia.	8588
Desired fit	Light push
Bush. Hole Dia. - Fin.	.8597/.8595
Wear limits - max. dia.	.8607
Pin Cl. in Bushing	.0006/.0002
Desired Pin Fit	.0004
Pistons:	
Cylinder dia.	3.4375/3.4395
Wear limits, cyl. bore	.008
Piston pin hole dia.	.8595/.8597
Ring groove width No. 1, 2 & 3	
Max. wear limit	.1305
Ring groove width No. 4	.252/.253
Max. wear limit	.255
Piston fit-feeler gauge	.003
Lbs. pull	5 to 10
Piston Rings:	
Ring width No. 1, 2 & 3	.123/.124
Wear limits - min. width	.121
Ring width No. 4	.2485/.249
Wear limits - min. width	.2465
Ring gap clearance	
No. 1, 2 & 3	.007/.017
No. 4	.007/.017
Ring side clearance	
No. 1, 2 & 3	.0035/.0055
No. 4	.003/.0045

TORQUES¾ FT.-LBS.						
Size (Diameter)	5/16"	3/8"	7/16"	1/2"	9/16"	5/8"
Cylinder heads		35-40	70-75	100-110	130-140	145-155
Main bearing caps and connecting rods	20-25	35-40	70-75	85-95	100-110	
Flywheels	20-25	35-40	70-75	85-95	100-110	145-155
Manifolds	15-20	25-30	50-55	80-90	110-110	130-140
Gear covers, water pumps, front and rear end, oil pans	15-20	25-30	50-55	80-90		
Flywheel housings	15-20	25-30	50-55	80-90	115-125	
Camshaft nut (7/8")						
Steel camshaft	120-130					

AIR CLEANER

A. GENERAL (Fig. 1)

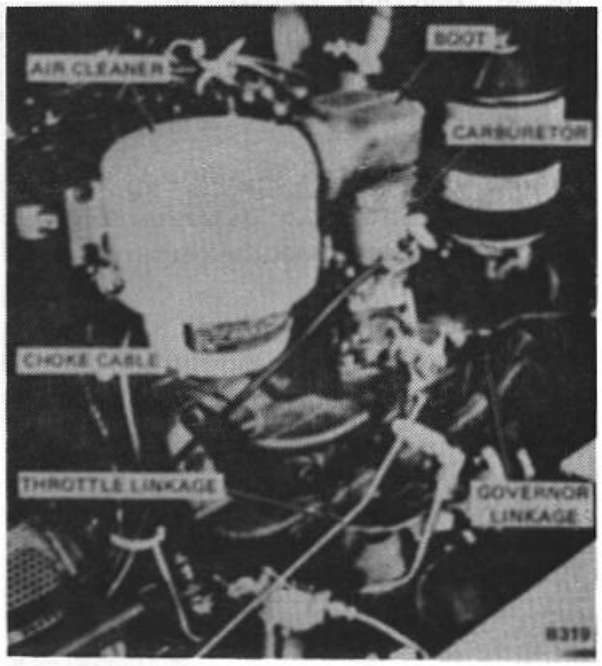


Figure 1.

The air cleaner may be serviced without removing it as an assembly.

Service the cleaner periodically. The service period depends upon the operating conditions and can be established observing the dust concentration and the inspection of the air cleaner.

When operating in severe dusty atmosphere, inspect and service the air cleaner daily, oftener if necessary.

B. SERVICING - OIL BATH TYPE (Fig. 2)

NOTE
Service when the reservoir is one fourth full of sediment or the oil has thickened to the approximate viscosity of SAE 60 oil at 70°F.

1. Unsnap the latches and lower the cup. Remove vortex chamber.

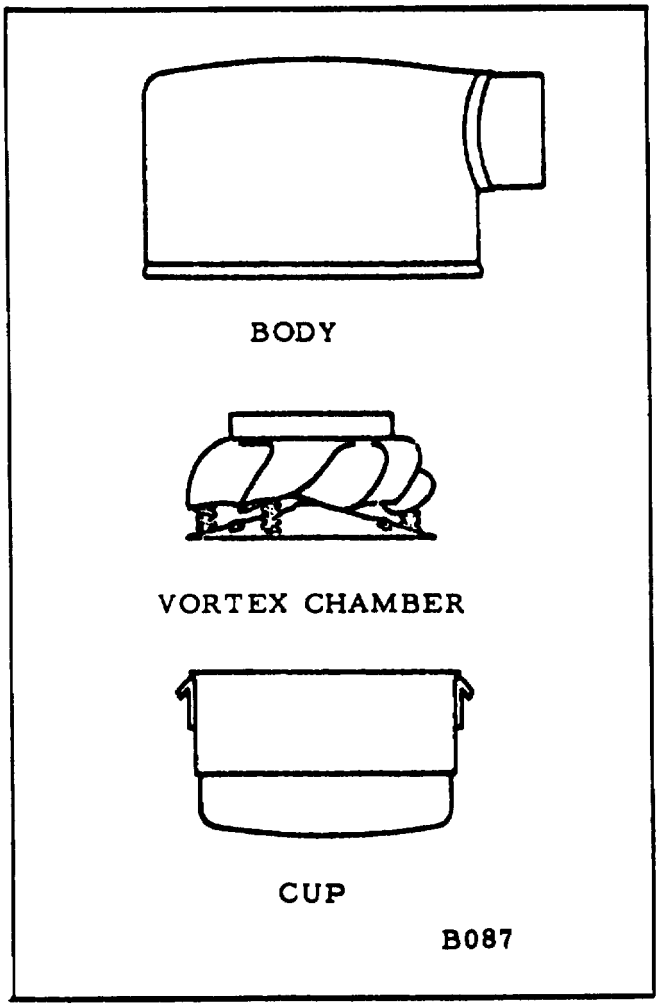


Figure 2.

2. Empty the oil and sediment. Wash the cup and vortex chamber thoroughly in solvent.

3. Fill cup to the indicated level with specified oil. Lower the vortex chamber into position.

NOTE
For air entering the air cleaner at temperatures above 100°F, use SAE 30 oil; 50°F to 100°F, use SAE 20 oil; 25°F to 50°F, use SAE 10 oil; -30°F to 25°F, use SAE 5; below-30°F, dilute oil with kerosene to the viscosity of SAE 20 oil at 70°F.

4. Attach the cup to the bottom of the body, making sure that it is properly seated and that latches snap over-center.

5. Check to make sure that the boot is in good condition and that the clamps are tight.

FUEL SYSTEM

GENERAL

The fuel system of truck engines using gasoline as a fuel consists of the following: a welded sheet metal tank, mechanical fuel pump and filter and air cleaner. (Fig. 1)

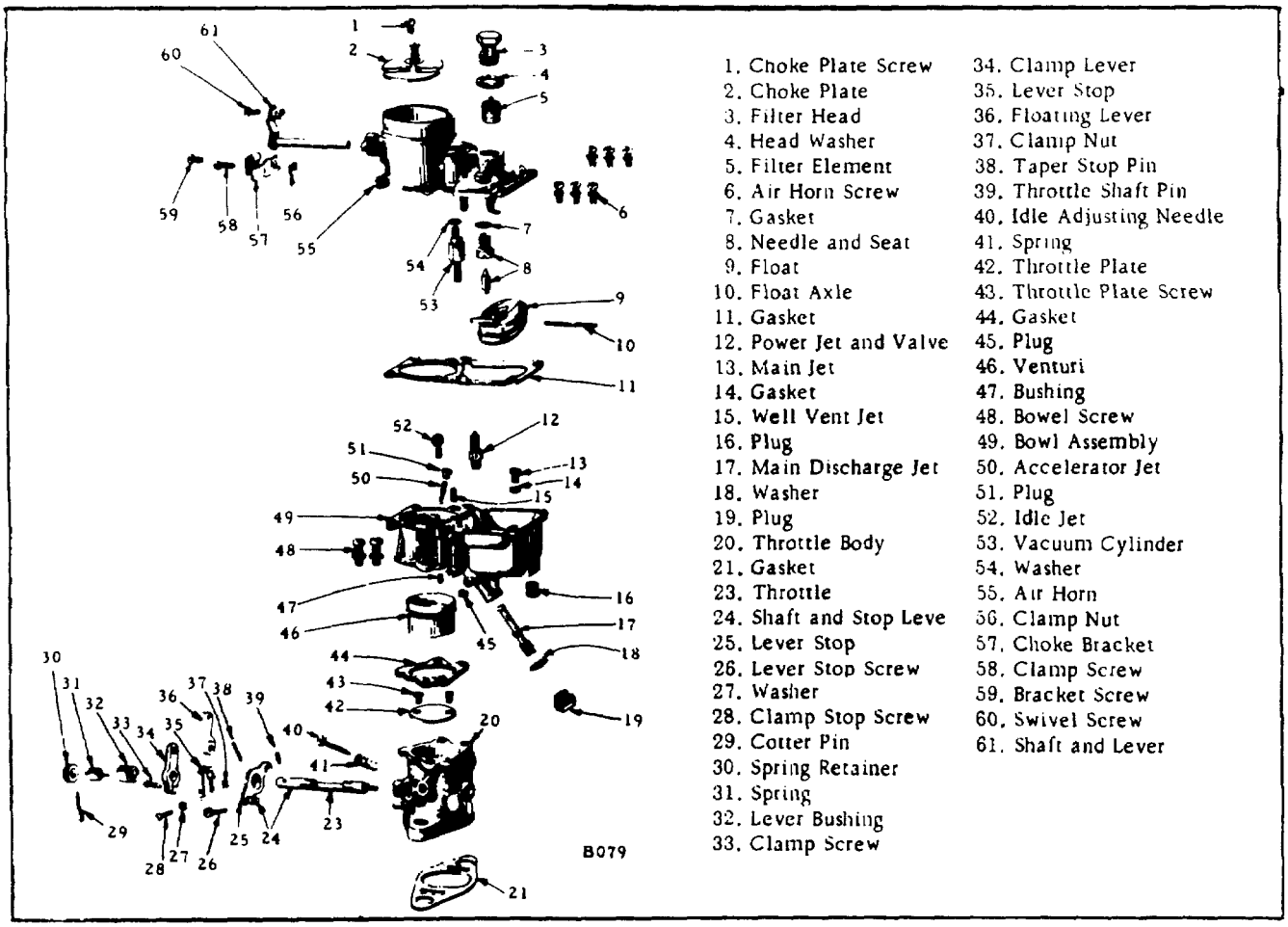
CARBURETOR

A. GENERAL (Fig. 3)

The carburetor is a downdraft unit incorporating both primary and secondary venturi. The upper, pressed-in section of the secondary venturi is sometimes referred to as the discharge nozzle venturi. Balanced construction is also used. This is a method of venting the fuel bowl to maintain proper air-fuel mixtures even though the air cleaner may become restricted. This balancing is frequently referred to as an "inside bowl vent." A completely sealed bowl cover is essential in this type of construction.

B. REMOVAL

1. Disconnect the choke cable, governor link and throttle link at the carburetor.
2. Disconnect the fuel line. Remove the air inlet boot and two mounting nuts holding carburetor to the manifold.
3. Lift carburetor from the manifold. Then remove excessive dirt from carburetor exterior.



1. Choke Plate Screw
2. Choke Plate
3. Filter Head
4. Head Washer
5. Filter Element
6. Air Horn Screw
7. Gasket
8. Needle and Seat
9. Float
10. Float Axle
11. Gasket
12. Power Jet and Valve
13. Main Jet
14. Gasket
15. Well Vent Jet
16. Plug
17. Main Discharge Jet
18. Washer
19. Plug
20. Throttle Body
21. Gasket
23. Throttle
24. Shaft and Stop Leve
25. Lever Stop
26. Lever Stop Screw
27. Washer
28. Clamp Stop Screw
29. Cotter Pin
30. Spring Retainer
31. Spring
32. Lever Bushing
33. Clamp Screw
34. Clamp Lever
35. Lever Stop
36. Floating Lever
37. Clamp Nut
38. Taper Stop Pin
39. Throttle Shaft Pin
40. Idle Adjusting Needle
41. Spring
42. Throttle Plate
43. Throttle Plate Screw
44. Gasket
45. Plug
46. Venturi
47. Bushing
48. Bowel Screw
49. Bowl Assembly
50. Accelerator Jet
51. Plug
52. Idle Jet
53. Vacuum Cylinder
54. Washer
55. Air Horn
56. Clamp Nut
57. Choke Bracket
58. Clamp Screw
59. Bracket Screw
60. Swivel Screw
61. Shaft and Lever

Figure 3.

C. DISASSEMBLY (Fig. 3)

1. Remove the large hex plug (3) and fibre washer (16) from top of the air intake assembly (55) using a 13/16" wrench.

2. Remove the screws and lockwashers (6) which attach the air intake assembly (55) to fuel bowl assembly.

3. Raise the air intake assembly (55) and loosen gasket from the fuel bowl assembly. Lift the air intake (55) with gasket clear of the bowl. Avoid damage to the float (9).

4. Remove gasket from air intake assembly (55).

5. Remove float axle (10) as follows: Press screwdriver against float axle at slotted side of float hinge bracket and force through hinge bracket. Remove the float axle completely with fingers from opposite side and remove float (9).

6. Remove fuel valve needle (8), valve seat (8) and fibre washer (7) from the air intake assembly.

7. Remove vacuum cylinder assembly (53) and fibre washer (54) from air intake assembly (55).

8. Remove the choke plate screw (1), choke plate (2) and choke plate lever and shaft assembly (61) as follows: File off rivited end of the choke plate screw (1). Remove choke plate screw (1). Pull out the choke plate shaft lever assembly (61) and choke plate (2).

9. Remove the lower hex plug (19) and fibre washer (18) from bottom of fuel bowl assembly (49) using a 1/2" wrench.

10. Remove the screws and lockwasher (48) which attaches the fuel bowl assembly to throttle body (22).

11. Separate the fuel bowl assembly from the throttle body (22). Remove the venturi (46) and gasket (44).

12. Remove idle jet (52) from the top surface of fuel bowl assembly (49).

13. Remove well vent jet (15) from top surface of fuel bowl assembly (49).

14. Remove the main jet (13) and fibre washer (14) from inside bottom of the fuel bowl.

15. Remove power jet valve assembly (12) from inside bottom of fuel bowl.

16. Remove the main discharge jet (18) from the passage in the outside bottom of fuel bowl assembly.

17. Do not attempt to remove idle channel bushing (47) or nozzle bushing, as these parts are pressed in at the factory and need not be removed to service the carburetor.

18. Remove the lead channel plugs and the accelerating jet channel plug (51) by first making a center-punch mark in center of each plug.

NOTE

In some modest the accelerating jet channel plug (51) is drilled at the factory to receive a plug extractor. Drill a #46 hole in center of plug.

Be careful to drill only through the plug to avoid damage to casting. Insert tapered thread end of a plug extractor tool into holes just drilled and screw down, counterclockwise, until tool is firmly fastened into plug. Then strike opposite end of tool sharply with a light hammer drawing plugs out of casting.

The threaded tip of the extractor tool can easily break off unless the casting and tool are held firmly, and the extractor driven

away from casting without tipping. Use plug extractor for the accelerating jet channel plugs. Remove corrosion, dirt or gum from the four passages after the plugs are removed by using an 1/8" drill with the cutting tip ground blunt to avoid damaging the casting. Clean fuel bowl thoroughly with cleaning solution and rinse in solvent. Remove the two throttle plate screws (43) and remove the throttle plate (42) and throttle shaft lever assembly (23).

NOTE

Threaded ends of throttle plate screws are riveted and must be filed flat before removal to avoid breakage or stripping of threads in shaft. Use caution in this operation to avoid scarring the side of the throttle body bore or the throttle plate. Do not attempt to remove the idle port plug from side of throttle body.

D. CLEANING AND INSPECTION

1. Clean all metal parts thoroughly with carburetor cleaning solution and rinse in solvent.

2. Blow out all passages in the air intake assembly, fuel bowl assembly and throttle body.

3. Be sure all carbon deposits have been removed from throttle bore and idle port. It is advisable to reverse the flow of compressed air in all passages to insure removal of all dirt. Never use a wire or drill to clean out Jets.

4. Float Assembly: Replace float assembly if loaded with gasoline, damaged, or if float axle bearing is worn excessively. Inspect top side of float hinge for wear where it contacts fuel valve needle.

5. Float Axle: Replace if any wear can be visually detected on the bearing surface.

6. Fuel Valve Seat and Needle Assembly: Replace fuel valve seat and needle because both parts wear, and may cause improper float level.

7. Idle Adjusting Needle and Spring: Inspect point of needle. This must be smooth and free of ridges.

8. Throttle Plate: Inspect plate for burrs or damaged edges. Never clean a throttle plate with a buffing wheel or a sharp instrument.

9. Throttle Shaft and Lever: Replace shaft and lever assembly if the shaft is badly worn or if lever is loose on shaft.

10. Vacuum Cylinder Assembly and Power Jet Valve: Replace these parts because extent of wear cannot be determined by visual inspection. Wear can result in poor idling and power jet action.

11. Choke Plate Assembly: Inspect for bends, burrs, or damaged edges. See that poppet valve is in good condition and works freely.

12. Choke Plate Shaft and Lever Assembly: Check bearing surfaces for wear. See that shaft is straight and that lever is tight on shaft.

13. Air Intake Assembly: Inspect machined surfaces of air intake for dents, warpage or other damages.

14. Air cleaner must fit tight or dirt will get into the engine.

15. Fuel Bowl: Examine for loose discharge nozzle bushing. Examine inside bottom of bowl and all passages for evidence of corrosion (Metallic oxides) or gum deposits.

16. Gaskets: Replace all gaskets and fibre washers every time the carburetor is disassembled.

E. ASSEMBLY (Fig. 3)

1. Place choke plate in air intake assembly with poppet valve toward gasket surface.

2. Insert shaft and lever assembly.

3. With choke plate closed, align hole in shaft with hole in plate.

4. Center the choke plate in a closed position and tighten screw. Do not attempt to rivet threaded end of screw.

5. Install vacuum cylinder assembly and new fibre washer in air intake assembly.

6. Install new fuel valve seat and fibre washer.

7. Install fuel valve needle in seat, followed by float and float axle. Insert tapered end of float axle (27) into float bracket on side opposite slot and push through the other side. Press float axle into slotted side until the axle is centered in bracket.

8. Set float level to the standard setting using a 6" depth gauge. (Fig. 4) Do not bend, twist or apply pressure on the float body. With air intake assembly in inverted position, as viewed from the free end of float, float body should be centered at right-angle to bowl cover. The float setting is measured from the machined surface of air intake assembly to top side of float body at highest point. The standard setting for this carburetor is 1-1/2 inches. To change the distance between float and the machined surface of air intake, bend float lever close to the float body.

9. Drive each of the lead plugs into channels until plug heads are flush with surface of the casting. Only one or two light hammer blows are required to seal lead plug in channel. Avoid driving plugs too deep, otherwise plug may block off other fuel passages.

10. Install idle jet in top surface of fuel bowl (no gasket is used).

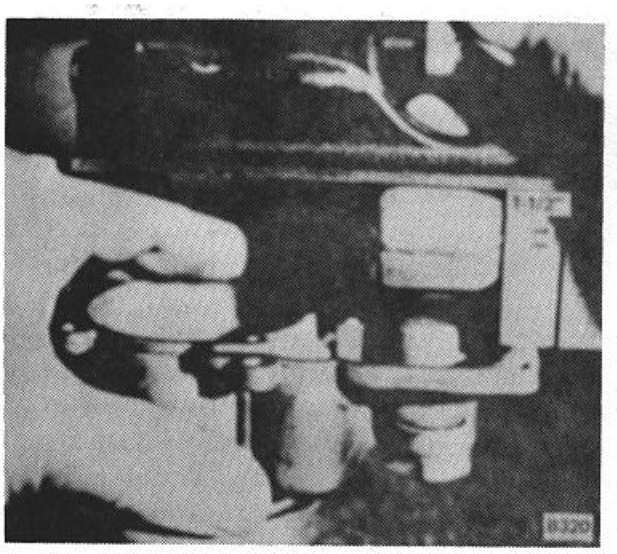


Figure 4.

11. Install main jet and fibre washer in bottom of fuel bowl and seat firmly.

12. Install power jet valve assembly.

13. Install main discharge jet into passage in outside bottom of fuel bowl.

14. Install lower plug and fibre washer in passage on outside bottom of fuel bowl, using a 1/2" wrench.

15. Install well vent jet in top surface of fuel bowl assembly.

16. If the fit of the throttle shaft is sloppy in the throttle body and it is desired to use the same throttle body for re-assembly of the carburetor, then it is absolutely necessary to install throttle shaft bushings. A poor fitting throttle shaft will upset engine idle, cause incorrect throttle plate location in relation to the idle discharge port, and allows air and dirt to be admitted into the throttle body around the shaft.

The following procedure should be adhered to for proper installation of the throttle shaft bushings. To properly re-bush the throttle body of the carburetor, it is absolutely necessary to have available the proper counterbore reamer, line reamer and bushing drive tool.

a. Place a suitable centering cone in the bed of a drill press. With one throttle shaft hole on this center, bring the spindle down until the counterbore reamer contacts the opposite shaft hole.

   Use correct reamer to obtain proper press fit on the outside diameter of the throttle shaft bushing.

b. With the casting still in place as described in the above paragraph, set the stop on the press to the length of the bushing. Check that the proper length bushing is being used for the particular shaft hole being counterbored.

c. The hole is then counterbored to accommodate the bushing.

d. A throttle shaft bushing is driven into place using the proper bushing driver tool.

e. The bushing is then reamed with the line reamer. Use the opposite shaft hole as a "pilot" to align the line reamer in the bushing.

f. Now turn the casting over and prepare the opposite hole to take the bushing. It will be necessary to reset the stops on the spindle again as described before. Then counterbore the hole.

g. Drive the second throttle shaft bushing into position.

h. Then line ream the inside diameter as the final machining operation. Pilot line reamer from side opposite bushing that is being reamed. A lathe may be substituted for the drill press in performing the counter-boring and line reaming operations.

17. Install throttle shaft and lever assembly and throttle plate in throttle body.

18. Any deviation from the following instructions will result in poor idle and low speed performance. Use new screws and do not attempt to rivet threaded ends. (A drop of shellac may be used for sealing.)

a. Back out throttle stop screw in throttle lever. Place the throttle body assembly on bench with mounting flange up.

b. Insert throttle shaft and lever assembly with throttle lever pointing down.

c. Rotate the throttle shaft to face the cut-out section in center. The threaded ends of the screw holes will then be facing the idling port plug.

d. Insert the throttle plate, starting the side of the plate with the shortest distance between screw holes and the beveled edge, into the shaft first. Center it, and then rotate shaft counterclockwise to close.

e. Turn the throttle body over and start the screws into shaft loosely. Tap the plate lightly to center it and tighten screws firmly. Throttle plate screws are never installed from the mounting flange side of the casting.

f. To properly center the plate in the throttle body bore, the screws should be started in the shaft and then with the plate closed, it should be tapped

on the mounting flange side. Pressure on the throttle plate must be maintained with the finger until the screws are tightened.

g. The edges of the throttle plate are beveled so that they will fit flush against the sides of the throttle body bore when the throttle plate is closed. If the throttle plate is not installed correctly, it will not close flush with the sides of the throttle body bore.

19. Place venturi in position in fuel bowl assembly. The notch in the venturi fits over the discharge arm of the fuel bowl assembly.

20. Place throttle body-to-fuel bowl gasket in position around venturi. One hole in this gasket is reinforced with a metal ring. The idle channel bushing in fuel bowl assembly (46) should pass through this ring.

21. Assemble the throttle body to the fuel bowl assembly.

22. Place gasket on air intake, assemble same to fuel bowl with screws and lockwashers. Tighten screws evenly and firmly.

23. Install large hex plug in top of fuel bowl cover. Tighten with 13/16" open end wrench.

24. Hold throttle lever in a closed position and turn throttle stop screw in until it just contacts stop on body, then turn screw in 1-1/2 additional turns.

F. INSTALLATION

1. Make sure mounting surfaces of carburetor and manifold are clean. Use a new mounting gasket.

2. Mounting nuts should be tightened down evenly and air intake connections tightened.

3. Adjust carburetor with engine hot and running at idle speed.

FUEL PUMP AND FUEL FILTER

A. GENERAL

Mounted at the flywheel end of the engine is a mechanical, single-acting fuel pump, which is actuated by a lobe on the engine camshaft. (Fig. 5)

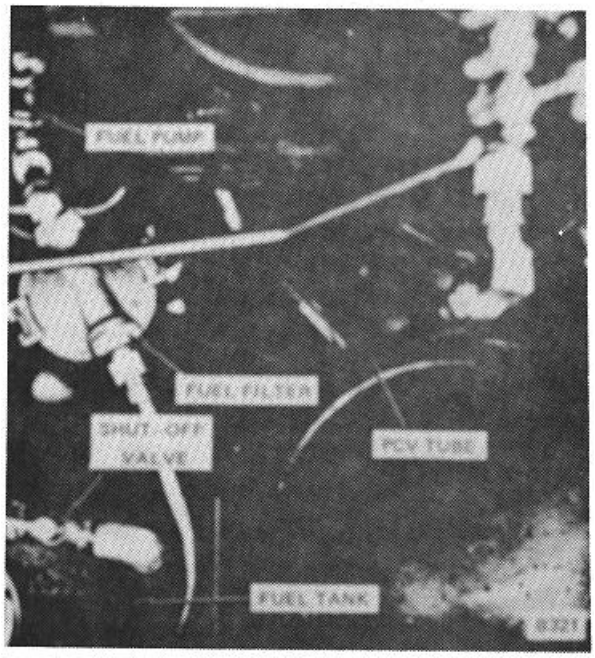


Figure 5.

The filter is attached to the inlet side of the pump.

B. REMOVAL

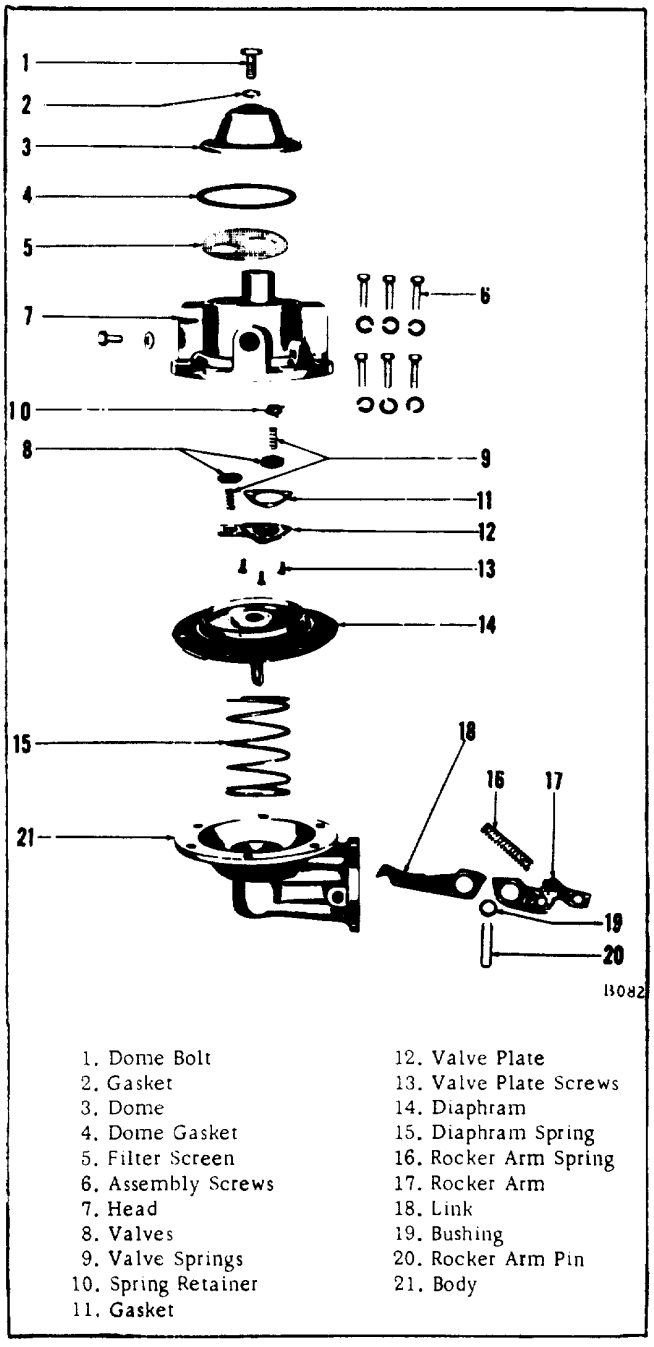
1. Disconnect the fuel line from the pump and the fuel line from the filter.

2. Unscrew the two mounting capscrews. Separate the filter from the pump.

C. DISASSEMBLY (Fig. 6)

NOTE

Refer to Figure 7 for filter disassembly.



1. Dome Bolt
2. Gasket
3. Dome
4. Dome Gasket
5. Filter Screen
6. Assembly Screws
7. Head
8. Valves
9. Valve Springs
10. Spring Retainer
11. Gasket
12. Valve Plate
13. Valve Plate Screws
14. Diaphram
15. Diaphram Spring
16. Rocker Arm Spring
17. Rocker Arm
18. Link
19. Bushing
20. Rocker Arm Pin
21. Body

Figure 6.

1. File match marks across a point at the union of the head (7) and body (21). Unscrew the assembly screws (6) and remove the head (7).

2. Unscrew the dome bolt. Remove the dome (3), dome gasket (4) and filter screen (5).

3. Unscrew the three valve plate screws (13). Lift out the valve plate (12), plate gasket (11), valves (8), valve springs (9) and the valve spring retainer (10).

4. Pry the' rocker arm spring (16) out of position, using a screw driver inserted-in the coils of the spring.

5. With the heel of the hand on the diaphragm (14), compress the diaphragm spring (15) and unhook the diaphragm from the link (18).

6. Drive the rocker arm pin (20) out. Remove rocker arm (17), linkage (18) and bushing (19).

D. CLEANING AND INSPECTION

1. Clean: all parts with solvent.

NOTE

The following are points where wear affects fuel pump performance as noted:

- **a. Worn linkage causes slow priming and lack of fuel.**
- **b. Worn pull rod causes improper diaphragm action.**
- **c. Dirty valve seats or worn valves result in reduced fuel flow.**
- **d. Ruptured diaphragm reduces the fuel pressure and flow.**

2. Visually check the cover and body for cracks and breakage. Inspect for diaphragm flange warpage by testing on a smooth flat surface. Examine all threaded holes for stripped or crossed threads. Broken, damaged or severely warped castings must be replaced.

3. Replace valves if obviously worn or damaged.

4. Remove any obstructions from filter screen. Replace screen if damaged or if it does not fit snugly in the head.

5. Inspect the rocker arm for scoring or wear on the push rod pad, and at the point of contact with link. Check the link for wear at point of contact with the rocker arm and diaphragm pull rod. Replace parts as necessary.

6. Replace diaphragm spring and valve springs. Replace diaphragm spring only if it is broken, distorted, rusted or pitted.

7. Replace the diaphragm if it is ruptured, cracked or worn.

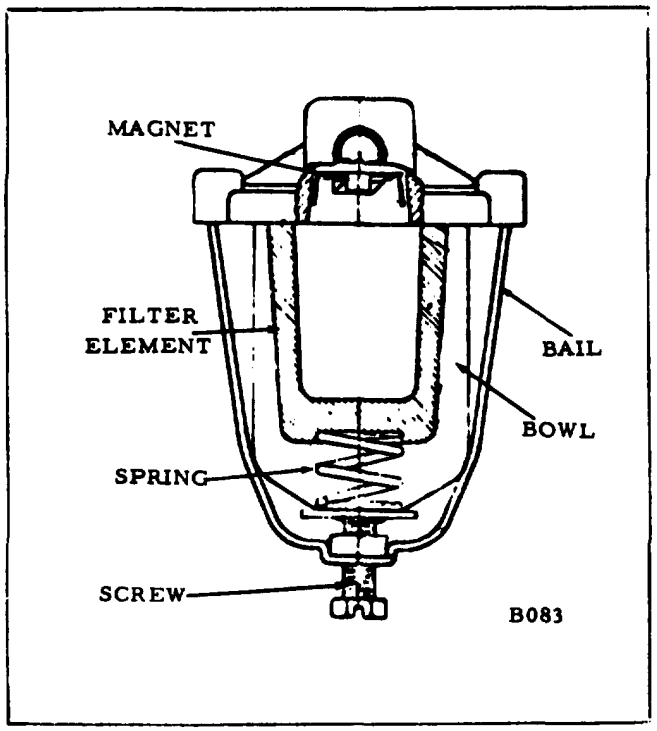


Figure 7.

E. ASSEMBLY (Fig. 6)

1. Soak the new diaphragm in clean kerosene, fuel oil, or gasoline until it is needed for installation. Assemble link, rocker arm, and bushing. Place the assembly in the body. Align rocker arm pin hole with body and drive in the rocker arm pin.

2. Install valves, springs and spring retainer. Put a drop of light oil on the valves, and use a new gasket between the plate and body.

3. Place the filter screen in the head. Install the vapor drum, using a new gasket.

4. Install the diaphragm spring and diaphragm.

5. Install the head on pump body. Be sure to line up the file marks. Install assembly screws and lockwashers loosely until screws just engage lockwashers. Actuate rocker arm several full strokes to flex diaphragm.

CAUTION:
Sufficient diaphragm cloth must be pulled inside of the pump body or pump will deliver too much pressure. Tighten the cover screws alternately and securely.

6. Test operation of pump valves by attaching pressure gauge to outlet and operate rocker arm. Pressure should not fall off rapidly.

F. INSTALLATION

1. Place a new mounting gasket on the fuel pump mounting flange. Use a non-hardening cement to hold gasket in position while installing the pump.

2. Insert the rocker arm through the fuel pump mounting pad opening of the adapter.

CAUTION
Make sure that the rocker arm pad rests against the fuel pump. Push rod in the adapter. Broken rocker arm or broken link and possible engine damage will result if pump is not properly installed.

3. Holding the pump in position against

the adapter, insert the bolts with lockwashers in the holes provided for them.

4. Start the bolts and turn them in finger tight. This will prevent damage to the threads. Then tighten bolts with a wrench.

5. Check the fuel lines for condition, cleanliness and alignment with the pump outlet. Start the fitting nuts and turn on finger tight. Using two wrenches, one on the nut and one on the fuel pump fitting, tighten enough to prevent vacuum and fuel leaks.

G. PRESSURE TEST

NOTE

The pressure test is made to check for excessively high pressures developed by the pump which may cause rich fuel mixtures, and in a few cases, flooding of the carburetor. A rich mixture is one of the causes of excessive fuel consumption and poor performance.

1. Disconnect the gasoline line at the carburetor, and insert a "T" fitting between the carburetor and the fuel line. (Fig. 8)

2. Start the engine and run it at low idle speed.

3. Read on the pressure scale the pounds pressure developed by the fuel pump and compare with the specifications.

H. CAPACITY TEST

NOTE

The capacity test determines the ability of the pump to produce a sufficient amount of fuel within a specified time. It is important that both a pressure and a capacity test be made to determine the condition of the fuel pump.

1. Disconnect the rubber hose at the tester and insert it in a suitable container. The container must be marked to show a one-pint level.

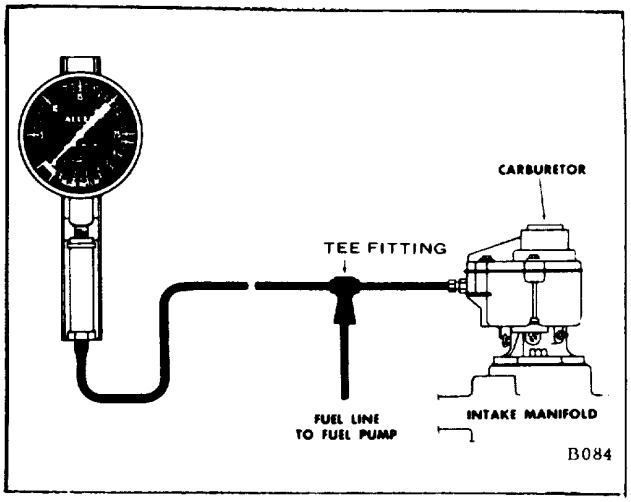


Figure 8.

CAUTION

Disconnecting the line between the carburetor and the pump removes the normal pressure on the fuel pump diaphragm causing it to flex abruptly. This may cause loose particles of dirt to enter the carburetor fuel line. Therefore, before connecting the line to the carburetor, it is recommended that the fuel line and pump be flushed. To do so, operate the starter until 1/4 to 1/2 pint of gasoline has been flushed out into a container.

2. Start the engine, and measure the time required to pump one pint of fuel into the container, at 1800 RPM. This should take one to 1-1/2 minutes.

3. If the capacity of the fuel pump is low, it may be due to leakage of air into the system. Check the vapor dome for looseness and also the gasoline line to the fuel tank and the inlet fitting on the pump for air leaks. Restrictions in the fuel line will also reduce pump capacity.

TROUBLESHOOTING

CAUSE	REMEDY
ENGINE	
Engine Will Not Start Or Is Hard To Start	
1. Clogged air cleaner	1. Clean. Service more often.
2. Low on fuel	2. Refill fuel tank.
3. Low grade of fuel	3. Change to higher grade of fuel.
4. Restricted fuel lines	4. Service fuel filter. Remove foreign particles from fuel system. Check source of supply.
5. Ice in fuel system	5. Thaw out entire system. Drain fuel tank and refill with clean fuel.
6. Insufficient fuel from pump	6. Refer to FUEL PUMP - Troubleshooting Guide, Insufficient Fuel.
7. Carburetor choke valve inoperative	7. Check and adjust carburetor choke valve so that it will open and close completely.
8. Defective carburetor (too rich or too lean)	8. Refer to CARBURETOR - Troubleshooting Guide.
9. Filler cap vent plugged	9. Clean the vent in the filler cap.
Black Exhaust Smoke At Idle	
1. Carburetor choke valve partially closed	1. Push choke button in. Check and adjust choke valve so that it opens and closes completely.
2. Air-fuel mixture too rich	2. Refer to CARBURETOR - Troubleshooting Guide.
3. Excessive pump pressure	3. Refer to FUEL PUMP - Troubleshooting Guide.
Black Exhaust Smoke Under Load	
1. Restricted exhaust system	1. Check heat control valve. Loosen, if stuck. Replace restricted muffler and exhaust pipes.

TROUBLESHOOTING

CAUSE	REMEDY
2. Clogged air cleaner	2. Clean. Service more often.
3. Low grade of fuel	3. Change to a better grade of fuel.
4. Rich air-fuel mixture, defective carburetor fuel pump	4. Refer to CARBURETOR - Troubleshooting Guide, and FUEL PUMP - Troubleshooting Guide.
Loss Of Power	
1. Restricted exhaust system	1. Check heat control valve; loosen, if stuck. Replace restricted muffler and exhaust pipes.
2. Clogged air cleaner	2. Clean. Service more often.
3. Low grade of fuel	3. Change to a better grade of fuel.
4. Rich or lean air-fuel mixture, defective carburetor or fuel pump	4. Refer to CARBURETOR - Troubleshooting Guide and FUEL PUMP - Troubleshooting Guide.
5. Carburetor throttle valve not opening	5. Adjust throttle control so that the throttle completely valve will open and close completely.
6. Carburetor choke valve partially closed	6. Push choke button in. Check and adjust choke valve so that it opens and closes completely.
7. Fuel filter clogged or low fuel pump	7. Clean. Service more often. Check fuel pressure in tank. If dirty, drain and clean tank. Refill with clean fuel. Refer to FUEL PUMP - Troubleshooting Guide.
Engine Cannot Reach Governed RPM	
1. Clogged air cleaner	1. Clean. Service more often.
2. Clogged fuel filter or low fuel pump pressure	2. Clean. Service more often. Check fuel in tank. If dirty, drain and clean tank. Refill with clean fuel. Refer to FUEL PUMP - Troubleshooting Guide.
3. Rich or lean air-fuel mixture, defective carburetor or fuel pump	3. Refer to CARBURETOR - Troubleshooting Guide and FUEL PUMP - Troubleshooting Guide.

TROUBLESHOOTING

CAUSE	REMEDY
4. Dirty or improper governor adjustment	4. Clean and calibrate governor. Adjust governed engine RPM.
Flat Spot In Acceleration Or Poor Acceleration	
1. Defective carburetor	1. Refer to CARBURETOR - Troubleshooting Guide.
Excessive Fuel Consumption	
1. Restricted exhaust system	1. Check heat control valve. Loosen if stuck. Replace restricted muffler and exhaust pipes.
2. Clogged air cleaner	2. Clean. Service more often.
3. Low grade of fuel	3. Change to a better grade of fuel.
4. Rich or lean air-fuel mixture, defective carburetor or fuel pump	4. Refer to CARBURETOR - Troubleshooting Guide, and FUEL PUMP - Troubleshooting Guide.
5. Carburetor choke valve partially closed	5. Push choke button in. Check and adjust choke valve so that it opens and closes completely.
Erratic Idle Speeds	
1. Low grade of fuel	1. Change to a better grade of fuel.
2. Rich or lean air-fuel mixture, defective carburetor or fuel pump	2. Refer to CARBURETOR - Troubleshooting Guide, and FUEL PUMP - Troubleshooting Guide.
3. Looseness in carburetor throttle valve control mechanism	3. Remove slack. Replace parts as necessary. Check carburetor throttle shaft. The shaft should not be loose in the body.
4. Fuel not vaporizing before entering combustion chamber	4. Check and free-up stuck heat control valve.
5. Vacuum leak between the carburetor mounting flange and intake ports in the block	5. Replace gaskets as necessary. Tighten screws securely.
6. Vacuum hose loose or deteriorated	6. Tighten hose clamps. Replace hose if necessary.

TROUBLESHOOTING

CAUSE	REMEDY
Engine Stops Running	
1. Out of fuel	1. Fill fuel tank.
2. Low grade of fuel	2. Change to a better grade of fuel.
3. Clogged fuel filter or fuel pump defective	3. Service fuel filter more often. Check fuel in tank. If dirty, drain and clean tank. Refill with clean fuel. Refer to FUEL PUMP Troubleshooting Guide.
4. Rich or lean air-fuel mixture, defective carburetor or fuel pump	4. Refer to CARBURETOR - Troubleshooting Guide, and FUEL PUMP - Troubleshooting Guide.
5. Filler cap vent plugged	5. Clean the vent in the filler cap.
Surging At Governed Speed	
1. Rich air-fuel mixture, defective carburetor	1. Refer to CARBURETOR - Troubleshooting or fuel pump Guide, and FUEL PUMP - Troubleshooting Guide.
2. Dirty or improper governor adjustment	2. Clean linkage and remove binding. Adjust governed engine RPM.
3. Vacuum leak between throttle body and body and intake manifold	3. Replace gaskets and tighten carburetor bowl; throttle mounting screws.
Engine Misses	
1. Low grade of fuel	1. Change to a better grade of fuel.
2. Clogged fuel filter or defective fuel pump	2. Service fuel filter more often. Refer to FUEL PUMP - Troubleshooting Guide.
3. Rich or lean air-fuel mixture, defective fuel carburetor or pump	3. Refer to CARBURETOR - Troubleshooting Guide, and FUEL PUMP - Troubleshooting Guide.
4. Fuel not vaporizing before entering the combustion chamber	4. Check and free-up heat control valve.

TROUBLESHOOTING

CAUSE	REMEDY
CARBURETOR	
Erratic Idling	
1. Incorrect idle needle valve adjustment	1. Adjust needle valves. If unable to improve idling, clean throttle body. Replace worn needle valves.
2. Carburetor mounting is loose	2. Remove carburetor and governor. Check and replace gaskets, if necessary. Make sure gaskets are installed correctly. Tighten mounting nuts securely.
3. Idle tube or air bleed carbonized	3. Disassemble and clean carburetor. Blow carbon from air bleed orifice and passageway with compressed air.
4. Idle discharge holes gummed or plugged	4. Disassemble and clean carburetor. Blow foreign matter from the idle discharge holes and the secondary idle air bleed.
5. Throttle body carbonized or throttle shaft	5. Disassemble and clean throttle body. Remove move carbon.
6. Incorrect float level	6. Check and adjust float level as necessary. Replace float if leaking.
7. Worn needle valve and seat	7. Install new needle valve and seat. Adjust float level.
8. Loose throttle body-to-main body screws	8. Install new gasket between main body and throttle body, if necessary. Tighten throttle body mounting screws.
Carburetor Floods Or Leaks	
1. Cracked main body	1. Replace main body. Make sure main body-to-throttle body screws are tight.
2. Defective body gaskets	2. Replace gaskets. Tighten screws securely.
3. High float level	3. Check and adjust float level.
4. Worn needle valve and seat	4. Clean and check needle valve. If worn, replace valve and seat. If not worn, check fuel pump pressure.

TROUBLESHOOTING

CAUSE	REMEDY
5. Excessive fuel pump pressure	5. Refer to FUEL PUMP - Troubleshooting Guide.
Poor Acceleration	
1. Vacuum cylinder not operating correctly	1. If loose, replace gasket and tighten. Manually check; replace if operation is not smooth. Replace all body gaskets and the carburetor mounting gasket.
2. Power jet and valve dirty or not operating	2. Vacuum cylinder not operating, refer to No. 1. Clean power jet and valve. Manually check the valve operation, if not smooth, replace.
3. Incorrect float level	3. Check and adjust float level as necessary. Replace float if leaking.
4. Worn needle valve and seat	4. Clean and check needle valve and seat. If worn, replace. If not, check fuel pump pressure.
5. Choke valve partially closed	5. Open choke valve. Adjust choke cable so that the valve will open and close completely.
6. Manifold heat control valve stuck	6. Free-up. Replace bi-metal spring, if necessary.
Poor Performance (Air-Fuel Mixture Too Rich)	
1. Restricted air cleaner	1. Service air cleaner more often.
2. Float level too high	2. Check and replace float, if leaking. Adjust float level.
3. Excessive fuel pump pressure	3. Refer to FUEL PUMP - Troubleshooting Guide.
4. Vacuum cylinder or power jet and valve stuck	4. Free-up or replace stuck assembly. Clean out all passages.

TROUBLESHOOTING

CAUSE	REMEDY
Poor Performance (Air-Fuel Mixture Too Lean)	
1. Main metering jet damaged; wrong size or type used	1. Replace metering jet with a new one of correct size and type.
2. Top shoulder seat of main discharge jet bad or tip damaged	2. Remove main discharge jet, clean, inspect and replace, if necessary.
3. Vacuum cylinder worn or stuck	3. Free cylinder if stuck. Replace if worn.
4. Power jet corroded or not seating	4. Clean power jet and channels. If seating is faulty, replace the jet.
5. Low float level	5. Adjust float level.
6. Low fuel pump pressure	6. Refer to FUEL PUMP - Troubleshooting Guide.
7. Air leak between carburetor base and engine intake ports	7. Tighten intake manifold-to-engine screws and carburetor mounting screws, Replace gaskets, if necessary.
FUEL PUMP	
Pump Leaks Fuel	
1. Cover-to-body loose	1. Tighten. Check cover gasket. Replace gasket if faulty.
2. Ruptured body	2. Replace fuel pump.
3. Fuel line fittings loose	3. Tighten fittings as necessary to stop leakage. Replace fittings, if necessary.
Insufficient Fuel Or Low Pump Pressure	
1. Fuel line leaks	1. Tighten fittings or cover.
2. Ruptured pump body	2. Replace fuel pump.
3. Dirt under valves or valves not seating	3. Remove foreign particles from valves and seats. Install new valve bodies.

TROUBLESHOOTING

CAUSE	REMEDY
4. Weak or broken spring	4. Check fuel pump pressure. If low, install new spring.
5. Worn plunger or bore rocker pin or link	5. Replace parts as necessary.
Pump Noise	Pump Noise
1. Fuel pump loose on mounting	1. Tighten mounting screws.
2. Worn plunger assembly	2. Replace parts as necessary.
3. Broken or weak plunger spring	3. Replace plunger spring and plunger, if necessary.
Excessive Pump Pressure	
1. Diaphragm improperly installed	1. Loosen body-to-cover screws, and press rocker tight as possible against the spring, then tighten the screws.
2. Wrong diaphragm spring or fuel pump	2. Replace spring or pump, if necessary.

SPECIFICATION LISTING

Carburetor:

Float Level	1-1/2 In.		
Jet Numbers		Discharge Jet	80
Accelerator Jet	10	Well Vent	32
Main Jet	21	Fuel Pump Pressure	3 - 4-1/2 PSI
Idle Jet	16	Fuel Pump Flow	3 - 4-1/2 PSI in 1 minute at 600 RPM
Venturi	21		

GENERAL (Fig. 1)

The S40CP fork lift trucks are equipped with a 12 volt system (Fig. 1) The system includes an alternator, alternator regulator, battery, cranking motor, switches, instruments, ignition components, and the necessary wiring.

BATTERY (Fig. 2)

A. MAINTENANCE

1. Electrolyte level in the battery should be checked at least once every two weeks. If the electrolyte level is found to be low, water should be added to each cell until the level rises to the bottom of the vent well. Do not overfill! Distilled water or water passed through a "demineralizer" should be used to eliminate the possibility of harmful impurities being added to the electrolyte. Many common impurities will greatly shorten battery life. Do not add any substance to the electrolyte except water.

2. The external condition of the battery and the battery cables should be checked periodically. The top of the battery should be kept clean and the battery hold-down bolts should be kept properly tightened. For best results when cleaning battery wash first with a dilute solution of ammonia or soda to neutralize any acid present, then flush off with clean water. Care must be used to keep vent plugs tight so that the neutralizing solution does not enter the cells. The hold-down bolts should be kept tight enough to prevent the battery from shaking around in its holder, but they should not be tightened sufficiently to place a strain on the battery case.

3. To insure good contact, the battery cable clamps should be tight on the battery posts. If the posts or cable clamps are corroded, the cables should be disconnected and the posts and clamps cleaned separately with a soda solution and a wire brush. Install

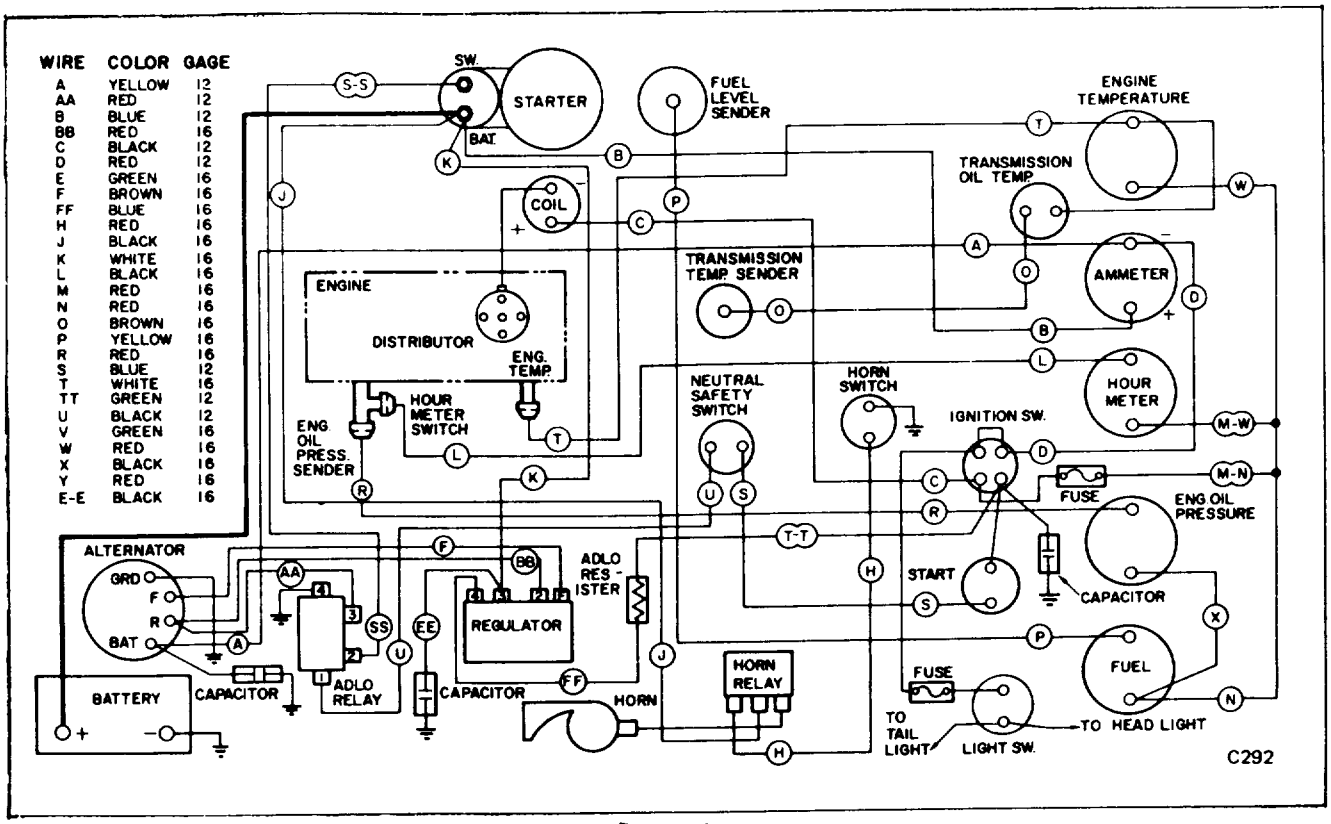


Figure 1.

Clamps on battery posts and tighten firmly, then coat posts and clamps with petroleum Jelly to help retard corrosion.

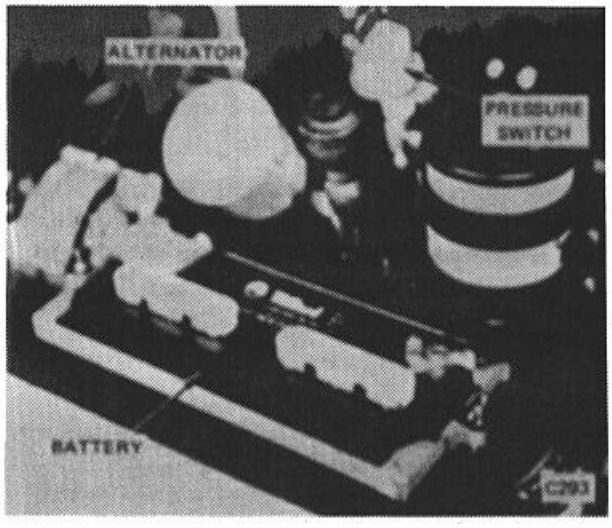


Figure 2.

B. TESTS Before making any battery condition test, make sure the battery terminal poets are free of corrosion, dirt and oxidation, This is necessary to insure the lowest possible resistance for all electrical connections.

1. State of Charge

a. The hydrometer test is merely a means of determining the state of charge of the battery. This test will not necessarily indicate whether the battery is able to perform its normal functions, such as starting.

b. Measure specific gravity of electrolyte in each battery cell. The hydrometer tube must be held vertically. Do not draw too much electrolyte into the hydrometer. The float must be freely suspended in the electrolyte and the reading taken at eye level. If water has been recently added to the cells or battery fast charged, the hydrometer reading will be false.

c. If the specific gravity readings are 1,215-1.270 at 800F., and variation between cells is less than 25 gravity points (.025) the battery presumably is at least 3/4 charged and in good condition for further use.

d. If the specific gravity readings are below 1.215 and the variation between cells is less than 25 gravity points, the battery presumably is in sound condition, but its state of charge is too low for further use or testing electrical circuits.

e. If the specific gravity readings show a variation between cells of more than 25 gravity points, an unsatisfactory battery condition is indicated, which may be caused by shorted cells, acid loss, or a worn out battery.

2. Voltage Test

a. Connect the voltmeter from the positive post to the negative post of the battery, Be sure the clips make a positive connection with a cleanportion of the battery posts, Under a no-load condition a fully charged battery should read at least 12.0 volts. (2.0 volts per cell).

b. If the reading is low, connect the voltmeter across each individual cell. If all cells are low but have equal readings, the battery is low and should be charged.

c. If some cell readings are 2.0 volts and another cell is discharged more than .5 volt, it indicates a short or the electrolyte is low in that cell.

C. CHARGING

1. Batteries removed from the vehicle for charging should be charged continuously

at a low rate until fully charged. Batteries may be safely slow-charged at a rate in amperes equal to 7% of the battery's ampere-hour capacity. This is called the "normal" charge rate. The battery is fully charged when specific gravity readings taken at hourly intervals show no increase during three consecutive readings.

2. A very low rate - not more than one-half the normal charging rate - should be used for charging a sulfated battery. In the case of badly sulfated batteries, as much as 100 hours of charging time may be required before the battery becomes fully charged. Badly sulfated batteries may require a continuous slow charge for 48 hours or more before a rise in gravity reading occurs. If the specific gravity reading of any cell fails to reach 1.250 (corrected to 80°F.) or if there is a variation of more than 25 gravity points between cells after thorough slow charging, replace the battery.

3. Although the slow-charge method is recommended for charging all batteries, discharged batteries in otherwise good condition may be given a boost with a quick charger if time does not permit complete slow charging. When using a quick charger, it must be remembered that the battery is only receiving a partial charge and that the battery electrolyte temperature must not be allowed to exceed 130°F. If the battery heats up excessively, quick charging must be discontinued.

D. COLD WEATHER CARE

A battery operated in an undercharged condition may freeze during severe winter weather. The freezing point of the electrolyte varies with specific gravity. A fully charged battery with 1.285 specific gravity corrected to 80°F. will not freeze at minus 80°F.

ALTERNATOR (Fig. 3)

A. GENERAL

The major parts of the alternator are the stator assembly, the rotor assembly and the two end frame assemblies.

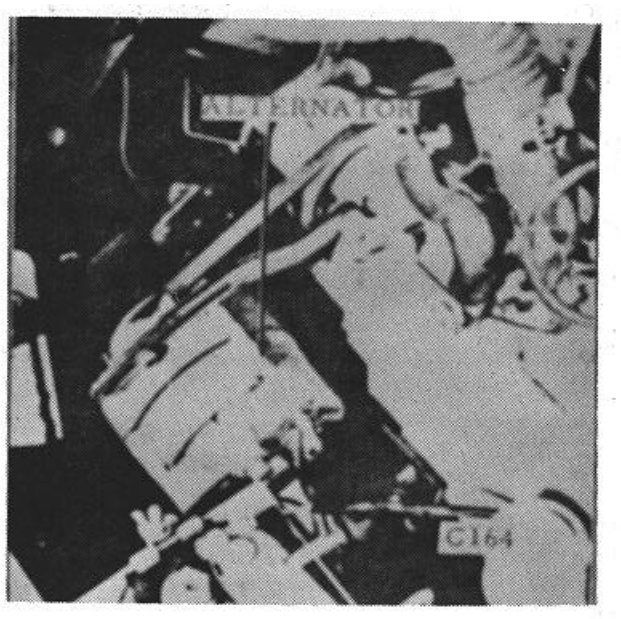


Figure 3.

The stator assembly (Fig. 4) is made up of a laminated iron frame and a stator or output winding which is wound into slots of the frame.

The stator assembly is sandwiched between two stationary end frames.

The rotor assembly contains a doughnut-shaped field coil mounted between two iron segments with several interlacing fingers which are called "poles". It is held together by a press fit on the shaft. The rotor turns inside the stator assembly.

The rotor shaft is supported by prelubricated bearings in each end frame, a ball bearing in the drive end frame and a roller bearing in the opposite end frame. (Fig. 5)

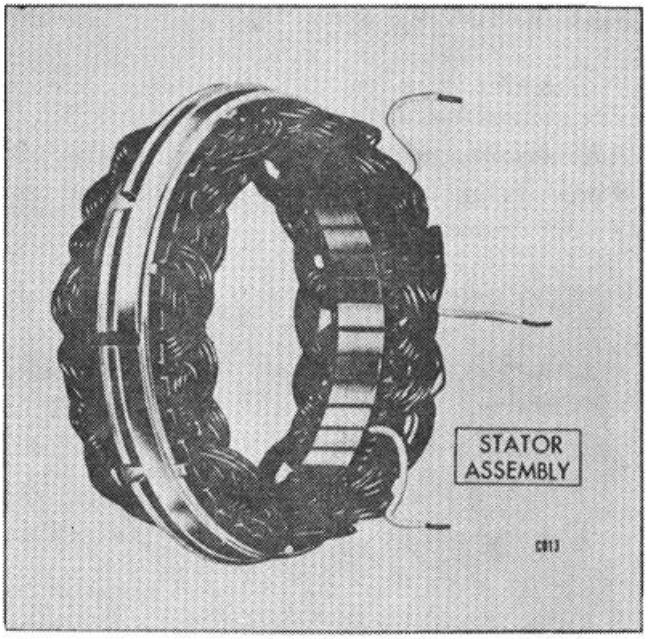


Figure 4.

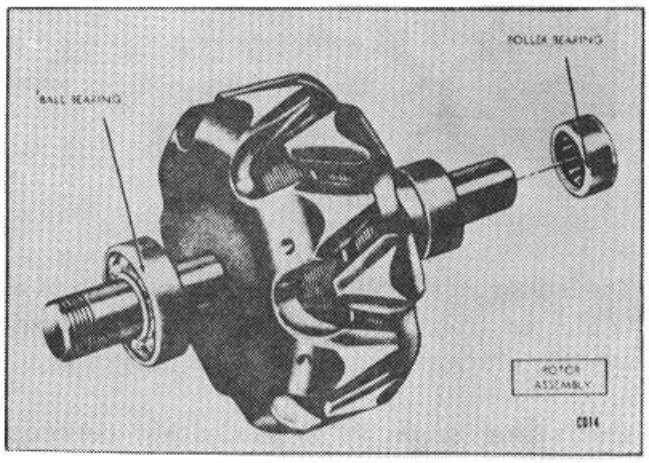


Figure 5.

Two slip rings upon which the brushes ride, are mounted on one end of the rotor shaft and are attached to the leads from the field coil. (Fig. 6) When the ignition switch is first closed, current from the battery passes through one brush, through the slip ring upon which the brush rides, and then through the field coil. After leaving the field coil, current flow continues through the other slip ring and brush before returning to the battery through the ground return path. This flow of electrical energy through the field winding is called field current.

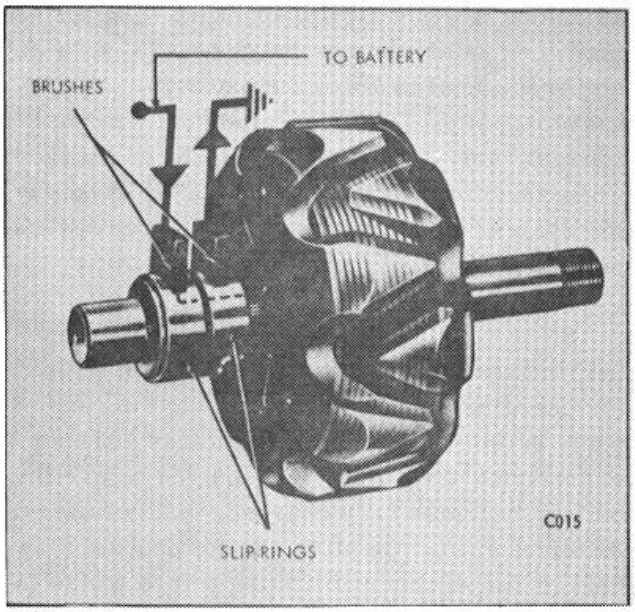


Figure 6.

Six electronic check valves called diodes are located in the end frame assembly nearest the slip rings. Three of these diodes are negative and are mounted directly to the end frame.

Three positive diodes are mounted into a strip called a "heat sink", which is insulated from the end frame. These six diodes change the alternating current developed by the alternator into direct current to charge the battery and power the accessories. (Fig. 7)

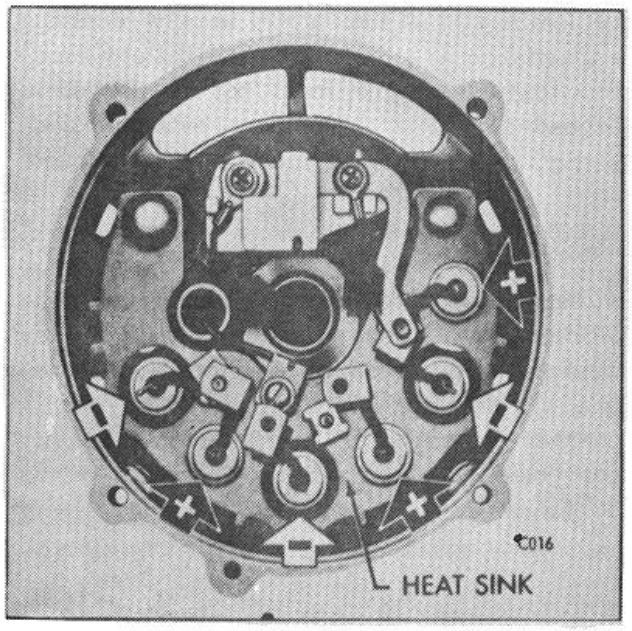


Figure 7.

The only field coil in the alternator is located on the rotor shaft. This field coil is surrounded by the poles of the rotor segments. Since it is a part of the rotor assembly, the field coil turns with the rotor. (Fig. 8)

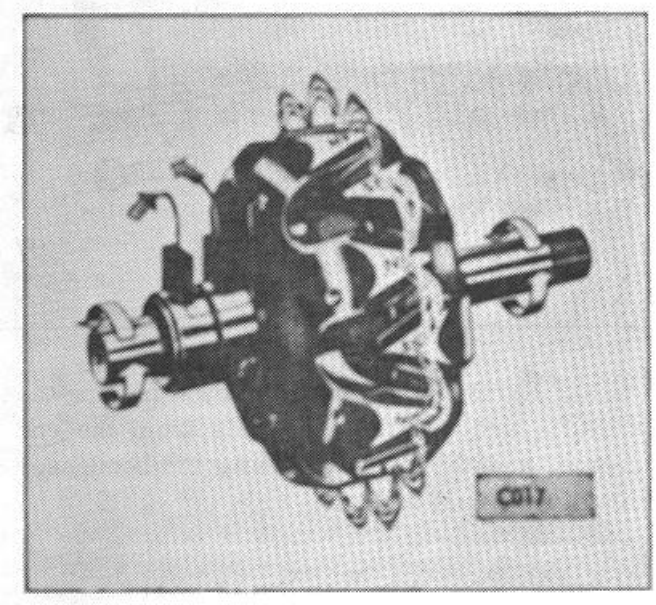


Figure 8.

The stator windings are attached to the stator frame and carry output current. They perform the same function as the rotating windings in the armature of a D.C. generator.

The brushes are connected in series with the field coil, and carry only the low field current.

IMPORTANT: Since the alternator and regulator are designed for use on only one polarity system, the following precautions must be observed when working on the charging circuit. Failure to observe these precautions will result in serious damage to the electrical equipment.

1. When installing a battery, always make absolutely sure the ground polarity of the battery and the ground polarity of the alternator are the same.

2. When connecting a booster battery, make certain to connect the negative battery terminals together and the positive battery terminals together.

3. When connecting a charger to the battery, connect the charger positive lead to the battery positive terminal and the charger negative lead to the battery negative terminal.

4. Never operate the alternator on open circuit. Make absolutely certain all connections in the circuit are secure.

5. Do not short across or ground any of the terminals on the alternator or regulator.

6. Do not attempt to polarize the alternator.

B. REMOVAL

1. Disconnect wires from alternator terminals. Tag each wire for identification at time of installation.

2. Loosen the mounting bolts and adjusting arm cap screw to loosen drive belt. Remove belt from pulley.

3. Remove the adjusting arm cap screw and mounting bolts, then lift alternator assembly from engine.

4. If a replacement unit is to be installed, remove pulley and fan for installation on replacement unit.

C. DISASSEMBLY (Fig. 9)

1. Scribe marks on the end flames and stator to help placing them in their original positions during assembly. Remove the through bolts.

2. Separate the drive end frame and rotor from the stator assembly, using a screwdriver to pry apart at the stator slot.

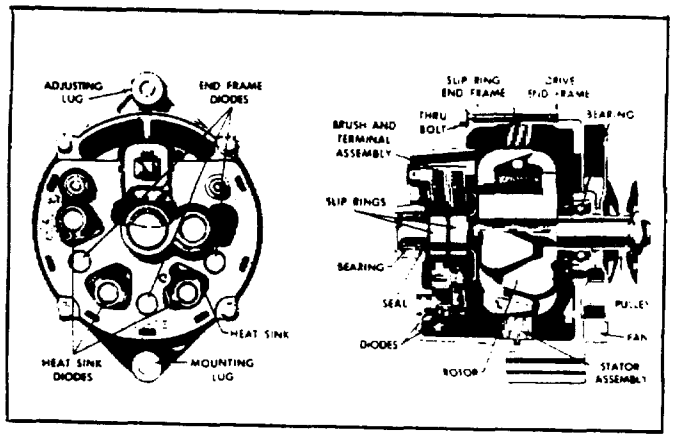


Figure 9.

NOTE: The fit between the stator and frame is not tight, and the two can be separated easily. Note that the separation is to be made between the stator and drive end frame.

3. Tape the slip ring end frame bearing to prevent the entry of foreign materials. Tape the shaft on the slip ring end.

4. Place the rotor in a soft-jawed vise. Tighten the vise only enough to enable removal of the shaft nut. Unscrew the shaft nut. Remove the pulley, fan and collar.

5. Separate the drive end frame from the rotor.

6. Remove the diodes only when necessary. To remove a diode, support the end frame or heat sink on an arbor press and push the diode out.

CAUTION: Do not strike the diode, as the shock may cause damage.

7. Remove the drive end bearing retainer and press the bearing from the drive end.

8. Remove the bearing from the slip ring end frame only when necessary. To remove the bearing, press out with a tube or collar that just fits inside the end frame housing. Press from the outside of the housing towards the inside.

9. Remove the brush holder assembly from the end frame by detaching the two brush holder assembly screws. (Fig. 10)

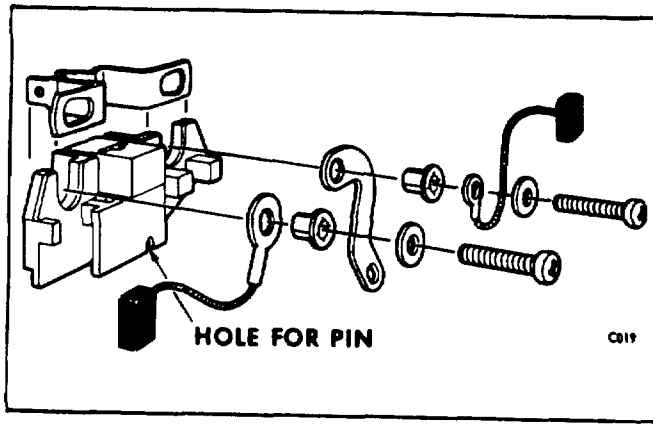


Figure 10.

10. Remove the heat sink by removing the "BAT" and "GRD" terminals from the end frame, and the screw attaching the condenser lead to the heat sink.

D. CLEANING ANO SERVICING

1. Clean the drive end frame bearing in solvent.

2. Inspect the bearing. If it is in satisfactory condition, it may be re-used, and should be filled one-quarter full with proper lubricant before reassembly.

CAUTION: Do not overfill, as this may cause the bearing to overheat.

3. When the slip ring end frame assembly is separated from the rotor and drive end frame assembly, the brushed will fall down onto the shaft and come in contact with the lubricant. If the brushes are to be re-used, they must be thoroughly cleaned with a soft dry cloth. Also, the shaft must be thoroughly cleaned before reassembly.

4. The brush springs should be inspected for any evidence of damage or corrosion. If there is any doubt as to the condition of the brush springs, they should be replaced.

5. The bearing in the slip ring end frame should be replaced if its grease supply is exhausted. No attempt should be made to relubricate and reuse the bearing.

6. If the slip rings are dirty, they may be cleaned and finished with 400 grain or finer polishing cloth. Spin the rotor in a lathe, or otherwise spin the rotor, and hold the polishing cloth against the slip rings until they are clean.

CAUTION: The rotor must be rotated in order that the slip rings will be cleaned evenly. Cleaning the slip rings by hand without spinning the rotor may result in flat spots on the slip rings, causing brush noise.

Slip rings which are rough or out of round should be trued in a lathe to .002 inch maximum indicator reading. Remove only enough material to make the rings smooth and round. Finish with 400 grain or finer polishing cloth and blow away all dust.

E. ELECTRICAL CHECKS

1. Rotor:

NOTE: The rotor may be checked electrically for grounded, open, or short circuited field coils.

a. To cheek for grounds, connect a 110-volt test lamp or an ohmmeter from either slip ring to the rotor shaft or to the rotor poles. If the lamp lights, or if the ohmmeter reading is low, the field winding is grounded. (Fig. 11)

b. To check for opens, connect the test lamp or ohmmeter to each slip ring. If the lamp fails to light, or if the ohmmeter reading is high (infinite), the winding is open. (Fig. 11)

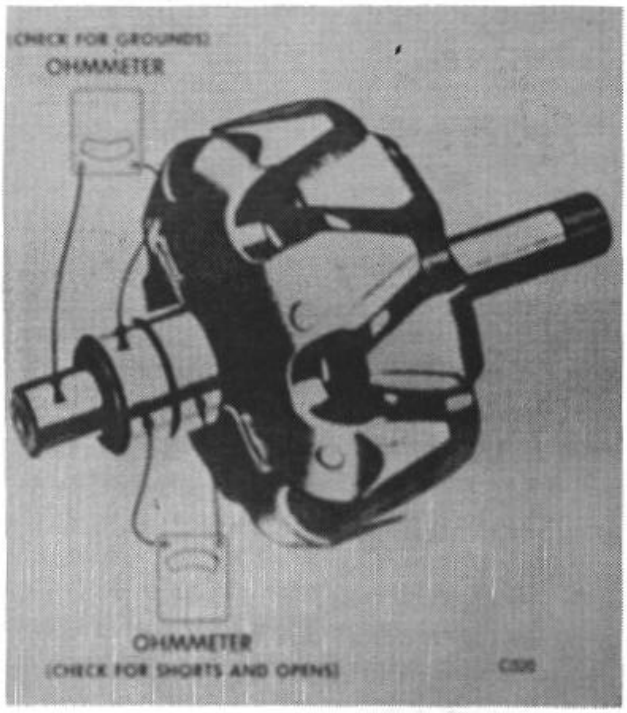


Figure 11.

c. The winding is checked for short-circuits by connecting a 12-volt battery and ammeter in series with the two slip rings. Note the ammeter reading. An ammeter reading above 2.3 amperes indicates shorted windings.

NOTE: If the rotor is not defective, and the alternator fails to supply rated output when checked, the trouble is in the stator or rectifying diodes.

2. Stator:

NOTE: To check the stator windings, remove all three stator lead attaching nuts (Fig. 12) and then separate the stator assembly from the end frame.

a. The stator windings may be checked with a 110-volt test lamp or an ohmmeter. If the lamp lights, or if the meter reading is low when connected

from any stator lead to the frame, the windings are grounded. If the lamp fails to light, or if meter reading is high when successively connected between each pair of stator leads, the windings are open. (Fig. 13)

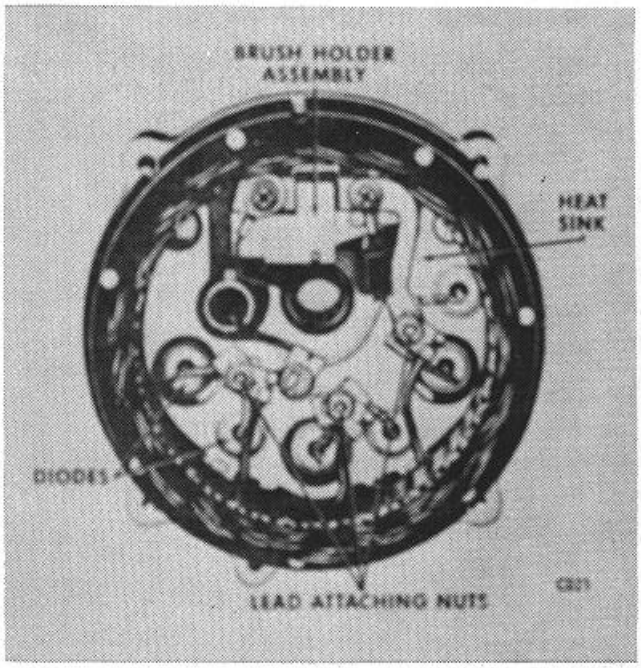


Figure 12.

b. A short circuit in the stator windings is difficult to locate without laboratory test equipment due to the low resistance of the windings. However, if all other electrical checks are normal and the generator fails to supply rated output, shorted stator windings are indicated.

3. Diode:

NOTE: Each diode may be checked electrically for a shorted or open condition.

a. One method of checking diodes is to use an ordinary ohmmeter commonly found in service stations. The lowest

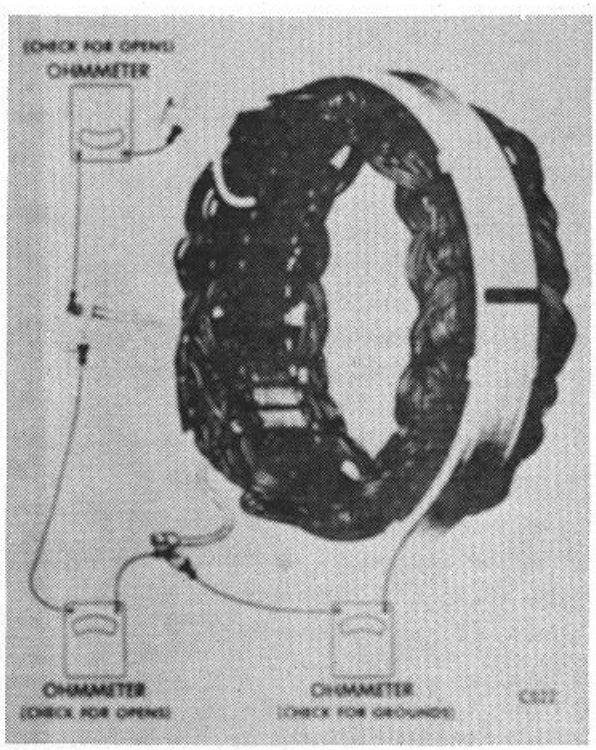


Figure 13.

range scale on the ohmmeter should be used, and the ohmmeter should have a 1-1/2 volt cell. To determine the cell voltage, turn the selector to the lowest scale, and then connect the ohmmeter leads to a voltmeter. The voltmeter will indicate the cell voltage.

b. With the stator disconnected, check a diode in the heat sink by connecting one of the ohmmeter leads to the heat sink, and the other ohmmeter lead to the diode lead, and note the reading. (Fig. 14) Then reverse the ohmmeter lead connections, and note the reading. If both readings are very low, or if both readings are very high, the diode is defective. A good diode will give one low reading and one high reading. Check the other two diodes in the heat sink in the same manner.

To check a diode mounted in the end

frame, connect one of the ohmmeter leads to the end frame, and the other ohmmeter lead to the diode lead and note the reading. (Fig. 14) Then reverse the ohmmeter lead connections, and note the reading. If both readings are very low, or if both readings are very high, the diode is defective. A good diode will give one low reading and one high reading. Check the other two diodes in the end frame in the same manner.

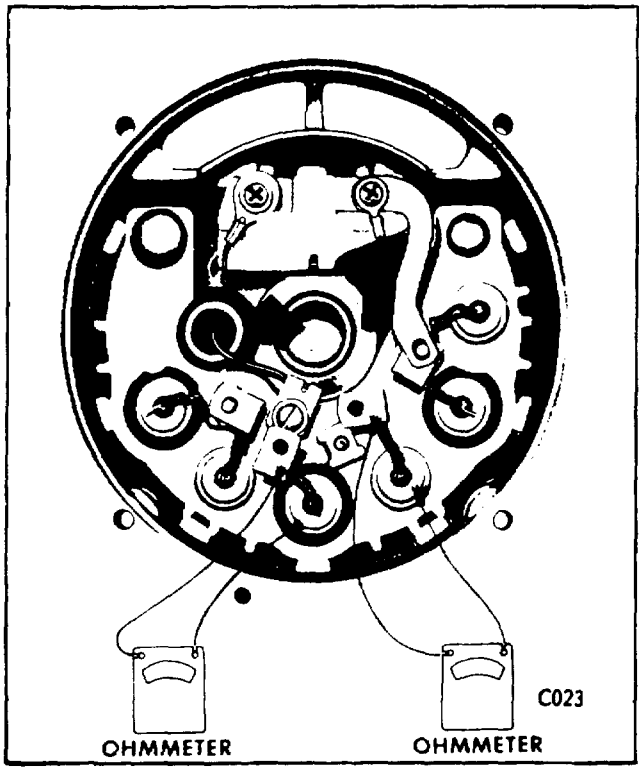


Figure 14.

c. An alternate method of checking the diodes is to use a test lamp of not more than 12 volts in place of the ohmmeter. With the stator disconnected, connect the test lamp leads across each diode as described in item b. first in one direction and then in the other. If the lamp lights in both checks, or fails to light in both checks, the diode is defective. When checking a good diode, the lamp will light in only one of the two checks.

CAUTION: Do not use 110-volt test lamps to check diodes.

F. ASSEMBLY

1. If diodes have been removed, press new ones into place, using a tool which fits over the outer edge of the diode. Support the frame end and heat sink at the same time.

CAUTION: Do not tap the diode into place, as the shock may damage it and the other diodes.

2. If removed during disassembly, replace by pressing the bearing into the drive end frame, using a collar that just fits over the bearing outer race. Attach the retainer plate.

3. Secure the rotor in a soft-jawed vise with the drive end up. Tighten the vise only enough to permit tightening the shaft nut to the correct torque.

CAUTION: Excessive pressure will distort the rotor.

4. Slide the drive end assembly over the rotor shaft.

5. Install the collar, fan and pulley. Secure the assembly with the nut tightened to 50-60 pounds-feet. Remove the assembly from the vise.

6. To install a new slip ring end bearing, place a flat plate over the bearing and press in from the outside towards the inside of the frame until the bearing is flush with the outside of the end frame. Support the inside of the frame with a hollow cylinder to prevent breakage of the end frame. Use extreme care to avoid misalignment or otherwise placing undue stress on the bearing.

7. Saturate the felt seal with SAE 20 oil, and then install the felt seal and steel retainer.

8. Install the springs and brushes into the brush holder, and insert a straight wire or pin into the holes at the bottom of the holder to retain the brushes. (Fig. 10) Then attach the brush holder assembly onto the end frame, noting carefully the proper stack-up of parts as shown in Figure 10. Allow the straight wire to protrude through the hole in the end frame.

9. Assemble the heat sink onto the slip ring end frame. (Fig. 15)

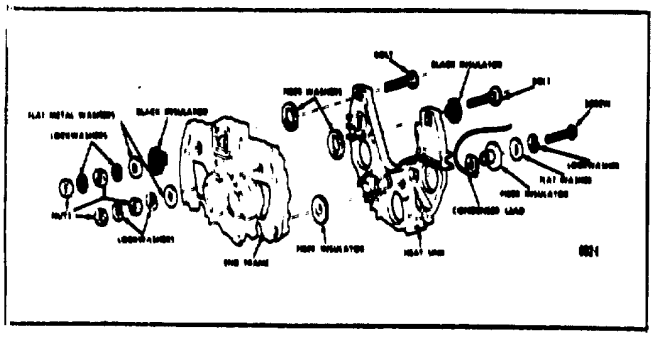


Figure 15.

10. Remove the tape over the slip ring end frame bearing and slip ring end of the rotor shaft. Make sure the shaft is clean.

11. Slide the slip ring end frame over the rotor shaft. Align the scribe marks previously made. Secure the assembly with the through bolts, tightening them alternately and evenly.

12. Withdraw the wires or pins holding the brushes of the slip rings. Check the output of the alternator.

G. OUTPUT CHECK

1. Check the alternator on a test bench, make electrical connections as shown in Figure 16, operate at specified speed, and check for rated output.

2. Adjust the load rheostat, if necessary, to obtain the desired output.

NOTE: Connect the negative battery post to the alternator frame.

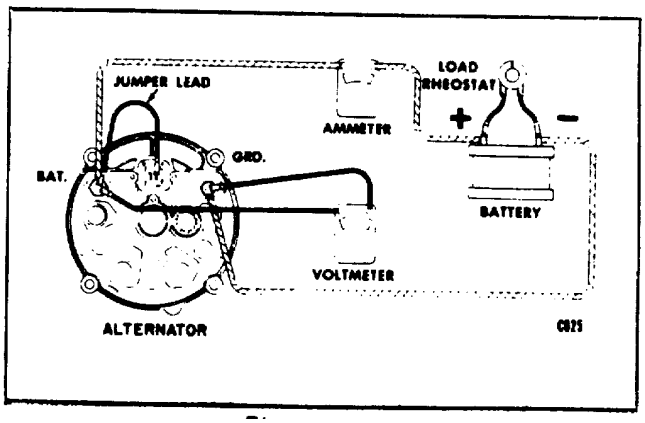


Figure 16.

H. INSPECTION

The frequency of inspection is determined largely by the type of operating conditions. High speed operation, high temperatures, and dust and dirt all increase the wear of brushes, slip rings and bearings.

At regular intervals, inspect the terminals for corrosion and lose connections, and the wiring for frayed insulation. Chock the mounting bolts for tightness, and the belt for alignment, proper tension and wear. When tightening belt tension, apply pressure against the stator laminations between the end frames, and not against either end frame.

I. INSTALLATION

1. Position alternator at mounting bracket and install mounting bolts, nuts, and lock washers.

2. Place belt in alternator pulley, then attach adjusting arm to alternator drive end frame with cap screw and washers. Adjust belt tension then tighten adjusting arm cap screw and mounting bolts.

3. Connect wires to generator according to identification made at time of removal, or by referring to the wiring diagram. Make sure connections are tight,

AUTOMATIC DISENGAGEMENT AND LOCK-OUT SYSTEM

A. GENERAL

The automatic disengagement and lock-out, or ADLO system consists of a resistor and a relay as shown in the wiring diagram. (Fig's 1 and 17)

The ADLO system protects the starter motor pinion and engine ring gear by eliminating the possibility of starter motor engagement with a running engine. Turning the ignition key closes the starter circuit. As soon as the engine fires, the output of the alternator will break the starter circuit in the relay and the pinion disengages. Disengagement takes place between cranking speed and low idle.

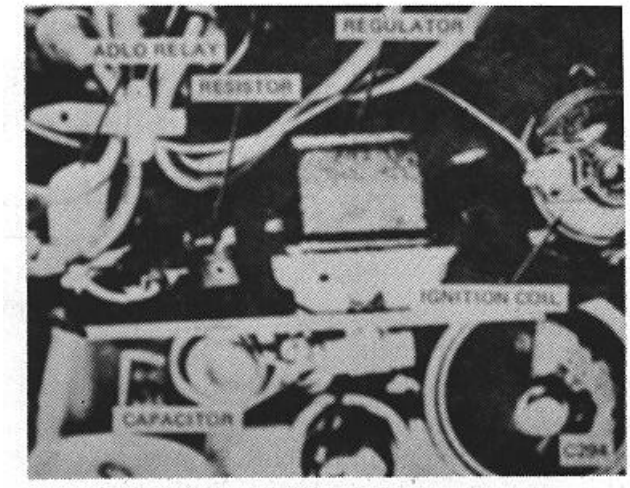


Figure 17.

B. TESTING

1. With engine stopped, remove relay cover and observe contacts which should be closed. If contacts are not closed, adjust contacts until they close by bending armatures.

2. Observe contacts while starting the engine in a normal manner; do not speed up the engine but allow it to idle in a normal manner. (Recommended idle speed.)

3. If contacts remain closed during cranking and open when engine starts, the relay operation is satisfactory and no further adjustments are required. Repeat Step 2 once more to insure that operation is satisfactory, then stop engine and replace cover.

4. If contacts open during cranking before engine starts, bend armatures and repeat Steps 2 and 3.

5. If contacts do not open when engine starts, operate at idle speed and bend upper contact armature until contacts open. Repeat Steps 2 and 3.

6. If relay contacts cannot be adjusted to open at engine idle, replace the relay.

7. Resistor a. If the resistor burns out, the starter can be engaged with the engine running and the ADLO system becomes ineffective.

b. The resistor is rated 7.5 ohms, maximum power dissipation: 25 watts. Check the resistor with the unit cold, using an ohmmeter or Multimeter. Replace a defective resistor.

8. Relay

a. A burnt coil will cause the points to stay closed. Thus, the starter can be engaged with the engine running.

b. If the points fuse, the starter can be engaged with the engine running.

c. If the points become pitted, coated, or make no proper contact, the engine can not be started. Replace the relay in these cases.

ALTERNATOR REGULATOR

A. GENERAL (Fig. 17)

The voltage regulator is shown in Figure 18. This regulator has four terminals. The terminals are of the slip-connection type, and a special connector body of the vehicle wiring harness is keyed to mating slots in the regulator base to insure proper connections. Also, a projection on the connector body serves to latch the assembly together. This prevents disconnections due to vibration. The assembly can be disconnected by lifting the latch slightly. (Fig. 18)

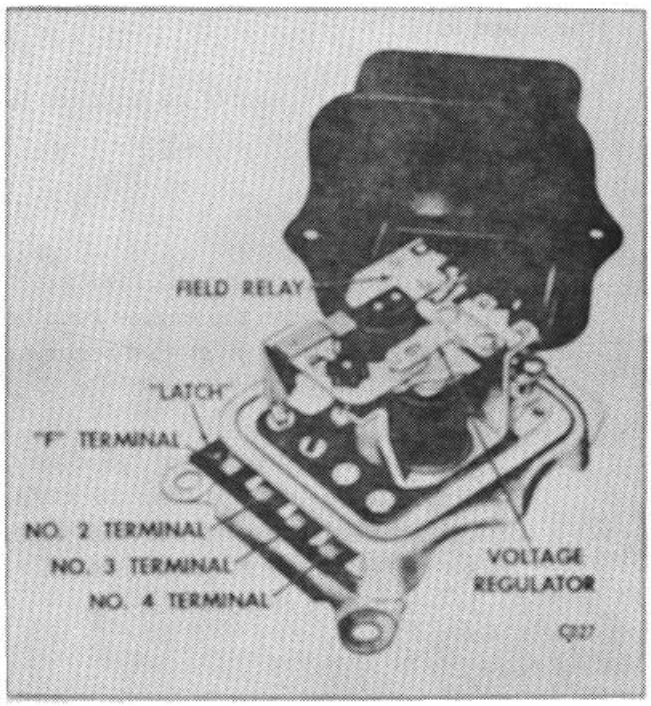


Figure 18.

A double contact voltage regulator unit and a field relay unit make up the regulator assembly. The voltage regulator unit operates to limit the generated voltage to a preset value, whereas the field relay connects the alternator field winding and regulator winding directly to the battery.

Each model regulator is designed for use on only one polarity system. Note the marking on the regulator base, or refer to the Specification Listing to determine the polarity.

A typical wiring diagram showing internal circuits of the regulator is illustrated in Figure 19.

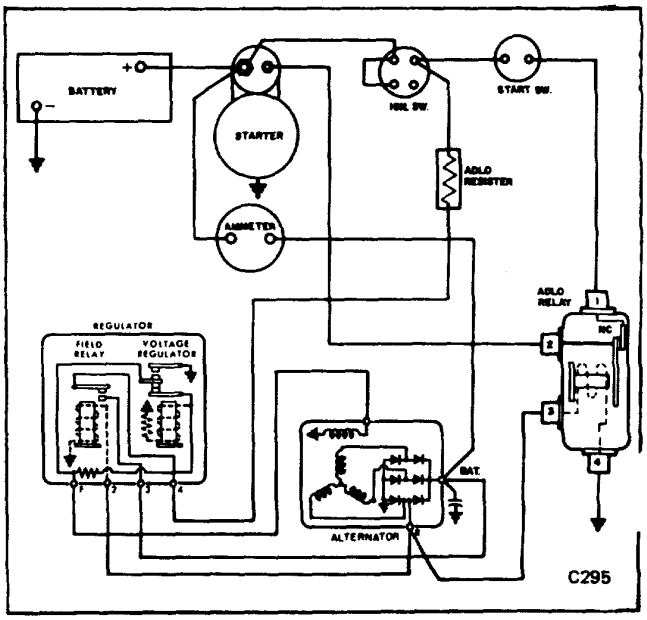


Figure 19.

Following is a description of the operation of units in this circuit. (Fig. 1) When the ignition switch is closed, current flows through a voltage - dropping resistor from the positive terminal of the ignition coil to terminal 4 of the voltage regulator, then out through regulator terminal F to the field of the alternator. This reduced field energizing voltage limits the alternator output while the engine is cranking. As the ignition switch is moved to the Start position, current flows through normally closed contacts (terminals 1 and 2) of the ADLO relay and to the starter solenoid. The engine begins to crank, while the alternator output is held to a low level by the reduced field voltage.

After the engine starts, and as the engine RPM

increases, the alternator output increases enough to magnetize the armature of the ADLO relay and open the normally closed contacts; the solenoid is de-energized and the starter disengages. As the alternator output increases further, the reduced-field-voltage contacts of the regulator are opened and full battery voltage is applied through regulator terminal 3 to the alternator field, and to ground.

As the speed of the alternator increases, the voltage at the "BAT" terminal of the alternator also increases. This impresses a higher voltage through the field relay contacts and across the voltage regulator shunt winding. The increased magnetism created by the higher voltage across the winding causes the lower contacts to separate, and field current then flows through a resistor resulting in reduced field current. This reduced field current causes the charging voltage to decrease, which decreases the magnetic pull of the voltage regulator shunt winding. The spring causes the contacts to close, and the cycle then repeats many times per second to limit the charging voltage to a pre-set value. As the alternator speed increases even further, the resistor connected across the contacts is not of sufficiently high value to maintain voltage control on the series contacts. Therefore the voltage increases slightly causing the upper or shorting contacts to close. When this happens, the alternator field winding is shorted and no current passes through the winding. With no current in the field winding, the charging voltage decreases. Also, the magnetism in the shunt winding decreases and the upper or shorting contact points open. With these points open, field current flows through the resistor and the field winding. As the voltage increases, the contacts close. This cycle then repeats many times per second to limit the charging voltage to a pre-set value at high generator speed. The voltage regulator unit thus operates to limit the value of charging voltage throughout the alternator speed range. Consequently the electrical accessories are protected from too high voltage which would damage them.

There are two units included in the alternator regulator: (1) Voltage regulator, (2) Field relay. In the following procedures, each is considered separately.

B. VOLTAGE REGULATOR

Three checks and adjustments are required on the double contact voltage regulator unit: (1) point opening, (2) air gap, and (3) voltage setting.

1. Point Opening: With the lower contacts touching, measure the point opening between the upper contacts. Adjust by bending the upper contact arm, being careful not to bend the hinge. (Fig. 20)

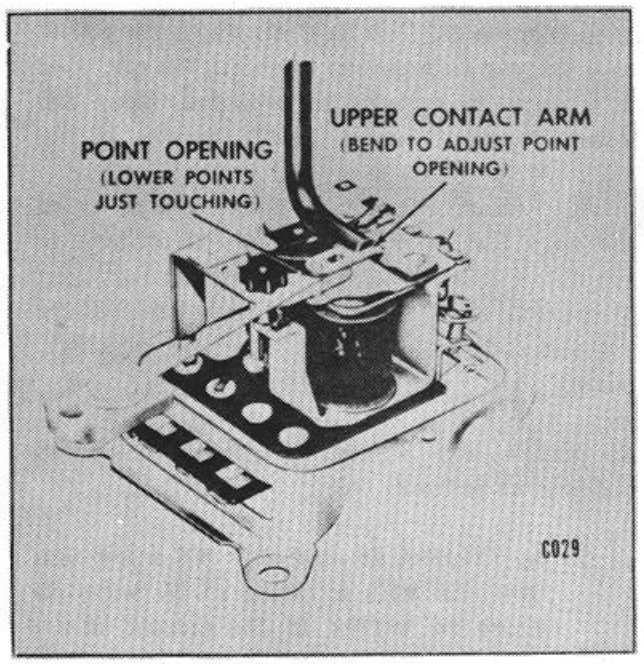


Figure 20.

2. Air Gap: Measure the air gap with a feeler gauge placed between the armature and core when the lower contacts are touching. To adjust the air gap, turn the nylon nut located on the contact support. (Fig. 21)

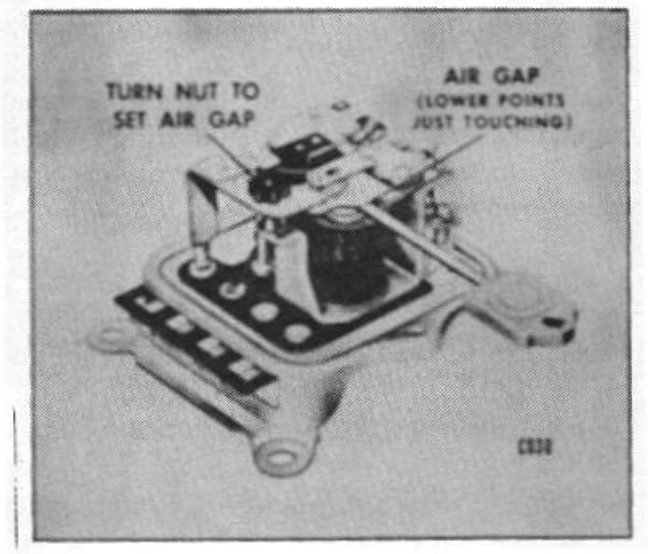


Figure 21.

NOTE: Only an approximate voltage regulator air gap setting should be made by the "feeler gauge" method. The final air gap setting must be whatever is required to obtain the specified difference in voltage between the upper and lower sets of contacts.

3. Voltage Setting: The voltage at which the regulator operates varies with changes in regulator ambient temperatures. The ambient temperature is the temperature of the air measured 1/4 of an inch from the regulator cover.

To check and adjust the voltage setting, proceed as follows:

a. Connect an ammeter and a 1/4 ohm resistor with a rating of 25 watts or more in series in the circuit at the "BAT" terminal on the alternator. (Fig. 22)

b. Make connections to the adapter as shown in Figure 23. Use a 25 ohm 25 watt variable resistor in series with the alternator field winding at the regulator "F" terminal, and connect a jumper lead from the adapter to the alternator "BAT" terminal as shown.

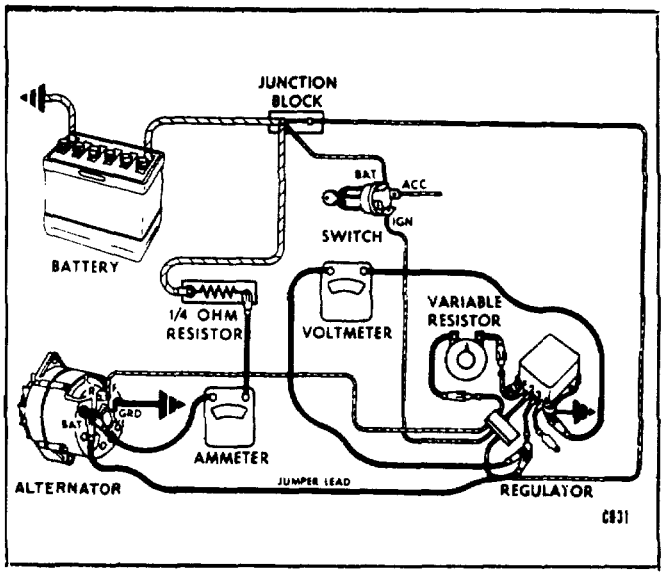


Figure 22.

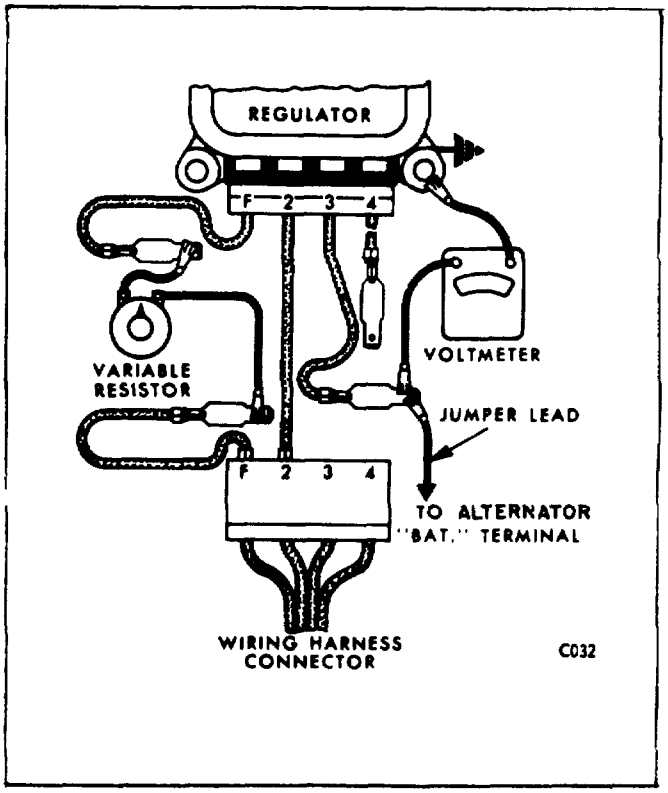


Figure 23.

Also, connect a voltmeter from the adapter to ground, as shown. Turn the variable resistor to the closed or "no resistance" position.

c. Operate the alternator for 15 minutes at approximately 1500 engine RPM (approximately 3500 alternator RPM). Leave cover on regulator to establish operating temperature. Accessories and lights must be turned off.

d. After the 15 minute warm-up period, cycle the alternator by the following procedure:

(1) Turn the variable resistor in the field circuit to the full resistance position.

(2) Disconnect then reconnect the jumper lead at the "BAT" terminal of the "Alternator."

(3) Return the variable resistor to the closed or "no resitance" position.

(4) Bring engine speed up to 2450 RPM (approximately 6000 alternator RPM) and note the voltage setting. Refer to the Specification Listing for specifications. The regulator should be operating on the upper or shorting contacts. If it will not operate on the upper contacts, the battery is in an extreme state of discharge, and must be at least partially charged before proceeding.

e. To adjust the voltage setting while operating on the upper or shorting contacts, turn the adjusting screw. (Fig. 24)

CAUTION: Always make final setting by turning the screw clockwise. This insures that the spring-holder will be against the head of the screw. If it is necessary to turn the screw counterclockwise, turn it until the screw head is approximately 1/8"', above the adjusting bracket, then pry holder up against screw head, then turn clockwise to make setting.

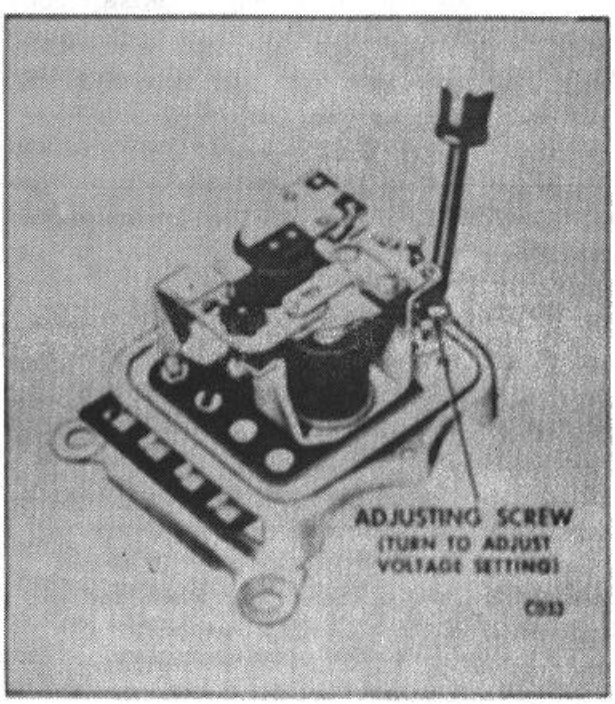


Figure 24.

f. After making the setting, cycle the alternator as covered in Step "d" above.

g. Then, operate at 2450 engine RPM (approximately 6000 alternator RPM), and note setting. Adjust if necessary.

h. Always cycle the alternator as covered in Step "d", before reading the final voltage setting on the voltmeter.

i. After making the voltage setting while operating on the upper set of contacts, check the voltage setting while operating on the lower set of contacts as follows: Slowly increase the resistance of the variable resistor with the engine operating at 2450 RPM (approximately 6000 alternator RPM) until the regulator begins to operate on the lower set of contacts. Then note the voltage reading, and refer to Specification Listing for specifications,

NOTE: If turning the variable resistor does not cause the regulator to operate on the lower set of contacts, return the variable resistor to the "no resistance" position, turn the carbon pile to slightly load the battery, and then adjust the variable resistor to cause the regulator to operate on the lower set of contacts.

NOTE: The most desirable method of determining that the regulator is operating on the lower set of contacts is to use earphones connected from the regulator "F" terminal to ground. As the variable resistor is turned, and operation changes from the upper set of contacts to the lower set, the earphone sound will fade away and stop completely and then return when the lower set of contacts begins to operate. The alternate method is to observe the voltmeter change from one value to another, but this is less desirable since it is not as accurate.

j. The difference in voltage between the operation of the upper set of contacts and the lower set is increased by slightly increasing the air gap between the armature and center of core and decreased by slightly decreasing the air gap. See Figure 22 for changing the voltage regulator air gap. If it is found necessary to make this air gap adjustment, it will be necessary to recheck the voltage setting of both sets of contacts.

C. FIELD RELAY

NOTE: Three checks are required on the field relay: (1) air gap, (2) point opening, and (3) closing voltage.

1. Air Gap: With the regulator removed from the vehicle, check the air gap with the points just touching. (Fig. 25) If adjustment is necessary, carefully bend the flat contact support spring.

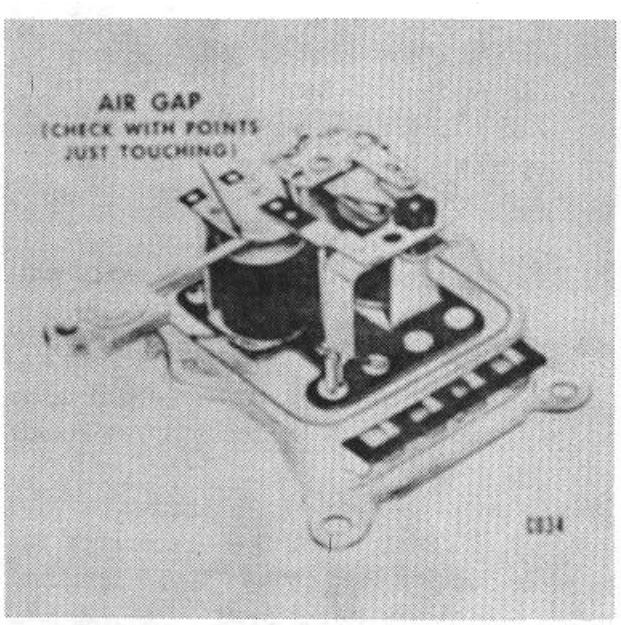


Figure 25.

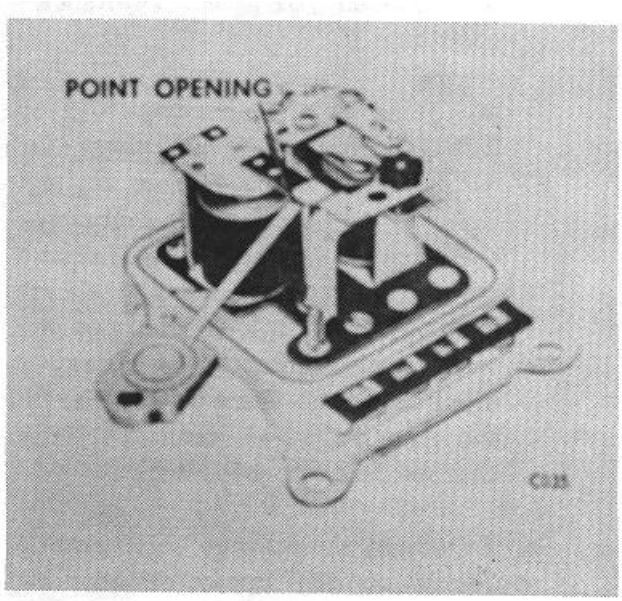


Figure 26.

2. Point Opening: Measure the opening between the points, and adjust by bending the armature stop. (Fig. 26)

3. Closing Voltage: The closing voltage of the field relay may be checked as follows:

a. Connect a 50-70 ohm variable resistor and a voltmeter to the adapter.

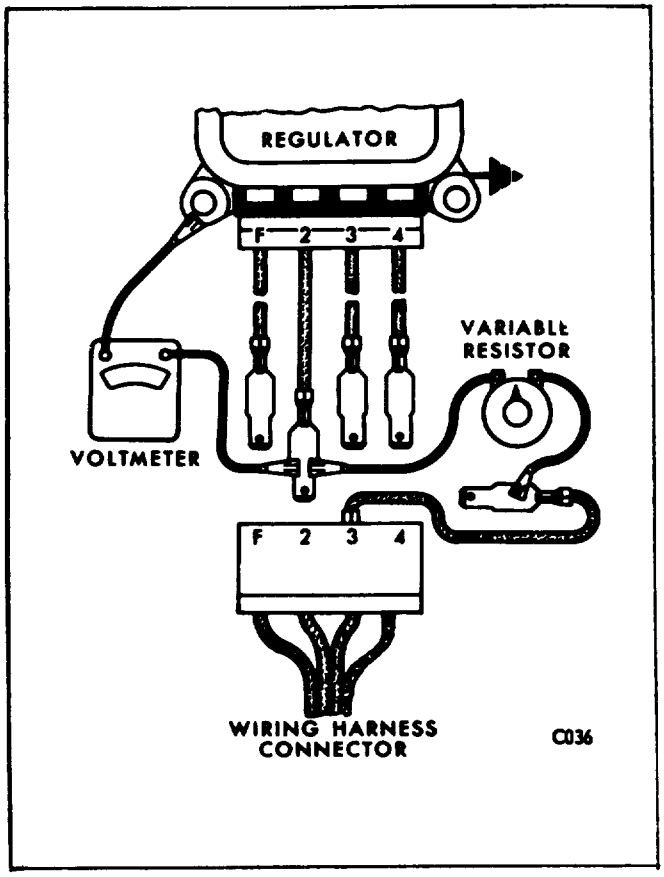


Figure 27.

(Fig. 27) Turn variable resistor to the open or "full resistance" position, and leave the ignition switch in the "off" position.

b. Slowly decrease resistance and note closing voltage of the relay. Adjust by bending heel iron. (Fig. 28) NOTE: If the field relay unit does not have an armature stop, a point opening check is not required.

D. MAINTENANCE

1. The voltage regulator contacts should not be cleaned unless the electrical performance indicates it is necessary. A sooty or discolored condition of the contacts is normal after a relatively short period of operation and is not an indication that cleaning is

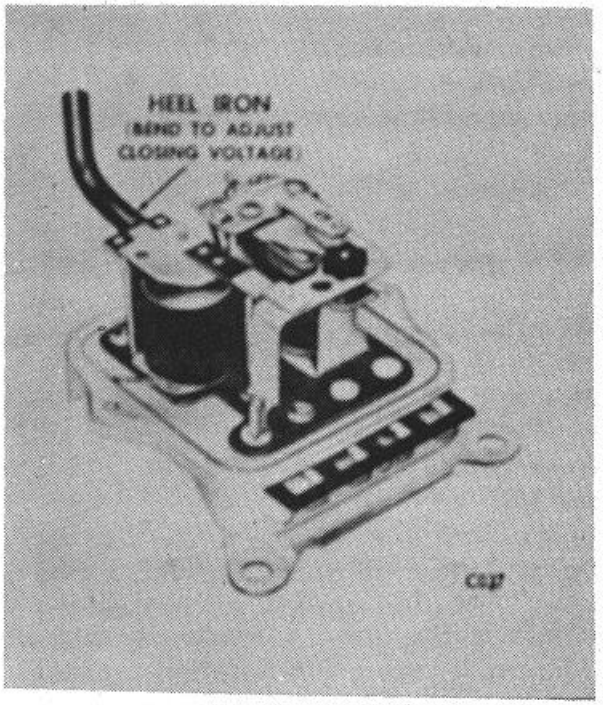


Figure 28.

necessary. However, if the voltage fluctuates as evidence by an unsteady voltmeter reading when checking the voltage setting, the contacts may have excessive resistance or may be sticking and they, therefore, should be cleaned.

CAUTION: Before cleaning contacts, make sure the unsteady voltage is not being caused by loose connections or high resistance elsewhere in the system.

2. The contacts on the voltage regulator unit are of a soft material and must not be cleaned with a file, A strip of No. 400 silicon carbide paper or equivalent folded over and then pulled back and forth between the contacts is recommended as a satisfactory method of cleaning. After cleaning, the contacts should be washed with alcohol to remove any residue. If the voltage control has not improved, repeat the cleaning and washing process.

3. To clean the field relay contact,. use a thin, fine cut, flat file. Remove only enough material to clean the points.

NOTE: Never use emery cloth or sandpaper to clean contact points.

E. CORRECTION FOR AMBIENT TEMPERATURE

It is important to remember that the voltage setting for one type of operating condition may not be satisfactory for a different type of operating condition. Vehicle underhood temperatures, operating speeds, and nighttime service all are factors which help determine the proper voltage setting. The proper setting is attained when the battery remains fully charged with a minimum use of water.

If no circuit defects are found, yet the battery remains undercharged, raise the setting by .3 volt, and then check for an improved battery condition over a service period of reasonable length. If the battery remains overcharged, lower the setting by .3 volt, and then check for an improved battery condition. Recommended voltage setting procedures are charted below.

Ambient Temperature Degrees	Voltage Setting
65	13.9-1.,0
85	13.8-14.8
105	13.7-14.6
125	13.5-14.4
145	13.4-14.2
165	13.2-14.0
185	13.1-13.9

NOTE: Operation on lower contacts must be .1 to .4 volt lower than on upper contacts.

CHECKING THE ALTERNATOR CHARGING SYSTEM

A. GENERAL

Trouble in the charging system will usually show up as an undercharged battery or an overcharged battery.

Before making any electrical checks, visually inspect all connections, including the slip-on connectors at the regulator and alternator to make sure they are clean and tight, then proceed. Since the regulator terminals are of the slip-on type, a special cable assembly or adapter must be used during testing so that meter connections can be made to the terminals.

CAUTION: To check the charging system, insert the adapter into the regulator, making connections only as shown in the illustrations. Avoid contact with the units when replacing the regulator cover.

B. UNDERCHARGED BATTERY

NOTE: This condition, as evidenced by slow cranking, can be caused by one or more of the following conditions:

1. A loose alternator drive belt.

2. A defective battery.

3. Malfunction of field relay.

4. A defective alternator.

5. A low voltage regulator setting.

1. Loose Drive Belt: The drive belt should be tightened to specification.

2. Defective Battery: A battery which is sulphated, or one with an intermittent open at a terminal post or in one of the cell connectors, will remain in an uncharged condition under normal operating conditions.

3. Malfunction of Field Relay: To check the relay, make connections to the adapter as shown in Figure 29; turn the switch to the "IGN" position, and observe the voltmeter. The reading should be battery voltage. If the reading is zero, either the line between the

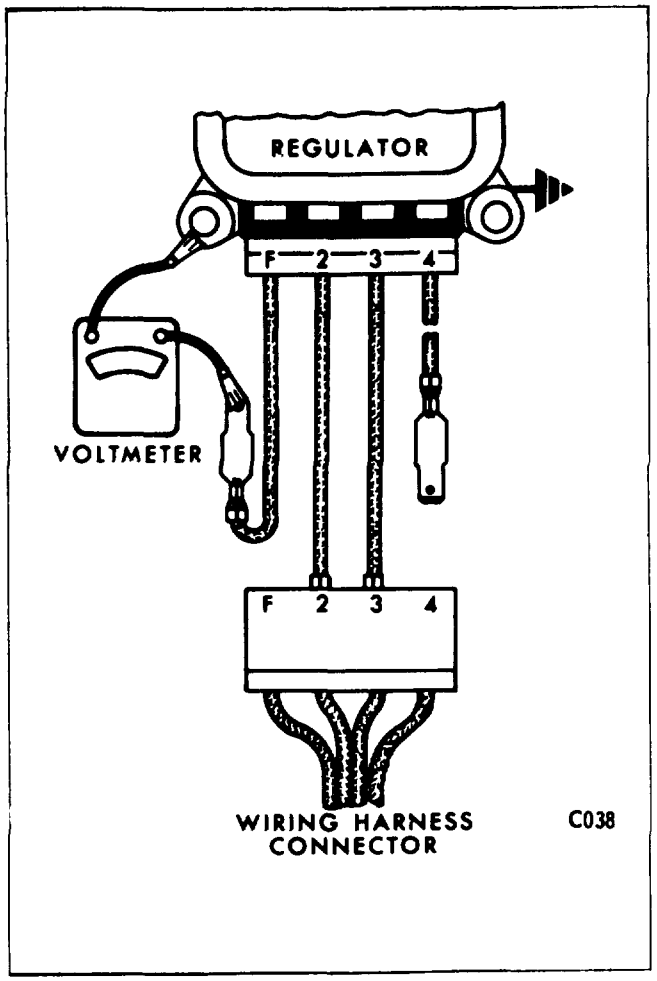


Figure 29.

switch to regulator No. 2 terminal is open, or the field relay is defective, and must be checked.

4. Defective Alternator: To determine if the alternator is operating properly, proceed as follows:

a. Connect an ammeter in the circuit at the "BAT" terminal of the alternator and a voltmeter from the "BAT" terminal to ground.

b. Make connections to the adapter as shown in Figure 30.

c. Turn on switch, operate engine at speed and check for rated output. If alternator does not provide rated output, it should be checked.

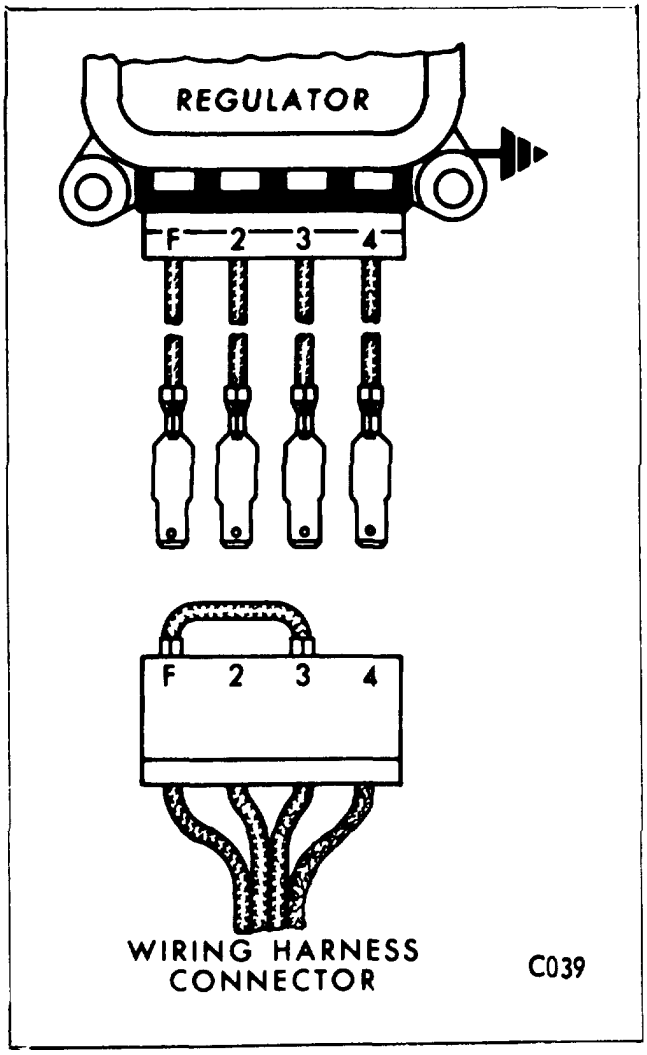


Figure 30.

CAUTION: Load the battery with a carbon rheostat or accessories to prevent high voltage. Do not allow the charging voltage to exceed the recommended voltage setting of the regulator.

5. Low Voltage Regulator Setting: If no circuit defects are found, yet the battery remains undercharged, the cause most likely is a low voltage regulator setting.

C. OVERCHARGED BATTERY

NOTE: An overcharged battery, as evidenced by excessive water usage, can be caused by:

(1) A shorted battery cell.

(2) A high voltage regulator setting.

1. Shorted Battery Cell: Checks for shorted battery cells should be made as this can cause the battery to be overcharged.

2. High Voltage Regulator Setting: If no circuit defects are found, yet the battery remains overcharged, the cause is probably a high voltage regulator setting.

CRANKING MOTOR

A. GENERAL

The 12 volt cranking motor is a 4 pole, 4 field coil unit that has the solenoid, solenoid plunger, and solenoid shift lever mechanism enclosed in the drive housing. (Fig. 31) A small diameter overrunning clutch type of drive is used to engage the cranking motor pinion with the flywheel. The armature shaft and clutch have mating spiral spines that prevent transfer of full cranking power until the pinion is fully engaged with the flywheel ring gear.

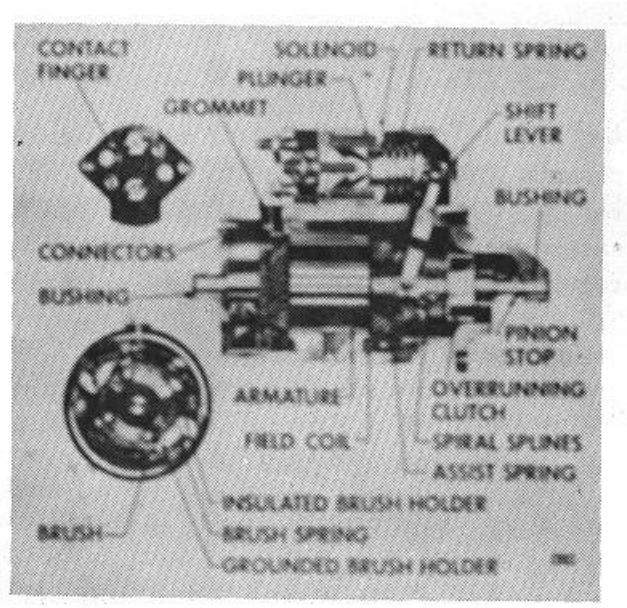


Figure 31.

Starter pinion is shifted into mesh with wheel ring gear teeth and starter circuit is completed by the solenoid when the solenoid is energized by the key starting-ignition switch, Primary circuit to ignition coil is also fed from the solenoid while the starter is operating.

The drive end housing is extended to enclose the entire shift lever mechanism and solenoid plunger. The solenoid flange is mounted on the drive end housing, with sealing compound used between flange and field frame. The shift lever return spring is a compression type spring located inside the solenoid case. A special assist spring is located around the armature and the collar of the clutch drive. This assist spring aids the solenoid in overcoming the return spring force in the first movement of the clutch along the armature shaft.

B. PERIODIC MAINTENANCE

No periodic lubrication of the cranking motor solenoid is required. The cranking motor and brushes can be inspected only when the unit is disassembled, so no service is necessary between overhaul periods.

C. STARTING CIRCUIT TESTS

NOTE: The following tests are for solenoid equipment cranking motors. However, they can be used as guides to check the starting circuits of cranking motors controlled by magnetic switches.

1. Disconnect the primary lead to the distributor to prevent engine starting. Referring to Figure 32, and with starter cranking engine during each check, measure V-1 (with voltmeter connected to the positive (+) battery post and the solenoid battery terminal), V-2 (with voltmeter connected to the solenoid battery terminal and solenoid motor terminal),

and V-3 (with voltmeter connected to the negative (-) battery post and the starter field frame).

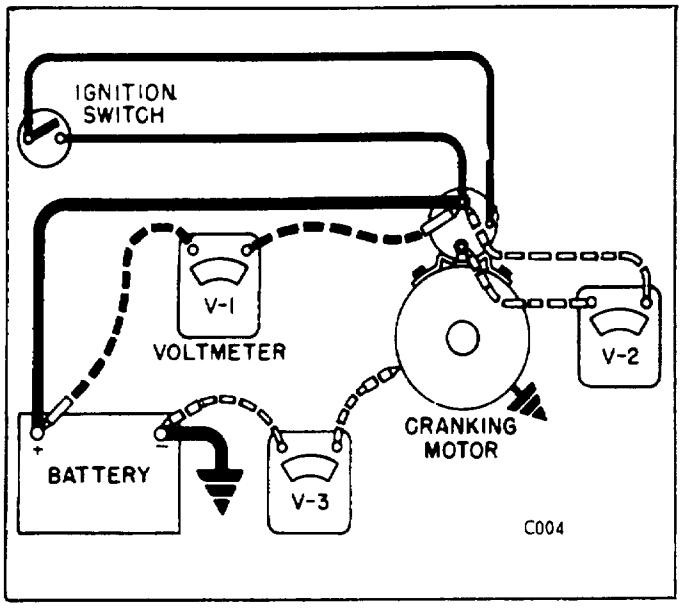


Figure 32.

2. If V-1, V-2, or V-3 exceeds 0.5 volt, excessive resistance is indicated in that part of the circuit being checked. Locate and eliminate the cause for any excessive voltage drop in these circuits in order to obtain maximum efficiency from the starting system.

3. If starter fails to crank engine, first make sure battery is not discharged, then check solenoid operation. If solenoid plunger fails to pull in, the trouble may be due to excessive resistance in the solenoid control circuit. Check all wiring and connections from ignition switch to solenoid for loose or corroded connections.

4. If cause of excessive resistance is not apparent, connect a short jumper lead across the solenoid "battery" and "S" terminals. If solenoid plunger pulls in, trouble is in solenoid control circuit. Check for defective ignition switch. If solenoid plunger does not pull in with jumper lead connected, solenoid is defective and must be replaced.

D. REMOVAL

1. Disconnect: the battery ground cable from the battery; the cable from the cranking motor, solenoid or magnetic switch; the wires from the solenoid or magnetic switch.

2. Remove the two capscrews holding the motor to the flywheel housing. Lift the motor toward the rear of the truck.

E. DISASSEMBLY (Fig. 31)

NOTE: Normally, the cranking motor should be dismantled only to the point where repair or replacement of parts can be made. However, the cranking motor should be disassembled completely at regular intervals for the cleaning and inspection of all parts.

1. Remove screw and lock washer attaching field coil connector strap to lower terminal on solenoid.

2. Remove through-bolts attaching commutator end frame and field frame to drive end housing. Remove commutator end frame.

3. Remove field frame from armature and drive-housing.

4. Remove armature and drive assembly from drive housing, tilting armature as necessary to disengage lugs on shift lever from drive collar.

5. Remove two screws and lock washers attaching solenoid to drive housing. Remove solenoid and return spring from drive housing and plunger.

6. Remove over-running clutch drive assembly from armature shaft as follows:

a. Slide thrust collar (Fig. 33) off end of armature shaft.

b. Slide a standard 1/2 inch pipe coupling or other metal cylinder of correct size onto shaft so end of coupling cylinder butts against edge of retainer. (Fig. 34) Tap coupling with hammer to drive retainer down toward arm' and off snap ring.

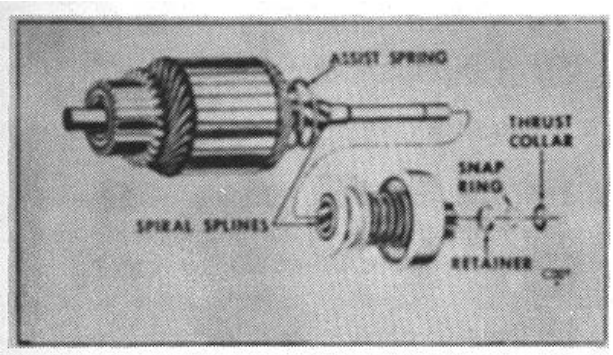


Figure 33.

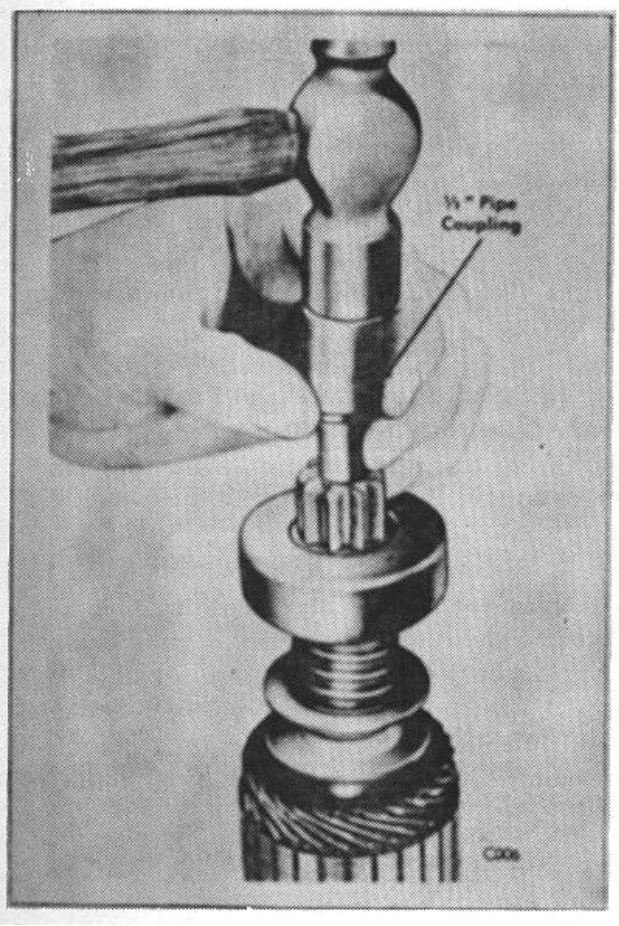


Figure 34.

c. Remove snap ring from groove in armature shaft. If snap ring is distorted during removal, it must be discarded and a new one obtained for assembly.

d. Slide retainer and over-running clutch assembly off armature shaft.

7. Remove the solenoid return spring and plunger. Remove the terminal assembly and the contact assembly. To disassemble the contact assembly, push in on the metal cup and rotate 1/4 turn. (Fig. 35) Slide the metal cup, spring, and washers off the push rod.

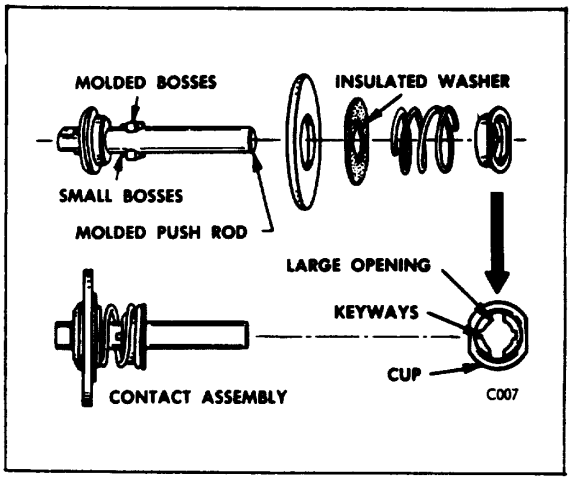


Figure 35.

F. SERVICE PROCEDURES

NOTE: The over-running clutch, armature, and fields should never be cleaned in a degreasing tank or with grease dissolving solvents, All parts of the motor except the clutch should be cleaned with oleum spirits and a brush. Wipe the clutch with a clean cloth.

1. Armature

a. Check armature - to - commutator leads to make sure they are securely

connected. Place one prod of test lamp on armature and the other prod on commutator. (Fig. 33) If test lamp lights, armature is grounded and should be replaced if defect is not readily apparent and repairable.

b. Place armature on growler. Hold hacksaw blade over armature and slowly rotate armature. If saw blade vibrates, armature is short-circuited. Before replacing, inspect commutator slots for copper or brush dust deposits. Clean thoroughly and retest.

c. Burned commutator riser bars are sometimes caused by an open-circuited armature. If bars are not too badly damaged, armature can sometimes be repaired by resoldering the leads in the riser bars, using rosin flux solder. After soldering, turn down commutator and undercut the mica.

d. Examine bearing surfaces at each end of armature shaft for evidence of wear, and examine spiral splines for damage. Replace armature assembly if shaft is worn or damaged.

2. Commutator

a. Inspect commutator and if found to be rough, out-of-round, worn or has high mica, filled slots, or is burned, repair as follows:

b. Turning Down. Place armature in a lathe and turn down commutator to remove worn spots, out-of-round, or rough condition. Do not cut deeper than necessary to clean up. (Fig. 37)

c. Undercut Mica. Mica between commutator segments must be below edges of segments. Start groove with a small three-cornered file, then use a hacksaw blade to undercut mica to a depth of 1/32 inch. Use No. 00 sandpaper to clean and smooth up commutator, then blow all dust and cutttings out of grooves.

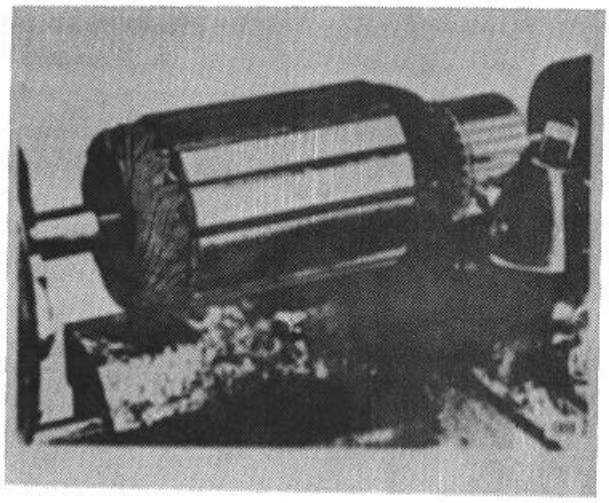


Figure 37

3. Field Coils

NOTE: Before checking field coils on enclosed shift lever starter, disconnect shunt field coil lead from brush holder bracket.

a. Place one test prod on field coil connector and the other on each field coil lead. If lamp does not light, coils are open-circuited.

b. Place one test prod on field frame and the other on each field coil lead. If lamp lights, coils are grounded.

c. If ground or open circuit is indicated in series connected coils, break the connection between coils and test each coil separately to determine which one is defective and must be replaced. If any coil is replaced, make sure connections are securely soldered and properly insulated.

4. Commutator End Frame

a. On open shift lever type, brush holders are mounted on commutator end frame. Two brush holders are insulated from the end frame and two are grounded. Test each insulated brush holder by placing one test prod on insulated brush holder and one on end frame. If the lamp lights, brush holder is grounded and the insulation should be replaced.

b. On enclosed shift lever type, the insulated brush holders, mounted in the field frame, are made of a nonconductor and are mounted on the same pin as the grounded brush holders.

c. Examine armature shaft bushing in end frame for wear. Replace bushing if hole is elongated.

d. Check brush spring tension. If not within limits, replace the new springs. Examine hinge pins and brush holders for bent or damaged condition. Any condition which might prohibit free brush action must be corrected.

5. Brushes

a. If brushes are worn down to less than one-half their original length, they must be replaced. Compare old brushes with a new one to determine how much they are worn.

b. Be sure that clips are securely soldered to the brush leads. When installing new brushes, side having trade mark must be out away from holder.

6. Drive Housing. Examine bushing in drive housing if worn excessively. Also replace oiler wick, if used. If necessary to replace shift lever (or solenoid plunger on enclosed shift lever type), remove bolt securing shift lever in drive housing.

7. Overrunning Clutch. Drive pinion must rotate freely in overrunning direction and must not slip in cranking direction. If drive pinion turns roughly or slips, replace complete overrunning clutch assembly.

8. The Bendix drive should be cleaned and a film of light oil applied to the screw shaft, as any accumulation of dirt on drive might restrict the free movement of the pinion.

G. ASSEMBLY (Fig. 31)

1. Place a few drops of engine oil on bushing in commutator end frame and in drive housing. Spread oil evenly on bushing.

2. If shift lever and solenoid plunger were removed from drive housing, assemble plunger to shift lever and secure lever in housing with bolt, lock washer, and nut. Make sure shift lever pivots freely on bolt.

3. Install overrunning clutch assembly on armature shaft as follows:

a. Apply a light coat of engine oil on armature shaft spiral splines.

b. Place assist spring over armature shaft with small end of spring against armature, then slide overrunning clutch assembly on shaft with drive pinion toward end of shaft.

c. Slide retainer onto shaft with cupped side facing end of shaft.

d. Install snap ring over end of shaft and place in groove in shaft. Use care not to distort snap ring while installing.

e. Install thrust collar on shaft with shoulder on collar next to snap ring.

f. Position retained and collar next to snap ring, then use two pairs of pliers as shown in Figure 38 to force retainer over snap ring.

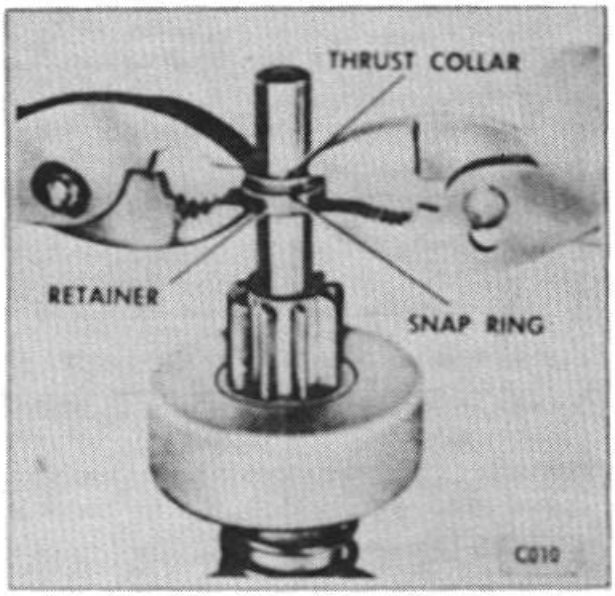


Figure 38.

4. Install thrust washer over end of armature shaft, then install armature and overrunning clutch assembly in drive end housing, tilting armature as necessary to make lugs on shift lever yoke engage collar on overrunning clutch.

5. Assemble solenoid and return spring to drive housing, with solenoid plunger inserted into solenoid case, and secure with two screws and lock washers.

6. Apply sealing compound to extended portion of solenoid case flange contacted by field frame. Make sure all brush holders, springs, and brushes are installed in field frame and all leads are securely connected.

7. Place field frame over armature shaft, pulling brushes out over commutator, and engage dowel pin in field frame in hole in drive housing. Install commutator end frame over armature shaft, then install through-bolts through commutator end frame and thread into tapped holes in drive housing. Tighten through-bolts firmly.

8. Attach field coil connector to solenoid terminal with screw and lockwasher.

9. Check drive pinion clearance as directed later under “Drive Pinion Clearance.”

10. If testing equipment is available, No Load and Torque Tests may be made to determine if starter is up to specifications.

H. DRIVE PINION CLEARANCE

1. The drive pinion clearance should be checked whenever the starter has been overhauled. There is no means of adjusting the pinion clearance. If clearance is not within specified limits, it may indicate excessive wear of the solenoid linkage or shift lever yoke lugs. Clearance between the end of the pinion and the pinion stop, with the pinion in cranking position, is shown in Specification Listing.

2. To check clearance, connect a voltage source of approximately 6 volts (three battery cells in series or a 6-volt battery) between the solenoid switch terminal (S) and ground.

CAUTION: Do not connect the voltage source to ignition coil terminal (R) of the solenoid. Do not use a 12-volt battery instead of the 6 volts specified as this will cause the motor to operate. As a further precaution to prevent motoring, connect a heavy jumper lead from the solenoid motor terminal to ground.

3. After energizing the solenoid with the clutch shifted forward, push the pinion back as far as possible to take up any movement, and check the clearance with a feeler gauge as shown in Figure 39. If not within specifications, disassemble and replace worn parts in solenoid and shift lever linkage.

I. TESTING

If the brushes. brush spring tension, and commutator

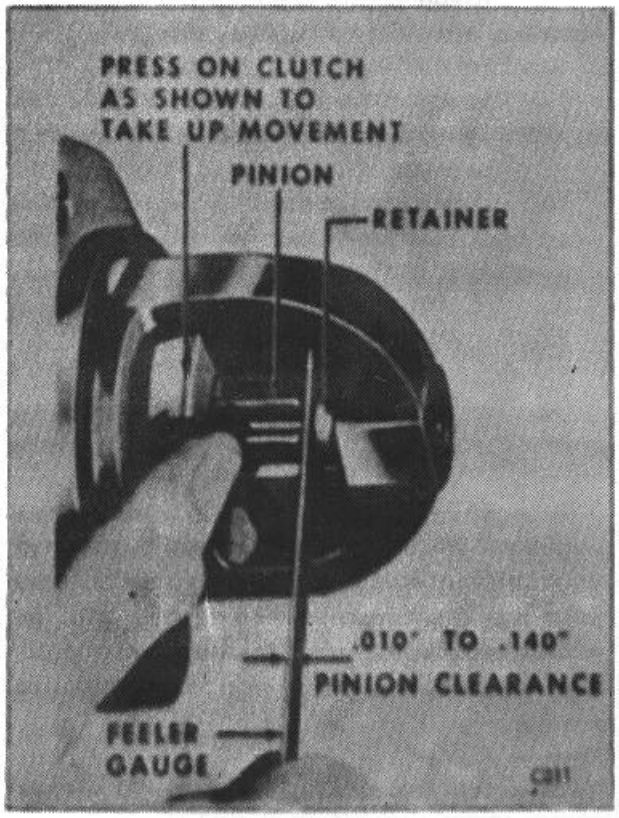


Figure 39.

appear to be in good condition, the battery and external circuit are found to be satisfactory, and the cranking motor still does not operate correctly, make the following tests:

1. No-load test: Connect the cranking motor in series with a battery of specified voltage and an ammeter capable of reading several hundred amperes. Read the armature RPM in addition to the current draw. (Fig. 40)

2. Torque test: It is advisable to use in the circuit a high current-carrying variable resistance, so that the specified voltage at the motor can be obtained. A small variation of the voltage will produce a marked difference in the torque developed. (Fig. 41)

3. Interpreting results of No-load and Torque Test:

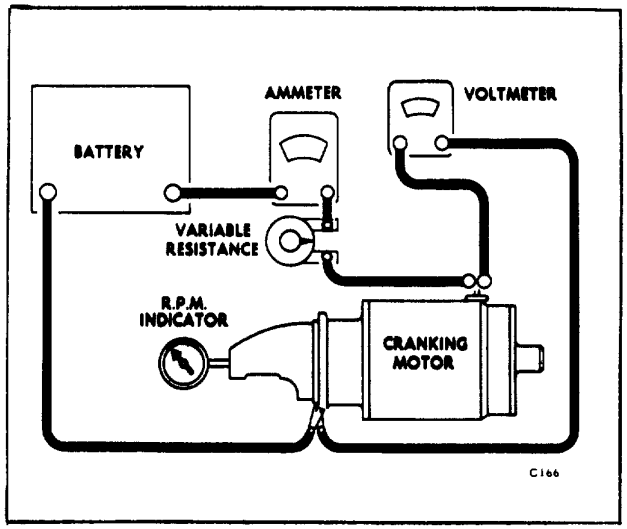


Figure 40.

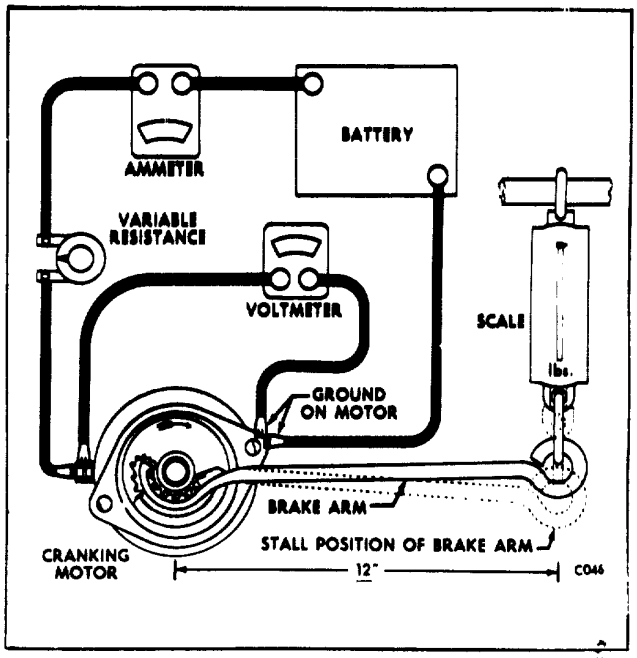


Figure 41.

a. Rated torque, current draw and no load speed indicate normal condition of cranking motor.

b. Low free speed and high current draw with low-developed torque may result from:

(1) Tight, dirty, or worn bearings,

bent armature shaft or loose field pole screws which would allow the armature to drag.

(2) Shorted armature: Check armature further on growler.

(3) Grounded armature or field: Check by raising grounded or return brushes and insulating them from the commutator with cardboard and then checking with a test lamp between the insulated terminal and the frame. If test lamp lights, raise other brushes from commutator separately to determine whether it is the fields or armature that is grounded.

c. Failure to operate with high current draw:

(1) A direct ground in the switch, terminal or fields.

(2) Frozen shaft bearings which prevent the armature from turning.

d. Failure to operate with no current draw:

(1) Open circuit: The open circuit may be in the fields, armature, at the connections or brushes, or between the brushes and commutator. Trace the circuit with the test lamp.

e. Low no-load speed, with low torque and low current draw:

(1) An open field winding. Raise and insulate ungrounded brushes from commutator and check fields with test lamp.

(2) High internal resistance due to poor connections, defective leads, dirty commutator, weak or broken brush springs, worn brushes, high mica on the commutator or other causes which would prevent good contact between the brushes and commutator.

f. High free speed with low-developed torque and high current draw indicates shorted fields. There is no easy way to detect shorted fields, since the field resistance is already low. If shorted fields are suspected, replace the fields and check for improvement in performance.

J. INSTALLATION

1. Place the cranking motor in position against the flywheel housing. Secure it with bolts, nuts and lockwashers.

2. Connect: the cable to the solenoid, the wires to the solenoid and the ground cable to the battery.

K. SOLENOID MAINTENANCE

1. Solenoids require no periodic maintenance other than keeping the terminals clean and tight. Always check action of solenoid if it has been removed.

2. If unit fails to function, first check wiring before condemning the solenoid.

3. Solenoid coil, terminals, and switch plunger can be replaced if burned or otherwise damaged.

DISTRIBUTOR (Fig. 2)

A. REMOVAL

Remove the distributor cap, coil to distributor wire, and distributor mounting nut. Note location of rotor in relation to distributor

before removing distributor from engine.

B. DISASSEMBLY (Fig. 42)

Unsnap the cap springs, remove cap and rotor. Then disassemble terminal, take off breaker plate attaching screws, and lift out breaker plate. Remove coupling or gear by grinding or filing off the peened-over head of pin and then driving pin out. Shaft and advance mechanism can then be lifted out. Advance mechanism is disassembled by taking off nuts fastening hold-down plate in place.

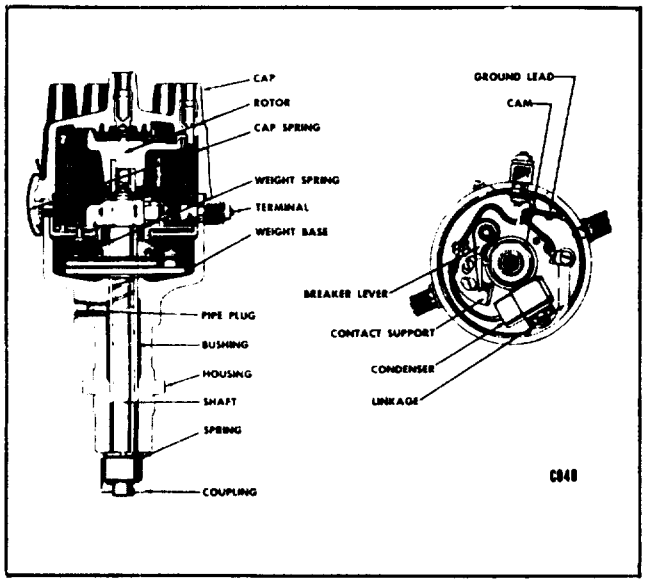


Figure 42.

C. ASSEMBLY AND TESTING

1. Reverse disassembly procedure to assemble distributor.

2. After reassembly, the contact point opening and cam angle should be checked and adjusted. Breaker lever spring tension should also be checked and adjusted, if necessary. Then the distributor should be carefully tested on a distributor tester that will check the centrifugal advance mechanism.

D. INSTALLATION

1. Be sure the distributor mounting is clean so there will be a good ground connection for the distributor.

2. Check engine breather pipes, since clogged pipes cause crankcase pressure which will force oil up into the distributor.

3. If the advance mechanism of the old distributor was found to be worn, check the engine for worn timing gears or oil pump, since these cause backlash which produces torsional vibration; such vibration causes rapid advance mechanism wear.

4. Be sure to install the new distributor all the way down in its mounting well. If the distributor is not pushed all the way down, the distributor shaft is likely to seize in the distributor housing and ruin the distributor.

E. TIMING WITH ENGINE RUNNING

1. Hook-up the timing light to the No. 1 spark plug (nearest the counterweight).

2. Paint or chalk the timing marks on the crankshaft pulley.

3. Run engine at 600 RPM. No. 1 plug should fire 2 degrees before top dead center. Loosen distributor clamp screw and rotate distributor clockwise to advance or counterclockwise to retard timing. Tighten clamp screw. Recheck timing with the light.

F. TIMING WITH ENGINE NOT RUNNING

1. Locate No. 1 cylinder spark plug wire on distributor cap; mark distributor body adjacent to No. 1 wire socket in cap. Remove distributor cap.

2. Intermittently operate starter until

crankshaft pulley comes to rest with the timing mark aligned with pointer. With pointer and timing mark aligned, rotor segment should point toward mark made on distributor body in Step 1, above. (Instead, rotor segment may point 1800 away from mark; in this case, engine must be rotated one complete revolution and timing mark realigned with pointer.)

3. With timing mark and pointer aligned and with rotor segment pointing to No. 1 spark plug wire position, points should just begin to open. Loosen distributor mounting capscrew and turn distributor housing clockwise until points close. Remove high tension wire from center socket in distributor cap. Turn on ignition switch and hold end of high tension wire (still connected at coil) 1/4 inch from a ground; then turn distributor housing counterclockwise until a spark jumps the gap between high tension wire and ground. When spark occurs, points are open. Hold distributor in this position while tightening mounting capscrew or clamp screw. Turn ignition switch off and install distributor cap. Install high tension wire to center socket in cap.

G. MANUAL ADVANCE ADJUSTMENT

1. After engine has been thoroughly warmed up, drive vehicle, using grade of fuel expected to be used in service. Engine should not ping or knock excessively under load and full throttle.

2. If knock is evident, loosen distributor mounting capscrew and turn distributor housing clockwise to retard spark until knock is eliminated.

3. Manual advance should be set to obtain the best possible engine performance with the particular grade of gasoline being used.

H. MAINTENANCE

1. Lubrication: This distributor incorporates a built-in oil reservoir from which shaft lubrication is obtained through a porous bushing. This reservoir back of the shaft bushing is filled with light engine oil and sealed before the unit is shipped. The supply of oil is sufficient to last for approximately 200 hours under normal operating conditions. The oil reservoir should be refilled every 100 hours of operation or more frequently when unusual heat or other operating conditions are experienced. To refill, remove the pipe plug at the base of the distributor, add oil until it flows out the plug hole, then replace the plug. In addition, a trace of high melting point ball bearing grease should be placed on the breaker cam every 100 hours. Also at 100 hours put one drop of light engine oil on the breaker lever pivot and a few drops on the felt wick under the rotor.

2. Inspection: The cap should be removed at regular intervals and the contact points, rotor and cap examined. Check the high tension wiring for frayed or damaged insulation and poor connections at the cap. Replace if necessary. Replace the cap or rotor if they are cracked or show carbonized paths indicating the secondary current is leaking to ground over the surface of the material.

3. Contact Points: Contact points that are burned or pitted should be replaced or dressed with a clean, fine-cut contact file. The file should not be used on other metals and should not be allowed to become greasy or dirty. Never use emery cloth to clean contact points. Contact surfaces, after considerable use, may not appear bright and smooth, but this is not necessarily an indication that they are not functioning satisfactorily.

4. Oxidized Contact Points: Oxidized contact points may be caused by high resistance or loose connections in the condenser circuit, oil or foreign materials on the contact surface, or most commonly, high break

current. Check for these conditions where burned contacts are experienced.

5. Contact Point Opening: Contact point opening must be set to specification. Points set too closely may tend to burn and pit rapidly. Points with excessive separation tend to cause a weak spark at high speed. The point opening of new points may be checked with a feeler gauge. Use a feeler gauge on used points is not recommended since the roughness of used points make it impossible to set the point opening accurately by this method. A dial indicator is recommended to check the point openings of used points. When necessary to check and adjust point opening with a feeler gauge, proceed as follows: Rotate breaker cam until breaker lever rubbing block is on the high point of the cam lobe thus giving the maximum point opening. Loosen the clamp screw holding the contact support and adjust point opening by 'turning the eccentric screw in the contact support. Tighten clamp screw, check with gauge again after tightening clamp screw. The contact points should be cleaned before adjusting if they have been in service. The cam or contact angle is the angle in degrees of cam rotation through which the points remain closed.

6. Contact Point Pressure: Contact point pressure must fall within the limits given. Weak tension will cause point chatter and ignition miss at high speed while excessive tension will cause undue wear of the contact points, cam and rubbing block.

7. Use of Distributor Test Fixture

a. The distributor test fixture accurately checks cam angle, spark advance and synchronization on distributors removed from the truck. It will also show excessive distributor shaft eccentricity as indicated by variation in synchronization.

b. After a distributor has been repaired, the calibration of the centrifugal advance mechanism should be checked. Proper engine performance cannot be obtained unless the centrifugal curve is within the limits specified for the particular engine.

8. Condenser: Four factors affect condenser performance, and each factor must be considered in making any condenser test.

a. "Breakdown" is a failure of the insulating material, a direct short between the metallic elements of the condenser. This prevents any condenser action.

b. "Low insulation resistance" or leakage prevents the condenser from holding a charge. A condenser with low insulation resistance is said to be "weak". All condensers are subject to leakage, which up to a certain limit is not objectionable. When it is considered that the ignition condenser performs its function in approximately 1/12,000 of a second, it can be seen that leakage can be large without detrimental effects. It must be considered, however, in any condenser test.

c. "High series resistance" is excessive resistance in the condenser circuit due to broken strands in the condenser lead or defective connections. This will cause burned points and ignition failure upon initial start and at high speeds.

d. "Capacity" is built into the condenser and is determined by the area of the metallic elements and the insulating and impregnating materials. For a complete check of the condenser, it is desirable to use a tester which will check for the above four conditions.

IGNITION COIL (Fig. 2)

A. Ignition Coil is mounted on the side of the cylinder block near the distributor.

B. Coil should be tested with conventional coil tester, following instructions furnished by manufacturer of testing equipment. Defects indicated by test are:

1. Open primary circuit.
2. Open secondary circuit.
3. Shorted turns in primary or secondary.
4. High voltage breakdown in secondary.
5. High resistance in primary connections.

C. If any of the above conditions are evident, coil must be replaced.

SPARK PLUGS

A. GENERAL

Spark plug life is governed to a large extent by operating conditions, and plug life varies accordingly. To insure peak performance, spark plugs should be checked, cleaned and regapped every 500 hours.

Worn and dirty plugs may give satisfactory operation at idling speed, but under operating conditions they frequently fail. Faulty plugs are evident in a number of ways such as wasting gas, power loss, loss of speed, hard starting and general poor engine performance.

Spark plug failure, in addition to normal wear, may be due to dirty or leaded plugs, excessive gap, or broken insulator.

Refer to Specification Listing as the use of spark plugs in the proper Heat Range is of vital importance to good engine performance. Frequently, the wrong type of spark plug, one with an improper heat range for the engine, may have been installed when replacing spark plugs originally fitted by the engine manufacturer, and such misapplication may lead to poor performance.

Where abnormal operating conditions cause chronic carbon or oil fouling of the plugs, the use of a type with one or two numbers higher (a "hotter" type) than recommended in Specifications, will generally remedy the trouble; and by the same formula, where chronic preignition or rapid electrode wear is experienced, a type with one or two numbers lower (a "cooler" type) will generally be found satisfactory.

B. REMOVAL

IMPORTANT: Before removing any spark plug, blow all dirt out of plug socket in cylinder head with compressed air.

1. Pull wires off spark plug terminals, using caution to avoid damaging wire terminals. Remove wires by firmly grasping large end of boot.

2. Use spark plug wrench and unscrew plugs from cylinder head. Ordinary wrenches may damage porcelain. If gaskets do not remain on plugs, remove them from cylinder head.

C. SERVICE

1. Inspect plugs for cracked porcelain and burned points, and check point gap. Also check for loose terminals. Replace plugs which have excessively burned electrodes or cracked porcelain. Plugs should be cleaned with conventional sand-blast c l e a n i n g equipment.

2. Setting spark plug gap is a precision operation and should be treated as such. Refer to Specification Listing for proper gap dimensions. All plugs must be set to the same dimension, using a standard round feeler gauge.

CAUTION: Before adjusting gap, file center electrode flat. In adjusting the spark plug gap, never bend the center electrode which extends through the porcelain center as this may break the lower insulator. Always make adjustments by bending the ground or side electrode. (Fig. 43)

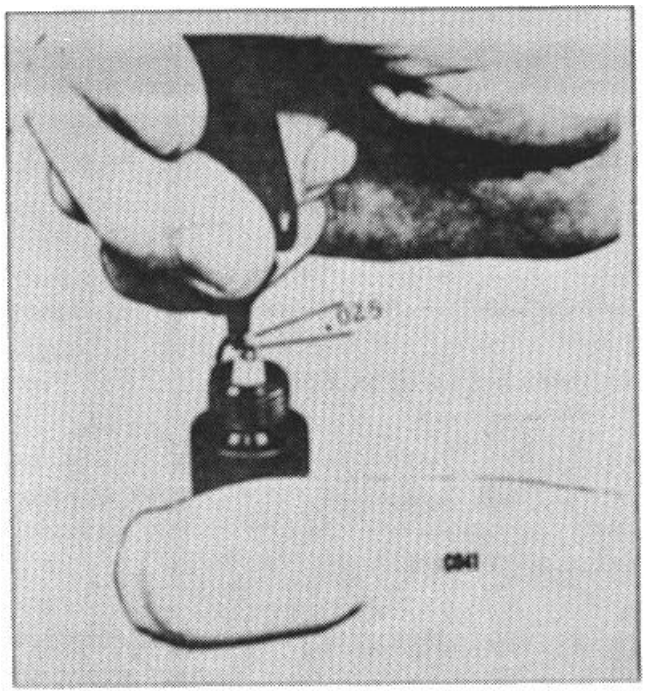


Figure 43.

D. INSTALLATION

1. Be certain that the old gasket is removed before installation of plug, and that the gasket seat is clean and smooth. Check also that the spark plug threads and the cylinder head threads are not dirty or damaged. Dirty or damaged threads cause a faulty torque reading, resulting in incorrect installation and consequent poor spark plug life and faulty operation.

2. Install the spark plugs in the engine with new gaskets and tighten. If torque wrench is not available, turn plugs in until they are finger-tight against the gasket, then using a proper fitting socket wrench, tighten 2/3 additional turn. Care must be exercised when tightening.

3. Spark plugs which are not tightened correctly will result in too high an operating temperature if too loose, or distortion of the spark plug body and change in gap setting or damage to the gasket if too tight.

CHECKING GAUGES AND INDICATOR LIGHTS

A. GENERAL

Do not remove any unit from the truck unless it is known to be defective.

Check wiring, connections and indicator lights before condemning any unit.

B. ENGINE OIL PRESSURE AND HYDRAULIC OIL

The transmission temperature warning light should be checked periodically for good connections and lighting ability.

Although the oil pressure gauge functions normally, the oil pressure should be checked to help determine engine condition.

Substitute an oil pressure gauge for the oil pressure sending unit, to determine the oil pressure.

C. CHECKING GAUGES

Before checking a gauge or sending unit, make sure all electrical connections are tight and free of dirt or moisture.

Wiring should be checked for broken or frayed insulation which may cause a short or ground in the circuit.

Any of these causes may have been the reason for failure.

The following equipment is necessary to make a complete check of these gauges:

1. One new fuel tank sending unit. If there is any question about the new tank unit being correct, then hook it up in series with a receiver unit known to be satisfactory. Operate tank unit by hand and see if receive unit reads zero with tank unit float in bottom position.

2. Two 5 foot lengths of insulated wire equipped with clip terminals at each end. These long lengths will permit individuals making the check to sit in seat of truck and observe gauge being checked. To check, proceed as follows:

a. Disconnect sender unit being checked and hook in tank unit as shown in Figure 44. Turn on ignition switch and operate float rod of tank unit by hand.

b. With float of tank unit at bottom position, receiver unit should register at bottom mark on dial.

c. Move float rod up to top position, then the needle of the unit being checked should move to top mark on dial.

NOTE: Allow one minute for receiver to come to rest.

d. If the receiver unit operates correctly, it is then known the sending unit or wiring is at fault.

NOTE: Do not attempt to repair the sender unit. When installing a new engine unit, do not use thread compound on unit threads, as this will increase electrical resistance of unit and cause faulty operation.

e. If the receiver does not operate correctly, then check the wire lead to the receiver unit.

(1) Attach one end of the ten foot length of wire to the terminal of the receiver unit to which the wire lead is attached.

(2) Ground the other end of the long lead and turn the ignition switch.

(3) If the gauge operates now and did not operate with the regular wire connection, the wiring is at fault.

f. If wiring is satisfactory, then replace receiver unit and check again with tank unit.

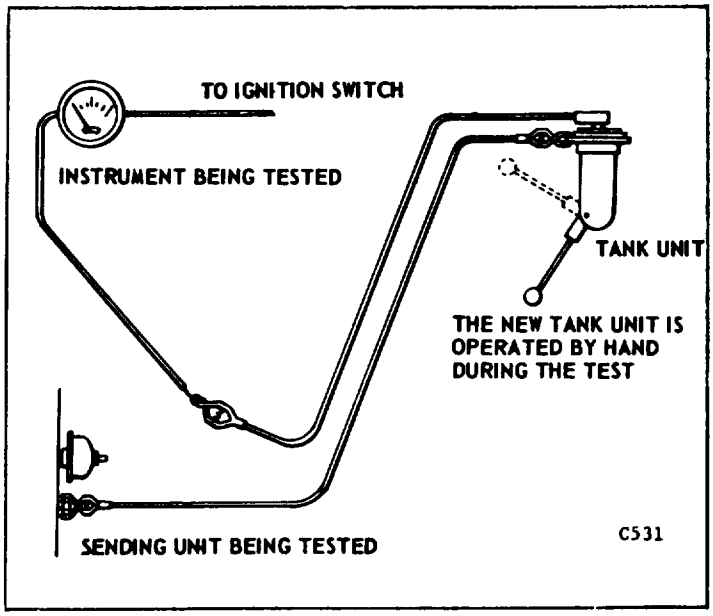


Figure 44.

TROUBLESHOOTING

CAUSE	REMEDY
A. Starting Circuit	
<u>No Cranking, No Lights</u>	
1. Battery dead	1. Recharge or replace battery.
2. Open circuit	2. Clean and tighten connections. Replace wiring.
<u>No Cranking, Lights Go Out When Cranking Is Attempted</u>	
1. Poor connection, probably at the battery terminals	1. Clean battery terminals and cable ends.
2. Defective cables	2. Replace defective cables.
<u>No Cranking, Lights Dim Slightly When Cranking Is Attempted</u>	
1. Pinion not engaging with the flywheel ring gear	1. Clean or replace defective parts.
2. Excessive resistance or open in cranking motor	2. Clean commutator. Replace brushes, Check and repair solenoid contacts. Repair poor connections.
<u>No Cranking, Lights Glow Very Dim When Cranking Is Attempted</u>	
1. Engine locked or turns too hard	1. Check engine. Repair as necessary.
2. Battery low	2. Recharge or replace battery.
3. Pinion jammed; defective mechanism	3. Free up and replace defective parts.
4. Damaged shaft bearings; dragging armature; short in cranking motor	4. Repair cranking motor.
<u>No Cranking, Lights Stay Bright When Cranking Is Attempted</u>	
1. Open in control circuit	1. Check ignition switch, connections and wiring. Check solenoid contacts and connections. Repair or replace as necessary.

TROUBLESHOOTING

CAUSE	REMEDY
Engine Cranks Slowly, But Does Not Start	
1. Battery in a discharged condition	1. Check, charge or replace battery.
2. Very low temperature	2. Battery must be fully charged, eliminate all resistance possible.
3. Undersized cables	3. Install cable of correct diameter.
4. Mechanical trouble in the engine	4, Check and repair as necessary.
Engine Cranks At Normal Speed But Does Not Start	
1. Defective engine systems other than the starting system	1. Check other engine systems.
Solenoid Plunger Chatters	
1. Hold-in winding of solenoid open	1. Replace solenoid.
B. Battery And Charging Circuit	
Remains In An Overcharged State	
1. High charging voltage	1. Check and reset voltage regulator.
2. Excessive resistance in the regulating circuit	2. Remove the resistance in the voltage regulating circuit. Clean and tighten connections. Replace wires having broken strands.
3. High ambient temperature	3. Adjust voltage regulator accordingly.
Uses Excessive Water	
1. Overcharging	1. Check charging circuit.
2. Cover seal leaking	2. Reseal or replace battery.
3. Case cracked	3. Replace battery.
Will Not Remain In A Charged State	
1. Defective alternator, regulator or external short	1. Check alternator, regulator and wiring. Repair as needed.

TROUBLESHOOTING

CAUSE	REMEDY
2. Excessive load demands	2. Reduce electrical load.
3. High self discharge	3. Clean battery top and recharge. Replace if necessary.
4. Defective or old	4. Recharge and make high discharge test. Replace if defective.
Cracked Battery Case	
1. Battery not secured or hold-down loose	1. Install new battery. Tighten hold-down correctly.
2. Battery frozen	2. Install new battery. Keep battery charged.
Bulging Battery Case	
1. Battery overheated	1. Battery overcharged.
2. Hold-down too tight	2. Loosen and tighten properly.
C. Ignition Circuit	
Engine Cranks Normally But Will Not Start	
1. Open primary circuit	1. Check connections, coil, contact points and ignition switch for open.
2. Coil primary grounded	2. Replace coil.
3. Points not opening	3. Adjust.
4. Burned points	4. Clean or replace.
5. Out of time	5. Check and adjust timing.
6. High tension leakage	6. Check coil head, distributor cap, rotor and leads. Remove all carbon deposits, residue and dirt.
7. Spark plugs fouled	7. Clean, adjust or replace. Correct reason for fouling.

TROUBLESHOOTING

CAUSE	REMEDY
Engine Runs But Misses On One Cylinder	
1. Defective spark plug	1. Clean and adjust or replace.
2. Distributor cap cracked or dirty; defective lead	2. Clean or replace distributor cap. Replace lead.
Engine Runs But Misses Different Cylinders	
1. Points worn, dirty or out of adjustment	1. Clean, adjust or replace as necessary.
2. Defective condenser or loose on mounting	2. Tighten, replace if necessary.
3. Frayed insulation on pig tail from points to condenser; pig tail broken	3. Replace pig tail.
4. Advance mechanism defective; bushings in distributor worn	4. Repair or replace distributor.
5. Defective high tension wiring	5. Replace.
6. Weak coil	6. Replace.
7. Loose connections	7. Clean and tighten.
Engine Misses At High Speed	
1. Weak distributor contact springs; point gap too wide	1. Adjust spring tension and point gap. Replace as necessary.
2. Worn distributor shaft or bushings	2. Repair or replace distributor.
3. Advance mechanism sticking or worn	3. Repair or replace distributor.
Engine Lacks Power Or Overheats	
1. Ignition timing off	1. Adjust timing.
2. Advance mechanisms defective	2. Adjust centrifugal advance. Replace vacuum advance unit if defective.
Engine Backfires	
1. Ignition timing off	1. Adjust timing.
2. Ignition crossfiring	2. Check high tension wiring, distributor cap or rotor for leakage paths.

TROUBLESHOOTING

CAUSE	REMEDY
3. Spark plugs of wrong heat range	3. Install spark plugs of a lower heat range.
Engine Knocks Or Pings	
1. Ignition timing fast	1. Retard timing.
2. Advance mechanism defective; distributor shaft or bushings worn	2. Rebuild or replace distributor.
3. Spark plugs of the wrong heat range	3. Install plugs of a lower heat range.
Rapid Wear Of Centrifugal Advance Mechanism	
1. Loose or worn timing chain or worn drive and camshaft gears	1. Replace parts as necessary.
Pitted Contact Points	
1. Condenser of wrong capacity	1. Install condenser of correct capacity.
2. Leads to coil reversed	2. Re-arrange leads.
3. Voltage regulator setting too high	3. Adjust voltage regulator.
4. Weak distributor contact spring	4. Adjust spring tension or replace spring and contact points.
5. Oil or crankcase vapors entering the distributor	5. Clean engine breather. Avoid over-lubricating the distributor.
6. Loose or dirty connections in the coil primary circuit	6. Clean and tighten connection. Replace wires that are corroded or have broken strands.
Spark Plugs Defective	
1. Excessive gap	1. Reset points.
2. Cracked insulator	2. Careless installation. Install new plug.
3. Plug sooty or wet with fuel	3. Clean and adjust. Repair defect in fuel system, most likely in carburetor. Check at plug.

TROUBLESHOOTING

CAUSE	REMEDY
4. Plugs have carbon deposits	4. Dry deposits indicate plugs are too cold. Install hotter heat range plug. Wet oily deposits indicate engine pumping oil. Repair as necessary.
5. Plug white or gray with blistered insulator	5. Install plug of a cooler heat range.

SPECIFICATION LISTING

Electrical System	
12 Volt	Negative Ground
Alternator	
Rotation	Clockwise
Cold Output	25 amps
and	14 volts
at	2000 Alt. RPM
	1670 Eng. RPM
Pulley Nut Torque	50-60 lb./ft.
Fan Belt Deflection	1/2 - 3/4 in.
Alternator Regulator	
Voltage Control:	
Air Gap	.067 in.
Point Opening	.014 in.
Voltage Setting:	
Regulated and Upper Points	13.8 - 14.8 volts
at	85
Lower Points	.1 - .4 volts lower than upper point setting
Cranking Speed	150 RPM min.
Cranking Motor	
Rotation	Clockwise
Brush Spring Tension	35 oz.
No Load Test:	
Speed	6200 - 9400 RPM
Current Draw*	49 - 76 amps
at	10.6 volts
Resistance Test (Lock Test):	
Current Draw*	270 - 310 amps
at	4.3 volts
Pinion Clearance	,010 - .140 in.
* Includes Solenoid	
Distributor	
Rotation (viewing rotor)	Counterclockwise
Point Gap	.022 in.
Dwell	25 - 40
Point Pressure	19 - 23 oz.
Centrifugal Advance:	
Dist. RPM	Degrees Advance
300	.5 - 2.5
400	3-5
800	5.5 - 7.5
1100	7.5 - 9.5
Timing	
Initial Timing	TDC at 500 RPM
Firing Order	1-3-4-2
Battery	
Specific Gravity State of Change	
1.260 - 1,285	Full
1.210 - 1,225	Half
1.150	Low to discharged
Spark Plugs	
Type	XD-16 or equivalent
Gap	.025 in.
Tightening Torque	30 lb./ft.

POWERSHIFT TRANSMISSION, CONTROL VALVE AND CONTROL LINKAGE

A. GENERAL

This is a single speed, constant mesh manually controlled transmission. (Fig. 1)

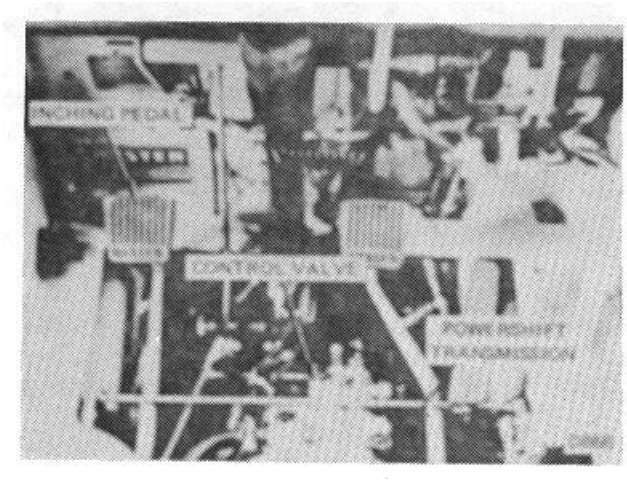


Figure 1.

Two multiple disc clutch packs provide the necessary coupling and uncoupling mechanism in the forward-reverse shifting system. (Fig. 2) The clutch packs may be removed from the truck without removing the transmission assembly.

Spur gears are used in the gear train, which work in conjunction with the forward-reverse clutches. Applying one of the clutches (never are the two clutches applied at the same time), connects a corresponding gear to the torque converter at the driven end of the gear train. The driving end of the gear train drives the differential pinion.

A crescent pump (Fig. 3) driven by the hub of the torque converter cover, supplies the necessary oil to the torque converter, clutches and lubrication system. It also supplies the clutch cooling oil needed to prevent overheating of the clutches during inching. Because

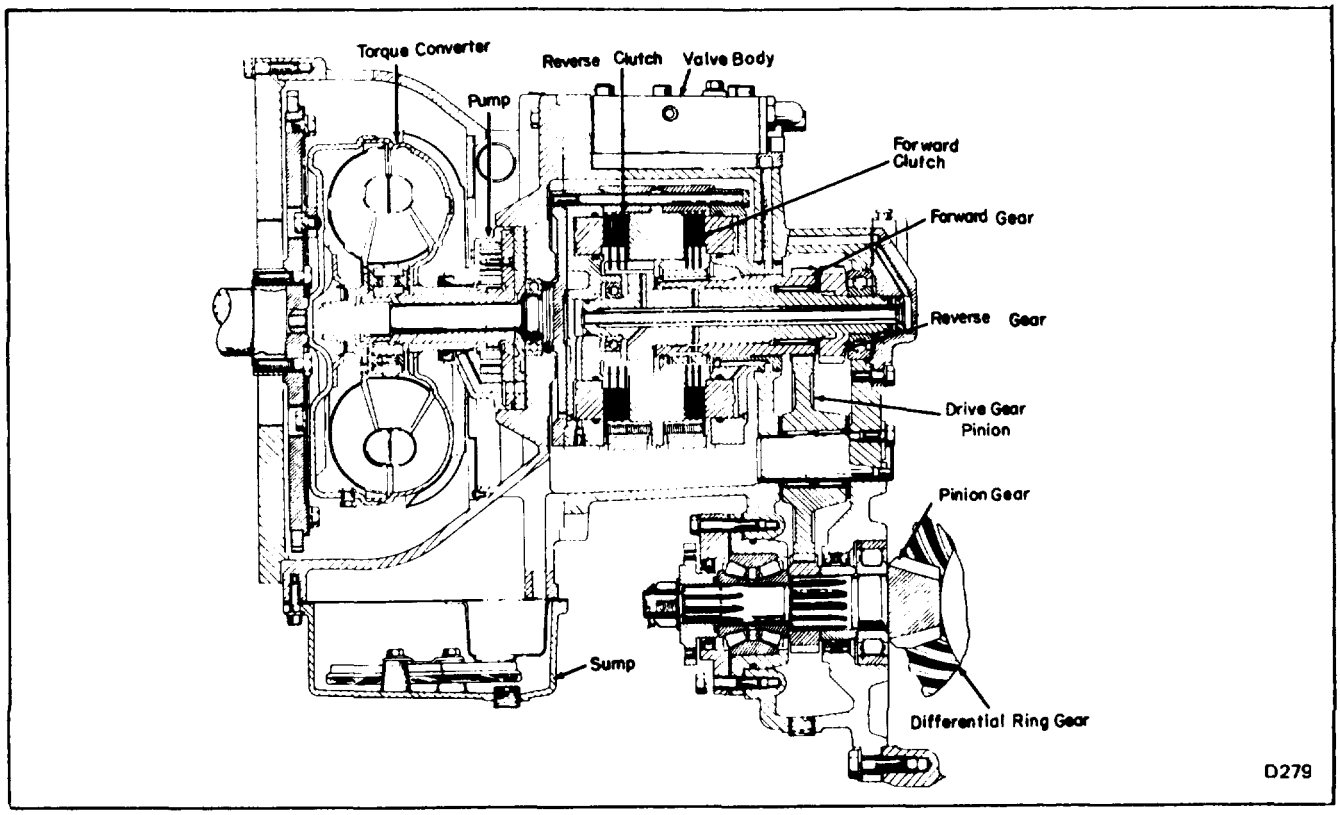


Figure 2.

the torque converter cover is attached to the engine flywheel, the oil pump is driven at flywheel speed.

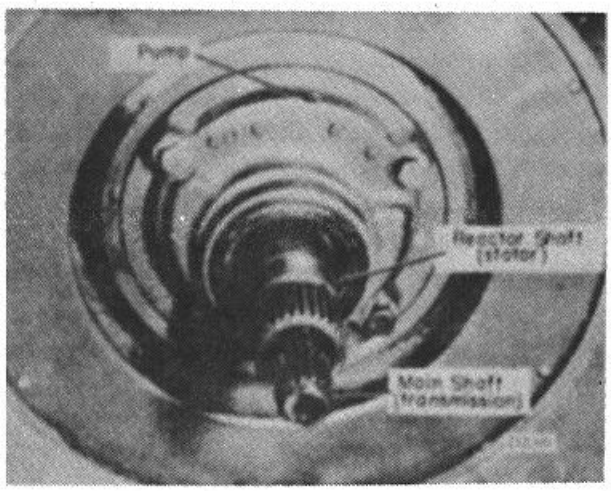


Figure 3.

A heat exchanger in the bottom of the radiator core cools the oil, preventing oil overheating.

A control valve is mounted on the transmission cover. (Fig. 1) A porting plate between the valve and the cover eliminates most external piping. Passages in the control valve body line up with passages drilled or cast in the transmission cover and the torque converter housing. Oil is routed to the various components through these passages.

Whenever the transmission is not in neutral, the electrical system in the starter control circuit is automatically opened, thus preventing engine starting when transmission is in gear. This function is performed by the neutral switch attached to the control valve.

To remove the transmission remove the engine and transmission as an assembly.

> **NOTE: If only the clutch pack is to be removed, disconnect the lines and linkages from the control valve and refer to B. Removal, Steps 1 through 5.**

B. REMOVAL AND DISASSEMBLY

1. Remove the front bearing retainer, being careful not to damage the seal rings. Note the shim pack thickness. (Fig. 4)

2. Unscrew the bolts securing the cover and the nuts off the tapered dowels. (Fig. 4)

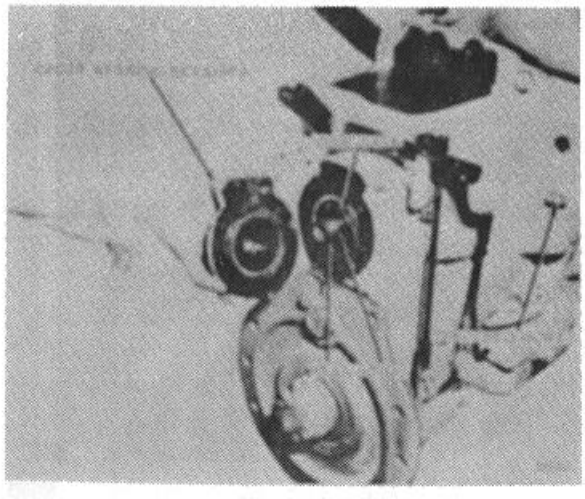


Figure 4.

3. Remove the tapered dowels by driving them down. Lift the cover off, being careful not to damage the seal rings or mating surfaces. (Fig. 5) NOTE: Control valve removal is not necessary.

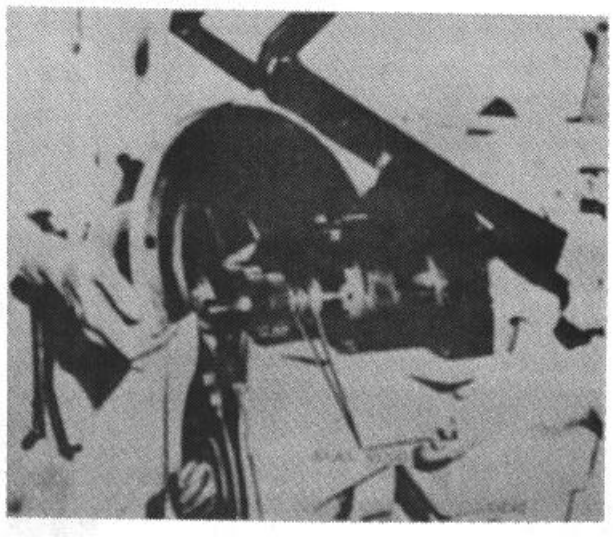


Figure 5.

NOTE: The reverse cluster gear can be removed at this time, without removing the clutch pack. (Fig. 6)

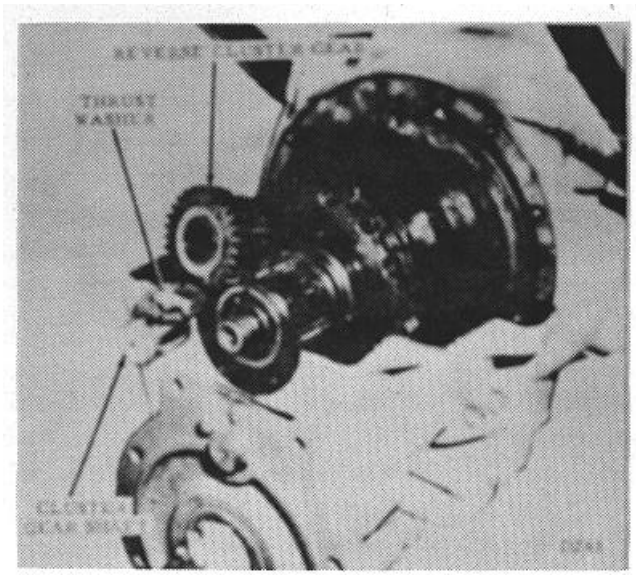


Figure 6.

4. Unscrew the mounting bolts securing the clutch pack to the main drive shaft flange.

NOTE: There are four groups of three bolts in the clutch pack. The center bolts in each group are assembly bolts (Fig. 7) and hold the pack together. The other eight screws hold the clutch pack to the converter output shaft. Do not remove the assembly bolts at this time; otherwise the pack will fall apart.

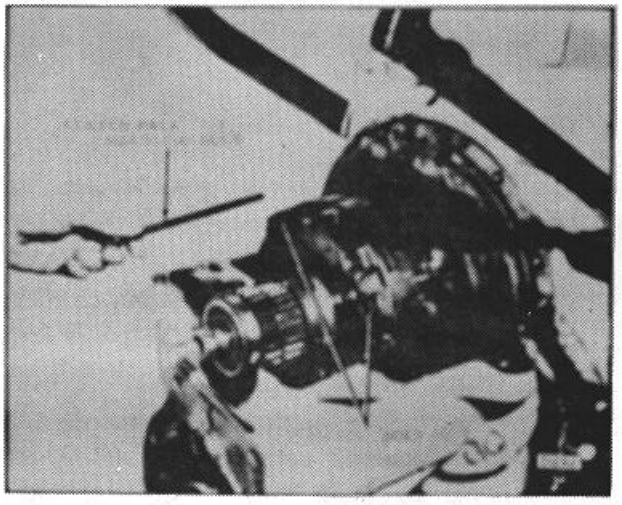


Figure 7.

5. Lift clutch pack from the transmission using the tool shown in Figure 8, and illustrated in Figure 9. If preferred, the pack may be slung for removal from the housing. Three-inch belting makes a good sling.

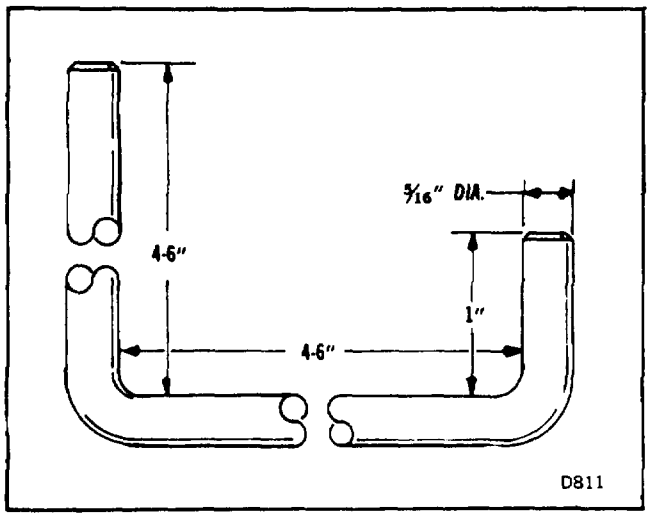


Figure 8.

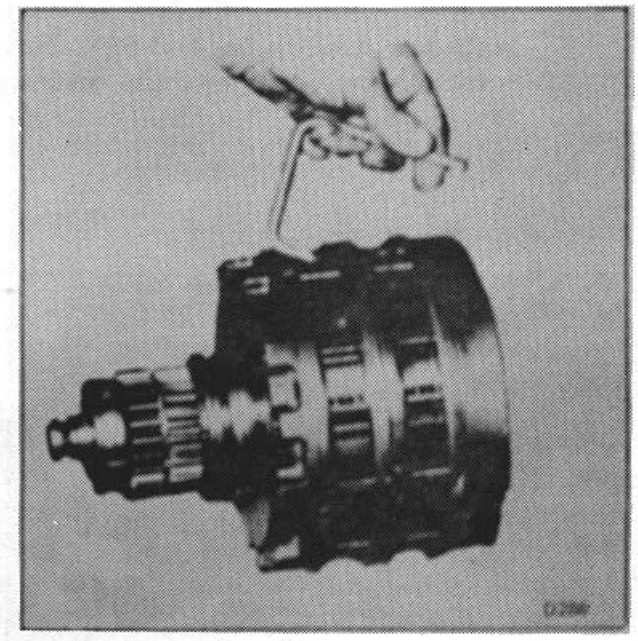


Figure 9.

6. Disassemble the clutch pack as follows:

a. Mark the relationship of each end housing and clutch ring. (Fig. 10)

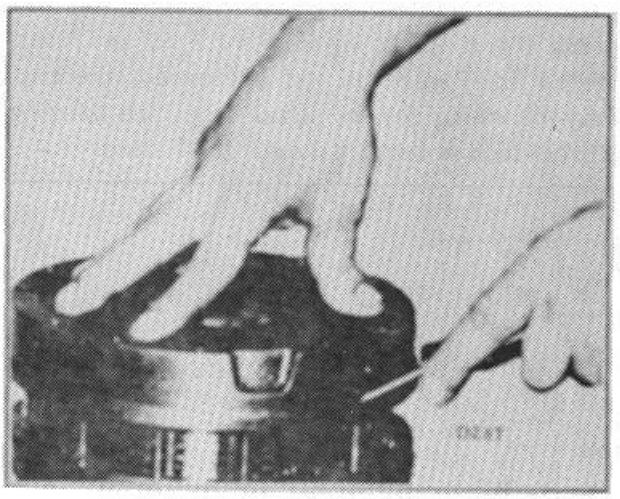


Figure 10.

b. Provide a clean work area. Remove the cast iron rings, snap ring, and pull the front support bearing from the reverse shaft. (Fig. 11) Remove the reverse drive gear and thrust washer. (Fig. 12) Remove the four assembly bolts and then the end housing assembly. Remove the top snap ring and lift the clutch hub from the forward drive gear (Fig. 13)

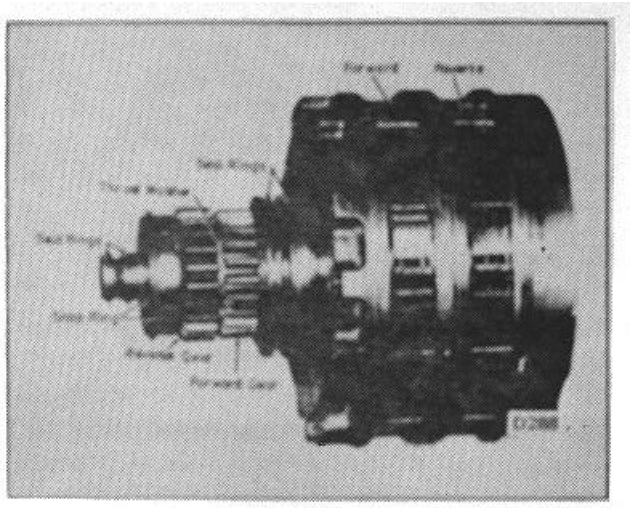


Figure 11.

c. Remove the bottom snap ring (Fig. 13) and lift the end housing from the forward drive gear. (Fig. 14) The remainder of the pack, clutch discs, separator plates, springs, clutch rings, center separator and thrust washers, may then be removed from the reverse shaft.

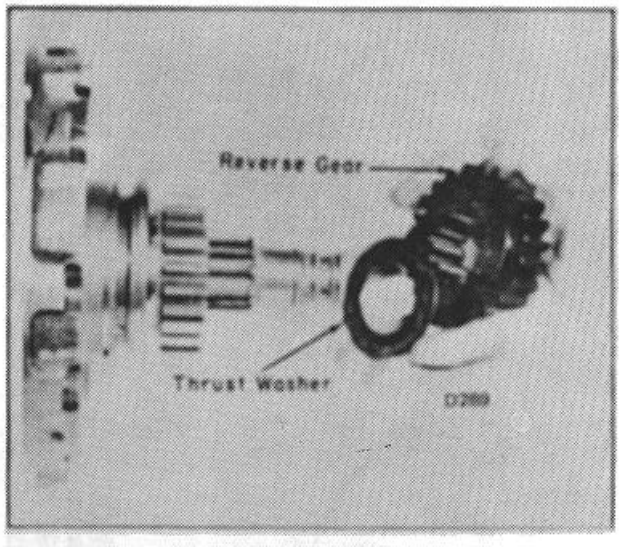


Figure 12.

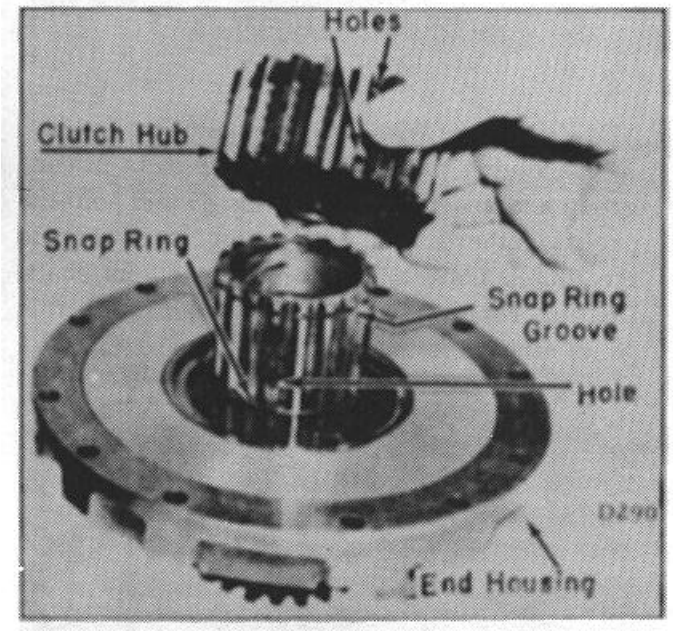


Figure 13.

d. Remove the clutch pistons from the end housing. Extract the O-rings from each. (Fig. 15)

7. Remove the engine and transmission. Remove the keeper retaining the idler gear shaft. Pull the shaft and lift the gear out of the case. (Fig. 16)

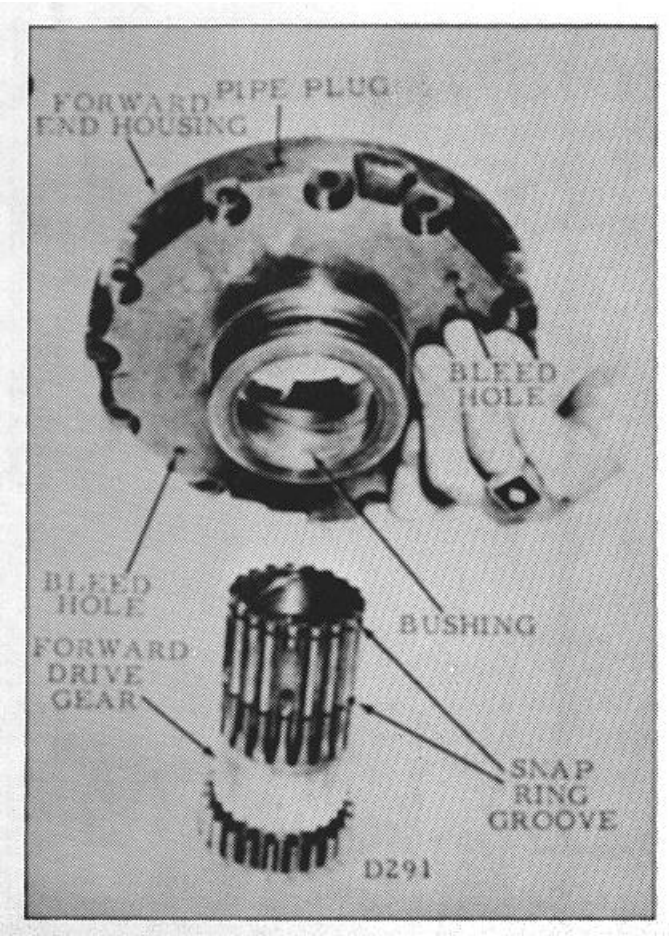


Figure 14.

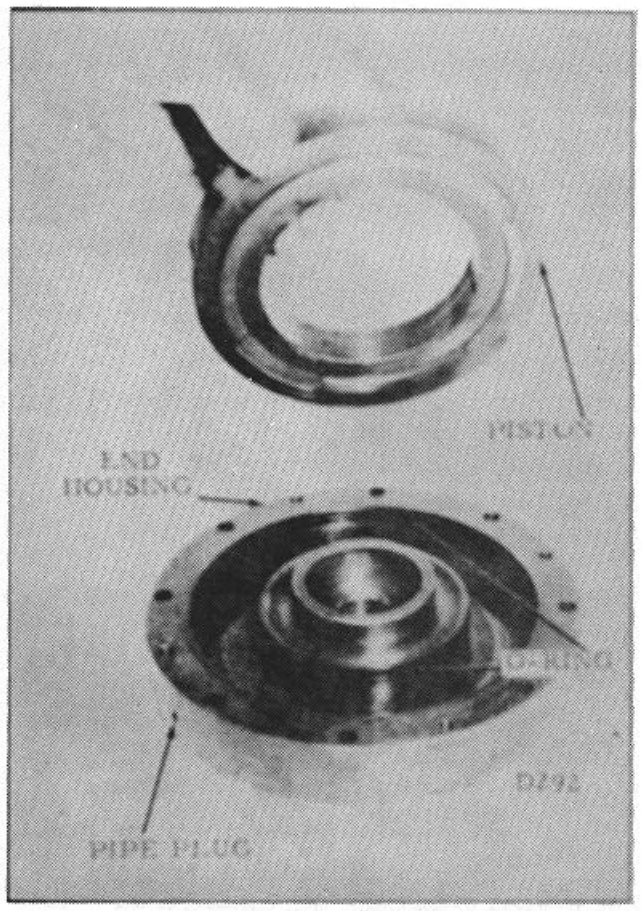


Figure 15.

8. Unscrew the transmission mounting bolts. Pull the transmission case away from the torque converter housing. (Fig. 17) Remove the differential pinion only if necessary.

9. Remove the parking brake drum. (Fig. 18)

10. Remove the pinion shaft nut and drum flange. (Fig. 19) Disassemble the internal brake and remove its backing plate.

11. Remove the seal retainer. (Fig. 20) Note thickness of shim set. Pull bearing retainer out of the case. Note thickness of shim set.

12. Press the pinion shaft through the front of the case.

C. CLEANING AND INSPECTION

1. Steam clean the transmission case. Apply the steam pressure directly into the internal oil passages to make sure they are completely open and clean. Remove all foreign particles from corners and crevices. Remove any detergent used as a cleaning agent with live steam made from clear water. Get the case as hot as possible with the live steam. Blow water off the entire case and out of the passage. Apply oil to all machined surfaces. Squirt oil into the passages. Remove all gasket material.

2. Clean the remainder of parts with solvent and blow dry with filtered compressed air. Always use fresh solvent when cleaning ball and roller bearings. Do not direct air

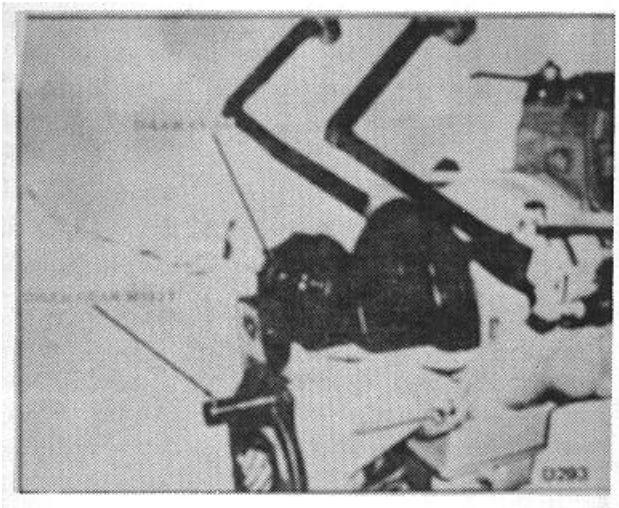


Figure 16.

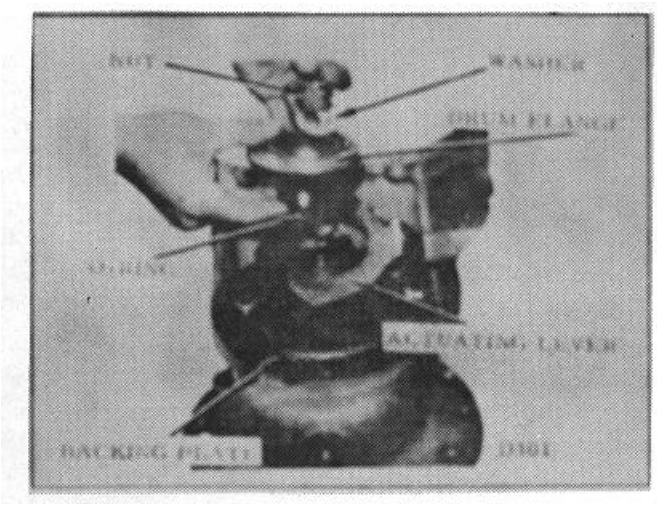


Figure 19.

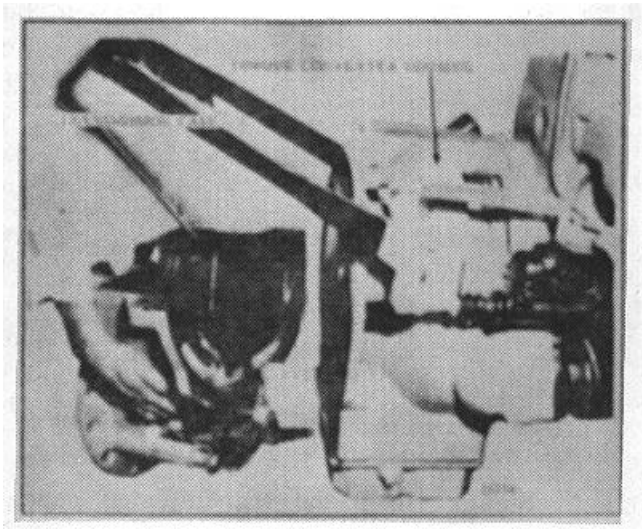


Figure 17.

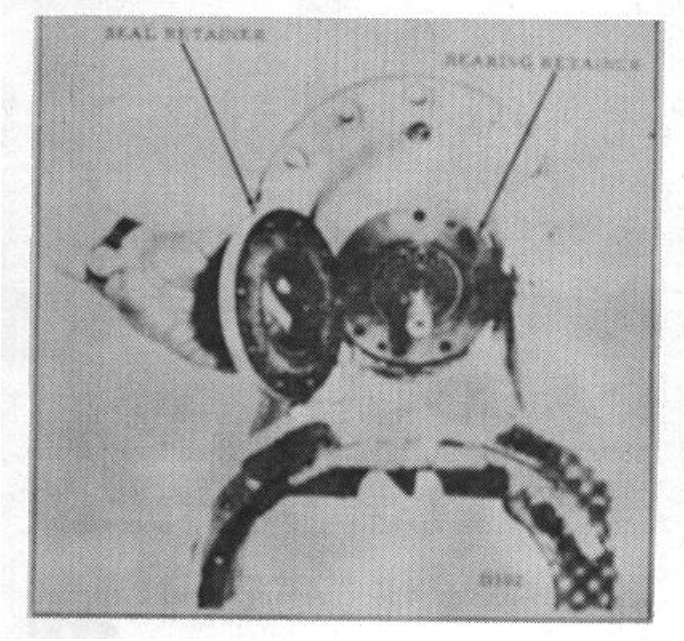


Figure 20.

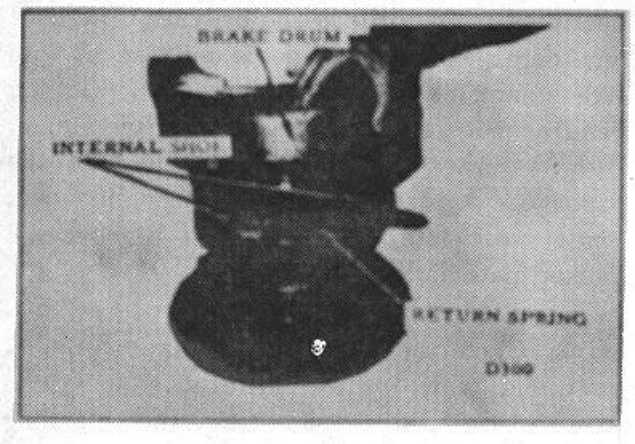


Figure 18.

stream from the air hose nozzle directly against the rollers of a bearing assembly. Do not spin ball bearings with compressed air.

3. Check bearings for nicks, chips and pits. Discard if any of these are found. Lubricate bearings with transmission oil. Spin ball bearings by hand. Discard bearings if roughness is felt or if any excessive looseness is detected. Compare used bearing with a

new one to check for looseness. Wrap bearing in clean paper until it is ready to be installed.

4. If a roller bearing is defective, check its mating surface for same condition. Replace the part if it is found to be defective.

5. All bearings should fit tight in their bores. Ball bearings should fit tight on mating shafts. Except where design permits, the bearing should not rotate in the bore or on the shaft, If this condition exists, replace parts as necessary.

6. Although not absolutely necessary, all O-rings and seals should be replaced. The O-rings must be free of flat surfaces, cuts, tears or any other form of deterioration. Discard if any of these exist. The seal lips should be sharp and smooth. Replace any that are not. Check the surface making contact with O-rings and seals. The surfaces should be smooth. In most cases, slight imperfections can be removed with fine sandpaper. Replace any part if normal service life cannot be expected.

7. Replace seal rings if machining marks are worn off, broken, or do not fit correctly in their grooves. Inspect the mating surfaces; these should be flat. Replace any part that has impaired sealing surfaces.

8. All thrust washers should be free of scores and grooves and within specifications. Replace as necessary. Do not try to repair thrust washers.

9. Bushings should fit tightly in their bores. The bearing surfaces should be free of imperfections, and so should the mating surfaces on the shaft. Minor defects can be eliminated by sanding with fine sandpaper, Bushings that are loose must be replaced.

10. Pistons in the clutch pack end covers must slide into and out of their bores freely. Slight imperfections may be removed with fine sandpaper. Orifices in the housing must be open and the pipe plugs tight. All passage ways leading to the piston chamber must be open. The ball plugs must fit tight on their seats and be staked into place. The plate and spacer tangs should not be worn nor their mating surfaces grooved. Slight grooving caused by plate or spacer tangs is permissible. Deeply grooved surfaces would interfere with clutch application or disengagement, Replace parts as necessary to insure proper clutch function, The friction material should be bonded to the clutch plates and thickness should be within specifications. The friction material should not be warped, galled or torn. Check the dish of each clutch plate on a surface. If not within specifications, or if any of the other foregoing defects are noticed, replace as necessary. Refer to Specification Listing. Make sure the copper tubing in the reverse shaft is tight. Replace shaft if it is loose. Compare all springs lengths with comparable new springs. Springs should not be distorted, pitted or show signs of wear. Replace as necessary. Replace the entire set in the clutch packs, if signs of overheating are noticed or if springs of a given pack are of different lengths.

11. Check all gears and splines for nicks and burrs. The teeth should not be broken or galled. Minor defects can be removed with a fine India stone. Replace all parts where excessive wear is noticed.

12. Check the mainshaft flange (converter output shaft) for runout and out-of-round. Converter must be removed to service main shaft.

D. ASSEMBLY AND INSTALLATION

NOTE: Do not, under any circumstances, assemble any of the parts dry. If the clutch friction discs and separator plates are installed dry, they will overheat and warp

or gall. Lubricate all parts with Dexron transmission fluid during assembly.

1. Place the piston in the forward-end housing, using new O-rings in the endhousing. (Fig. 15) Slide the forward-end housing over the forward gear. (Fig. 14) Secure the assembly with a snap ring.

2. Place the assembly in a tubular fixture. Slide the forward clutch hub onto the spline of the forward drive gear, making sure the oil holes are aligned. (Fig. 21) Secure the hub with a snap ring.

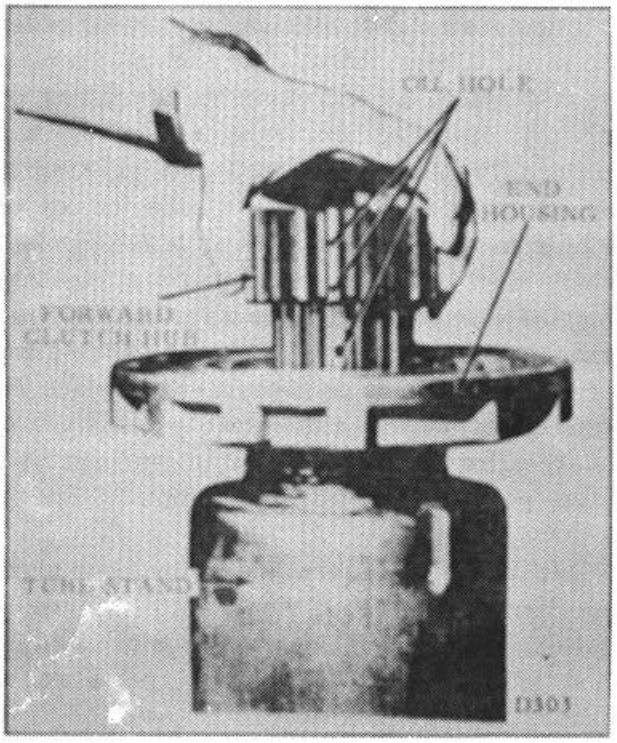


Figure 21.

3. Place the clutch ring on top of the end housing, making sure the bolt holes of each are in line. (Fig. 22)

4. Beginning with a separator plate, alternately assemble the separator plates and friction discs into the clutch ring.

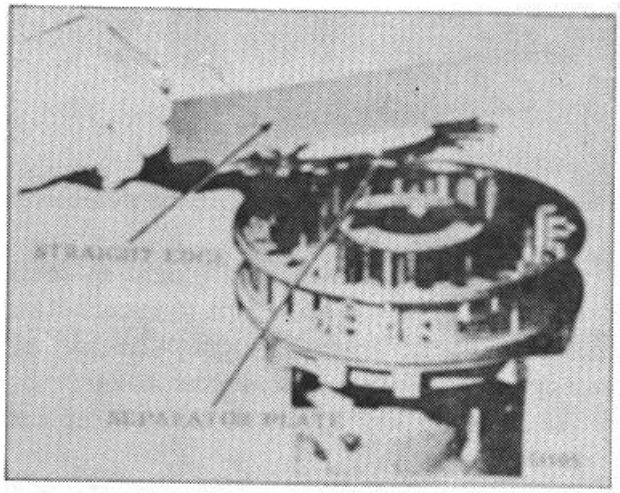


Figure 22.

NOTE: The separator plates are dished and must be installed with the dish facing the same way on all plates. It is not important whether the dish is up or down. (Fig. 23)

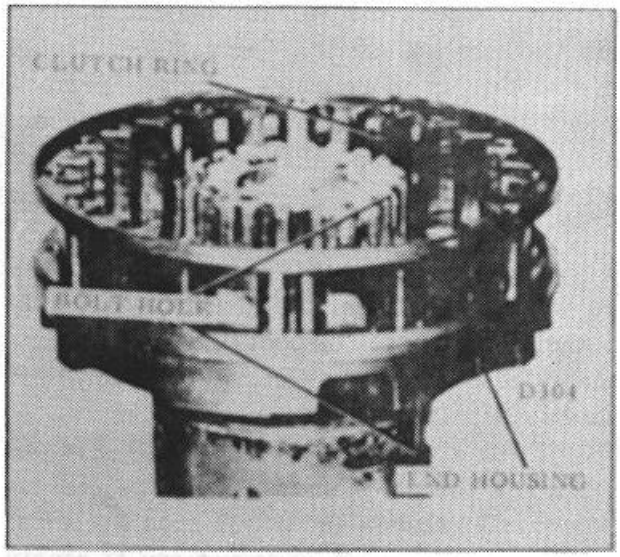


Figure 23.

NOTE: Each separator plate is slotted to its outside edge in four places. The first plate should be placed in the clutch ring so that the slots are in line with the center holes in each group of holes of the end housing. (Fig. 24) Do not align the second plate with first, but rotate it the width of one tooth to the right or left (Fig. 25) before dropping it into clutch ring.

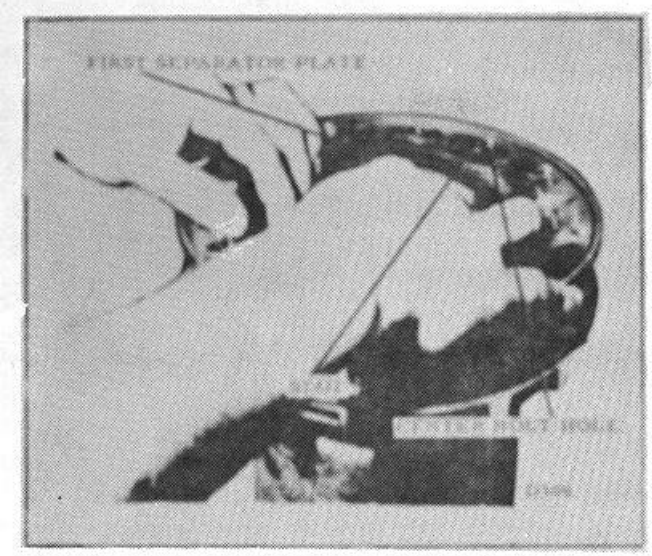


Figure 24.

Figure 25.

5. Place the center thrust washer on the forward clutch hub, making sure the teeth on the back of the washer engage the teeth on the gear hub. Slide the inner and outer clutch springs into the empty tooth spaces of the clutch ring and onto the tangs of the first separator plate. (Fig. 26)

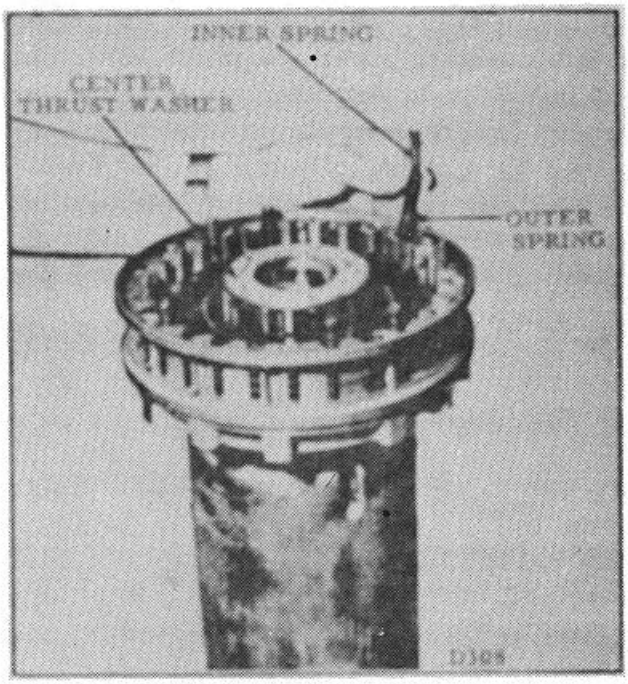


Figure 26.

NOTE: If the springs are not all the same height the first separator plate is incorrectly installed.

6. Place the pressure plate on top of the springs, using two mounting bolts to align the bolt holes. (Fig. 27) Remove the bolts.

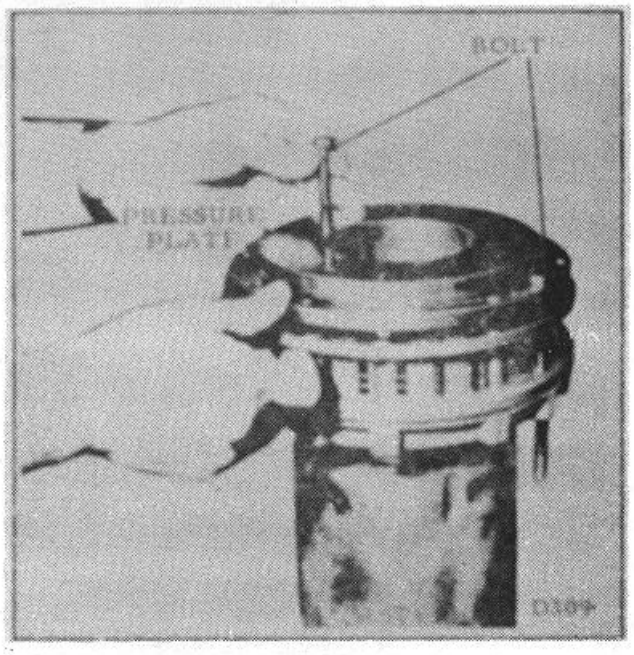


Figure 27.

7. Position the reverse clutch ring on top of the pressure plate. Align the bolt holes and hold them in alignment with two mounting bolts. Compress the forward clutch pack together by applying pressure to the reverse clutch ring; retain the pack in this position with two wires placed 1800 apart. Lower the reverse clutch hub into the center of the assembly. (Fig. 28)

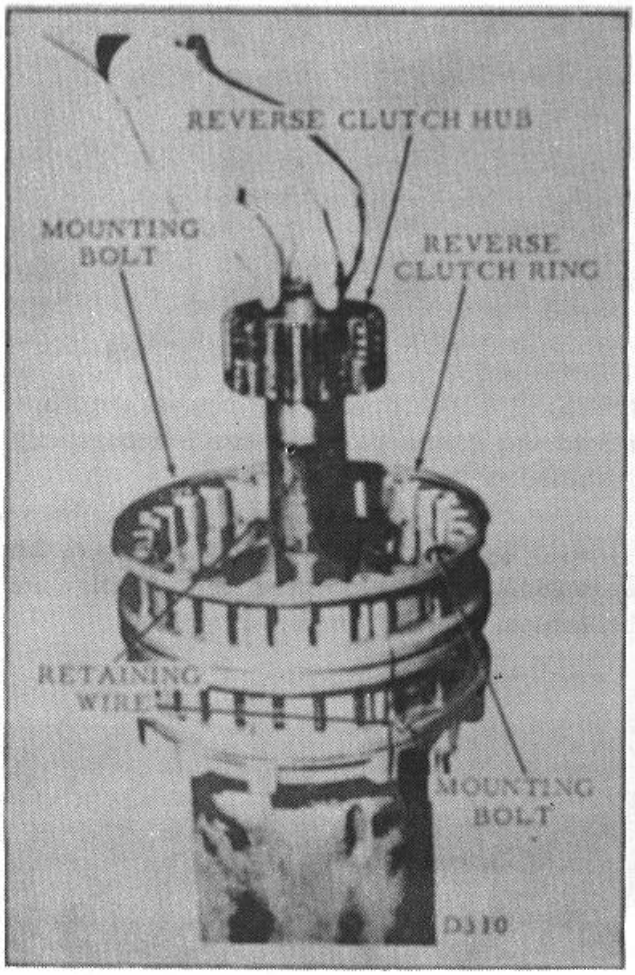


Figure 28.

8. Beginning with a friction disc alternately install all the remaining friction discs and all the separator plates, except for the last one. Make sure the plates all dish in the same direction.

NOTE: All but the last separator plate are installed as shown in Figure 29. Place the last plate on top of the springs as shown in Figure 30.

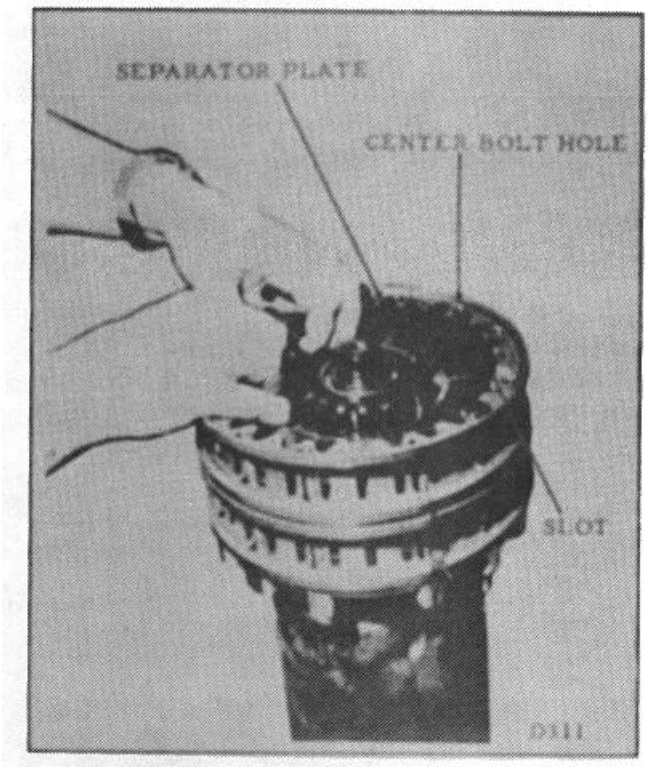


Figure 29.

Figure 30.

9. Press the bearing into the clutch drive end housing. Remove the aligning bolts from the clutch pack. Place the end housing on top of the last separator plate.

10. Align the bolt holes and hold in alignment with two mounting bolts. Make sure two assembly bolts are within reach. Press down on the end housing, slide a bolt through the assembly and screw it into the end housing. (Fig. 31) Maintain the pressure on the end housing while securing the assembly with another bolt 180° from the first.

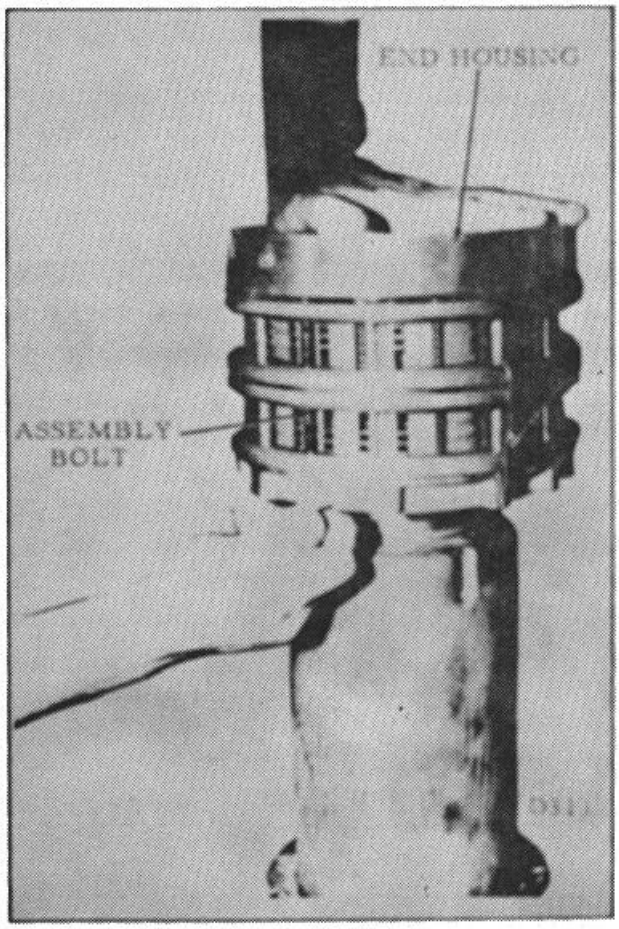


Figure 31.

11. Screw the remaining assembly bolts and alternately tighten to 15 lb./ft., lubricated. Check the scribed lines made on the end housing before disassembly; these should be the same distance from the clutch ring as before disassembly.

NOTE:
If in Step 11, either scribed line is too far from the clutch ring or the shaft will not turn, Step 12, the clutch pack is incorrectly assembled.

12. Place the thrust washer on top of forward gear. (Fig. 32)

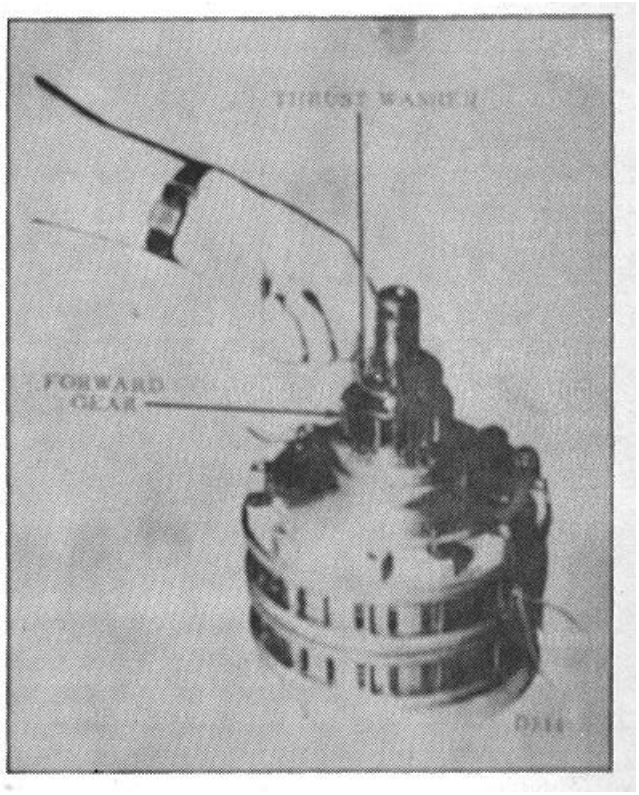


Figure 32.

13. Slide the reverse gear into position next to the thrust washer. Drive the output bearing onto the output shaft, snap ring up. (Fig. 33)

14. Secure the output gear. with a snap ring. Carefully work the seal rings onto the reverse shaft. (Fig. 34) Remove the wires from the clutch pack.

15. Assemble the gears and clutch pack into the transmission case in the reverse order in which they were removed. Adjust the front bearing retainer as follows:

a. Attach cap to transmission case with a .030 inch shim and no gasket.

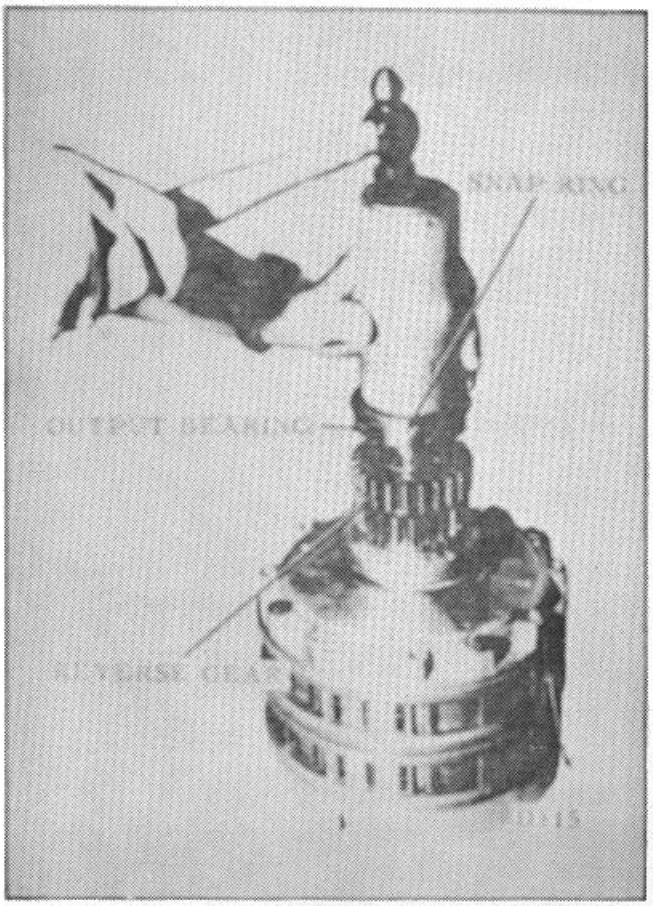


Figure 33.

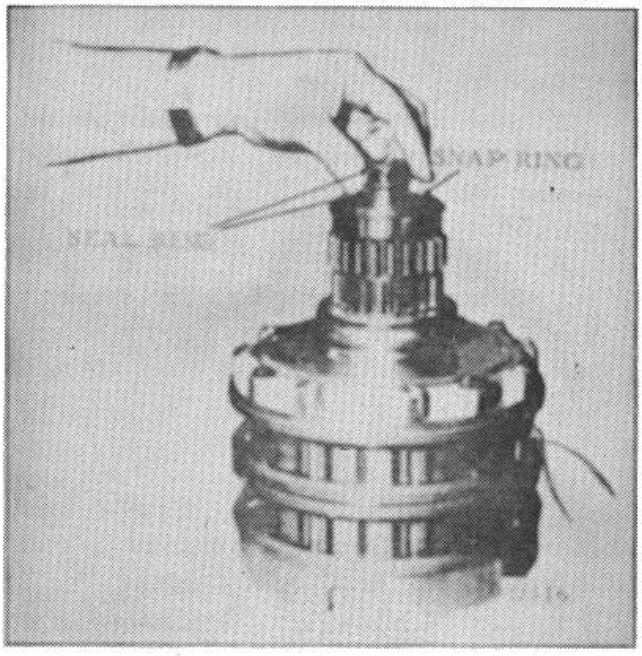


Figure 34.

b. Measure gasket gap. Adjust shim pack by adding or deleting shims until gasket gap is between .003 and .008 inch.

c. Install cap with shims and gasket in place. Tighten capscrews to 20 lb./ft., lubricated threads.

TORQUE CONVERTER AND OIL PUMP

NOTE:
To gain access to the oil pump or torque converter engine removal is necessary.

A. CONVERTER REMOVAL

1. Remove the bolts holding the converter to the engine flywheel. These are accessible through the opening at the right hand top of the converter housing. (Fig. 35)

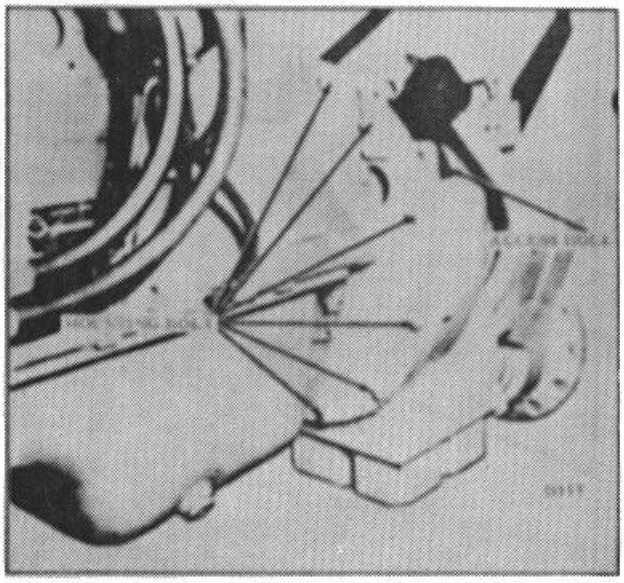


Figure 35.

NOTE:
Make sure the aligning marks are clearly visible on the flywheel and converter. If they are not already marked, mark the two components (Fig. 36) to retain relationship upon reassembly. Do this before removing the converter attaching bolts.

2. Unscrew the six converter mounting

nuts. Rotate the converter to facilitate removing them.

3. Remove the starter and disconnect the pedal return spring.

4. Block the transmission to prevent its dropping when the engine is removed. Prepare engine for removal.

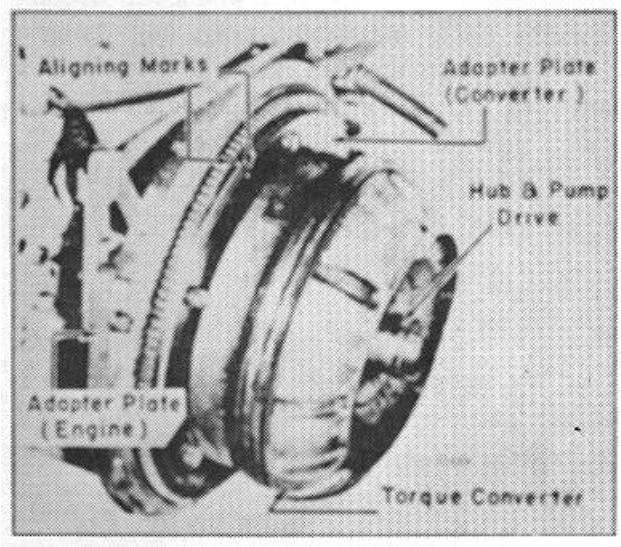


Figure 36.

5. Remove the bolts retaining the converter housing to the engine adaptor plate. The heads of the bolts are in back of the plate. (Fig. 35)

6. Slide the engine away from the transmission, being certain the converter stays in the housing. Lift the engine from the truck.

7. Pull the converter from the transmission main shaft.

B. OIL PUMP REMOVAL

1. Remove torque converter.

2. Unscrew the four capscrews. Slide the pump off the shaft. (Fig. 37)

3. Remove the pump porting plate. (Fig. 38) The plate may be stuck tight against the gasket. In this case rap the plate with a soft-faced hammer. Work carefully, as the plate is easily damaged and cannot be easily repaired.

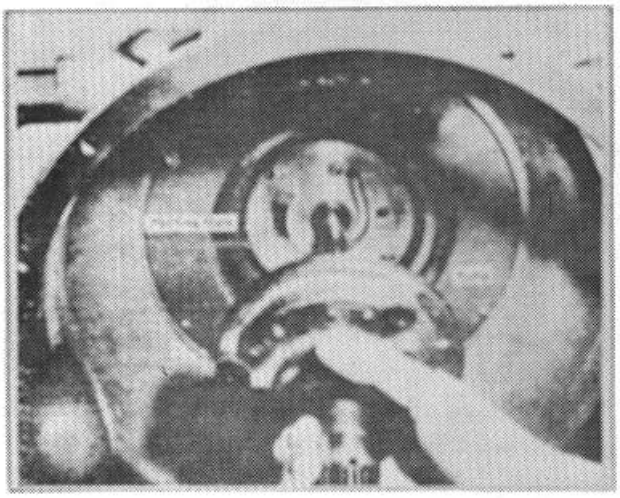


Figure 37.

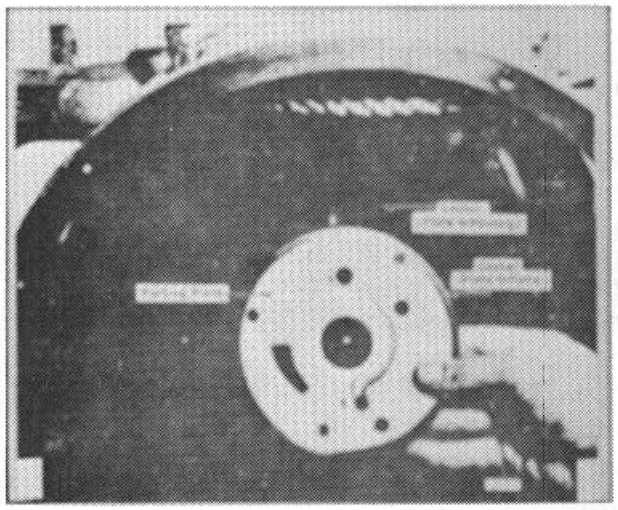


Figure 38.

NOTE:
To remove the transmission mainshaft, it is necessary to remove the forward-reverse clutches from the transmission and snap ring from mainshaft. (Fig. 39)

C. DISASSEMBLY

NOTE:
The Torque Converter is a sealed unit and cannot be disassembled.

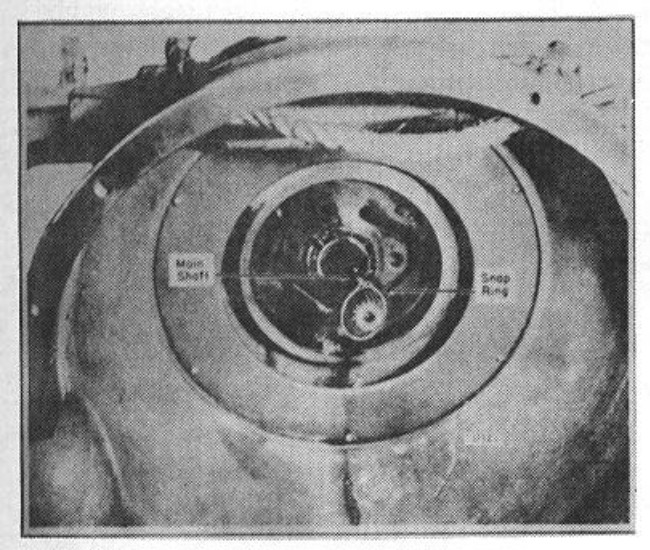


Figure 39.

1. Remove the two flat head machine screws from the pump assembly.

2. Push the reactor shaft from the pump body.

3. Mark gear relationship with prussian blue. Remove the gears.

D. CLEANING AND INSPECTION

1. Clean all parts in solvent. Remove all gasket material from the adapter plate and the pump bore of the converter housing. Discard all gaskets and O-rings.

2. The mating parts of the pump are ground and lapped. For this reason, the only items serviced on the pump are the seals and gasket.

3. Inspect all parts for scratches, wear, burrs, and nicks. Especially watch for wear of pump gears into the pump housing or wear of the driving gear bushing. Replace the pump if either is worn, or if there is any doublt as to the dependability of any other part. l)o not try to repair any defective part.

E. ASSEMBLY AND INSTALLATION

1. The oil pump may be assembled and installed by reversing the disassembly and removal procedure. Lubricate all parts during assembly.

2. Make certain the match mark on the converter plate lines up with the mark on the flywheel. Bolt the converter adapter plate to the converter (Fig. 40) an mount the converter to the engine flywheel, match-marking the plate and flywheel, whenever a converter is being installed. (Fig. 36) Using a dial indicator, check the runout of the impeller hub. (Fig. 41) The total runout should not exceed .005 inch. If this figure is exceeded, pry between the converter and the plate and bend until the correct runout is achieved.

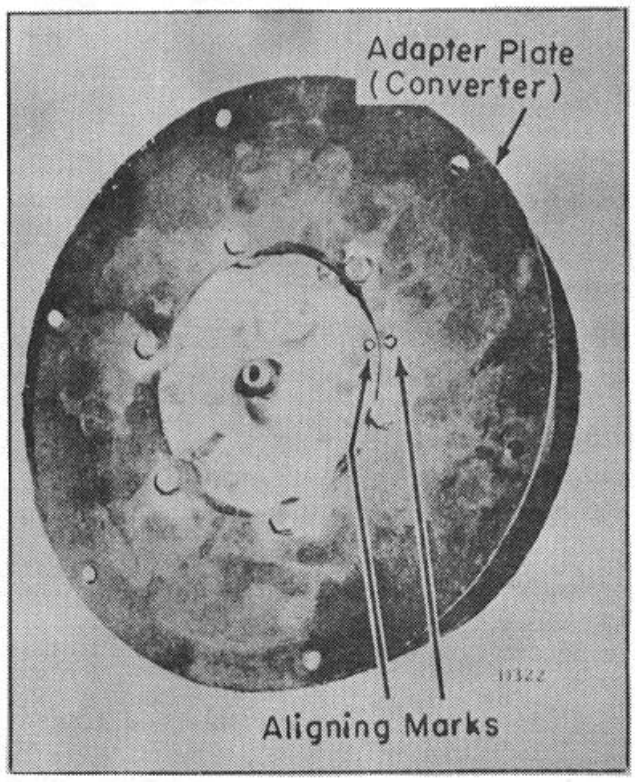


Figure 40.

3. Remove the converter from the flywheel and slide on the drive shaft. Make sure the converter and pump tines engage. Mount the entire assembly on the engine adapter plate and secure. Line up the match marks on the converter plate and flywheel, and secure. Fill to proper level with specified oil. Remove

the plug at pressure check port No. 1. (Fig. 42) Fill this port with oil to furnish initial pump lubrication.

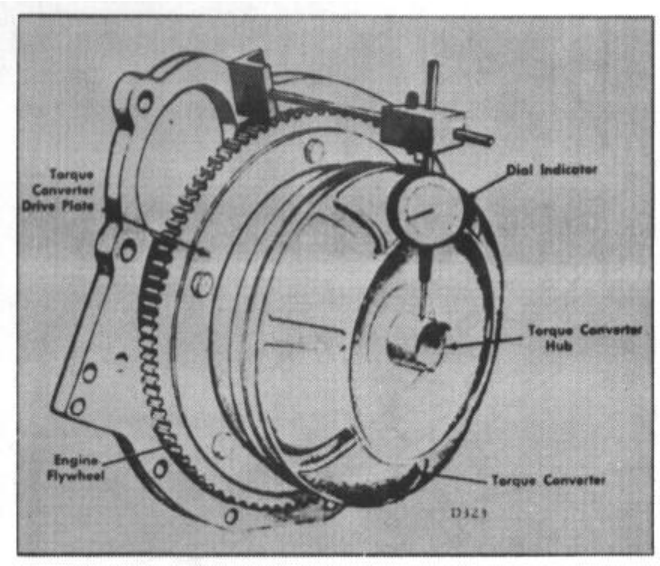


Figure 41.

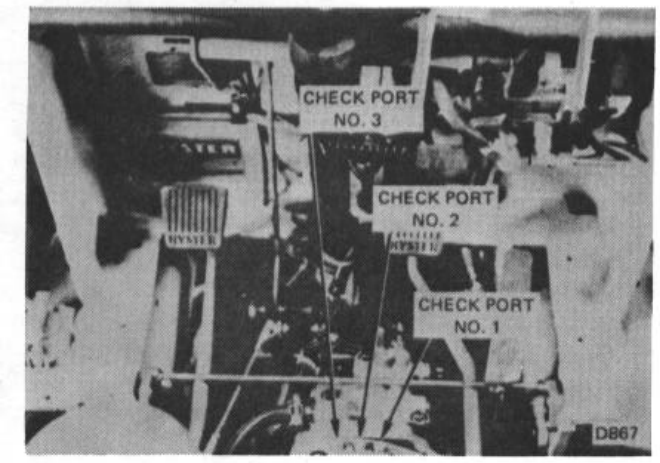


Figure 42.

F. CHECKS

1. With the truck thoroughly warmed-up, put a load on the forks and set the emergency brake.

NOTE:
It may be necessary to run the truck against some heavy object to prevent it from moving while making the test.

2. With the transmission in gear, apply full throttle and check engine speed with the truck stationary.

CAUTION:
Under no circumstances apply full throttle longer than 30 seconds. Otherwise the torque converter may become overheated and possibly damaged.

3. If the engine and converter are in good condition, the stall speed should be within 100 RPM of the specified stall speed of a given truck. Refer to the Engine Section for stall speeds.

4. If the stall speed is 100 or 300 RPM slower than that specified, it is a general indication that engine performance is down. Check carburetion, timing, valves, etc.

5. If the stall speed is 400-500 RPM slower than that specified and the engine is in good condition, the converter stator is slipping and entire converter assembly must be replaced.

6. If the stall speed is more than 100 RPM higher than the specified speed, it is an indication that the clutch pack is slipping.

CONTROL VALVE

The control valve may be removed by disconnecting the attaching hoses and disconnecting the linkage from the directional spool, (Fig. 43) Remove the five capscrews that hold the control valve to the transmission housing. Hold the control valve in place while removing the last capscrew, as the seat for the converter outlet check ball is behind the control valve. Slide the control valve away from the housing, being careful not to lose the ball from this check valve. The porting plate may be removed to complete the disassembly. (Fig. 44)

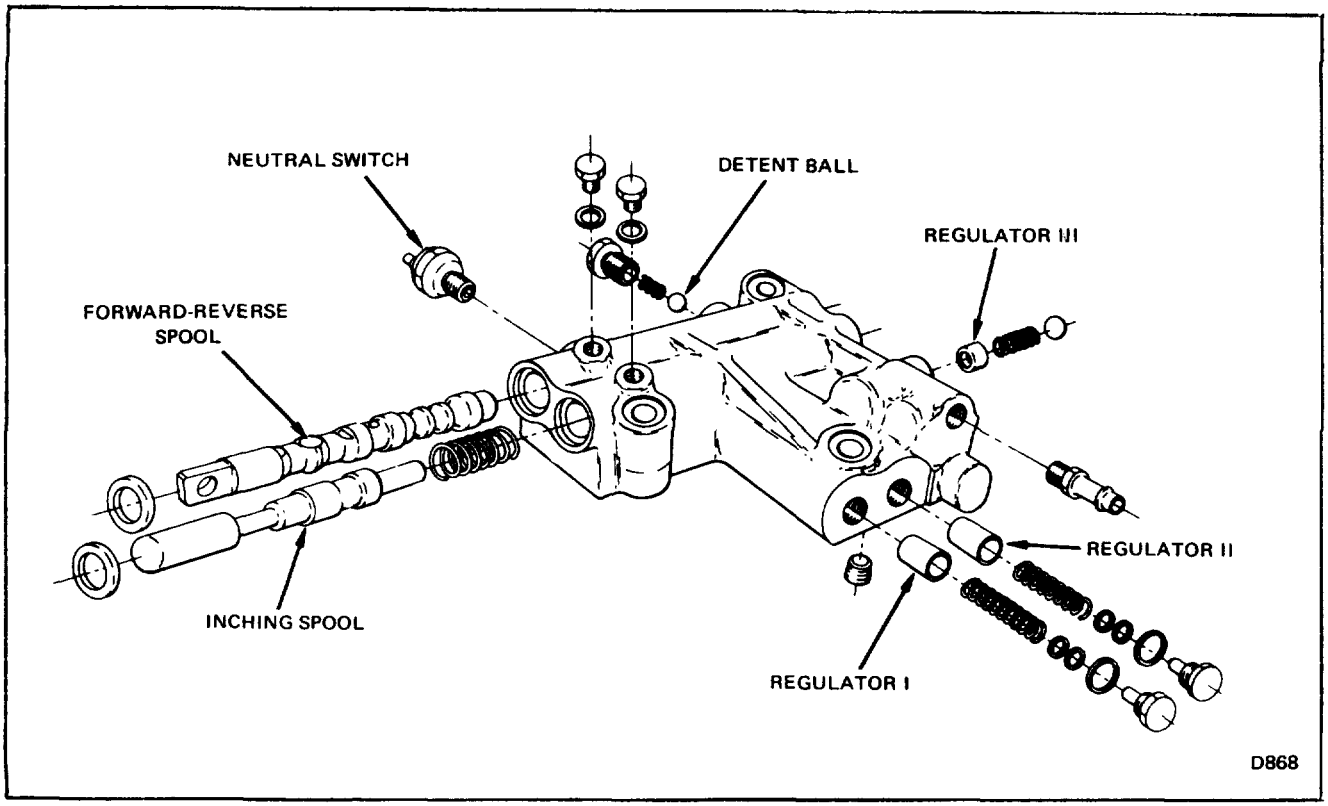


Figure 43.

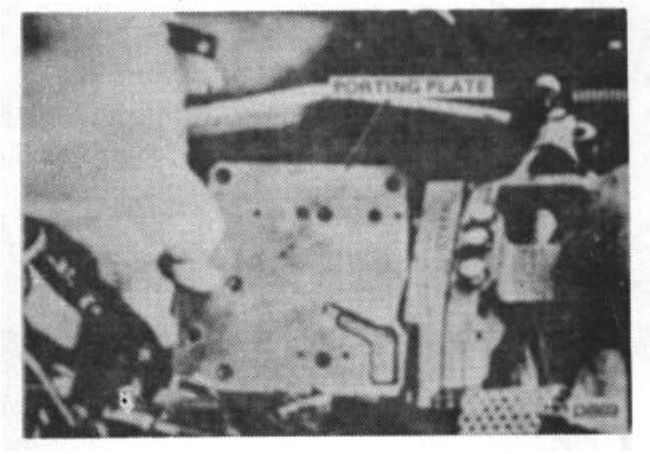


Figure 44.

INSTALLATION OF CONTROL VALVE

IMPORTANT: Always use new factory gaskets, because they are made of a special non-shrinking material.

Install the valve and porting plate with the Allen head capscrews that go through vertically into the transmission cover. These screws should be snug, not tightened.

Install the two capscrews that go through the torque converter housing horizontally into the valve. Run them up tight.

Tighten the six Allen head capscrews, drawing them up slowly and evenly. Torque them to 20 lb./ft. with lubricant.

SHIFTING LEVER ADJUSTMENT

With the directional spool in neutral position, adjust the linkage so the shifting lever is in a vertical position.

BRAKE AND INCHING LINKAGE ADJUSTMENT (Fig. 45)

1. Adjust brakes by turning adjusting screw through the backing plate at the drive wheels until shoes are within one notch of dragging.

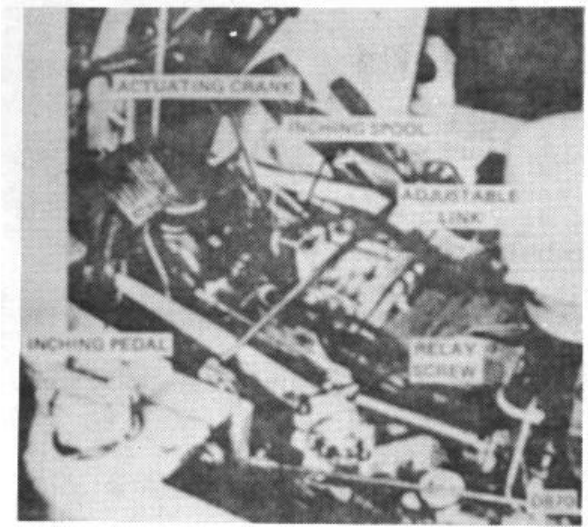


Figure 45.

2. With master cylinder piston in fully retracted position, adjust the cylinder push rod so that it just contacts piston with brake pedal up.

3. With pedals up against the stop, shorten or lengthen the adjustable link until the actuating crank clears the inching spool by .015 to .032 when the inching spool is pushed in against its stop.

NOTE:
Jam nuts on the adjustable link must be tight when the clearance is checked.

4. Adjust the relay screw and its jam nut so that a 90 to 100 pound force on the inching pedal will fully extend the inching spool.

5. Check the adjustment after the truck has been run and brakes applied several times in each direction.

PRESSURE CHECKS

A. GENERAL

Oil flows from the case through a filter to the adapter plate for the pump inlet. Always prime the filter (fill it with transmission oil) before operating the transmission. Also prime the torque converter charging pump by pouring 1/2 pint of transmission oil into Port 1.

B. TAKING PRESSURES

1. Attach pressure gauges to the torque converter housing and the tachometer to the engine. See PRESSURE CHECK CHART for gauge range. (Fig. 46)

2. Check the oil level with the transmission in neutral and the engine at idle speed.

3. To check whether oil is flowing through the torque converter unit, disconnect the oil cooler return hose from the nipple in the front bearing cap, hold the hose in the transmission fill pipe and operate the engine. A steady flow of oil should come from the hose.

4. Allow the engine to reach operating temperature.

5. Allow the transmission oil to reach operating temperature (100° - 200°F.).

6. Recheck the transmission oil level in neutral at engine idle speed.

7. Adjust inching controls.

8. Block the truck up so the transmission can be put in gear.

9. Proceed with pressure checks as outlined in the PRESSURE CHECK CHART.

WARNING:
Do not remove check port plugs 1, 2, or 3, or regulator plugs I, II and III while the engine is running.

	PUMP PRESSURE–PORT 1	CONVERTER INLET PRESSURE–PORT 2	CONVERTER OUTLET PRESSURE–PORT 3
CONTROL POSITION	NEUTRAL	NEUTRAL	NEUTRAL
SETTING	95 PSI @ 600 RPM	75 PSI @ 2450 RPM	NOT ADJUSTABLE
RANGE: MIN. MAX.	30-70 PSI @ 600 RPM 105 PSI @ 2450 RPM	5-20 PSI @ 600 RPM 75 PSI @ 2450 RPM	2 PSI @ 600 RPM 50 PSI @ 2450 RPM
	REGULATOR I	REGULATOR II	REGULATOR III

Figure 46.

PRESSURE CHECK ANALYSIS

A. CHECK PORT NO. 1

1. Pressure too low at 600 RPM and in neutral:

   a. Leak between pump and control valve.

   b. Misaligned control valve porting plate.

   c. Regulating valve I stuck open or weak spring.

   d. Misaligned inching spool.

   e. Clogged supply line to pump.

   f. Misaligned pump porting plate.

   g. Insufficient pump output.

2. Pressure too high at 600 RPM and in neutral:

   a. Misaligned gasket between converter housing and transmission cover.

   b. Misaligned control valve porting plate or gasket.

   c. Restriction between pump and manifold in control valve.

   d. Misaligned control valve gasket.

   e. Misaligned pump porting plate or gasket.

   f. Too many shims.

3. Pressure too low at 2450 RPM and in neutral:

   a. Same as No. 1 above.

   b. If pressure is satisfactory at 600 RPM but low at 2450 RPM check regulating valve I in control valve.

4. Pressure too high at 2450 RPM and in neutral:

   a. Same as No. 2 above.

   b. Regulating valve "I" not operating.

   c. Excess oil dump line restricted between control valve and sump.

B. CHECK PORT NO.2

NOTE:
Get satisfactory results at check port No. 1 before attempting adjustment here.

1. Pressure too low at 600 RPM, 1500 RPM and 2450 RPM and in forward:

   a. Misaligned control valve porting plate or gasket.

   b. Misaligned inching spool.

   c. Regulating valve II stuck open or weak spring.

   d. Broken or non-sealing seal rings on forward end housing.

   e. External leak around control valve or valve porting plate.

   f. Leaking past O-rings in forward end housing.

2. Pressure too high at 600 RPM, 1500 RPM and 2450 RPM and in forward:

   a. Misaligned control valve gasket.

   b. Too many shims.

   c. Bleed-off ports in forward end housing clogged.

d. Restriction in forward circuit between control valve and piston.

e. Misaligned porting plate or gaskets.

3. Pressure too low at 600 RPM, 1500 RPM and 2450 RPM and in reverse:

a. Misaligned control valve porting plate or gasket.

b. Misaligned inching spool.

c. Regulating valve "II" stuck open or weak spring.

d. Broken or non-sealing seal rings on reverse drive shaft in front cap or in end housing.

e. External leak around control valve or valve porting plate.

f. Leak past O-rings in reverse end housing.

g. Leak around outside of improperly swaged copper tube.

h. Leak in front cap - external or internal.

4. Pressure to low at 600 RPM, 1500 RPM and 2450 RPM and in reverse:

a. Misaligned control valve gasket.

b. Too many shims.

c. Bleed-off ports in reverse end housing clogged.

d. Restriction in reverse circuit between control valve and piston.

C. CHECK PORT NO. 3

NOTE:
Get satisfactory results at check ports number 1 and 2before attempting adjustment here.

1. Pressure too low at 600 RPM and 2450 RPM and in neutral:

a. Flow from control valve to converter unit blocked by misaligned gasket.

b. Regulator valve III stuck open.

c. Pipe plug in bottom of control valve left out.

d. Weak spring in check valve.

2. Pressure too high at 600 RPM and in neutral:

a. Leak-through from pump output line to converter supply line at pump because of worn or faulty gasket, worn or faulty pump gears, damaged pump porting plate.

3. Pressure too high at 2450 RPM and in neutral:

a. Same as No. 2 above.

b. Regulating valve III inoperative.

c. Restriction in excess of oil dump line.

d. Clogged transmission oil filter.

e. Regulating valve III shimmed too high - new spring required.

TROUBLESHOOTING

CAUSE	REMEDY
Foams at Filler Tube	
1. Improper -oil level	1. Adjust to proper level.
2. Air in system	2. Pump intake hose, fittings and gasket loose or defective.
3. Pump loose on mounting	3. Tighten, repair or replace as necessary. Replace adapter to pump mounting gasket and pump body to transmission case gasket.
4. Sticking converter reactor	4. One-way clutch defective.
5. Transmission overheating	5. See Transmission Overheats.
Transmission Overheats	
1. Improper oil level	1. Adjust to proper level.
2. Inching and operating truck with loads above capacity	2. Reduce load.
3. Abnormal clutch slipping	3. Operating truck with foot on inching pedal when not inching; using brake pedal to inch instead of inching pedal; change driving habits. Adjust inching spool and inching pedal.
4. Glazed or wrong clutch friction disc and/or separator plates	4. Replace the clutch pack that is slipping.
5. Insufficient clutch pressure	5. Check oil pressure and adjust to specified PSI if necessary.
6. Warped or worn clutch friction discs	6. Replace clutch packs as necessary.
7. Brake dragging (Foot or hand brake)	7. Adjust brakes. Inspect and repair as necessary.
8. Truck left parked, in gear and engine running for long periods	8. Place in "Neutral" before leaving truck. Turn engine off if truck is to be left for long periods.
9. Driving with hand brake partially applied	9. Change driving habit.

CAUSE	REMEDY
10. Restricted oil cooler and/or circuit	10. Defective or kinked hoses, straighten or replace as necessary.
11. Dirty filter	11. Replace filter element.
12. Defective one-way clutch in converter	12. Remove and replace converter.
Inching Quality Low	1. Adjust to proper level.
1. Improper oil level	2. Adjust brakes.
2. Improper brake adjustment	3. Free linkage. Replace worn parts. Adjust linkage.
3. Sticky, loose or improper inching linkage adjustment	4. Check and adjust to proper pressure.
4. Forward-reverse clutch pressure too high	5. Check for looseness and backlash of ring gear and pinion in the differential. Adjust and repair as necessary.
5. Ring gear and pinion out of adjustment	Check axle splines and flange screws. Replace axle and differential side gears if necessary. Tighten flange to hub screws.
Lack of Power	
1. Low oil level	1. Adjust to proper level.
2. Engine not developing specified torque	2. Check engine. Adjust or repair as necessary.
3. Clutches slipping or dragging	3. Refer to the specific operational default.
4. Converter not functioning correctly	4. Reactor slipping, replace torque converter. Reactor sticking, replace torque converter.
Truck Does Not Move in Either Direction	
1. Low oil level	1. Add oil to proper level.
2. Hand or foot brake locked	2. Hand brake applied. Release.
3. Brake shoes dragging	3. Adjust or repair as necessary.

TROUBLESHOOTING

CAUSE	REMEDY
4. Clutches not applying	4. Check pressures. Adjust if necessary. Defective clutch. Repair as necessary.
Clutch Partially Applied Or Slipping	
1. Oil leaking into apply oil passage when not	1. Spool valve clearance too great. Replace desired to do so spool and if necessary, replace valve assembly. Valve mounting gasket defective or valve body loose on its mounting. Replace or tighten mounting screws as necessary.
2. Weak or broken retraction springs	2. Replace entire set.
3. Indentions worn in the clutch hub or clutch ring	3. Replace both if necessary.
4. Jammed piston or limited piston travel	4. Foreign particles between piston and housing. Repair as necessary. If fwd.-rev. pack is in question, the bleed hole in the housing may be restricted. This condition is apt to be noticed at high speeds. Remove piston and eliminate restriction.
5. Defective end housing O-rings or seal rings	5. Replace rings as necessary. If seal rings are defective, inspect mating bore and replace bore component if the ring-sealing surface is not in good condition.
6. Glazed, worn wrong or warped clutch friction discs or separator plates	6. Remove, inspect and replace parts as necessary.
7. Steel ball in end housing loose or missing	7. Stake in place. Install a new ball and stake in place.
8. End-housing-pipe plug missing	8. Install a new plug.
Control Valve Will Not Shift	
1. Spool valve sticking in valve body due to dirt or misalignment caused by external damage to linkage.	1. Flush with clean solvent and check for scoring of spool valve and bore or for spool binding. Oil spool before installing. Check linkage.

SPECIFICATION LISTING	
Powershift Transmission	
Forward Speeds	1
Reverse Speeds	1
Gear Ratios:	
Forward	1.045:1
Reverse	1.160:1
Torque Converter at Stall	2.2:1
Dimensions - In Inches	
Thrust washers - Width	
Clutches - fwd. to rev.	.061 - .063
Gears - fwd. to rev.	.061 - .063
Idler - Main	.090 - .092
Gear - forward cluster	.061 - .063
Mainshaft	
Diameter - bushing surface	9040 - .9045
Runout - flange	.003
Reverse Clutch End Housing	
Side clearance - hub seal ring	.0015-.007
Maximum	010
Gap. - hub seal ring	.002 - .008
Maximum	011
Clearance - housing to piston	.004 - .012
Maximum	.015
Bore diameter:	
Bearing	2.165
Piston (O.D.)	6.506 - 6.508
Piston (I.D.)	3.990 - 3.992
Seal ring	1.125 - 1.127
Reverse Clutch Piston	
Diameter - outside	6.416 - 6.498
Diameter - inside	4.000 - 4.002
Separator Plate	
Width	.080 - .084
Dish	.015 - .020
Dish - maximum	.035
Dish - minimum	.004
Friction Disc	
Width - overall	127- .133
Thickness - friction material	.020
Depth - groove	007 - .012
Retraction Spring - Outer	
Diameter	365 - .375
Free length	1.87
Minimum free length	1.75
Retraction Spring - Inner	
Diameter	.243 - .250
Free length	1.914
Minimum free length	1.781
Reverse Shaft	
Side clearance - seal rings	.0025- .007
Maximum	010
Gap - seal rings	.002- .008
Maximum	011
Diameter - bushing surface	1.747 - 1.748
Forward Clutch End Housing	
Bore - Piston (O.D.)	6.506 - 6.508
Bore - Piston (I.D.)	3.990 - 3.992
Diameter - bushing	2.5 - 2.501
Maximum	2.505
Clearance- piston to housing	.004 - .012
Maximum	015
Side clearance - seal ring	.002 - .0045
Maximum	.007
Gap - seal ring	.003 - .008
Maximum	.011
Forward Clutch Piston	
Diameter - outside	6.496 - 6.498
Diameter - inside	4.000 - 4.002
Forward Gear	
Bore - bearing	1.8700 - 1.8705
Diameter - inside bushing	1.750 - 1.751
Maximum	1.755
Runout - torque converter hub	.005
Main Idler Gear Assembly	
Side clearance	.004- .022
Lash	Non-adjustable
Bore diameter - bearing	1.8695- 1.8700
Width - hub	2.010 - 2.012
Diameter - shaft	1.4997 - 1.5000
Minimum	1.4977
Cluster Gear Assembly	
Side clearance	.005- .019
Bore diameter - bearing	1.6200 - 1.6205
Width - hub	1.927 - 1.929
Diameter - shaft	1.131 - 1.133
Minimum	1.128

Pump Relief Valve Spring	
Diameter	.400 - .410
Free length	3.375
Width - shim	.0625
Shims permissible (number)	3
Converter Relief Spring	
Diameter	.421 - .431
Free length	2.125
Width - shim	0625
Shims permissible (number)	3
Converter Outlet Spring	
Diameter	1.437
Free length	.4688
Inching and Shifting Spool Actuating Springs	
Diameter	.625
Free length	1.875
Minimum	1.750

TORQUE VALUES	
Torques - Lbs./Ft. with Lubricated Threads	
Pump body to converter housing	9
Transmission case to converter housing	72
Cover to transmission case	15
Tapered dowel	36
Valve mounting screws	15
Valve button head screw	12
Cushion control body	10
Front bearing retainer bolts	20
Clutch pack screws an place bolts	15
Pinion bearing retainer to transmission case	18
Backing plate to bearing retainer	33
Brake drum to flange	33
Pinion shaft - Powershift	100 - 200
Pinion shaft - Standard	300- 400

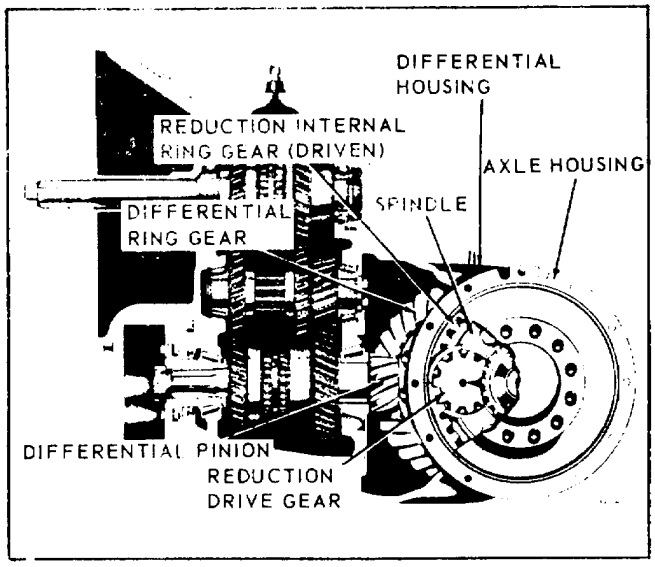


Figure 1.

DRIVE AXLE

A. GENERAL (Fig. 1)

The drive axle consists of an automotive type differential and housing, internal reduction gears and housings, axles and housings and brake assemblies. Although the service brakes area attached to the drive axle these are covered in the brake section.

Lubricating oils of the drive axle and powershift transmission are of different types. Two seals around the differential pinion shaft prevent the mixing of the two oils.

The oil level plug is located on the differential housing. The filler opening is located above the level plug on the differential housing. The drain plug is located on the bottom of the differential.

The pinion shaft of the powershift model is supported by two tapered roller bearings which take the forward and reverse thrusts.

A third bearing takes the radial thrust; this bearing is located opposite the pinion teeth, next to the pinion. A common cup is shared by the tapered bearings; running clearance is maintained by a spacer between the bearings. The cup, spacer and bearings are select fit, serviced as an assembly and located on the parking brake end of the pinion shaft.

An internal reduction gear is located on each end of the drive axle. Each of these consists of an internal ring gear, two tapered bearings and a straight spur pinion gear. The internal gear rotates on the two bearings and is supported by a spindle bolted to the axle housing.

Each pinion is integral with an axle. This component is supported at the gear end by a ball bearing retained by a collar. The opposite end is splined to the axle side gear in the differential.

Studs, nuts and tapered dowels secure the wheels to the internal gear. The entire reduction gear is enclosed by a housing which is attached to the axle housing and supports the service brake assemblies.

Oil, common with the differential, lubricates the reduction gear assembly. A seal pressed into the outer end of the housing and a cap pressed into the outer end of the internal gear, prevents leakage in these areas.

CAUTION:

It is important that the internal gear housing be drained of flushing oil after flushing the drive axle. This is accomplished by removing the 12 capscrews around the internal gear housing and pulling the housing loose to allow the oil to drain. Extensive damage to the transmission and differential may result if this precaution is not taken.

B. REMOVAL

1. Remove load arms. Remove pressure and bleed back hoses, attach hoist to top of upright, remove the two upright mounting caps, the two tilt cylinder rod end pins and lift upright from truck.

2. Place bar across frame above transmission and chain transmission to bar.

3. Unscrew the differential housing to transmission housing capscrews. Disconnect the brake lines at a point near the backing plate. (Fig. 2)

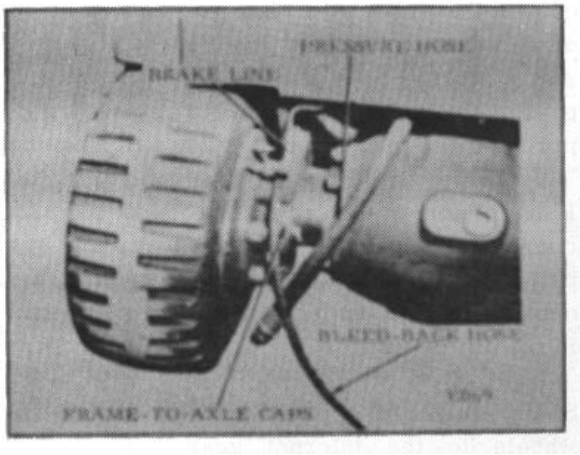


Figure 2.

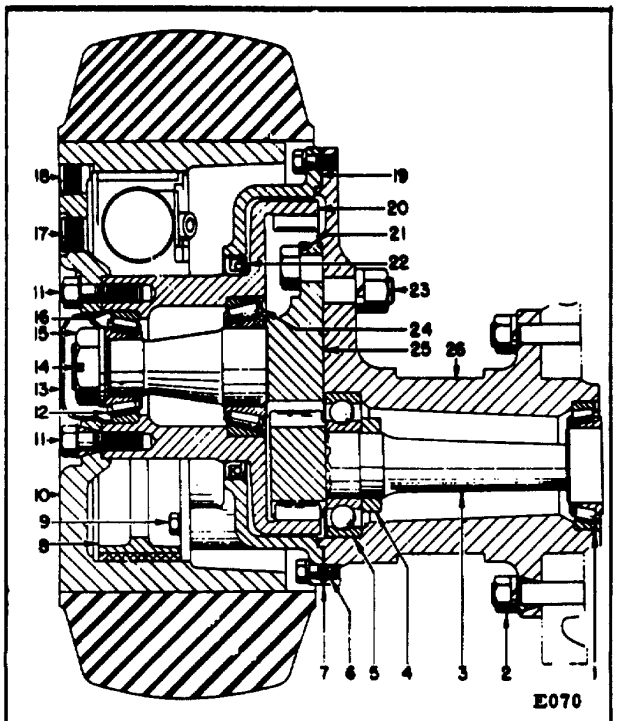
Figure 4.

4. Raise the front of the truck slightly. Then lower it onto blocks placed directly behind the drive wheels.

5. Remove the frame to axle housing caps. (Fig. 2) Roll the axle assembly away from the truck.

C. DISASSEMBLY (Fig. 3)

1. Block the assembly so that the wheels are free. Unscrew the nuts securing the wheels. Tap the wheel with a hammer to loosen the tapered dowels. (Fig. 4) Remove the dowels. Pull the wheels off.



1. Side Gear Bearing
2. Stud, Nut & Lockwasher
3. Axle
4. Retaining Collar
5. Ball Bearing
6. Capscrew & Lockwasher
7. Gasket
8. Service Brake
9. Stud, Nut & Lockwasher
10. Wheel & Tire
11. Stud, Nut, Lockwasher & Tapered Dowels
12. Outer Wheel Bearing
13. Cap
14. Cotter Pin
15. Spindle Nut
16. Washer
17. Pipe Plug
18. Pipe Plug
19. Reduction Gear Housing
20. Internal Ring Gear
21. Spindle Bolt
22. Oil Seal
23. Nut & Lockwasher
24. Inner Wheel Bearing
25. Spindle
26. Spindle

Figure 3.

2. Unscrew the 12 capscrews holding the reduction gear housing to the axle housing. Remove the housing. Be careful not to damage the oil seal. (Fig. 5)

NOTE:
If desirable, the axle assemblies can be removed from the differential housing as a unit, as shown in Figure 6.

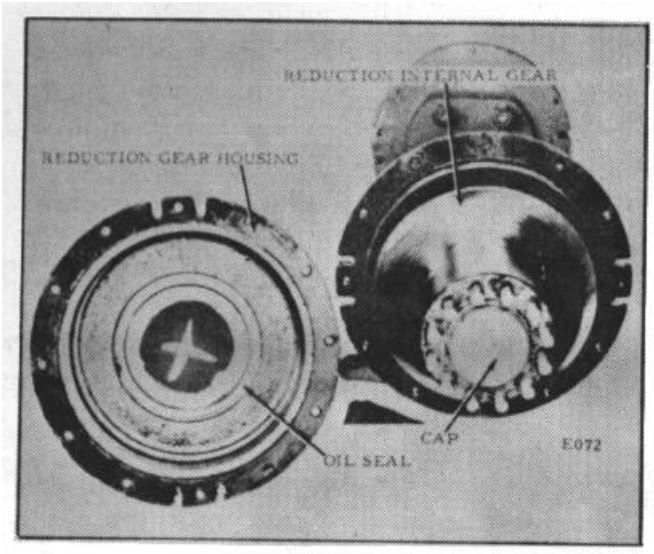


Figure 5.

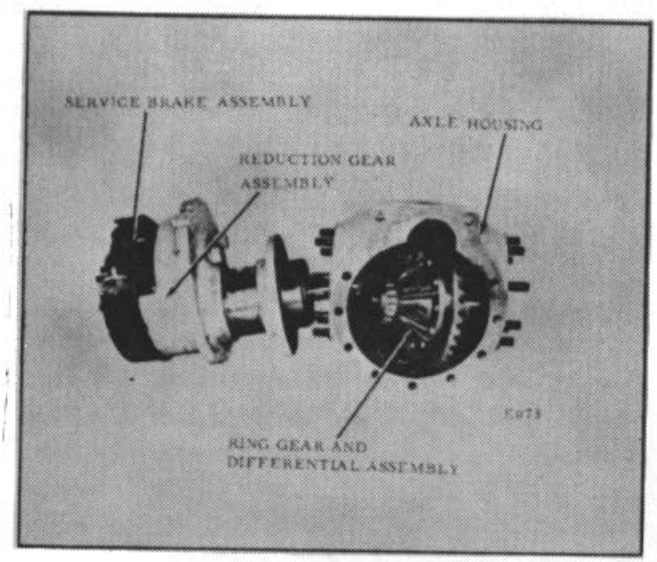


Figure 6.

3. Pry the cap (Fig. 5) from the reduction gear hub. Pull the cotter pin, and unscrew the castellated nut and washer from the stub shaft. Pull the internal gear and outer bearing from the shaft. (Fig. 7)

4. Unscrew the bolts securing the spindle to the axle housing. (Fig. 8) Discard damaged copper washers.

5. Unscrew the 8 nuts securing each axle housing to the differential housing. With a soft hammer, drive each axle housing away

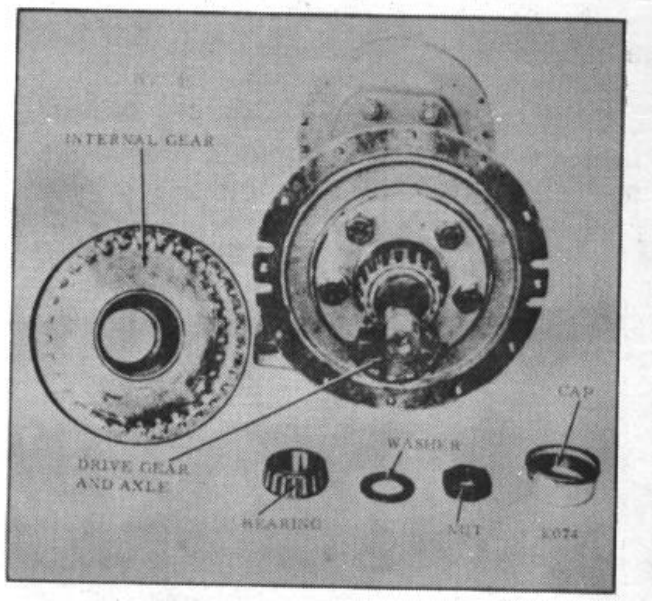


Figure 7.

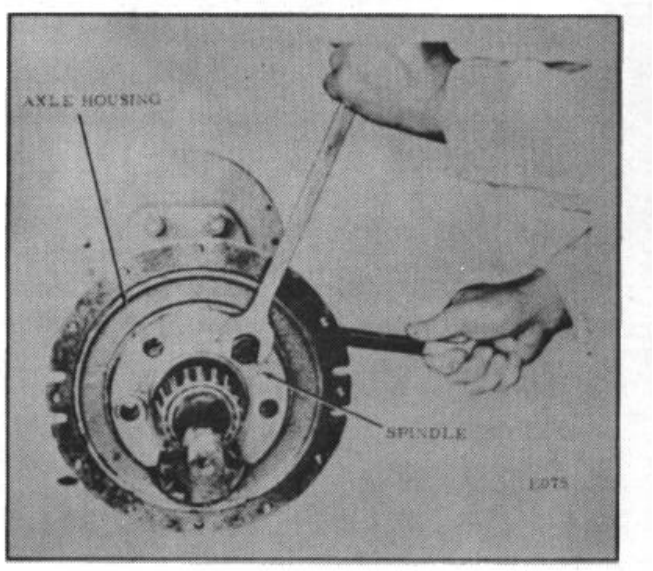


Figure 8.

from the differential until a slight gap appears between the flanges. Drive the axle housing back onto its studs and remove the 4 tapered dowels. (Fig. 9)

6. Pull the axle housing off the studs. (Fig, 6) Remove the reduction drive gear. (Fig, 10)

7. Remove the axle bearing after the re-

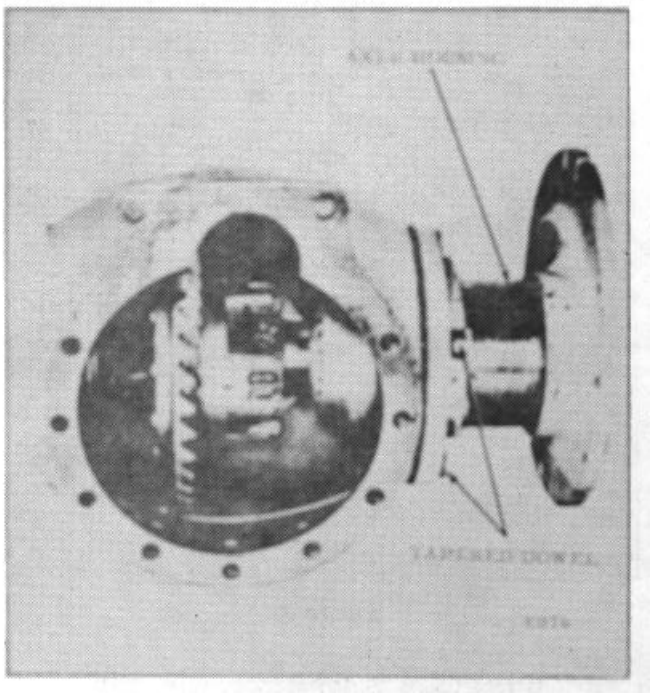


Figure 9.

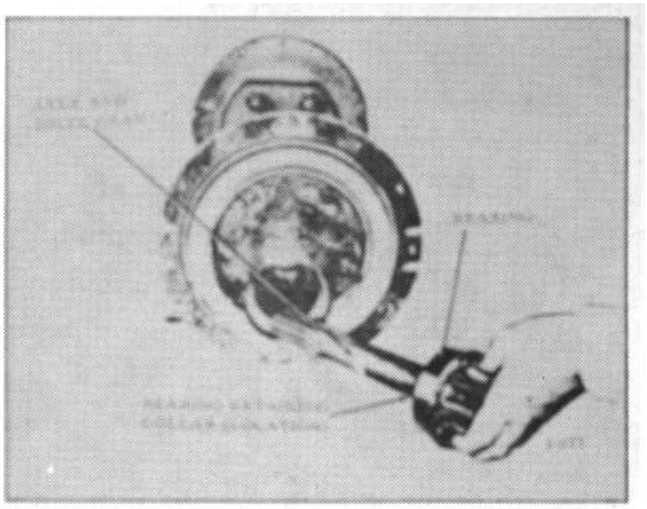


Figure 10.

taining collar has been removed and only if necessary. To remove the collar, cut it in two with a cold chisel and hammer.

8. Lift out differential and gear assembly. (Fig. 11)

9. Mark differential case halves, cut lock wires, and remove bolts from case. Figure 12. Separate halves. Figure 13 is an exploded view of the differential assembly.

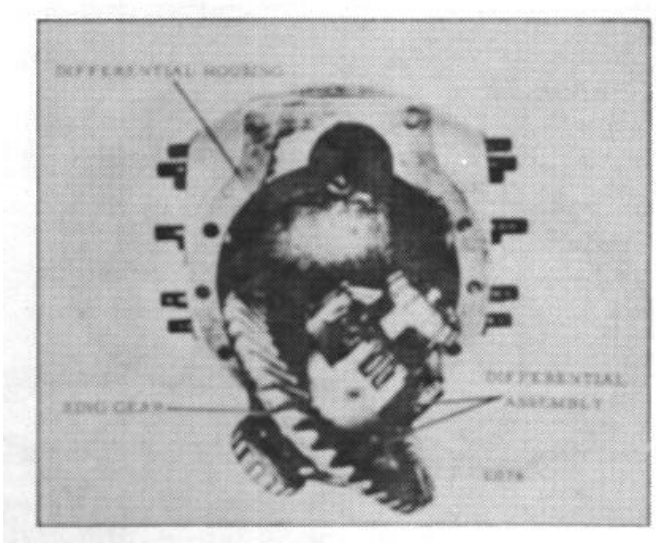


Figure 11.

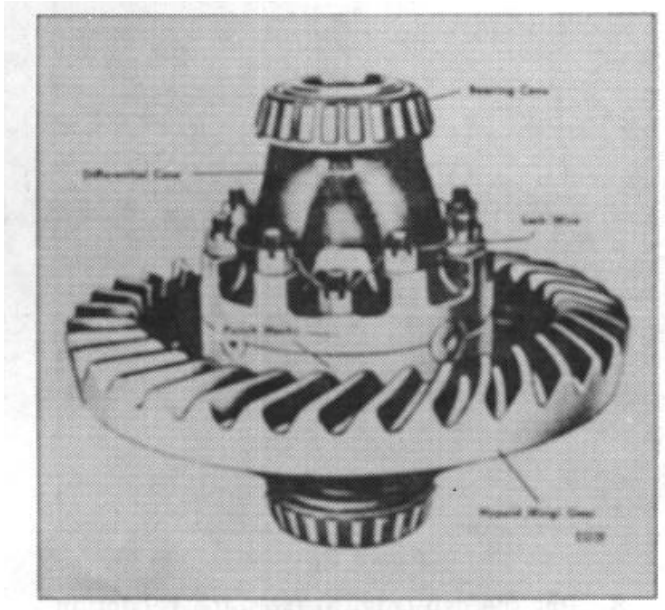


Figure 12.

10. Remove rivets and separate ring gear and case. Do not remove gear unless it is necessary. If replacement of the ring gear is required, the rivets should be drilled from the gear side, using a drill slightly larger than the rivet itself. (Fig. 14) The remaining portion of the rivet can then be driven out with a punch.

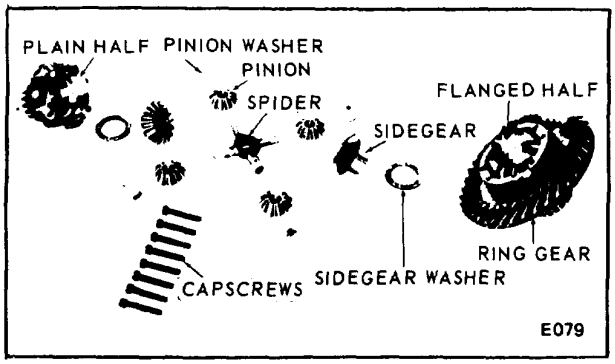


Figure 13.

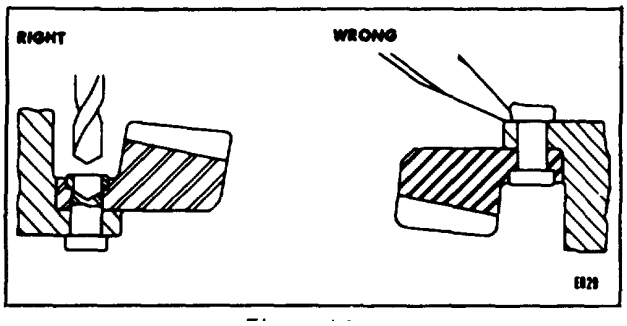


Figure 14.

CAUTION:
Knocking off or "busting" rivets (Fig. 14) is a dangerous practice both from the standpoint of personal safety and because such practice may cause distortion to the gear cases or gears and will elongate the holes.

11. If necessary to replace differential bearings, place case in press as illustrated in Figure 15 and press bearing from journal.

12. Remove the pinion shaft from the transmission, only if necessary.

NOTE:
The pinion shafts are assembled in the transmission case and are covered in the transmission section.

D. CLEANING AND INSPECTION

1. Clean parts having ground and polished surfaces, such as gears, bearings, and shafts, with solvent type cleaners such as emulsion cleaners or petroleum solvent, excluding

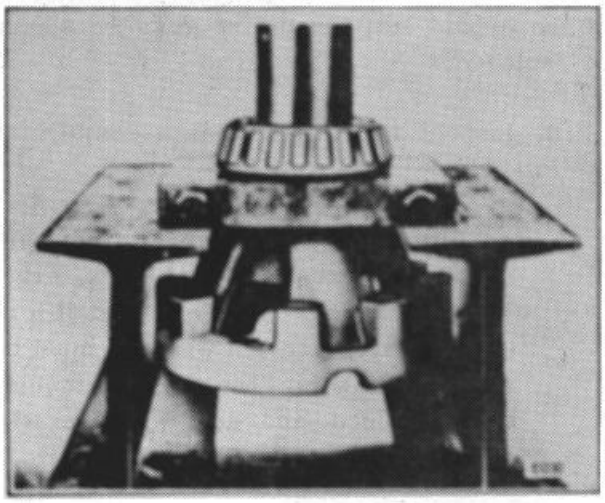


Figure 15.

gasoline. Do not clean these parts in a hot solution tank or with water and alkaline solution.

2. Rough parts such as differential carrier casting may be cleaned in hot solution tanks with mild alkali solutions, providing these parts are not ground or polished.

NOTE:
Parts cleaned in solution tanks or with alkali cleaners should be thoroughly rinsed after cleaning to remove all traces of alkali.

CAUTION:
Exercise care to avoid skin rashes and inhalation of vapors during cleaning process used.

3. Parts should be completely dried immediately after cleaning.

4. Inspect all bearings, cups and cones, including those not removed from parts of the drive unit. Replace if rollers or cups are worn, pitted or damaged in any way. Remove parts needing replacement with a puller or press. Avoid the use of drift and hammers.

5. Inspect gears for wear or damage. Gears which are worn, ridged, pitted or scored should be replaced. When necessary

to replace either the pinion or ring gear of the hypoid set, the entire gear set should be replaced.

6. Inspect the differential assembly for the following:

a. Pitted, scored or worn thrust surfaces of differential case halves, thrust washers, spider trunnions, and differential gears. Thrust washers must be replaced in sets. The use of combination of used and new washers will result in premature failure.

b. Wear or damage to the differential pinions and side gear teeth.

7. Inspect axle shaft for twisted or cracked splines and other signs of impeding failure.

E. ASSEMBLY

1. If ring gear was removed from case, rivet the gear to the case half with new rivets. Rivets should not be heated. They are upset cold. When the correct rivet is used, the head being formed will be at least 1/8 inch larger in diameter than the rivet. The head will then be approximately the same height as the preformed head.

CAUTION:
Excess pressure will cause distortion of the case holes and result in gear run-out.

NOTE:
Tonnage required for squeezing cold rivets is charted below. These pressures are approximated for annealed steel rivets and pressure can be adjusted to suit individual working conditions.

Diameter of Rivet	Tonnage Required
7/16"	22
1/2"	30
9/16"	36
5/8"	45

2. Lubricate differential case inner walls and all component parts with axle lubricant. Position thrust washer and side gear in gear and case half assembly. Place spider with pinions and thrust washers in position. Then install remaining side gear and thrust washer.

3. Align mating marks, position component case half and draw assembly together with four capscrews equally spaced. Check assembly for free rotation of differential gears and correct if necessary. Install remaining capscrews.

4. If bearings are to be replaced, press them squarely and firmly on differential case halves.

5. Assemble remaining parts in the reverse order in which they were removed, making the necessary adjustments as assembly progresses.

6. Heat the pinion bearing retaining collar enough to drop into place next to the pinion bearing.

7. Remove the plugs from the oil filler port and oil level port. (Fig. 16) Add oil

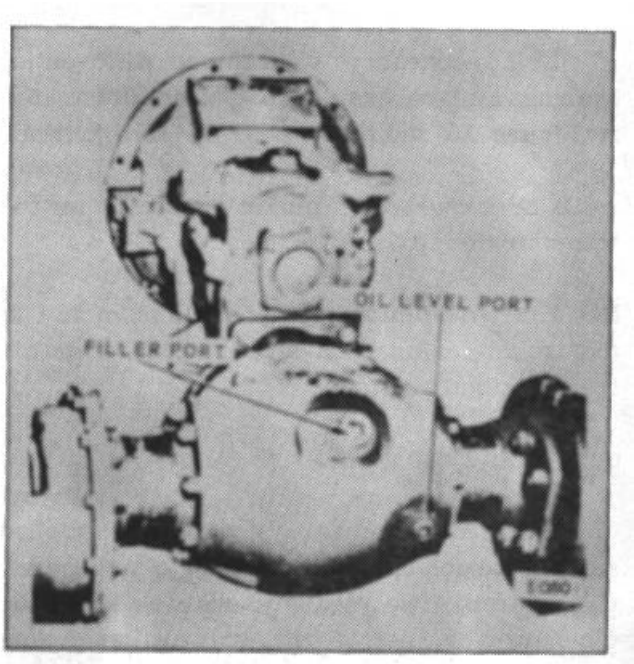


Figure 16.

through the filler port until it comes out the level port. Operate the truck a few minutes. Add more oil, if necessary.

CAUTION:
Be sure to re-check the oil level after a few minutes of operation, since some of the oil will flow into the reduction gears.

ADJUSTMENTS

A. PINION SHAFT BEARINGS

1. The preload of the pinion shaft bearings in the powershift transmission is not adjustable. If a slight preload is not indicated, replace the bearing assembly.

B. DIFFERENTIAL BEARINGS

1. Secure one axle housing to the differential case with a .010 inch gasket between the flanges.

2. Set the other housing in place and draw the nuts down until the tapered bearings Just seat in the bearing cups. At this point there should be no differential assembly end play nor any preload on the bearings.

3. Make sure the flange surfaces are parallel. Measure the distances between the flanges with a feeler gauge. This thickness, less the required preload, will give the proper number of gaskets or shims necessary for the axle flanges.

NOTE: The recommended bearing preload is .005 to .008 inch.

4. Check ring gear for runout. If runout exceeds .008 inch, remove differential and check for cause.

C. RING GEAR AND PINION

NOTE:
Correct pinion depth and correct backlash between the ring gear and pinion are necessary to obtain proper tooth contact. The pinion depth is shim-adjusted. The shims are on each side of the pinion shaft bearing carrier in the powershift models. Be sure the pinion bearings are preloaded.

1. Secure the axle assembly to the transmission using the original gaskets. While the mounting nuts are being tightened, work the ring gear to make sure that backlash is present.

CAUTION:
Damage to the ring gear or pinion may result if the two are drawn together during the mounting procedure.

NOTE:
The ring may be worked back and forth with a screw driver inserted in the filler, check or drain holes.

2. Mount a dial indicator on the axle housing with the indicator finger inserted into the filler hole and against a tooth on the ring gear. (Fig. 17) The tooth and the finger should form an angle as close to 90° as possible.

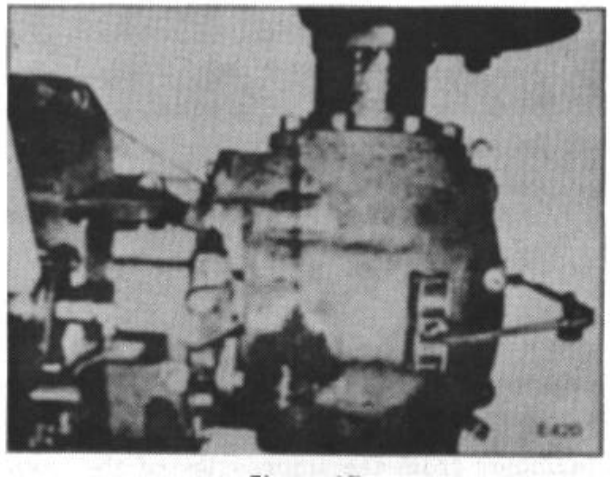


Figure 17.

3. Check the backlash between the ring gear and pinion by working the ring gear back and forth and noting the indicator reading.

4. If backlash is not between .008 and .011 inch, adjust as necessary.

NOTE:
To decrease backlash, remove shims from between the pinion side of the differential housing and the axle housing flange, and place them on the ring gear side. To increase clearance, remove the shims from the ring gear side of the housing and place them on the pinion side.

CAUTION:
It is important to place the shims removed from one side of the housing on the opposite side. Otherwise the bearing preload will be affected.

5. Rotate ring gear and check backlash at several points on the ring gear. Separate drive axle from the transmission when the backlash is within specifications.

6. Apply a light coating of white lead to several of the pinion teeth, on both the drive and coast sides. Secure the differential assembly to the transmission case using new gaskets with the same thickness as the old gaskets. Tighten down four capscrews spaced evenly around the flange and rotate the pinion shaft one full turn in both directions. At the same time, note the amount of backlash between the ring gear and pinion. Remove the capscrews and lift the differential assembly from the transmission.

7. Compare the pattern with those shown in paragraph D. Tooth Contact.

D. TOOTH CONTACT

NOTE:
The following figures show the results of too little or too much pinion depth as determined from the impression of the tooth bearing on the white lead.

NOTE:
Reference to moving pinion toward or away from ring gear in above description refers to the removal or addition of shims between the transmission and differential mounting flanges. Reference to moving gear toward or away from pinion refers to transferring 'shims between the R and L axle flanges.

1. Check adjustments at drive side of bevel gear tooth.
2. Figures 18 and 19 show correct tooth contact.

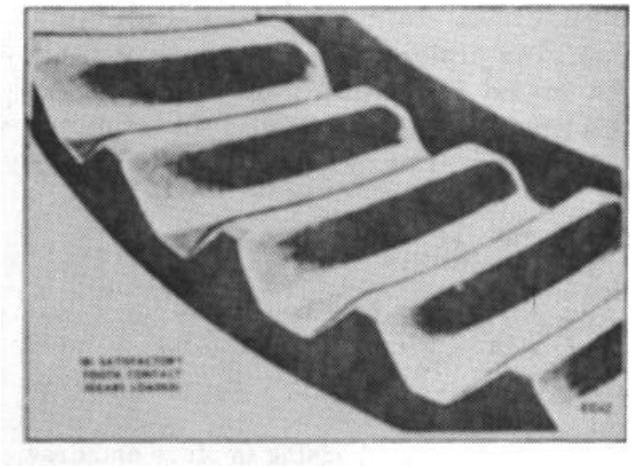


Figure 18.

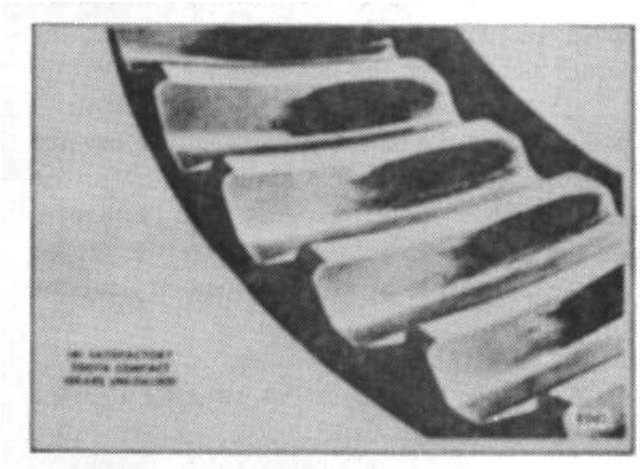


Figure 19.

3. Figure 20 shows short contact at heel. To correct, move gear toward pinion. Then move pinion away from gear to again secure correct backlash.

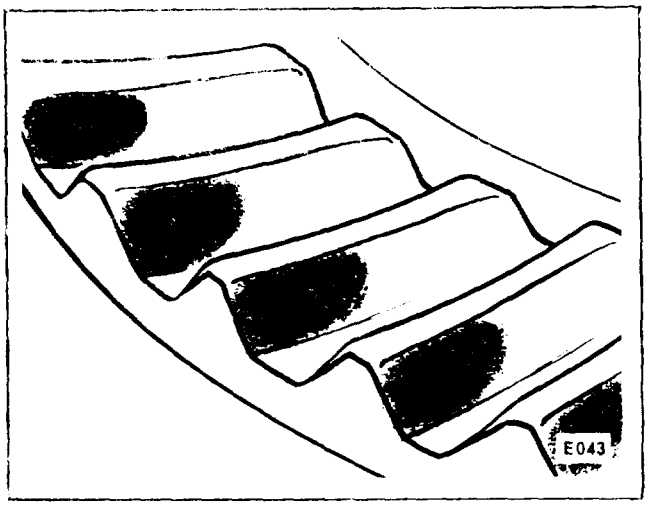


Figure 20.

4. Figure 21 shows short contact at toe. To correct, move gear away from pinion. Then move pinion toward gear to again secure correct backlash.

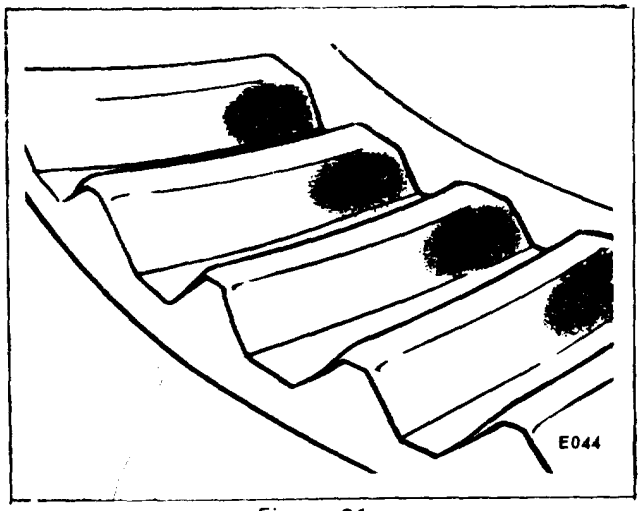


Figure 21.

5. Figure 22 shows heavy contact on flank or lower portion of tooth. To correct, move pinion away from gear until contact comes to full working depth of tooth without breaking contact at flank. Then move gear toward pinion to secure correct backlash.

6. Figure 23 shows heavy contact on face or upper portion of tooth. To correct, move pinion toward gear until contact covers flank of tooth without breaking contact at face. Then move gear away from pinion to secure correct backlash.

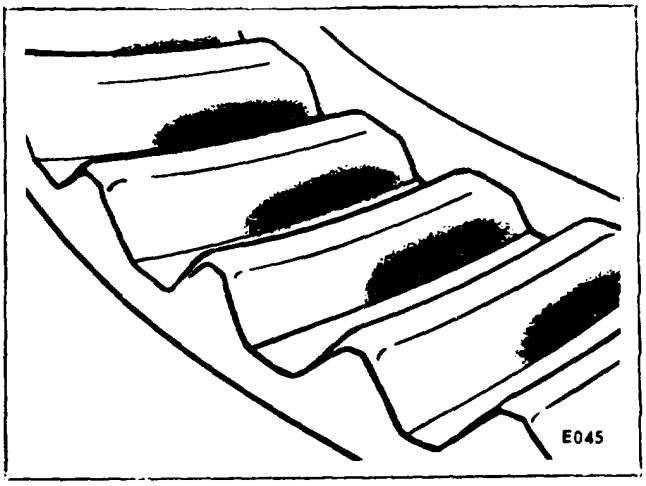


Figure 22.

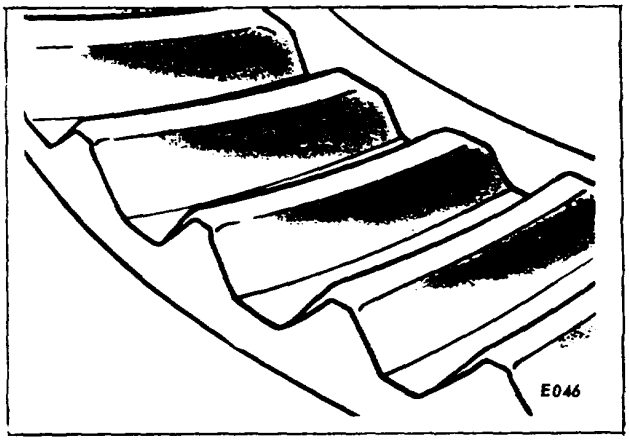


Figure 23.

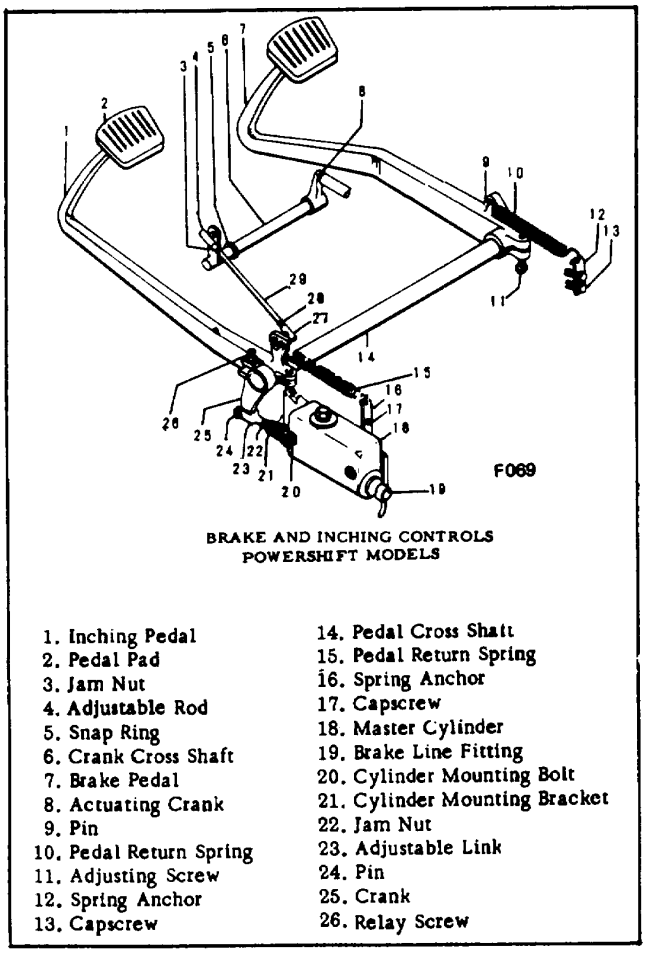
SPECIFICATION LISTING	
Lubrication	
Powershift Drive Axle:	
Type (MIL-L-2105)	SAE 90 E.P.
Quantity	21 pints
Wheel spindle nut preload	one castellation clockwise from zero end play
Differential pinion shaft preload (torque)	
Powershift	5- 15 lbs. in,
Differential side bearing preload	.005 - .008 in.
Ring gear and pinion backlash	.008 - .011 in.
Torques:	
NOTE: Unless specified all values are given in pounds-feet with threads lubricated.	
Wheel nuts	65
Brake mounting plate nuts	40
Internal gear cover screws	19
Wheel spindle bolts	160
Axle housing flange nuts	100
Axle housing flange bolts	100
Transmission mounting screws	90
Transmission (Differential)	
Pinion shaft nut	100 - 200
Bearing retainer bolts	18

SERVICE BRAKE SYSTEM

GENERAL

The service brake hydraulic system is made up of a master cylinder assembly, two brake cylinder assemblies and the necessary lines (tubing) and connections to complete the system.

Braking is accomplished by applying pressure to the brake pedal. (Fig. 1) Powershift models



BRAKE AND INCHING CONTROLS
POWERSHIFT MODELS

1. Inching Pedal
2. Pedal Pad
3. Jam Nut
4. Adjustable Rod
5. Snap Ring
6. Crank Cross Shaft
7. Brake Pedal
8. Actuating Crank
9. Pin
10. Pedal Return Spring
11. Adjusting Screw
12. Spring Anchor
13. Capscrew
14. Pedal Cross Shaft
15. Pedal Return Spring
16. Spring Anchor
17. Capscrew
18. Master Cylinder
19. Brake Line Fitting
20. Cylinder Mounting Bolt
21. Cylinder Mounting Bracket
22. Jam Nut
23. Adjustable Link
24. Pin
25. Crank
26. Relay Screw

Figure 1.

also have an "inching pedal". (Fig. 2) Depressing the inching pedal disengages the transmission and at the proper time applies the brake. There is a definite operating relationship between the service brake and the power-shift transmission which must be maintained in order to retain good inching quality.

CAUTION: Do not use an alcohol base antifreeze as a substitute for denatured alcohol, which is recommended in some of the following procedures. This type of anti-freeze contains additives that may be harmful to rubber parts.

BRAKE SHOES

A. GENERAL

The brake shoes are self-centering, thus eliminating a shoe centering adjustment. The shoe anchor or shoe stop permits some inward or outward movement of the shoe, in alignment with the axle radius. Upon brake application, lining surface pressures force the shoe to self-center, establishing the anchor pivot point.

Each of the four, two in each drive wheel, brake shoes is equipped with bonded lining.

B. REMOVAL AND DISASSEMBLY

1. Tilt the uprights back and place several 2 x 6 blocks under each outer upright. Then tilt the uprights forward until the forward drive wheels are off the ground. (Fig. 2)

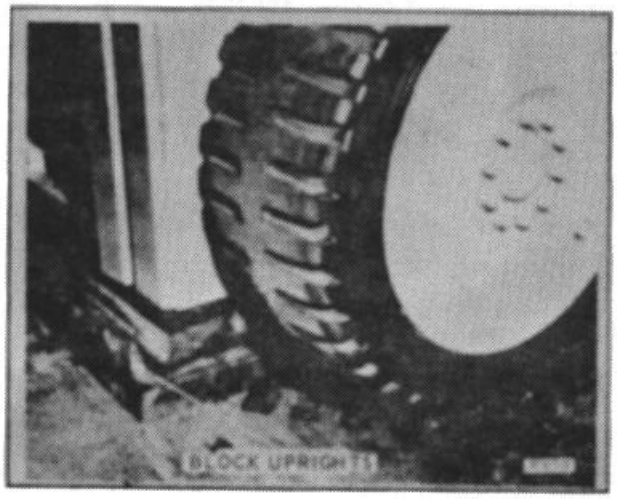


Figure 2.

2. Unscrew tile nuts retaining the wheel and with) soft-faced hammer rap the wheel to loosen the tapered dowels. (Fig. 3) Remove the dowels.

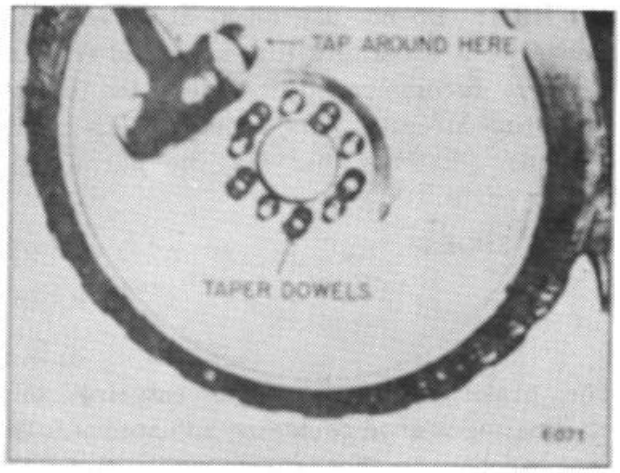


Figure 3.

3. Pull the wheel from the truck. (Fig. 4) Inspect the surface of the drum for badly worn areas, and, if resurfacing is necessary, this should be performed before assembly.

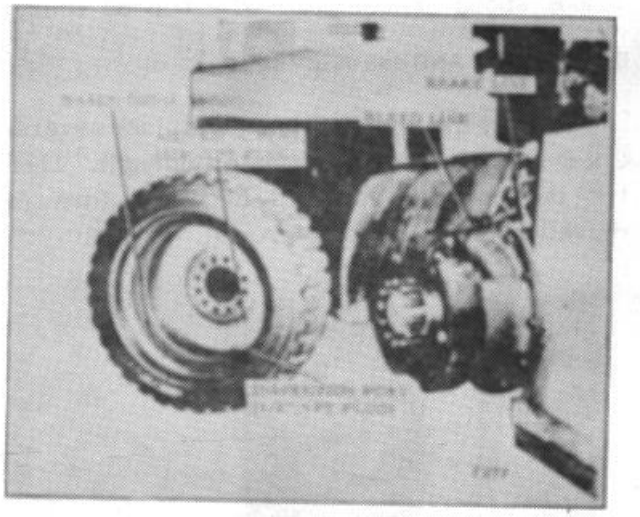


Figure 4.

NOTE: The old tire can be pressed from the wheel and used on a new hub, or a new tire can be pressed onto the old hub. The drum has a slight taper near the open end to facilitate tire replacement, Place the tire on the tapered end making sure the tire and drum are square with each other before applying pressure to the units. If tire is pressed on over the closed end of the drum, it will be loose and work off the drum during operation.

4. Remove the two shoe retaining caps and springs and brake return springs. (Fig. 5) Use clamp or wrap wire around both ends of the wheel cylinder to keep wheel cylinder pistons in place.

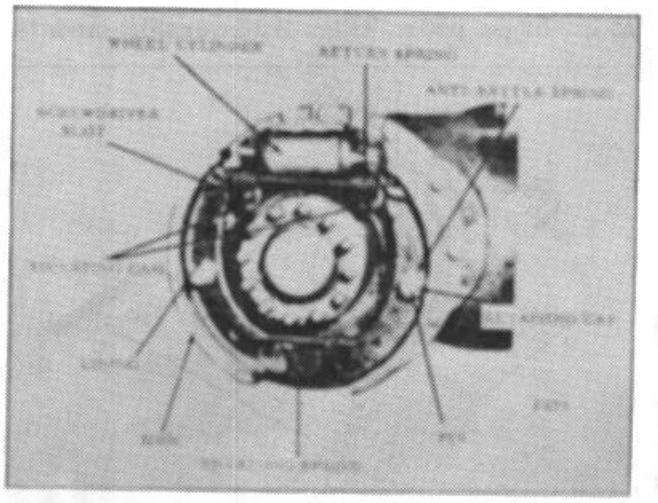


Figure 5.

C. CLEANING AND INSPECTION

1. Use solvent to clean all metal parts, except the brake shoe assemblies. The shoe rib and table can be wiped with solvent dampened cloth. No solvent should get on the lining. Since solvent may not readily remove brake fluid residue, use denatured alcohol for this purpose.

2. The wheel cylinder should be overhauled whenever brake linings are replaced. Refer to the Wheel Cylinder Section.

3. Examine drums for cracks, heat checks, and deep grooves. The drums should not be bell-mouthed or barrel-shaped nor should the mounting holes be elongated. If any of these exist, the drums should be replaced. Glaze on drums, otherwise in good

condition, can be removed by sanding with coarse sandpaper.

4. The brake shoe linings should be replaced if worn almost to the table or if the bonding agent is failing. Do not attempt to save lining with deep scores or soaked with either grease or brake fluid.

5. Check all springs and shoe hold-down parts. Discard any part that is broken, rusted, twisted, nicked or appears fatigued.

6. Replace wheels with elongated mounting holes. Check threads on wheel studs and wheel nuts.

7. Check adjusting cams and cam friction lock springs. Cams should turn easily, but must not be loose. If the cam is seized, soak in kerosene or penetrating oil to loosen.

NOTE: For best results, the new linings should be ground concentric with the brake drums. If this is not done, high spots may prevent proper lining to drum contact and proper adjustment. Linings are ground before or after the relined shoes are installed on the axles, depending upon the type of grinding equipment in use. Regardless of grinder type, the known drum diameter (measure with micrometer if unknown) is transferred to the grinder and the shoes are mounted and advanced into the grinder wheel as required to make one complete grinding cut the full width and length of the lining.

D. INSTALLATION

1. Install the wheel cylinder, if it was removed.

2. Insert push rod end of each shoe in wheel cylinder and center brake shoe on backing plate.

3. Install hold-down pins, cups and springs in the reverse order of removal.

4. Place one of the return spring hooks in one shoe and stretch the spring far enough to hook to other end in the opposite shoe.

5. Hook one end of the retaining spring in a brake shoe hole and the other end in the hole of the opposite shoe.

6. Back off adjusting cams.

7. After making sure there is no dirt in the wheel drum assembly, slide assembly onto the hub, being careful not to damage the stud threads. Place a tapered dowel on the proper studs and secure assembly with the attaching nuts.

8. Bleed the hydraulic system and apply the brakes, to center the shoes.

9. Adjust the brakes. Remove the blocks.

10. Test braking and inching under operating conditions.

E. BRAKE ADJUSTMENT

1. Raise the drive wheels. Remove the large pipe plug from the face of the wheels.

2. Release the parking brake. Turn the wheel until the large hole is in line with an adjusting cam.

3. Using a large screw driver, tighten an adjusting cam; then, loosen it just enough to allow the wheel to turn. (Fig. 6) A slight drag is permissible. Adjust the remaining cams in the same manner.

NOTE: To set the shoes closer to the drum, tighten the front adjusting cams by turning them clockwise. Turn the rear cams counter-clockwise to tighten them.

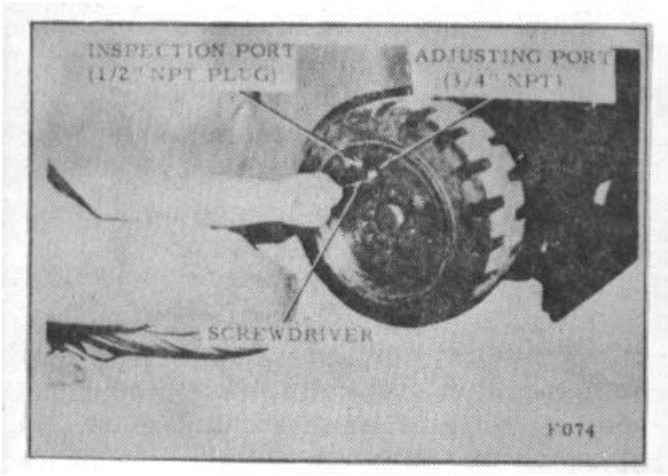


Figure 6.

4. Apply the brakes to center the shoes. Check the shoe-drum relationship, by removing the smaller plug and viewing through the hole. Readjust the brake, if necessary.

5. Screw the plugs into the wheels. Lower the wheels.

MASTER CYLINDER

A. GENERAL (Fiq. 7)

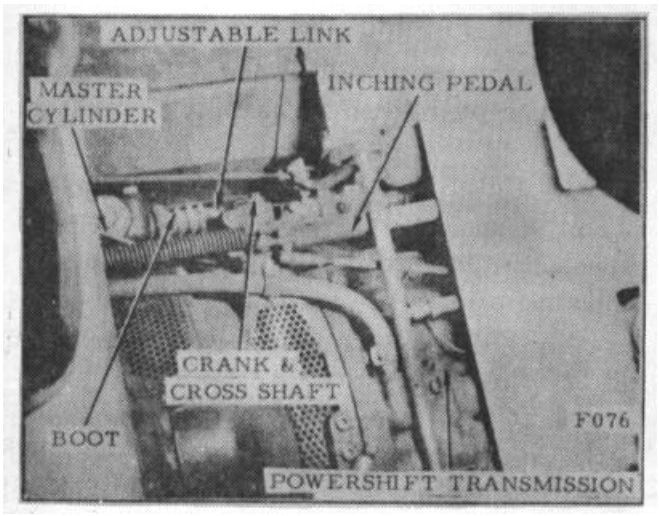


Figure 7.

Converting mechanical effort into hydraulic pressure is the main function of the master cylinder, which is of the compensating type. Its primary compensating function is to maintain a constant volume of fluid in the hydraulic system at all times, regardless of expansion (heat) or contraction (cold). The secondary compensating function is the replacement of additional fluid into the system to offset any loss due to seepage.

The cylinder (Fig. 8) consists of body and reservoir casting, double check valve and seat, piston cup return spring, piston cup, piston, piston stop, boot and push rod.

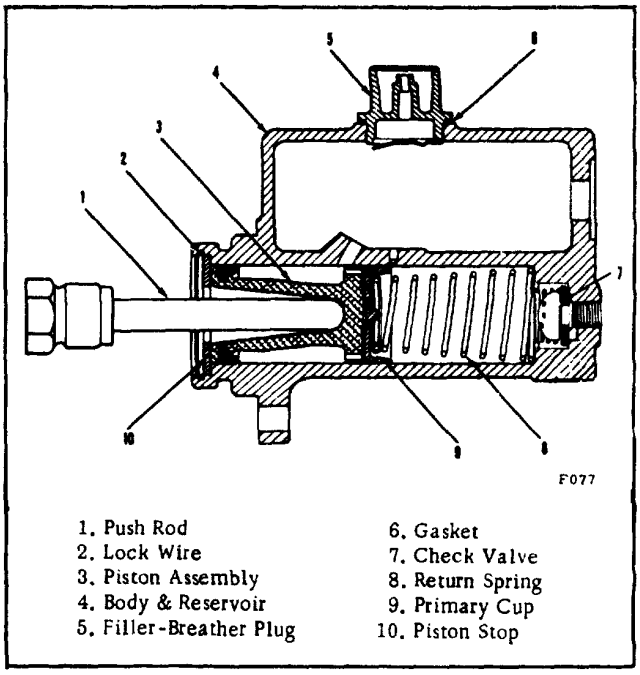


Figure 8.

The fluid reservoir is cast integral over the master cylinder body. A combination filler and breather plug is screwed into the top of the reservoir.

B. REMOVAL

1. Remove floor board and clean master cylinder, making sure no loose dirt is left in the working area.

2. Disconnect the hydraulic line from the master cylinder. Plug or tape both openings. A short, machine-sharpened pencil is a good tool for this purpose.

3. Remove mounting screws. Then work boot off the piston rod and pull master cylinder away from the rod.

C. DISASSEMBLY (Fig. 8)

1. Thoroughly clean outside of the cylinder assembly, with denatured alcohol.

2. Remove filler cap and gasket, Empty the reservoir. Remove boot and brake line fitting.

3. Position cylinder in a vise, open end up, so that the pressure of the vise jaws do not distort the cylinder. (Note "Caution" below). Using a screwdriver, pry lock wire from groove in cylinder bore. Internal parts should then slide from the cylinder in the following order: First the piston stop followed by the piston cup. Next to be removed is the piston, followed by the piston spring, and check valve assembly. The last component to be removed will be the check valve seat.
The check valve seat is firmly seated into the fitting end of the cylinder bore and can be extracted either with a stiff wire hook, or pushed from its seat with stiff wire inserted into and through the fitting hole.

CAUTION: Internal parts are spring-loaded and may be released faster than the serviceman's reflexes. Therefore, personal harm may result from looking directly into the cylinder bore when removing the lock wire or attempting to removed a seized component. Free one side of stop, then complete removal as illustrated In Figure 9,

D. CLEANING AND INSPECTION

1. Clean all parts in denatured alcohol making sure there is no trace of dirt, sludge, metal particles, or other foreign materials on or in the cylinder components.

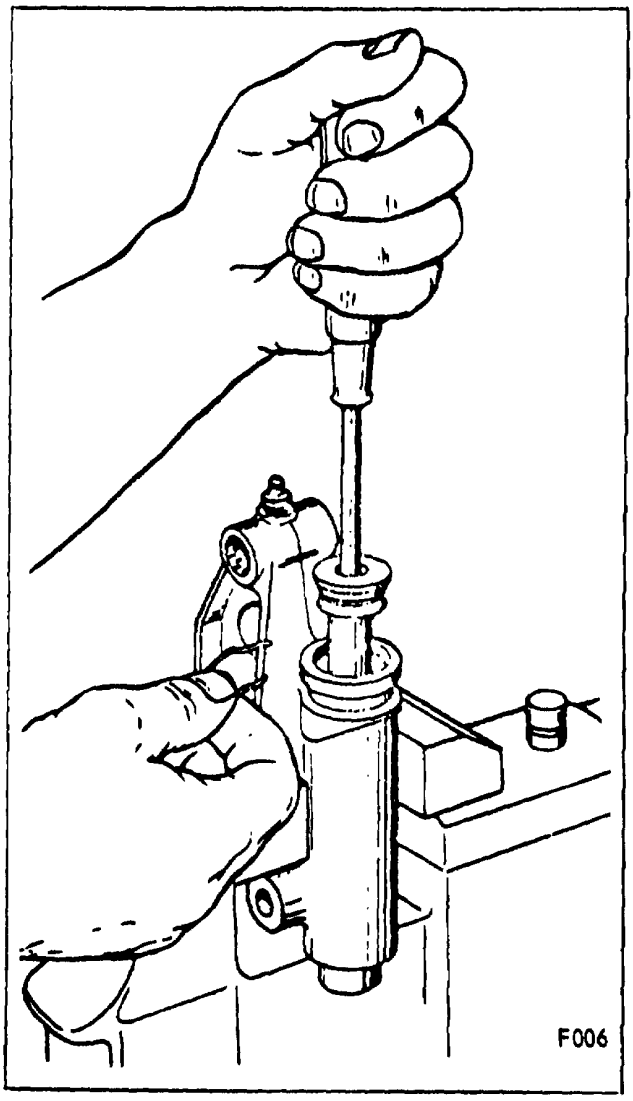


Figure 9.

NOTE: Do not use mineral base solvents to clean cylinder components, as they will attack and deteriorate rubber parts.

2. Hold cylinder toward a strong light and sight through cylinder bore. Inspect wall for pitting and scratches. If any of these or other defects are noticed, hone the cylinder wall. (Fig. 10)

3. Measure cylinder bore diameter. Figure 11 illustrates checking cylinder with a step-gauge. Discard cylinder if diameter is

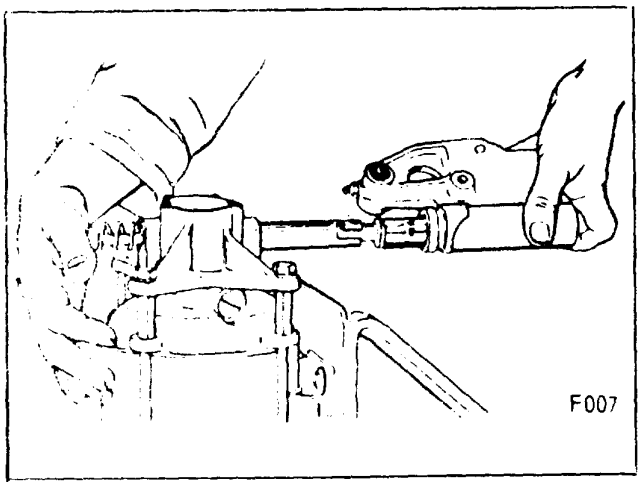


Figure 10.

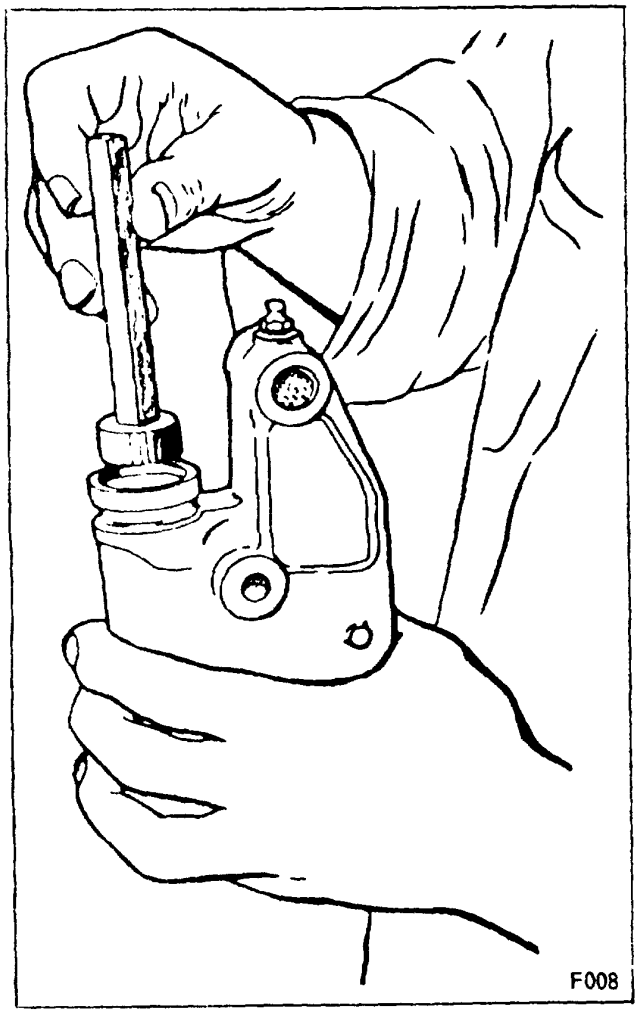


Figure 11.

increased to .005 inch over standard. Pressure marks and discolorations 'may be polished out with crocus cloth. Make sure intake and by-pass ports are open. The by-pass port may be probed with a soft iron wire.

NOTE: Burrs in the by-pass port are caused cy honing the cylinder wall and probing the by-pass port. These must be removed, otherwise, the primary cup may be damaged during assembly or brake operation. Figure 12 illustrates using a Wagner de-burring tool.

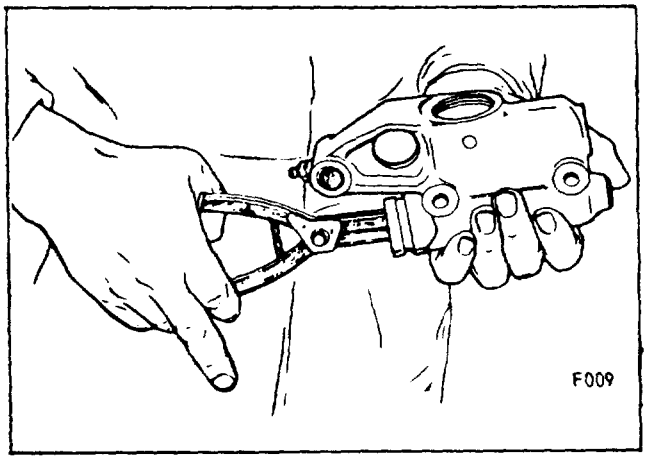


Figure 12.

4. Check piston bearing surfaces for scratches or corrosion and rubber parts for swelling, softening and tackiness. The spring must be free of corrosion and pits. Make sure the vent in the filler cap is open.

E. ASSEMBLY

1. Lubricate all parts including the cylinder bore with brake fluid. Assemble parts in the opposite sequence of disassembly, makeing sure the lip of the primary cup is toward the fitting end of the cylinder. Be certain the lock wire is firmly seated in the master cylinder groove.

2. After cylinder has been assembled, purge with clean hydraulic brake fluid. To purge cylinder: Fill the reservoir with fluid.

Using a spare push rod, work the piston through its entire stroke until fluid is forced from the fitting end of the cylinder. After fluid begins to flow from the fitting, continue to work the piston until at least 1/4 pint of fluid is expelled from the fitting hole. Throughout the purging, keep sufficient fluid in the reservoir to prevent air from being pumped into the cylinder.

3. Cap fitting end of cylinder. Then fill reservoir.

4. Place a new gasket on the filler cap and screw the cap into the reservoir.

F. INSTALLATION

1. Install master cylinder using the reverse of removal procedure. To prevent an aerated system, tighten the line to master cylinder fitting while depressing the brake pedal.

2. Adjust the master cylinder.

G. ADJUSTMENT

1. Adjust the adjustable link with pedal back until cylinder push rod contacts the piston in the master cylinder.

2. Check the pedal free-travel. Check inching.

NOTE: If the pedal linkage does not provide proper clearance between the master cyl-, inder piston and the linkage with brakes released, the piston cannot return to full "off" position and the primary cup lip will seal the cylinder by-pass port. Then the compensating feature of the master cylinder cannot function and surplus fluid cannot return from the brake lines. Brakes will drag after several applications if the by-pass port is blocked.

3. Make sure the rubber boot is in position on the push rod and master cylinder. This is important, otherwise, dirt and water can enter the master cylinder bore, causing premature failure.

WHEEL CYLINDER

A. GENERAL

There are two cylinders on each truck. One in each brake assembly. (Fig. 6) Their purpose is to change hydraulic flow and pressure to the mechanical equivalents.

The wheel cylinder houses two opposed pistons, two rubber cups and a spring. On the outside of the cylinder is a bleed valve, hydraulic line fitting and two rubber boots.
(Fig. 13)

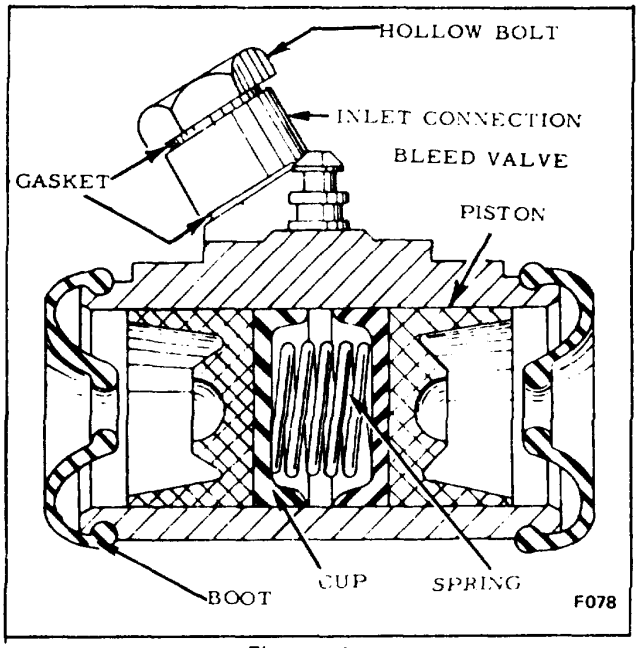


Figure 13.

Although not utilizing the same drilled passages, the line fitting and bleeder valve are in communication with the cylinder bore in this manner.

The spring is placed between the cups. Consequently, each of the cups is held in constant contact with its mating piston. The cups and pistons are assembled in the cylinder bore so that the lips of the cups face each other. The flat side of each cup contacts the flat side of the mating piston leaving the opposite end of the pistons (which are recessed) facing the open ends of the cylinder.

The purpose of the boots is to prevent foreign materials entering into the open ends of the cylinder. A boot is slipped over each end of the cylinder, forming a seal against foreign elements, A seal is also formed around the piston to the brake shoe link. It is important that these boots be inspected at every opportunity and replaced whenever any defect is noticed.

Pressure formed in the master cylinder is transferred from the master cylinder through the hydraulic lines to the wheel cylinder bore. The cups are forced apart by the pressure and this motion is carried to the brake shoes through the connecting links.

B. PROCEDURES

1. Removal: Refer to Brake Shoe Removal Section.

2. Cleaning and Inspection: Refer to Master Cylinder, Cleaning and Inspection.

SELF-ADJUSTERS

Text deleted. This model not equipped with self-adjusters.

Figure 14 deleted.

Figure 14.

BLEEDING THE SYSTEM

A. GENERAL

Bleeding the system means removing air from the system.

When a brake line is disconnected from and then reconnected to an individual cylinder, only that cylinder need be bled. Most of the time the foregoing is true for the master cylinder also.

NOTE: Always check master cylinder fluid level before starting the bleeding process. If a pressure bleeder or master cylinder filler is not available, keep a close check on the fluid level in the master cylinder during bleeding, otherwise, fluid level may become too low and allow air to enter the system.

CAUTION: Do not mix two brands of brake fluid unless they are known to be compatible. Use specified fluid only.

B. BLEEDING - COMPLETE SYSTEM

1. Make sure the entire working area around the master cylinder is clean, then remove the filler cap. Inspect brake fluid for discoloration, foreign particles, viscous fluid, and sludge. If unnatural conditions exist, the system must be flushed. If foreign particles are found, the entire system must be checked. Using the "process of elimination" method, start at the master cylinder and work toward the wheel cylinder farthest from the master cylinder. Open the first connection and check the fluid that drains from it. If the particles are still present, repeat the process on the next connection. Repeat checking until the wheel cylinders are reached, If particles are still present, both wheel cylinders should be inspected, and repaired as necessary.

2. Check brake fluid level and air pressure in the pressure bleeder; then attach bleeder to the master cylinder. (Do not open the valve on the bleeder at this time.) Affix bleeder hose to the bleed valve on the wheel cylinder farthest from the master cylinder. (Fig. 15)

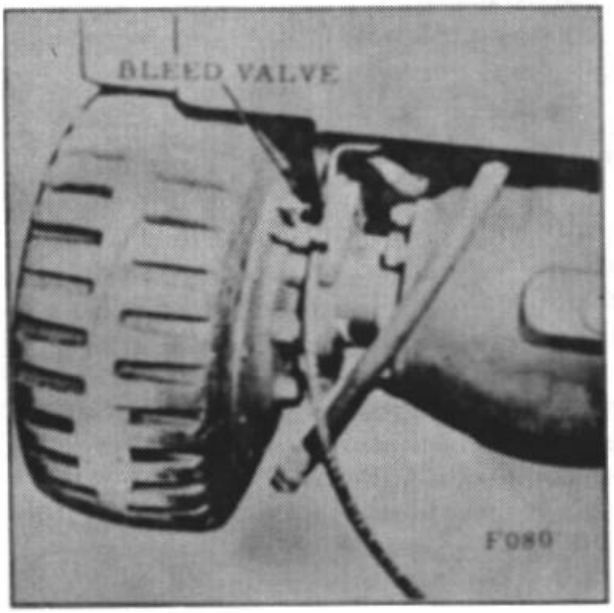


Figure 15.

3. Partially fill a clean glass container with clean brake fluid. Place the free end of the bleeder hose below the surface of the fluid in the container.

4. If the pressure bleeder has been attached:

First open the pressure valve on the bleeder and then the bleed valve on the wheel cylinder. Permit fluid to flow from the system until it flows clean and free of air bubbles. Close the bleed valve on the wheel cylinder and remove bleeder hose.

5. If pressure bleeder is not available:

After making sure the master cylinder is full, open the wheel cylinder bleed valve; operate the brake pedal, allowing it to move slowly from one extreme to the other until the fluid worked from the system is clean and free of air bubbles. Watch the fluid level in the master cylinder and keep sufficient fluid in the reservoir to eliminate the possibility of air being pumped into the system.

6. Check the pressure in the pressure bleeder or fluid level in the master cylinder if bleeder is not being used. Clean the glass container and repeat the bleeding process on the other wheel.

NOTE: In order to detect any foreign materials that may be in the cylinder being bled, the glass container must be clean at the beginning of the bleeding process.

C. PARTIAL BLEEDING

1. To bleed an individual wheel, follow the procedure given for bleeding the complete system, but bleed air from only the cylinder being serviced.

2. To bleed the master cylinder, connect pressure bleeder to the master cylinder, then open pressure valve and loosen the hydraulic

line to master cylinder fitting. Allow fluid to flow until the emitted fluid is clean and free of air bubbles, then tighten the fitting.

3. The master cylinder can be bled manually as follows: Loosen the hydraulic fitting at master cylinder until fluid oozes out. Depress the brake pedal. The pedal will drop slowly toward the floor-board. Just before the end of the pedal stroke, tighten the fitting. Allow pedal to return to "off" position. Repeat procedure until, expelled fluid is clean and free of air bubbles.

FLUSHING THE SYSTEM

A. GENERAL

There are several reasons for flushing the system, some of which are: existing fluid too viscous; operating conditions require fluid of different specifications; change in the brand of brake fluid (and the two are not compatible); fluid is discolored or contaminated (dirt, metal particles, mineral oil, condensation, sludge).

Use denatured alcohol as a cleaning agent. Do not employ flushing fluids containing mineral oil, kerosene, carbon tetrachloride, etc., or use anti-freeze alcohol. Any of these in the hydraulic system will cause rubber parts to swell and soften, endangering brake dependability. If any fluid of the foregoing type has entered the hydraulic system all rubber parts in the system must be replaced, and metal parts thoroughly cleansed.

B. FLUSHING

1. Attach a bleeder hose to the bleed valve (Fig. 17) on each wheel cylinder, then open the valves. For valve location, refer to Bleeding. Place free end of hose in a clear glass container.

2. Unscrew master cylinder filler cap. Place a drain pan under the master cylinder, then disconnect hydraulic line from the cylinder. Operate the brake pedal until reservoir is empty. Inspect the reservoir. Remove any foreign particles and sludge found in the reservoir.

NOTE: The line is disconnected from the master cylinder to prevent flushing foreign particles from the cylinder to the rest of the system, where they may lodge and later move into the wheel cylinder where serious damage could result. To help determine which assembly is defective (during the flushing process metal particles may be flushed from the system), note the hose from which the particles come and check the cylinder to which that hose is connected.

3. If foreign particles or sludge had to be removed, fill master cylinder with alcohol and brush the inside of the reservoir with a soft bristled brush. After brushing is completed, operate brake pedal until reservoir is empty.

NOTE: If foreign matter is abrasive, overhaul cylinder.

4. When the reservoir is clean, connect the hydraulic line to the master cylinder and fill reservoir with alcohol.

5. Operate pedal and keep adding alcohol until clean alcohol flows from the bleeding hoses. If clean fluid flows from one hose and not the other, close the bleed valve connected to the hose from which the clean fluid was expelled. Operate the pedal until clean fluid comes from the hose on the open valve.

6. When both bleeding hoses emit clean alcohol, pump all the fluid out of the system.

7. Close the bleed valve closest to the master cylinder. Fill fluid reservoir with specified brake fluid. Then operate brake pedal until 1/2 pint of brake fluid is pumped from the system. Close the bleed valve farthest from the master cylinder and open the other. Then pump another 1/2 pint of brake fluid from the system.

NOTE: Be sure all of the fluid alcohol is pumped from the system before starting to measure the brake fluid.

8. Fill master cylinder to the specified level and bleed the system. Make sure the filler cap is clean and vent holes open. Place a new gasket on the filler cap and screw cap into the master cylinder.

CAUSE	REMEDY
<u>One Brake Drags</u>	
1. Brake line restricted	1. Remove restriction, flush system, refill and bleed.
2. Improperly adjusted wheel bearing	2. Remove, clean, inspect, reinstall.
3. Distorted or maladjusted shoe	3. Replace. Adjust.
4. Weak or broken retracting spring	4. Replace.
5. Drum out-of-round	5. Service as necessary.
6. Faulty wheel cylinder	6. Overhaul or replace.
7. Dirty brake fluid	7. Remove fluid, flush and refill system.
8. Air in system	8. Bleed, check wheel cylinder if air returns to the system.
<u>Brakes Drag</u>	
1. Not enough pedal free travel	1. Adjust in accordance to series and model. Refer to Adjustments - Brakes and Inching
2. Mineral or other contaminants in the system	2. Remove and clean all brake lines and overhaul master cylinder and both wheel cylinders.
3. Faulty master cylinder	3. Overhaul.
<u>Hard Pedal</u>	
1. Distorted brake shoe and/or backing plate	1. Repair or replace as necessary.
2. Linings glazed or worn	2. Remove glaze from lining and drum. Replace.
<u>Spongy Pedal</u>	
1. Air in system. May be caused by low fluid level in reservoir, defective master cylinder check valve, or wheel cylinder	1. Fill reservoir, replace defective component. Bleed system.
2. Loose master cylinder mounting	2. Tighten.

TROUBLESHOOTING

CAUSE	REMEDY
3. Cracked brake drum	3. Replace.
4. Lining ground too small for drum	4. Re-size or replace.
5. Wrong fluid	5. Flush system; refill with specified fluid.
Unequal Braking	
1. Distorted brake shoe and/or backing plate	1. Repair or replace.
2. Drum out-of-round	2. Resurface or replace.
3. Linings glazed or worn.	3. Remove glaze from drum and linings. Replace.
4. Oil or brake fluid on linings	4. Take necessary steps to prevent future contamination and replace linings.
5. Faulty wheel cylinder	5. Repair, replace.
Brakes Chatter	
1. Linings glazed or worn	1. Remove glaze from shoe and drum. Replace.
2. Oil, grease or brake fluid on linings	2. Take necessary steps to prevent future contamination and replace linings.
3. Loose lining	3. Replace.
4. Not enough pressure being applied due to maladjusted brake and/or excessive pedal free Travel	4. Adjust as necessary in accordance to series and model.
Excessive Pedal Travel	
1. Insufficient fluid in reservoir which may be due to leakage	1. Refill; repair as necessary.
2. Brakes out of adjustment	2. Adjust
3. Linings worn	3. Replace
Pedal Gradually Goes to Floor Board	
1. Insufficient fluid in reservoir which may be due to leakage	1. Refill; repair as necessary.

CAUSE	REMEDY
2. Fluid leaking past primary cup in master cylinder	2. Overhaul master cylinder.
Noisy-or Grabbing Brakes	
1. Distorted or maladjusted brake shoe or distorted backing plate	1. Repair or replace as necessary.
2. Linings glazed or worn	2. Remove glaze on shoe and drum. Replace.
3. Oil, grease or brake fluid on lining	3. Take necessary steps to prevent future contamination. Replace.
4. Scored drums	4. Resurface. Replace.
5. Dirt on drum-lining surfaces	5. Remove dirt.

SPECIFICATION LISTING

Brake Fluid	SAE 70R3
Brake Drum Diameter	10.495-10.505
Master Cylinder Diameter	1.000 - 1.007
Wheel Cylinder Diameter	1.500 - 1.507
Pedal Free Travel	1/4" to 1/2"

NOTE: Tapered dowels should protrude from mating surface when installed. Replace any that are flush or recessed.

PARKING BRAKE SYSTEM

GENERAL

The parking brake is attached to the lower front of the transmission. It may be either an external shoe dual grip type or an internal expanding shoe type.

A cable with one end attached to a hand lever and the other to the actuating pawl lever is the means of controlling the parking brake.

PARKING BRAKE

A. GENERAL (Fig. 16)

The parking brake assembly consists of the following: a backing plate assembly, two shoe and liner assemblies, two retracting springs, an actuating cam and lever, two rollers, and a brake drum.

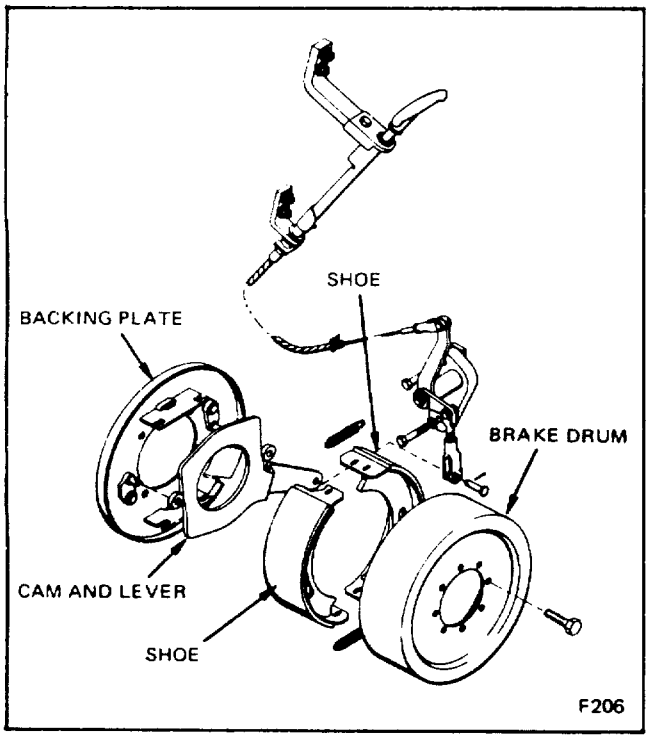


Figure 16.

Brake shoes and springs are interchangeable within the assembly.

Equal drum-shoe alignment is controlled by the actuating cam and the only adjustment necessary is through the linkage, which is a cable.

B. DISASSEMBLY

1. Raise truck off the floor enough to allow working space on the underside and block in this position.

2. Remove brake drum mounting bolts after setting the parking brake to prevent the drum from turning.

3. Release park brake and disconnect cam lever from linkage clevis. Remove the drum.

4. Using spring pliers, remove the lower and upper springs. (Fig. 17) Slide shoes in the appropriate direction to free them from

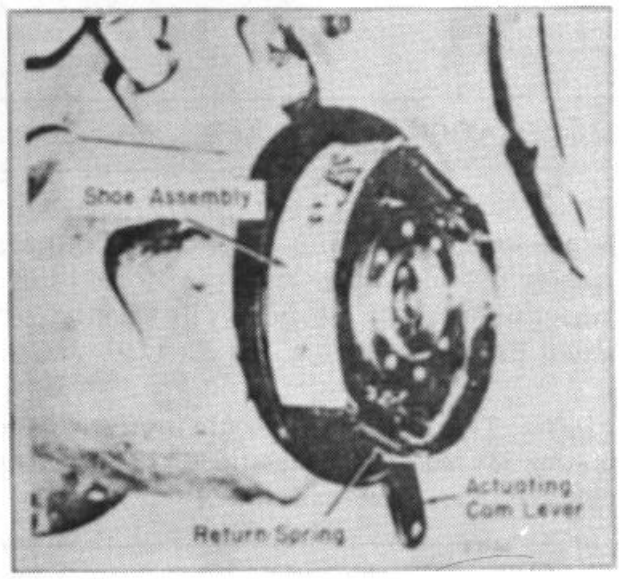


Figure 17.

guides on the backing plate, then place in a clean area.

5. Remove flange (Fig. 18) from transmission output shaft when it is necessary to remove cam (Fig. 19) or front transmission seal.

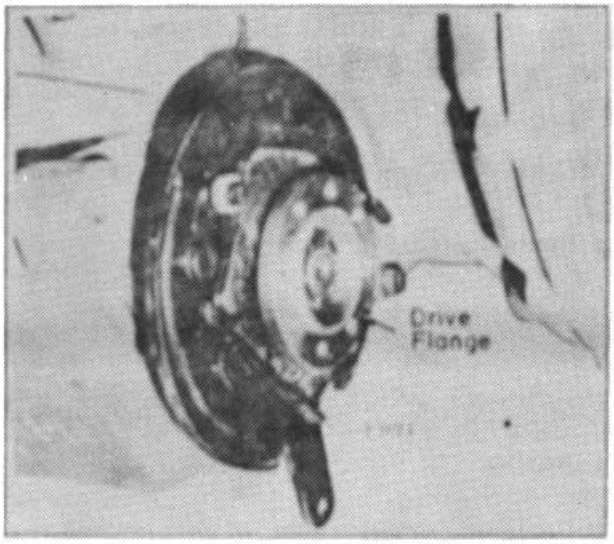


Figure 18.

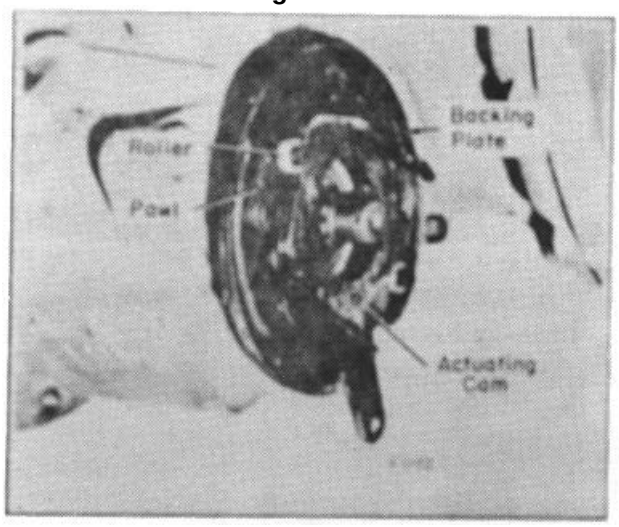


Figure 19.

C. CLEANING AND INSPECTION

Refer to Cleaning and Inspection procedure of the service brake system.

D. ASSEMBLY

NOTE: Apply Lubriplate to all sliding surfaces.

1. Slip rollers on the pawl pins. If operating cam was removed, install it making sure the lever lies in the backing plate depression, then install flange.

2. Slide shoes into the guides and install springs in the shoe holes nearest the backing plate.

3. Turn cam in the direction to bring shoes as close together as possible. Slide drum over the shoes onto the pilot of the flange. Install the attaching screw. Operate cam lever several times, then revolve drum to check for scraping or binding.

4. Connect linkage clevis and adjust cable on standard models.

NOTE: Check cylinder piston-cylinder clearance before connecting clevis on power-shift models.

CAUSE	REMEDY
Will Not Apply	
1. Cable disconnected or anchor clamp loose	1. Connect, Tighten clamp.
2. Brake lining worn	2. Replace.
3. Rollers missing, broken or worn	3. Install new ones.
Applies But Will Not Hold	
1. Maladjusted	1. Adjust.
2. Grease on lining	2. Replace, repair cause of foreign matter.
3. Worn lining	3. Replace.
4. Cables seized	4. Free-up or replace.
Will Not Release or Drags	
1. Adjusted too tight	1. Adjust correctly.
2. Shoe retracting spring weak or broken	2. Replace.
3. Cables seized	3. Free-up or replace.

GENERAL

The hydraulic system consists of the following assemblies: Hydraulic tank, full-flow filter, system pump, manual control valve, tilt cylinder, hoist cylinder. (Fig. 1)

The hoist cylinder assembly, which includes the lowering control valve, and tilt cylinder assembly,/are discussed in the Hoist Section.

Although procedures for several hydraulic components are outlined in other sections, it is important that these components be considered when troubleshooting the entire hydraulic system.

A positive displacement pump draws oil from the hydraulic tank and delivers it to the manual control valve. This model is equipped with a gear type pump.

Pump mounting utilizes an adapter (Fig. 2) which is machined to hold the pump in alignment with the driving gear. Contained within the adapter is a ball bearing and the pump drive gear which meshes with the camshaft gear, The pump drive gear also drives the engine governor.

When the circuit selected has received the required amount of oil, or the pressure within the circuit becomes too high, excess oil is by passed by a relief valve, which is located in the manual control valve.

GEAR PUMP

A. GENERAL

This pump is located on the left side of the engine, under the engine manifold and attached to the timing gear housing. (Fig. 3)

Oil is prevented from by-passing the body and end cover by a neoprene gasket between the components. A replaceable shaft seal is pressed into the front cover. Communication

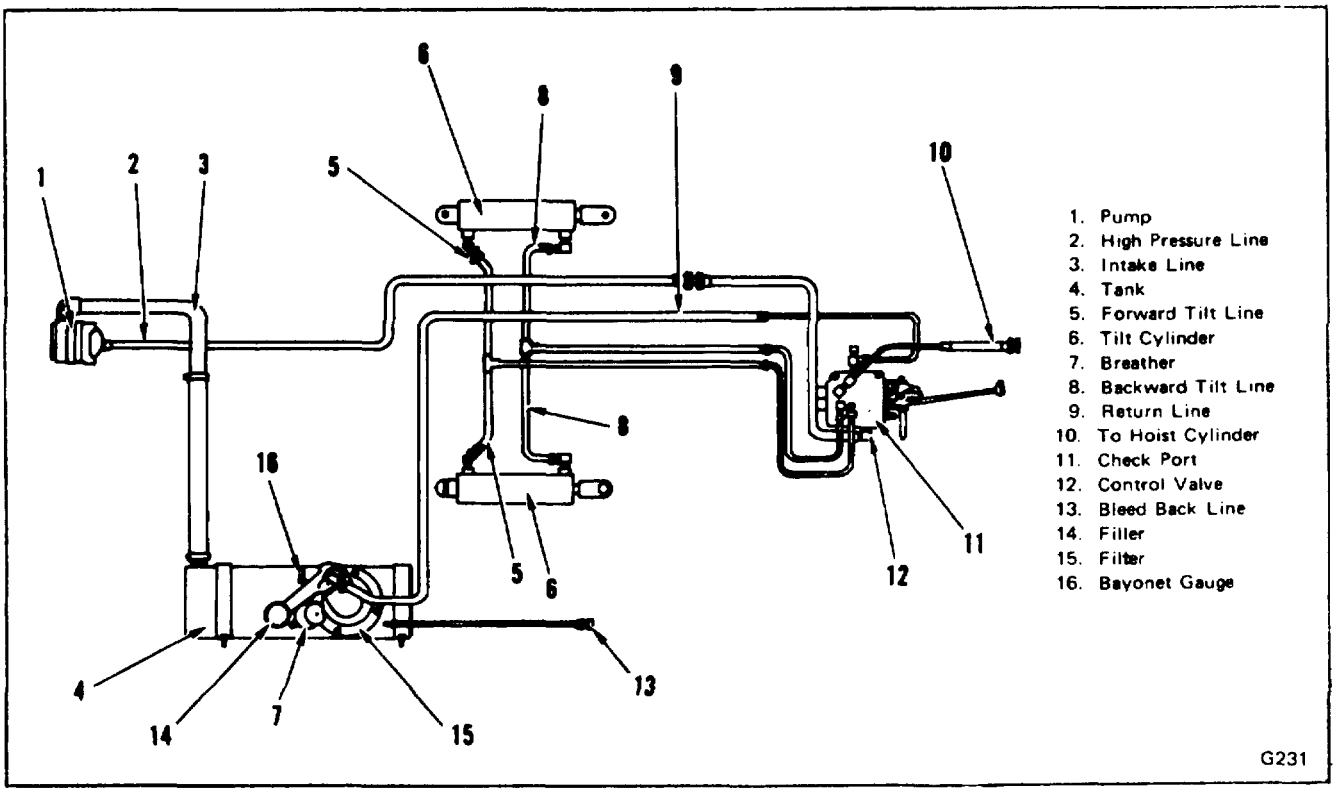


Figure 1.

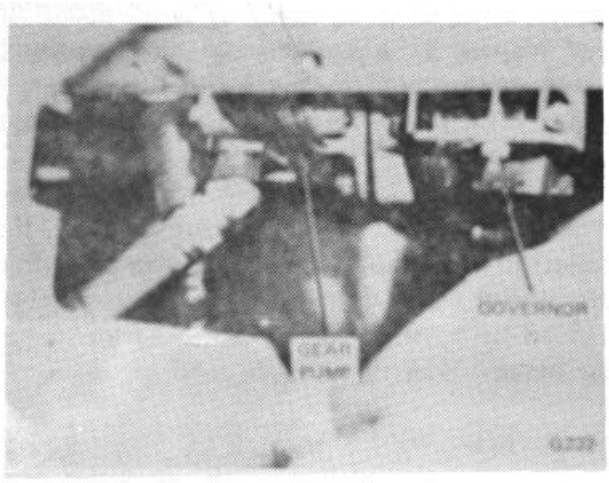
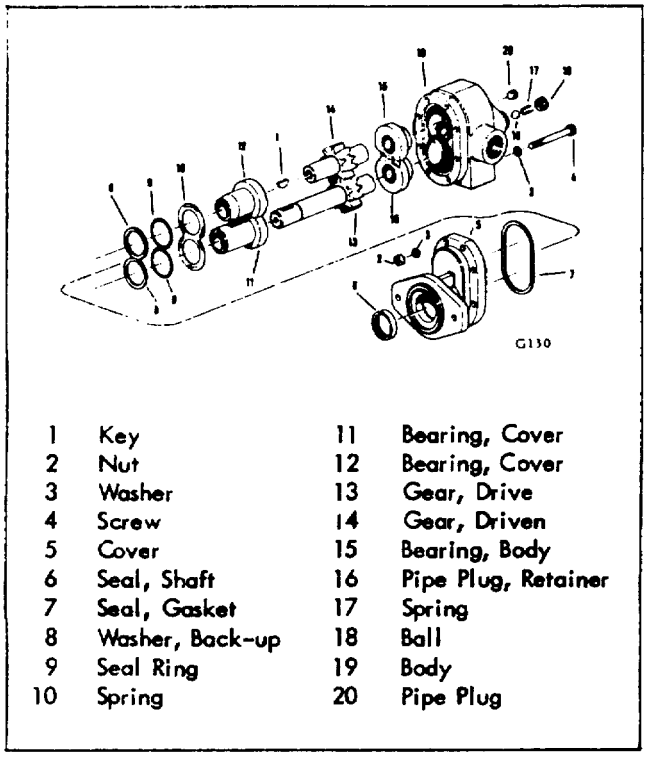


Figure 2.



1	Key	11	Bearing, Cover
2	Nut	12	Bearing, Cover
3	Washer	13	Gear, Drive
4	Screw	14	Gear, Driven
5	Cover	15	Bearing, Body
6	Seal, Shaft	16	Pipe Plug, Retainer
7	Seal, Gasket	17	Spring
8	Washer, Back-up	18	Ball
9	Seal Ring	19	Body
10	Spring	20	Pipe Plug

Figure 3.

of the high pressure and low pressure oils between the bearings and front cover is prevented by an O-ring and back-up ring placed o0i each bearing hub and between the bearings and cover. These pumps also utilize springs to create an initial pressure loading of the bearings.

To assure proper pump lubrication the pump is equipped with a relief valve. This assembly is made of a ball and spring and located in the end of the body.

B. REMOVAL

1. Remove the inspection plate at the left rear wheel well. (Fig. 4)

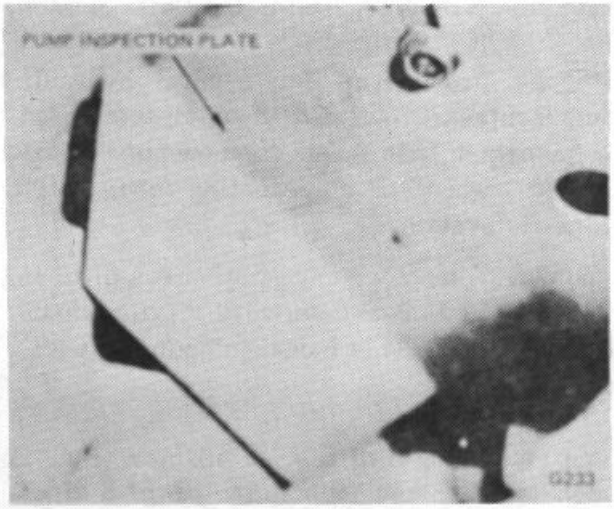


Figure 4.

2. Clean the pump exterior and work area around the pump, removing all loose dirt which may enter the hydraulic system when the hoses are disconnected, or the timing gear cavity when the pump is removed.

3. Check general condition of hydraulic hoses and pump mounting. Disconnect inlet and outlet hoses. Remove inlet fitting and cap all openings to prevent dirt from entering the system.

4. Unscrew mounting nuts and washers. Then work the pump away from timing gear case.

5. Either lift the pump out past the engine manifold or remove from the bottom of the truck. The access hole may be utilized.

C. DISASSEMBLY

1. Disassemble in the sequence as indicated by the numbers on Figure 3.

2. Cover bearings, 11 and 12, may remain in the cover or body when these parts are separated.

3. Identify gears and bearings so that they may be returned to their original positions if used in reassembly.

4. Press the seal out of the cover, using an arbor press and dowel.

D. CLEANING AND INSPECTION

1. Clean all parts thoroughly in solvent.

2. Check gears and shafts for nicks, burrs, cracks, or chipping. Discard component if any of these are present.

3. Examine gear chamber of body for evidence of contact between gears and body, especially the intake cavity of the body. Although wear of more than 1/64 of an inch is abnormal, it is not critical if the bearings are not defective.

4. Inspect the body and bearing for irregularities of the bore caused by bearing attempting to turn or sings of working.

5. Examine bearings and body for scratches and pitting. Use fine sandpaper on a surface plate to dress out any slight imperfections of bearings. Do not attempt to remove deep scratches or gouges. Figure 5 illustrates method of dressing the bearing. Check bearing bores for concentricity or smearing. Place bearings in their respective positions in the body and check clearance between bearing flats. Under no circumstances should these clearances exceed specifications.

6. Check milled seal and gasket recesses of the cover for any obstruction that would prevent normal seating. Make sure internal threads of front cover and threads on capscrews are in good condition.

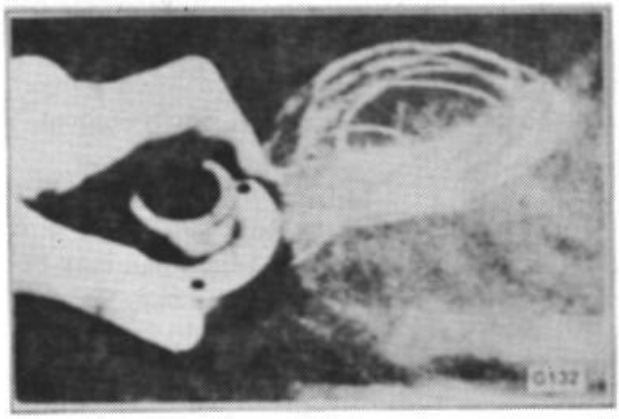


Figure 5.

7. The relief valve ball should be free of pits. The spring should not be distorted nor the seat grooved.

E. ASSEMBLY

1. Replace rubber O-rings at time of overhaul. Press a new seal assembly into the cover with an arbor press. The seal must enter at right angles to the body recess and must not damage the body. Apply thin film of non-hardening cement to the seal bore, and remove excess cement after seal is installed. Lubricate all parts during assembly.

NOTE: Generously lubricate all parts during pump assembly.

2. Insert body bearings in match marked positions, and oil grooves toward pressure side of the pump.

3. Install drive and driven gear with match marks aligned.

4. Slide cover bearings onto gear journals in match marked position. Replace pressure spring.

5. Insert seal ring in the body bore. Install back-up rings and O-rings in the mounting flange bore. Back-up ring goes in first.

6. Slide cover over gear shafts, being careful not to damage O-rings, and make sure that the seal ring is in position when flange makes contact with pump body. Secure mounting flange to body.

7. Insert relief valve ball into body, tap lightly with a brass drift and light hammer to insure seating. Install spring and cap.

F. INSTALLATION

1. Flood pump with oil to remove any foreign particles and insure lubrication.

2. Place new gasket and O-ring on the adapter. Place adapter in its mounting bore on the engine. Be sure the governor drive pin is in the pump gear governor pin hold. (Fig. 6)

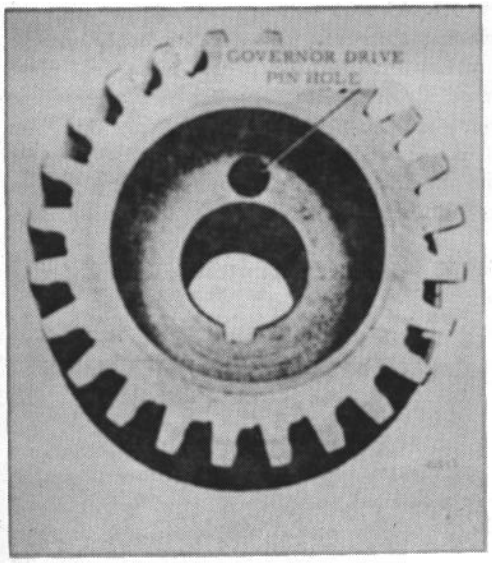


Figure 6.

3. Place a new gasket on pump and work pump into a position near the adapter. Align pump drive key with the keyway in the adapter gear bore. Push pump shaft into the adapter bore being careful not to lose the drive key.

4. Secure pump and adapter to the timing gear case. Observe the alignment between mounting bore, adapter and pump frequently to avoid binding of components. Tighten each mounting bolt alternately and torque evenly.

5. Replace hydraulic hoses and tighten sufficiently to eliminate pressure and vacuum leaks.

6. Be sure no load is imposed on the hydraulic system, then prime the pump. When pump is primed and the system is charged, check the pressure relief setting, adjust if necessary.

G. BREAK-IN PROCEDURE

1. Break-in will be required for new pumps, rebuilt pumps, or those out of service for an extended time.

2. Prime pump: Fill suction hose with correct hydraulic oil. Pour oil in suction and discharge pump ports before securing hoses. Due to position and/or location, complete filling of suction hose may be impossible, so fill to permissible limit.

3. Start engine and run at 1000 RPM until pump picks up prime. Prime pick-up may be checked by activating control lever. Run engine at 1000 RPM for 10 minutes after prime pick-up.

MANUAL CONTROL VALVE

A. GENERAL

The Control Valve (Fig. 7) consists of a one piece body, operating spools, two check valves for each spool, an adjustable relief valve and the necessary seals and plugs.

The body is constructed of a one piece casting, cored to contain passages for a full series parallel circuit. Cored body outlet ports are machined for removable SAE O-ring fittings.

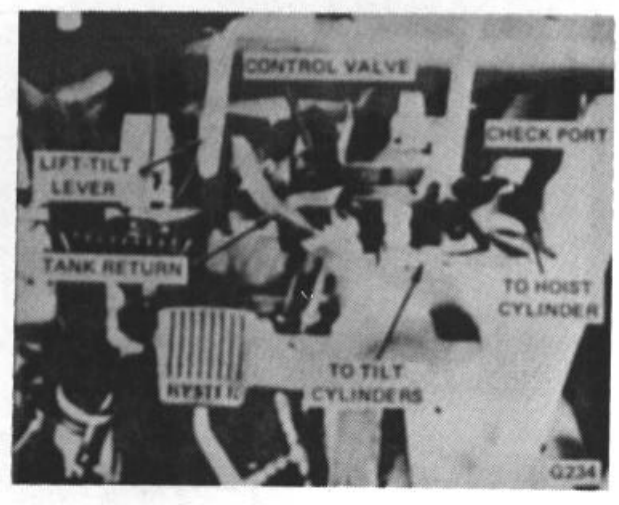


Figure 7.

The spools are hard plated for corrosion resistance and contain notches to obtain metering control of the load.

Check valves prevent back flow from cylinder ports to inlet port.

An adjustable relief valve is incorporated in the valve to prevent excessive oil pressure in the hydraulic system.

Make certain that reusable spools and check valve poppets are clearly tagged so that when used in reassembly, they can be matched to their respective bores. Switching of the poppets may cause improper seating and sticking. Switching spools may reduce side clearance causing spools to bind or it may increase side clearance causing excessive leakage.

No special tools are required for disassembling or assembling the control valve, although tools described below will be helpful.

For compressing the spring on spring centered spools, two retainer plates with bolts and nuts (Fig. 8) may be used. To compress spring, place one retainer plate over eye end of spool and against bottom spring spacer and the other retainer plate against the top spring spacer.

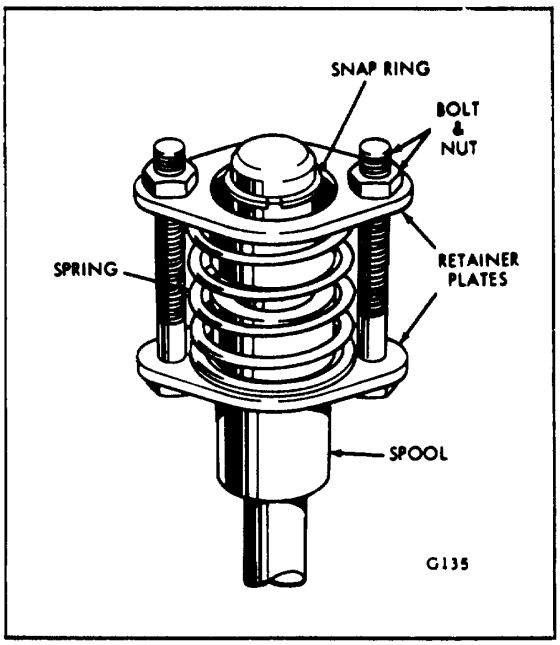


Figure 8.

Line up holes and install bolts and nuts. Tighten nuts evenly to compress spring sufficiently to allow removal of snap ring. Caution should be exercised as spring is compressed. Unscrew nuts slowly until all spring pressure has been released.

A sleeve type tool (Fig. 9) can be made for ease in snap ring installation on spring centered type spools. Select a piece of round

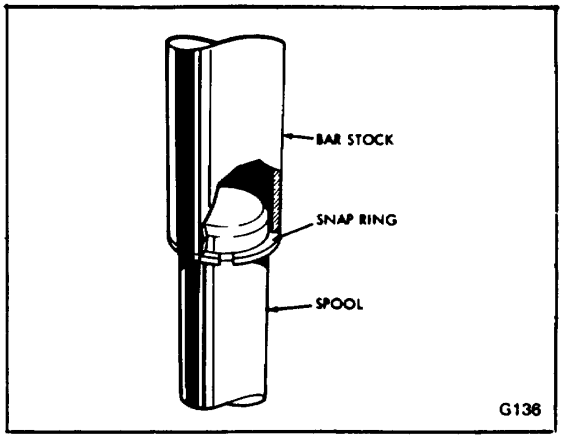


Figure 9.

bar stock approximately 5 inches long and slightly larger in diameter than the snap ring being installed. Bore a hole in the stock slightly larger than the stud end of the spool. Remove any sharp edges. To use sleeve type tool when ready to install snap ring, compress spring, then position snap ring on stud end of spool. Position tool against snap ring, and tap rather sharply, with a rawhide mallet, until snap ring is seated in groove.

B. REMOVAL

1. Note hydraulic line connections at the valve; tag if necessary to assure correct hydraulic hook-up on installation. Disconnect all hydraulic lines, capping all openings to prevent contamination of the system with foreign particles. Inspect general condition of the lines, replacing any that were leaking before being disconnected or when continued service is doubtful.

NOTE: Disconnect steel tubing at both ends to eliminate any possibility of distorting the tube shape.

NOTE: Use two wrenches when removing or replacing hydraulic lines. This will help prevent changing the angle of the installed fitting and twisting the lines.

2. Extract cotter pins from the connecting links at the valve spools. Push roll pins out, to disconnect the links from the spools. Check each link for elongated holes and check handle lever-to-spool mechanism for any signs of impending failure.

3. Remove remaining attaching screws and lift the valve out of the truck.

C. DISASSEMBLY (Figs. 10 and 11)

1. Cap all openings and clean exterior.

2. Remove and disassemble spools,.

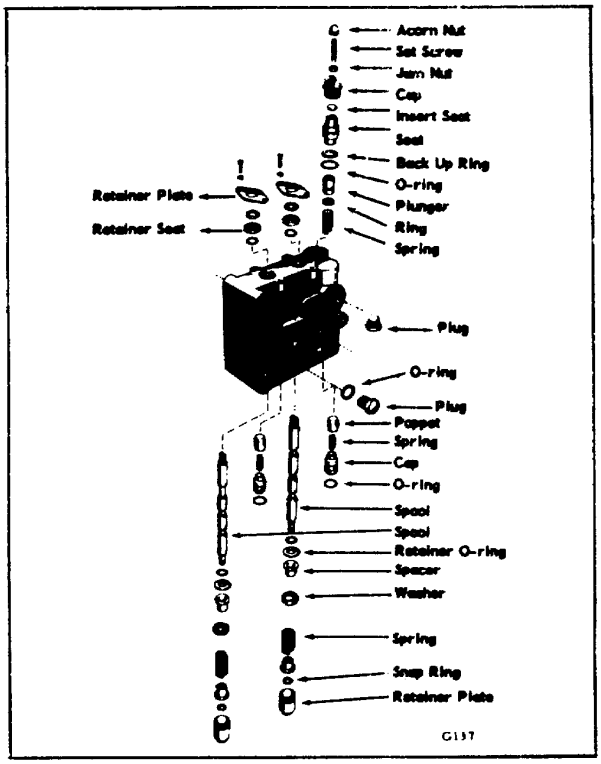


Figure 10.

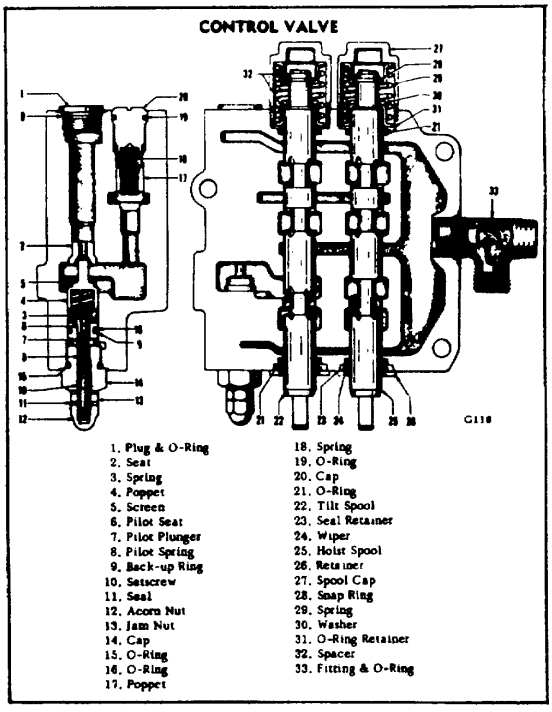


Figure 11.

a. remove screws and spool cap. Grasp spring end of spool and withdraw from valve body. Clamp spool in a soft-jawed vice, compress spring.
b. Remove snap ring, spring retainer, spring, and spring retainer from spool.

3. Remove Check Valves

a. Unscrew plug and remove O-ring.

b. Remove spring guide, spring and poppet.

NOTE: If necessary a soft wire hook with smooth ends may be used for removal of poppets. Check valve poppets should be identified so that when used in reassembly, they can be returned to their respective bores.

4. Remove Relief Valve

a. Remove plug and O-ring from body opposite relief valve.

b. Unscrew and remove acorn nut, two seals and jam nut.

c. Back off adjusting screw to relieve spring tension. Remove cap with adjusting screw installed. Remove O-ring and back-up ring from cap.

d. Remove pilot plunger spring, pilot plunger, pilot seat, large spring, poppet assembly and seat from body bore.

5. Remove plugs and O-rings from valve body.

D. CLEANING' INSPECTION AND REPAIR

1. Wash all parts thoroughly in solvent.

2. Inspect the valve body bores and spools for grooves, deep scratches or excessive wear.

3. See that spools fit their respective body bores with a slight hand pressure and without perceptible side clearance.

4. If the spools are loose, scored or damaged or the valve body has damaged threads, cracks or scored bores, the control valve should be replaced with a new unit.

5. Inspect the check valve poppet and its seating face in the valve body for grooves or defects which may cause leakage.

6. Check the poppet for free movement in the body bore. If the poppet appears to be faulty replace with a new one. Small nicks and grooves can be removed from the poppet seating face in the body, by lapping poppet in body seat using a fine grain grinding compound. Lap seat sufficiently to remove defects. Thoroughly wash valve body to remove all traces of grinding compound.

7. Inspect the relief valve plunger and seat for ridges or scoring which may cause improper seating and leakage. Replace parts if worn or damaged.

8. Inspect covers for any breaks or separation of brazing.

9. Inspect springs for weakness or distortion.

10. Inspect split flanges for cracks, damage, or stripped threads.

11. Discard all O-rings, gaskets and wipers and replace with new parts when reassembling the control valve.

12. After all parts have been inspected and valve is not to be reassembled immediately, coat reusable parts with clean hydraulic oil.

E. ASSEMBLY

NOTE: Prior to reassembly of the valve make certain that bench, tools, and all valve parts are thoroughly clean and free from dust and foreign matter. If necessary, thoroughly rewash the parts. Lubricate all parts with hydraulic oil, especially O-rings.

1. Assemble and Install Spools

    a. Clamp the spool in a soft-jawed vise, then position spring retainer, spring and spring retainer on spool. Compress spring and install new snap ring. Make certain snap ring is fully seated in groove, then remove spring compressor, Remove spool assembly from vise.
    b. Place O-ring retainer and a new O-ring on spool assembly, then install spool,. Care should be taken to prevent cutting the O-ring. With spool fully inserted in valve body bore, install spool cover and secure with screws,
    c. Install O-ring, O-ring retainer, wiper and retainer plate over eye end of spool and into position in body. Secure retainer plate with screws and washers,

2. Install Check Valves

    a. When installing check valve poppets, and new parts are not used in reassembly, make certain that poppets are installed in their respective bores.
    b. To install, slide poppet in body bore until fully seated, then insert spring, guide. Place a new O-ring on plug and install until plug bottoms.

3. Install Relief Valve

    a. If guide was removed during assembly, press a new guide in place. Place an O-ring to groove of seat then install seat in body bore. Place O-ring on plug and install. Place an O-ring and back-up ring in groove of plunger then install plunger in guide. Install spring and follower. Place an O-ring on cap and install. Install adjusting screw gasket, jam nut and gasket. Temporarily install acorn nut but do not tighten.
    b. After reassembly of relief valve, do not attempt to adjust to the proper setting. Refer to "Relief Valve Adjustment".

F. INSTALLATION

Use reverse of removal procedure. Adjust the relief pressure.

G. RELIEF VALVE ADJUSTMENT

1. Remove the plug from the test port, near the inlet port. (Fig. 7) Connect a 3000 PSI gauge to the test port.

NOTE: If the valve is not equipped with a test port, connect the gauge to the valve inlet port using a tee fitting.

2. Remove acorn nut from relief valve. Loosen Jam nut and hold while backing off adjusting screw until no tension is felt on relief valve.

3. With pump running at specified speed and oil at operating temperature, operate one spool to a power position. Turn adjusting screw clockwise until correct pressure setting is obtained.

4. After correct pressure setting has been

obtained, hold screw and tighten jam nut. Install and tighten acorn nut.

5. Remove the gauge and screw the plug into the test port.

H. TESTING

1. Operate the spool farthest from the relief valve to a power position and hold against the relief valve. Check all external port connections and seals for possible leakage.

2. Spool Operation

Operate each spool on the valve to its power position. Spools should move from the power position to neutral without any hesitancy.

3. Check Valve Leakage Test

Operate each spool in its power position under load, until about half the stroke of the cylinder is reached. Return the spool to neutral position and again apply load to cylinder. There should be no cylinder drop when the load is again applied. With the cylinder port still under load, stop pump flow to the control valve by either turning off the test stand pump motor or the vehicle engine, and carefully move the valve spool from the neutral to the power position. In the power position the load should remain stationary.
If load does not remain stationary, the check valves should be repaired.

OIL TANK

A. GENERAL

The hydraulic oil tank is of welded steel construction, bolted into the right hand frame channel, (Fig, 12) The tank is equipped with a fill pipe with breather cap and screen strainer, a bayonet gauge, full-flow filter, drain plug and internal baffles.

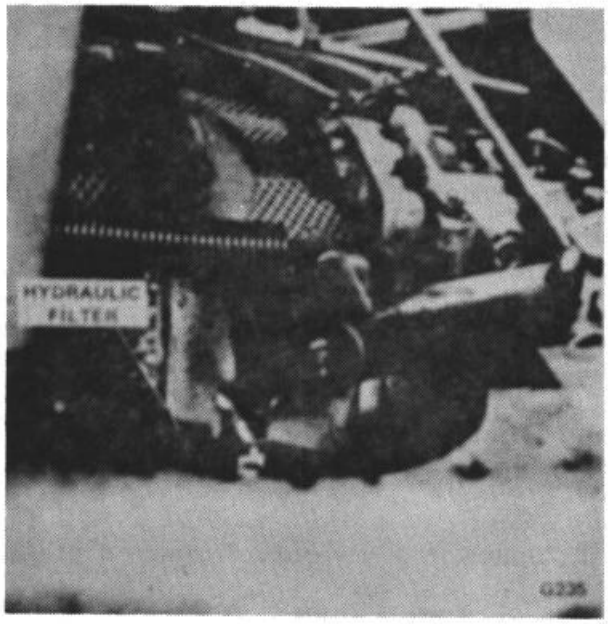


Figure 12.

B. REMOVAL

1. Drain the oil from the tank by removing the drain plug located in the bottom of the tank toward the rear.

2. Disconnect all lines and hoses. Cap or plug all openings to prevent the entrance of foreign material.

3. Remove the battery and battery tray.

4. Remove the tank mounting bolts and lift the tank from the truck.

C. CLEANING AND INSPECTION

1. With the filter removed, inspect the tank for foreign matter.

2. Steam clean the tank and dry thoroughly.

3. Inspect for leaks.

NOTE:
After welding the tank, clean welds completely and remove scale, slag or any other foreign material from the inside of the tank.

4. Inspect all hoses, fittings and tubes. Replace any hose, tube or fitting that is frayed, cracked, cross-threaded or otherwise deteriorated to a point where satisfactory service is doubtful. Check tank hoses for softness and peeling or flaking on the inside.

CAUTION:

Any foreign particles or loose material in the tank outlet hoses may be drawn into the hydraulic system. The filter will not catch the material until it passes through the hydraulic system.

D. INSTALLATION

1. Follow the reverse of removal procedures.
2. Inspect hoses for general condition and replace any that are faulty.
3. Connect hoses.
4. Install the hydraulic filter.
5. Fill the tank to the full level.

CAUTION:

Never operate the engine without oil in the hydraulic system. A few revolutions without oil may damage the hydraulic pump.

Every 5000 hours drain the oil out of the tank. Remove air cleaner and filter. Flush tank making sure the screen is clean and no contaminates are left in the tank.

FULL-FLOW FILTER

A. GENERAL

Maximum protection against foreign particles is given to the hydraulic components by a full-flow filter in the system. (Fig. 12)

Since both the filler tube and returning oil lines are attached to the filter head, all oil must enter the head and pass through the filter before entering the reservoir area of the tank. Therefore, foreign matter is removed from oil being added to the tank and metal particles or other material from failing hydraulic components are prevented from contaminating the supply of oil.

Contained in the can is a filter, relief valve assembly and a pressure spring. The can assembly is secured in the tank by the filter head and necessary screws.

A 2.25 inch tube, flanged near the top and flared at the bottom, tension spring and bell-shaped valve make up the relief valve assembly. The valve is held against the flared end of the tube by the tension spring which is hooked to the upper end of the tube.

When the filter is assembled and installed, the pressure spring is placed between the head and valve flange, forcing the flange against the top of the filtering element and seating the element on the bottom of the can. An oil seal is formed between the flange and element, element and can, and valve and seat. Also, oil leakage at the filter assembly and tank junction is prevented by two gaskets, one between tank and can flange and the other between can flange and head flange.

Oil enters the head cavity, passes into the valve tube to the relief valve, flows around the outside of and then through the element where it enters the tank below the oil level. f for any reason the oil cannot pass through the element, the relief valve is forced off of its seat and allows it to enter the tank without being filtered.

B. SERVICE

NOTE:

When a new truck has been in operation for 200 hours, replace the filter element. After that, replace the element every 2000 hours or once a year. Remove the element as follows:

1. Disconnect the hydraulic lines from the filter head. Unscrew the capscrews securing the filter assembly to the tank. Lift the filter assembly out of the tank. (Fig. 13)

2. Unscrew the round head screws holding the head and container together.

CAUTION:
The filter is spring-loaded. Therefore, the filter must be disassembled carefully, otherwise, bodily harm may result.

3. Discard the element. Clean the remaining parts of the assembly in clean solvent.
4. Assemble and install filter.

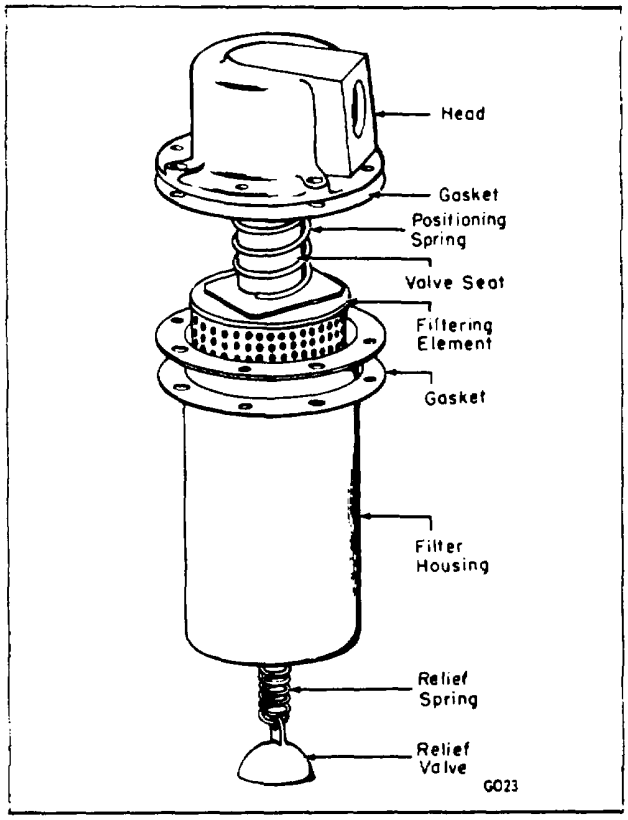


Figure 13.

TROUBLESHOOTING CAUSE	REMEDY
A. Pump	
<u>Pump Making Noise</u>	
1. Partially clogged intake	1. Pump must receive intake oil freely or cavitation will result. Drain system, and clean intake line, intake pipe, and replace filter.
2. Air leak at pump intake piping joints or pump shaft packing.	2. Test by pouring oil on joints and around drive shaft. Listen for change in operation. Tighten joints affected and replace pump drive.
<u>Pump Not Delivering Oil</u>	
1. Pump drive in wrong direction of rotation	1. Must be reversed immediately to prevent seizure. check direction of drive rotation against proper pump rotation as indicated by arrow on outer surface of ring.
2. Pump drive shaft coupling sheared	2. Remove pump, and determine damage to pump cartridge. Replace needed parts. Check engine high idle to determine whether it is higher than recommended.
3. Fluid intake pipe blocked or oil viscosity too heavy to pick up prime	3. Drain complete system. Add new fluid of proper viscosity. Check all filters for dirt and sludge.
4. Air leaks at intake. Pump not priming	4. Circuit must be tested at input connections. Determine where air is being drawn into line connections and tighten. Check intake opening in reservoir. Check minimum drive speed which may be too slow to prime the pump.
B. Manual Control Valve	
<u>Oil Leaks At Either Spool End</u>	
1. Defective oil seal	1. Replace seal. If leaking continues, replace valve spool or valve assembly as necessary.
2. Valve spool or body scored	2. Replace valve spool or assembly as necessary.

CAUSE	REMEDY
Unable To Push Spool In	
1. Oil leaking into cap	1. Refer to "Oil Leaks At Either Spool End".
Spool Will Not Return To Neutral	
1. Weak or broken spring	1. Replace springs.
2. Bent valve spool	2. Replace valve spool. Check valve body bore. Replace the assembly if bore is defective.
3. Oil leaking into cap	3. Refer to "Oil Leak At Either Spool End".
4. Foreign particles lodged between spool and bore	4. Disassemble, clean and inspect valve parts. Replace parts as necessary.
5. Sticking linkage	5. Lubricate, straighten, free-up linkage as necessary,
No Motion - Slow Or Jerky Action	
1. Regulating valve not operating properly	1. Remove and check the pilot valve and regulating valve. Replace parts as necessary. Replace valve assembly if the bore is defective.
2. Dirt lodged between regulating valve and bore or between pilot valve and seat	2. Disassemble the control valve assembly and clean thoroughly.
3. Defective pilot valve spring or regulating valve spring	3. Check for broken, bent or worn springs. Replace springs as necessary.
4. Defective O-ring on the regulating valve	4. Replace the O-ring. Check the pilot valve for ridges at the seating area.
5. Internal crack in valve body	5. Replace valve assembly.
6. Spool not moving the full stroke	6. Check and repair linkage. Check valve spool, bore and oil seal on cap end, Replace parts as necessary.
Load Will Not Hold	1. Clean, inspect and replace parts as necessary,
1. Check valve not seating	

SPECIFICATION LISTING	
Oil Tank Capacity	8 gals.
Oil Specification:	
SAE 10 W oil meeting Military Specification MIL-L-2104, Supplement 1, Viscosity Index-90 min.	
Filter Relief Open At	15 - 20 PSI
System Relief Pressure (Gear Pump)	
at 600 RPM	1750 PSI
at 2500 RPM	1950 PSI
Gear Pump Output:	
2400 RPM, Zero PSI	14.7 GPM
at 2400 RPM, Zero PSI	14.7 GPM
at 2200 RPM, Relief PSI	13.5 GPM
Control Valve Spool Travel:	
Hoist Spool	3/8 in.
Tilt Spool	5/16 in.

GEAR PUMP DIMENSIONS

Parts:	New Dimensions Max.	New Dimensions Min.	Permissible Worn Dimensions Max.	Permissible Worn Dimensions Min.	Permissible Worn Clearance
Gear bore, body	2.001	2.000	2.0040		.0075
Gear tip, diameter	1.9980	1.9970		1.9965	
Bearing bore	.7515	.7505	.754		.007
Gear journal	.7485	.7475		.747	
Bearing cover*					Thickness of flanges must match within .0003"
Flange thickness	.411	.401		.391	
Bearing body*					
Flange thickness	.250	.249		.240	
Gear thickness	.8700	.8695		.8690	Thickness of gear must match within .0003"

* These bearings are lead flash plated. Removal of surface plating or mild phonographic grooving is not cause for replacement providing flange thickness is not less than permissible worn dimension.

Torque:
Gear pump ass' y nuts 28-32 ft./lb.

GENERAL

The system consists of the following: steering linkage, steering gear, axle, drag link and tie rod.

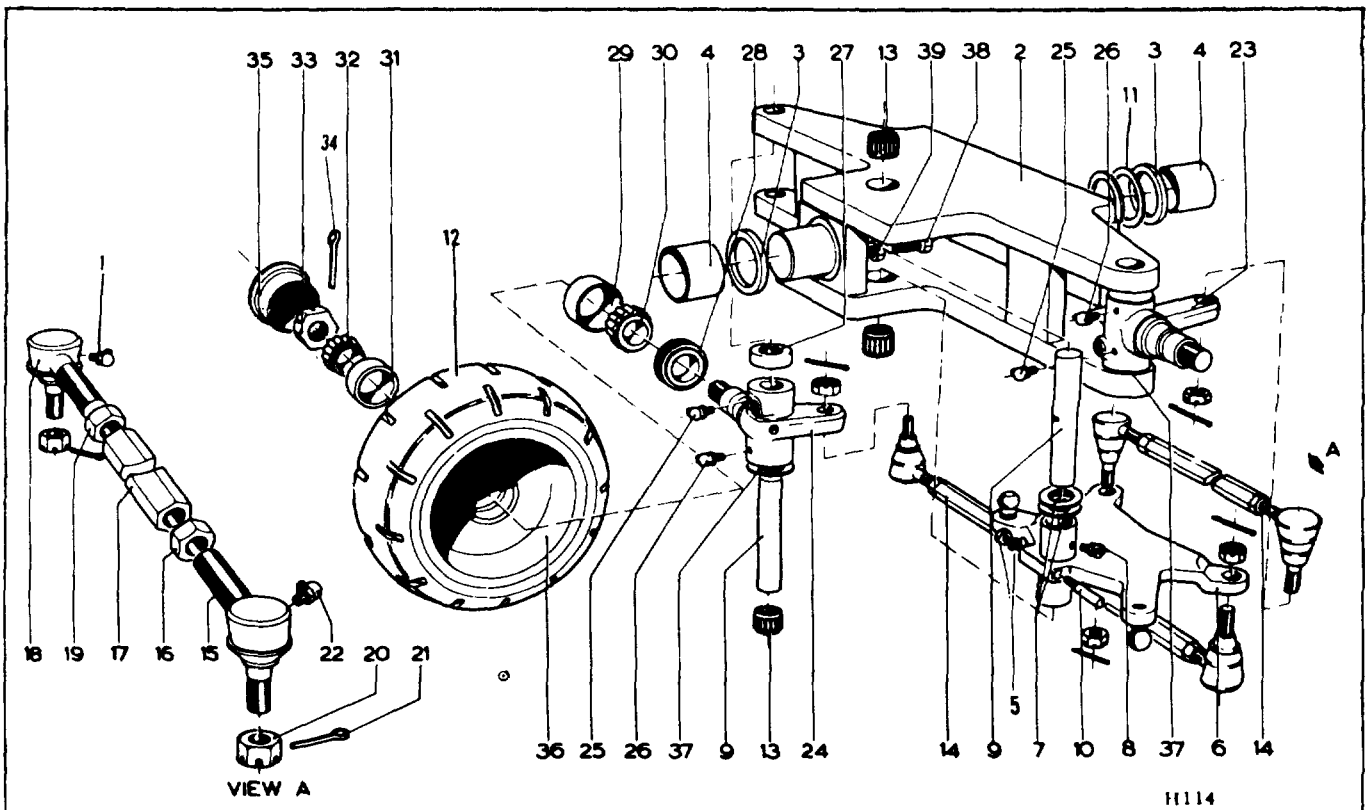
STEERING AXLE

A. GENERAL (Fig. 1)

The steering axle supports the rear of the truck with two axle stub shafts.

The front and rear stub shafts rotate within synthane bushings which are replaceable.

Thrust washers are provided to reduce wear of the axle and mounting saddles.



1. Grease Fitting
2. Steering Axle
3. Thrust Bearing
4. Stub Shaft Bearing
5. Nut & Lockwasher
6. Steering Arm
7. Shim Pack
8. Grease Fitting
9. King Pin
10. Retainer Pin
11. Shims
12. Tire
13. Needle Bearing
14. Tie Rod Assembly
15. Rod End
16. Jam Nut
17. Tie Rod
18. Tie Rod End
19. Jam Nut
20. Castellated Nut
21. Cotter Pin
22. Grease Fitting
23. Spindle - L.H.
24. Spindle - R.H.
25. Grease Fitting
26. Grease Fitting
27. Thrust Bearing
28. Oil Seal
29. Bearing Cup
30. Bearing Cone
31. Bearing Cup
32. Bearing Cone
33. Nut
34. Cotter Pin
35. Bearing Cap
36. Wheel
37. Thrust Washer
38. Capscrew
39. Jam Nut

Figure 1.

End clearance of the axle is adjusted by shims placed between the washer and saddle.

The axle is bored in the proper geometrical location, which when aligned with a similar hole in the steering center arm, facilitates correct wheel alignment.

Manual steering trucks have adjustable stops located in the axle frame.

Steering center arm and spindles are held in by a heat-treated pin. The pin rotates within replaceable needle bearings. Vertical clearance is controlled by shimming. The needle bearings retain their position by a press fit.

B. REMOVAL

1. Raise rear of truck and block in position, Remove wheels and hubs. Disconnect drag link.

2. Raise roller-equipped jack against each end of axle, in such position as to rest axle on jacks when axle is released from the truck.

NOTE:
If preferable, the wheels may be left on and the assembly rolled from under the truck.

3. Mark and remove front and rear stub shaft caps. (Fig. 2) Lower both jacks at the same time, until axle is clear of the frame. Then remove axle from either side of the truck.

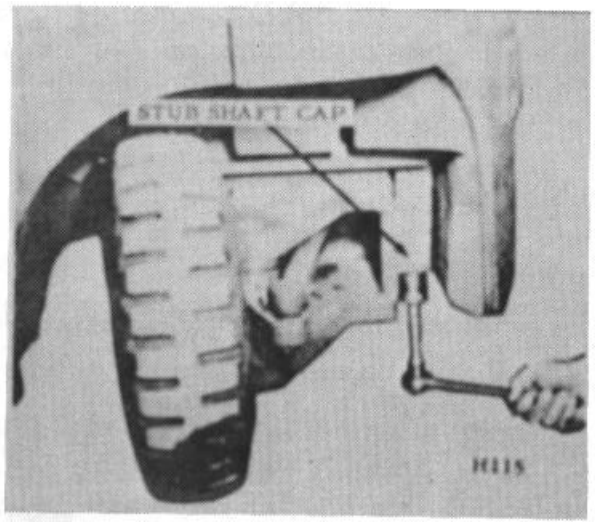


Figure 2.

C. DISASSEMBLY

1, Remove the nut and lockwasher from the taper bolt and drive the bolt from the spindle. (Fig. 3)

2. With a heavy drift, drive through the bearing on the topside of the axle down until the bearing and king pin on opposite side are free. Remove the king pin and pull the spindle, spindle spacer and thrust bearing from the axle. The thrust bearing is between the upper axle support and the spindle. Complete bearing removal.

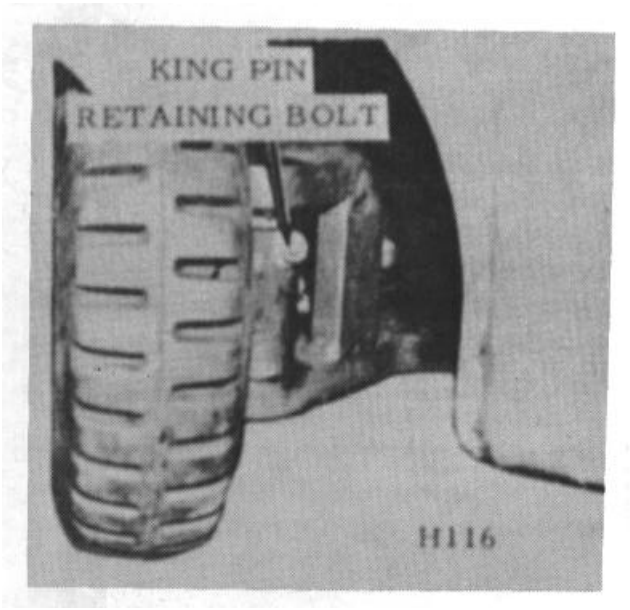


Figure 3.

NOTE:
Step 2 refers to an axle equipped with closed end bearing. If the axle is equipped with open end bearings, the caps must be removed before the pin can be driven out. (Fig. 4)

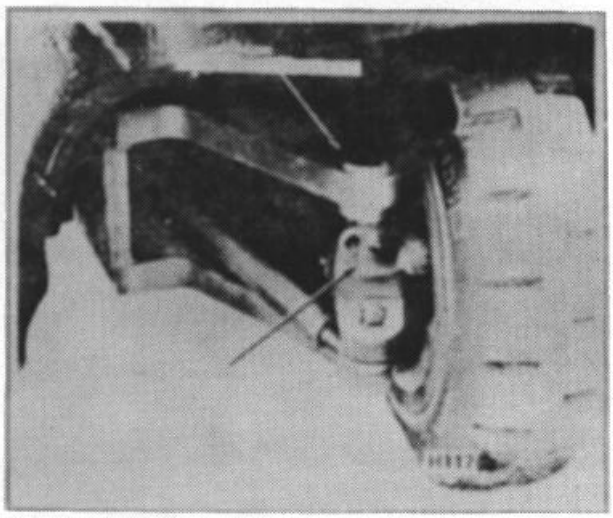


Figure 4.

NOTE:
It will be necessary to remove the center steering arm if replacement of the inside tie rod ends is required.

3. The center steering arm is secured to the axle in the same way as the spindles and it is removed in the same manner. The steering arm is removed through the left hand, front opening in the axle. (Fig. 5) Two spacers are provided on the steering arm, one on either side.

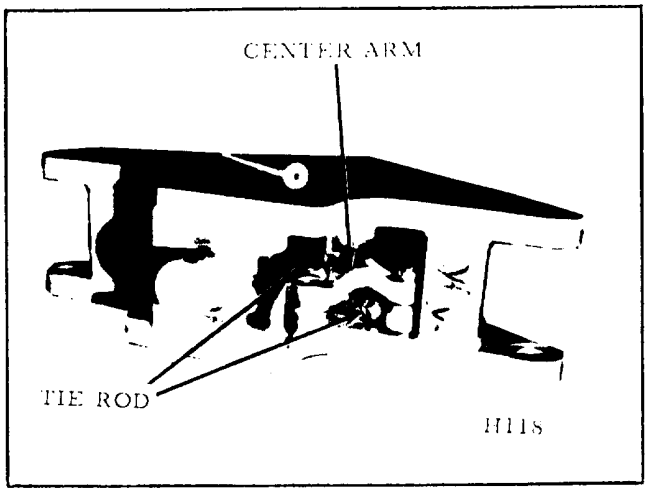


Figure 5.

D. ASSEMBLY

NOTE:
When replacing the tie rod assemblies or ends, check the center-to-center dimension of tie rod ends before installing the tie rod assembly.

1. Locate and mark the center of each tie rod end (Fig. 6) using a machinist rule fitted with a circle-center-finder attachment. Follow the instructions of attachment manufacturer and make the center mark on the housing of the tie rod end, opposite the ball stud.

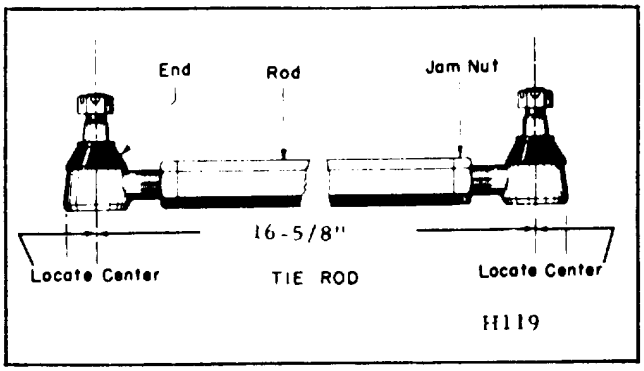


Figure 6.

2. Measure the distance between the center marks and adjust to 16-5/8 inches.

3. Turn each end into the tie rod an equal number of turns and lock jam nut.

4. To reassemble the center steering arm or the spindles, assemble the parts in the axle and replace the taper bolt through the spindle and king pin groove.

5. Center the king pin in the axle bearing hole and start a new bearing into the hole, making sure the lube hole in the bearing is in line with its grease fitting. Repeat on opposite side of axle before driving the bearings home.

CAUTION:
Do not drive bearings beyond trunnion surface. (Fig. 7) Driving bearings against king pin will damage bearing.

6. Attach the bearing caps (Fig. 4) if so equipped.

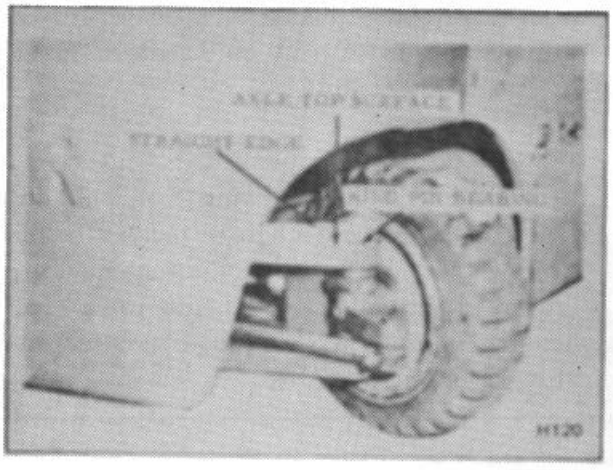


Figure 7.

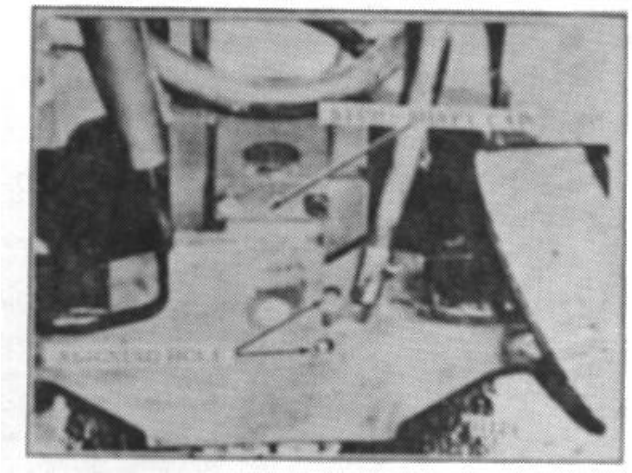


Figure 8.

AXLE AND LINKAGE ADJUSTMENTS

A. STEERING AXLE

NOTE.
Perform the following before steering cylinder adjustment is made.

1. Raise rear wheels off the ground. Then disconnect drag link.

2. Place a one-inch round bar in the centering holes of the axle and center steering arm. (Figs. 8 and 9)

3. Establish and mark center of axle. Adjust tie rods until the distances between each wheel and the center mark are equal.

4. Secure lock nuts. Check distance between steering wheels making sure that they are parallel with each other as well as square with the axle.

B. STEERING SYSTEM

1. Raise rear wheels off the ground.

2. Check drag link ball joints. Adjust if necessary to remove looseness.

3. Remove pitman arm. Place a one-inch bar in the centering holes of the axle and center steering arm. Then center the steering gear. (Figs. 8 and 9)

Figure 9.

4. Place pitman arm on proper serrations on lever shaft. Install lockwasher and secure pitman arm with nut.

5. Remove the one-inch bar. Adjust steering stops for equal wheel travel. Wheels must also stop on stops rather than steering axle or any other part of truck.

NOTE:
The tie rod ends are self-adjusting and require no service other than periodic

lubrication and inspection for looseness. Looseness due to wear is determined by grasping the tie rod and attempting to move it relative to the stud.

SPINDLE (Fig. 4)

A. REMOVAL

1. Remove wheel. Disconnect the tie rod. Unscrew nut from king pin retainer pin. (Fig. 4) Knock out retainer pin.

2. Remove the bearing cap (Fig. 4) or break out the end of the upper needle bearing; then, using a bar of slightly smaller diameter than king pin and hammer, drive out king pin.

3. Remove the spindle and remainder of the upper bearing. Remove lower bearing if end was broken out during king pin removal.

B. INSTALLATION

1. Lubricate all parts before installing. Place spindle and thrust bearing in position. Thrust bearing is placed between the spindle and axle upper member.

2. Align spindle, thrust bearing and axle bore. Push king pin into position until the retainer pin holes are indexed with those of the spindle.

3. Push retaining pin into bore sufficiently to hold king pin to position.

4. Align lube holes (Fig. 10) of the lower bearing with grease fitting on spindle. Press lower pin bearing into place until bearing end almost contacts the king pin surface. The bearing can be pressed into position by placing a jack under the bearing and axle.

CAUTION:
Whenever needle bearings are removed, they must be replaced with new ones. Do not use old bearings as microscopic damage occurs during removal.

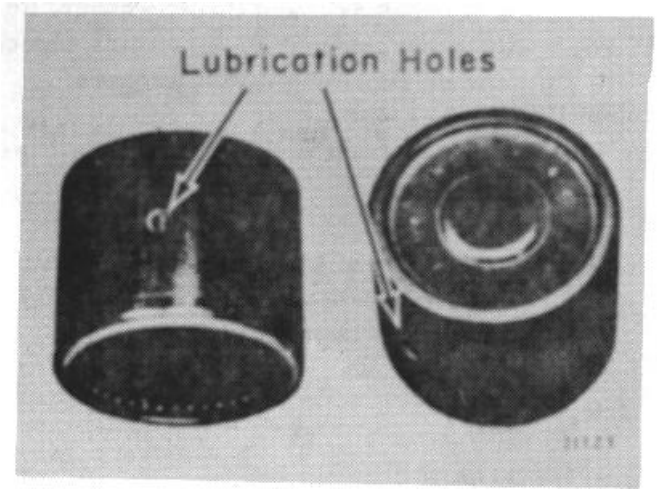


Figure 10.

5. Install upper bearing. Secure king pin by driving retaining pin into position, and securing it with the nut.

NOTE:
Install upper and lower bearings, flush with inner surfaces of the axle arms. (Fig. 7)

SUPPORT BEARINGS

A. REMOVAL

1. Raise truck sufficiently to remove pressure on stub shafts. Mark front and rear caps.

2. Pry axle to the rear (Fig. 11) and measure between

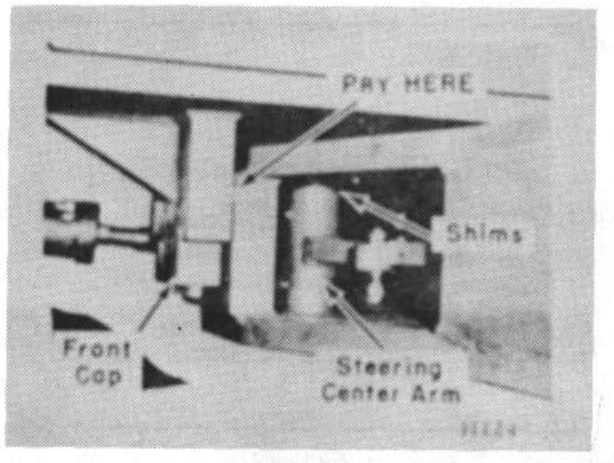


Figure 11.

axle and thrust washer. Record this measurement to determine choice of shims when replacing thrust washers.

3. Remove front and rear bearing caps. (Fig. 2)

4. Raise rear of truck sufficiently to allow sliding bearings and thrust washers from the stub shafts. Block wheels to prevent them from rolling while axle and truck are separated.

B. INSTALLATION

1. Place bearings, thrust washers and shims in position on stub shafts. Adjust clearance as close to zero as possible, without binding.

2. Guide axle into position while lowering truck.

3. Install caps in proper places as indicated by marks previously made.

BALL SOCKET AND BALL STUD

A. DISASSEMBLY

Remove cotter pin and unscrew adjusting screw plug, remove ball stud, seats, spring and bumper. (Fig. 12)

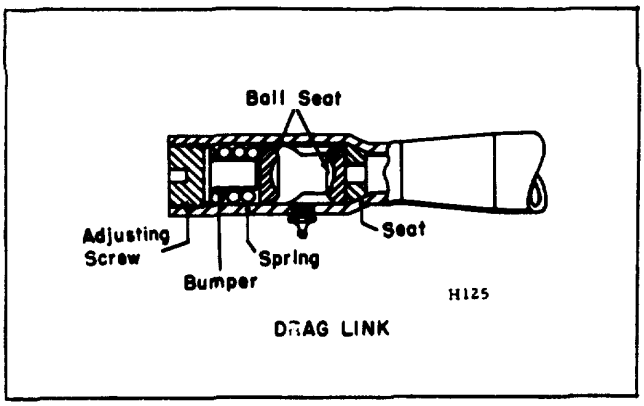


Figure 12.

B. INSPECTION

1. Thoroughly wash parts and socket shell with solvent. Examine parts and ball stud for flats, scoring, galls and excessive wear. Replace parts as necessary.

C. ASSEMBLY

Assemble parts in the reverse order of removal. Insert lubricated ball stud into socket opening and tighten adjusting plug until an abrupt resistance to turning effort is felt, then back off to nearest lock point and insert cotter pin.

MANUAL STEERING GEAR

A. GENERAL

This is a recirculating ball type unit. In this steering gear the steering wheel control forces are transmitted through a recirculating ball worm to a rack. In turn the rack drives the pitman shaft.

B. REMOVAL

1. Match mark the pitman arm and shaft. Remove the pitman arm from the steering gear pitman shaft.

2. Release the column support clamp under the instrument panel. Disconnect the horn wire.

3. Remove the mounting flange bolts.

C. DISASSEMBLY (Fig. 13)

1. Loosen adjusting screw locknut and remove the housing side cover by unscrewing adjusting screw.

2. Remove adjusting screw from slot in end of pitman shaft making certain shim found on adjusting screw is kept with the screw.

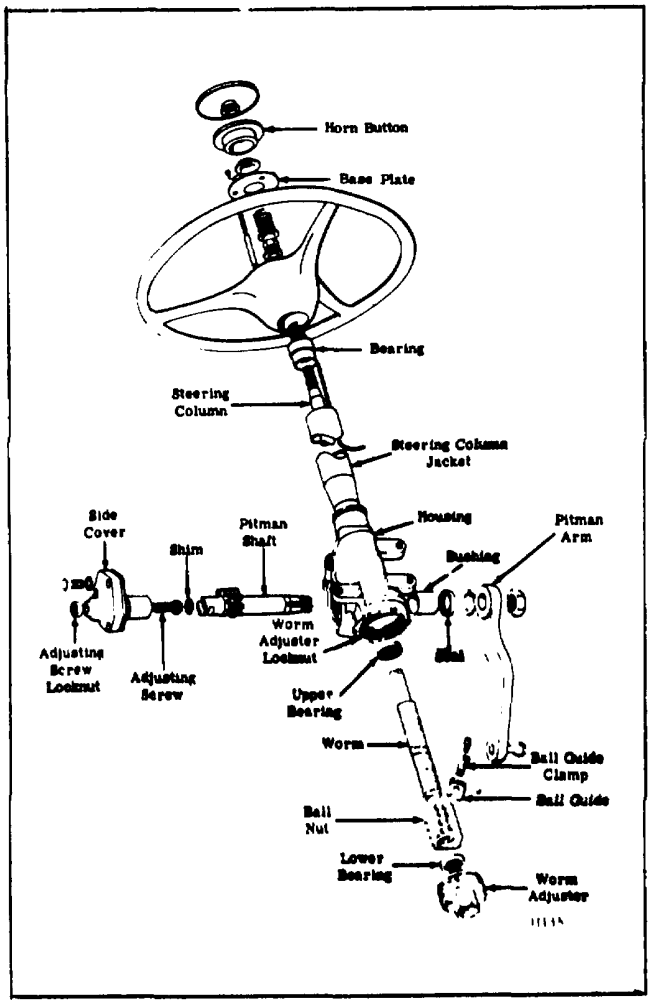


Figure 13.

3. Remove pitman shaft from housing using care that threads do not damage seal in housing.

4. Loosen worm bearing adjuster locknut and remove adjuster and lower bearing,

5. Push worm and shaft with ball nut through bottom of housing and remove upper bearing.

6. Remove ball return guide clamp and guides from ball nut. Turn ball nut over to remove balls and remove ball nut from the steering shaft worm.

D. INSPECTION

1. Clean and inspect all ball and roller bearings and races including race in housing.

2. Inspect pitman shaft bushings in gear housing and side cover, Replace bushing in housing and replace side cover if bushings are worn excessively.

3. It is advisable to replace pitman shaft grease seal in housing to avoid leakage of lubricant. Seal must be Installed with feather edge toward inside of housing.

4. Inspect steering shaft for wear or pits in bearing races which would require replacement of shaft. Check shaft for straightness.

5. Inspect teeth of ball nut and pitman shaft. If scored or excessively worn it is advisable to replace both parts to insure proper mating of teeth,

6. Check serrations of pitman shaft; if twisted, replace shaft.

7. Check fitted pitman shaft adjusting screw and shim in slot in end of pitman shaft. With shim in place, screw head must be free to turn in slot with zero to .002 end play. If end play Is excessive, selectively fit a new shim which is furnish-in four different thicknesses.

8. Inspect steering column jacket for distortion, A ripple or wavy feeling in jacket surface, particularly at lower end, would usually indicate a sprung jacket, Replace jacket if sprung or otherwise damaged.

9. Inspect control shaft bearing in tube of gear housing and steering shaft upper-bearing in control lever housing support. Replace worn or damaged parts.

E. ASSEMBLY (Fig. 13)

1. To assemble the steering gear, reverse the order or procedure given for disassembly. In addition, observe the following instructions.

2 Lubricate bearings and gears with steering gear lubricant.

3. use all new gaskets to avoid oil leaks.

4. When assembling ball nut on worm be sure to place 25 balls in each circuit, making a total of 50 balls.

5. When installing pitman shaft avoid damaging or turning feathered edge of leather seal in gear housing.

6, Temporarily install steering wheel and adjust worm shaft thrust bearing for proper load and pitman shaft for proper gear lash as described under G. Adjustments.

F. INSTALLATION

1. Install the steering gear in the reverse of removal.

2. Check steering alignment. Adjust as outlined under AXLE AND LINKAGE ADJUSTMENTS, if necessary.

G. ADJUSTMENTS

1. Disconnect steering linkage from pitman arm. Turn steering wheel gently in one direction until it stops, then turn it back one revolution. Never turn steering gear hard against stopping point as damage to ball nut assembly may result.

2. Check lash between ball nut and pitman shaft by working pitman arm. If a perceptible lash does not exist, loosen lock nut and turn pitrman shaft adjusting screw counterclockwise until lash can be felt when working pitman arm.

3. Turn steering wheel slowly from one extreme to the other, Wheel, should turn freely and smoothly through entire range. Roughness indicates faulty worm thrust bearings or pitted races. Hard pull or binding indicates misalignment of steering gear in its mounts or an excessively tight adjustment of worm thrust bearings. Any misalignment must he corrected before steering gear can be properly adjusted.

4. Tighten housing and cover bolts. Loosen worm thrust bearing adjuster lock nut and turn thrust bearing adjuster until a slight load is felt when turning steering wheel near extreme end positions, then tighten lock nut. Do not back out adjuster far enough to permit thrust bearings to get out of line with ends of worm.

5. After locking bearing adjuster, check load on thrust bearings with steering wheel turned to near one extreme position. Attach a spring scale to rim of steering wheel. The pull required to keep the steering wheel turning slowly should read between 3/8 and 7/8 pounds. Readjust to obtain this load, if necessary.

6. Turn steering wheel from one extreme to the other while counting the turns. Then turn wheel back exactly one-half the total number of turns and have the lower spoke pointing straight down. This places the steering gear on the high point at which no lash should exist between ball nut and pitman shaft teeth.

7. Tighten housing side cover bolts. Loosen lock nut and turn pitman shaft adjusting screw clockwise until lash is removed. After tightening the adjusting screw locknut, rotate wheel back and forth and check for tight spots. Also recheck pull at wheel rim as given above. The pull required to keep the wheel moving through the high point should be between 1 and 2 pounds. Readjust if necessary to remove tight spots.

CAUSE	REMEDY
Hard Steering	
1. Lack of steering gear lubrication	1. Add lube to proper level.
2. Incorrect axle alignment	2. Align as necessary,
3. Seized steering shaft bearings	3. Replace bearing.
4. Lower coupling flange rubbing against adjuster	4. Loosen bolt and assemble properly
5. Steering adjustment tight	5. Check adjustment.
No Recovery From Turn To Straight-Ahead	
1. Tight ball sockets and other linkage connections point.	1. Tighten ball sockets until parts are compressed solid - then back off to nearest lock
2. Tight knuckle pins, bushings	2. Make free.
3. Same as hard steering	3. Same as hard steering.
4. Tight sector to rack-piston adjustment	4. Adjust pitman shaft.
5. Thrust bearing adjustment too tight	5. Remove gear from truck and adjust.
6. Rack-Piston Nut and worm preload too tight	6. Remove gear and replace balls as required.
Shimmy	
1. Loose ball sockets or other linkage connections point.	1. Tighten ball sockets until parts are compressed solid then back off to nearest lock
2. Badly worn and unevenly worn tires	2. Replace.
3. Looseness in steering gear	3. Adjust gear, and perhaps repair gear.
Lost Motion At Steering Wheel	
1. Loose ball sockets or other linkage connections point.	1. Tighten all sockets until parts are compressed solid then back off to nearest lock point

TROUBLESHOOTING

CAUSE	
2. Pitman arm loose on lever shaft	2. Tighten lever shaft nut.
<u>External oil leaks - Recirculating Ball and Nut Gear</u>	
1. Side Cover O-ring Seal	1. Replace seal.
2. Pitman Shaft Seals	2. Replace seals.
3. Housing End Plug Seal	3, Replace seal.
4. Adjuster plug seal	4. Replace seal.
<u>Excessive wheel kickback or loose steering - Recirculating Ball Gear and Nut Gear</u>	
1. Lash in linkage	1. Adjust parts affected.
2. Excess lash between Pitman sector and Rack-Piston	2. Adjust to Specification.
3. Loose thrust bearing adjustment	3. Remove gear and adjust
4. Ball nut and worm pre-load	4. Change balls to obtain correct pre-load.

SPECIFICATION LISTING	
Torques	
Steering cylinder ball studs	125 ft./lbs. dry
Tie rod ends	95 ft./lbs. dry
Steering wheel nut	34 ft./lbs. dry
Upper adjusting nut in steering gear	10 ft./lbs. dry
Recirculating Ball and Nut Gear - (Lubricated Threads):	
Guide Clamp Screws	8 to 12 ft./lbs,
Flange assembly nuts	12 to 20 ft,./lbs.
Flange pinch bolt	20 to 25 ft./lbs,
Lash adjuster nut	25 to 35 ft./lbs,
Side Cover Bolts	30 to 35 ft./lbs.
Rack-Piston End Plug	50 to 60 ft./lbs.
Adjuster Plug Locknut	50 to 110 ft./lbs.
Pitman Arm Nut	100 to 125 ft./lbs.

FREELIFT UPRIGHT ASSEMBLY

A. GENERAL

The uprights are constructed of formed channel with bronze strip bearings. The uprights are pivoted around the axle housings of the drive axle and are held to the axle by caps on the upright hangers. The strip bearings are located between the inner and outer channel members.

Besides a three-stage hoist cylinder and carriage, the free lift upright assembly includes an inner upright and an outer upright.

CARRIAGE

A. GENERAL

This is a hook type assembly equipped with canted load rollers. This type of roller is designed to take the load and side thrust. The rollers are shim adjusted. The bearings are shielded and lubricated for the life of the bearing.

Working in conjunction with the latching mechanism is a lug and block, The block lifts the inner upright while the lug triggers the latching mechanism, at the end of the carriage free-lift stroke.

When the free-lift stroke is completed, a latch on the inner upright is locked around the lug, securing the carriage to the inner upright. This block will be referred to as a "lifting block".

Load arms on the hook type carriage are hooked over the top of the upper crossmember, and held in position by a spring-loaded pin and lever assembly. The pin is pushed into notches on the top of the upper crossmember by the spring. Pulling up on the lever disengages the pin so the load arm can be repositioned.

B. REMOVAL

1. Lower the carriage. Remove the load arms. (Fig. 1) Disconnect the high pressure and bleed back hoses from the carriage.

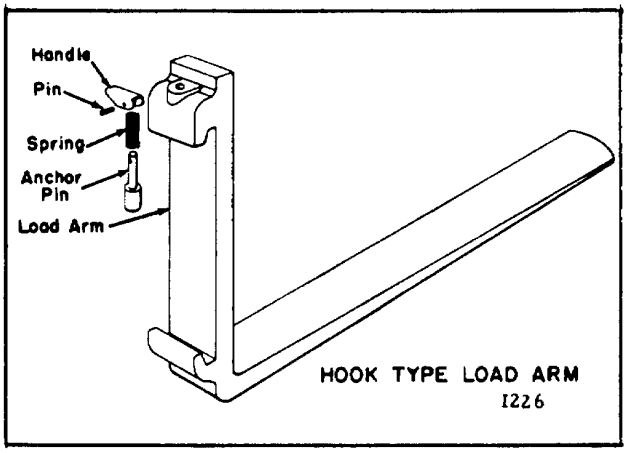


Figure 1.

2. Attach hoist to the carriage, and remove the slack.

3. Disconnect the load chains from the carriage. (Fig. 2) Lift the inner upright until it is free of the carriage.

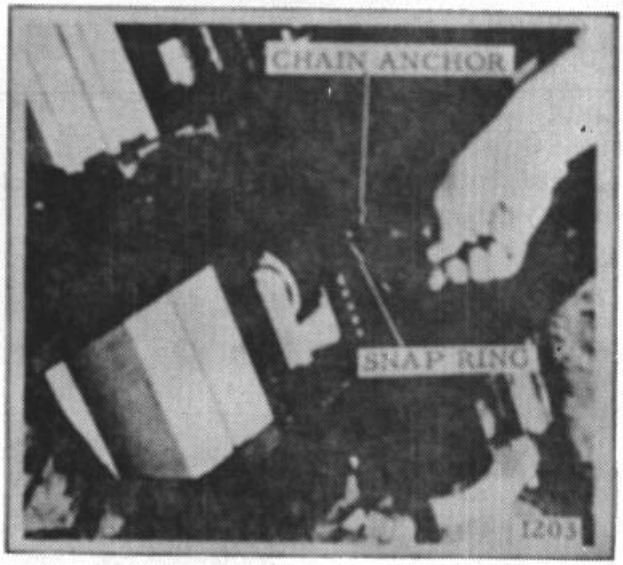


Figure 2.

4. Either back the truck away from the carriage or pull the carriage away from the truck.

C. DISASSEMBLY (Fig. 3)

1. Remove snap ring from one of the stub shafts. Remove the shims next to the load roller.

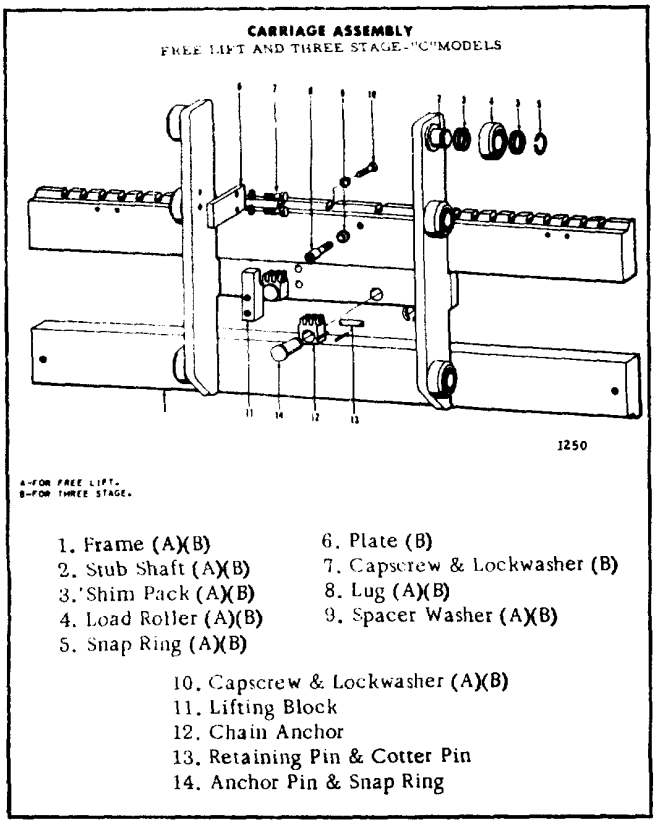


Figure 3.

2. Pull load roller off and note the thickness of the shim packs. (Fig. 4)

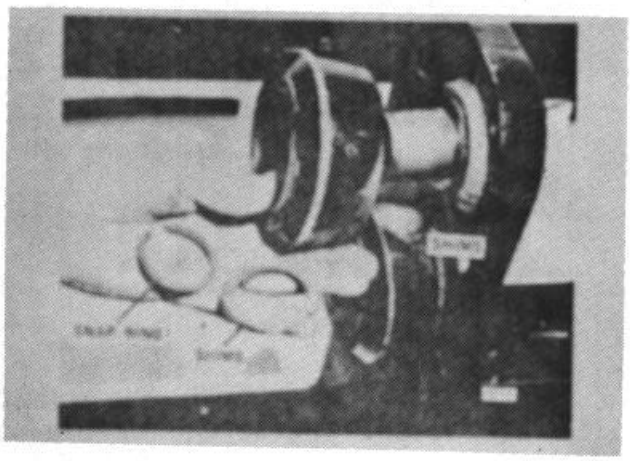


Figure 4.

3. Remove the remaining rollers.

D. ADJUSTING LOAD ROLLERS AND INSTALLATION

1. Make sure that the load rollers cannot move sideways on the stub shafts. If necessary, add shims to the original shim pack (or pack thickness) to eliminate clearance between the shims and the retaining snap ring, at time of installation.

2. Install the carriage using the reverse of the removal procedure, transposing shims until the carriage fits in the inner upright as tight as possible and still permits no-load lowering. Check lug-go-latch clearance.

3. Check and adjust latch clearance as follows:

a. Raise the carriage until the lifting block on the carriage just makes contact with a similar block on the inner upright.
b. Measure the clearance as indicated in Figure 5.

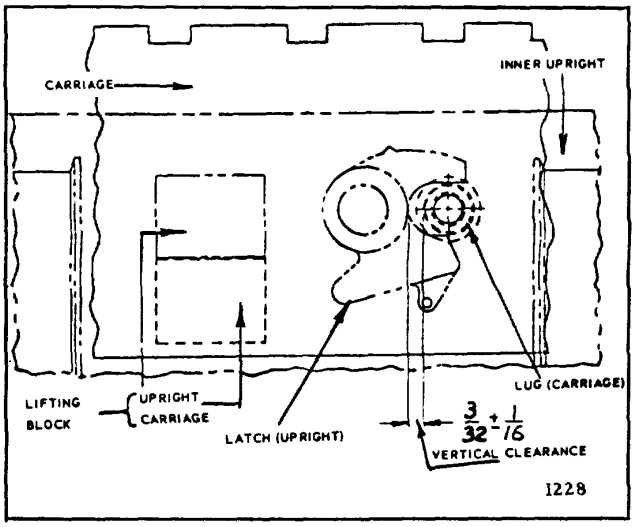


Figure 5.

c. If clearance is more than 5/32 inch or less than 1/32 inch (desired clearance is 3/32

inch) check for too much side play in the latch shaft. If little side play is noticeable, the carriage position with respect to the inner upright must be changed.

IMPORTANT: When placing the lug closer to or farther away from the latch, all the shim packs of the load rollers are altered. In altering the packs, remember the following: (1) When shims are removed from one side of a load roller, they must be placed on the other side of the same roller. (2) Alter the shim packs of all the load rollers on a given side of the carriage the same; that is, if a .030 inch shim was removed from the outer side and placed on the inner side of the lower roller on the right vertical member, alter the pack of each of the two upper rollers on the right vertical member by transposing a .030 shim. (3) Whenever shims are removed from the outer side of and placed on the inner side of the rollers on the right vertical member, the opposite must be done to shim packs on the left vertical member and vice versa.

UPRIGHTS

A. GENERAL

Latches and latch lugs (socket head capscrews) are utilized to maintain the proper operating sequence of the upright assembly, by securing the inner upright to the outer and releasing it at the proper time. (Figs. 6 and 7).

There are three latches and two lugs, which make up the latching mechanism. The latches are located at the top of the inner upright. One of the lugs is located on the back of the upper crossmember of the carriage. The other is in front of the upper crossmember of the outer upright.

Attached to the top of the hoist cylinder is a crosshead and cylinder guide assembly. The guide, which is shim-adjusted, slides in two guide rails. One guide rail is welded to the back of each outer upright channel. (Fig. 7)

Taking the load and side thrust imposed on the uprights are four canted load rollers. One roller is located at the top of each outer upright channel. The other two are at the bottom of the inner channels. The rollers are equipped with sealed ball bearings, lubricated for life and replaced as an assembly.

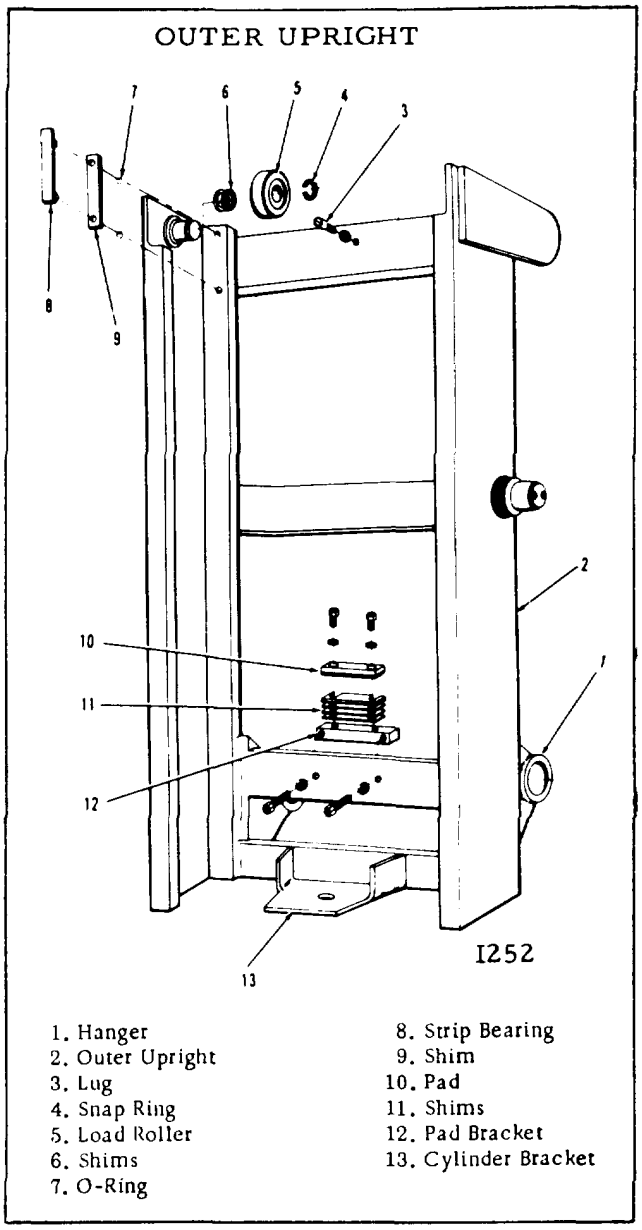
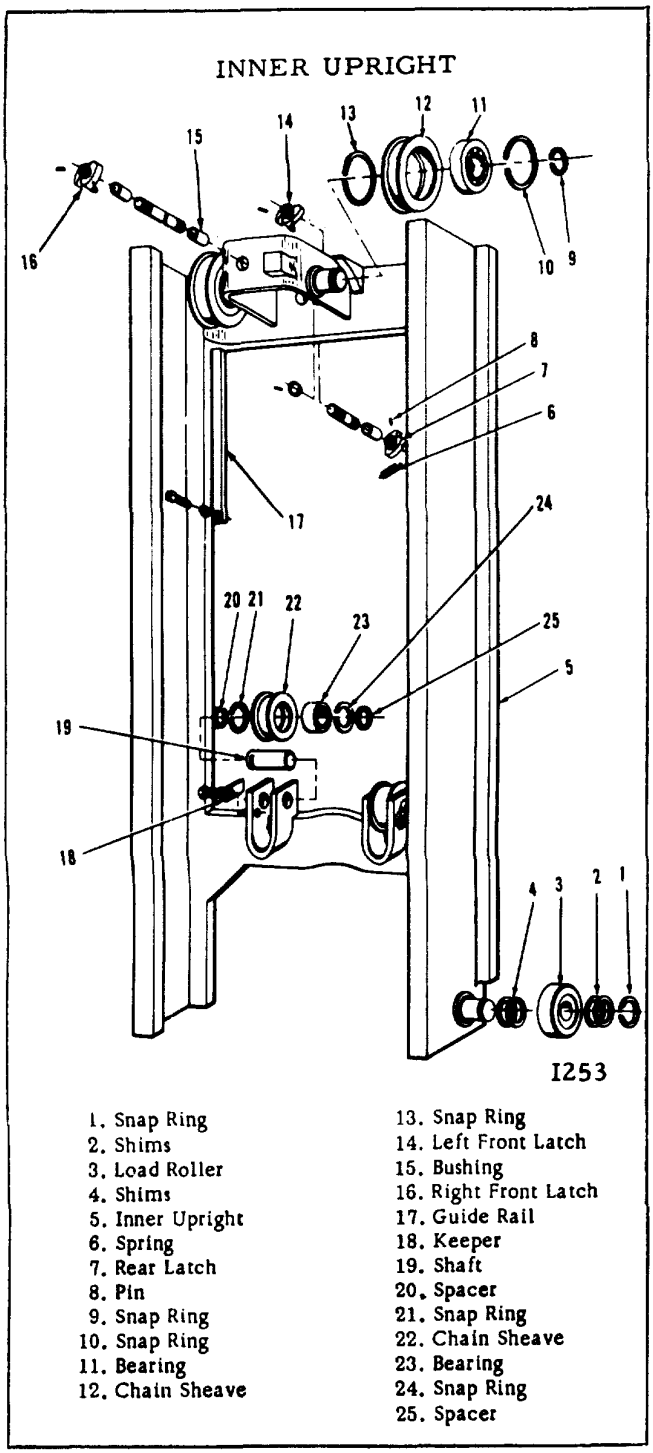


Figure 6.



1. Snap Ring
2. Shims
3. Load Roller
4. Shims
5. Inner Upright
6. Spring
7. Rear Latch
8. Pin
9. Snap Ring
10. Snap Ring
11. Bearing
12. Chain Sheave
13. Snap Ring
14. Left Front Latch
15. Bushing
16. Right Front Latch
17. Guide Rail
18. Keeper
19. Shaft
20. Spacer
21. Snap Ring
22. Chain Sheave
23. Bearing
24. Snap Ring
25. Spacer

Figure 7.

Six chain sheaves provide the necessary rolling surfaces for the two load chains. The sheaves are ball bearing equipped and located in the following places: Two in back of an intermediate crossmember of the inner upright; one on each side of the crosshead; one on each side of a box at the top of the inner upright. The box is welded on the front of the upper crossmember. The bearings are shielded, lubricated for the life of the bearing, and replaceable.

One end of each load chain is attached to the back of the carriage and the other end is attached to a chain anchor. The bottom ends of the chain anchors are attached to the cylinder base. Provision for chain adjustment is at this point.

The bottom crossmember of the outer upright supports the cylinder. Bolted on top of the support is a shim-adjusted pad. The pad supports the inner upright when it is completely lowered. Shims are used to adjust the relationship between the inner and outer uprights.

A sliding surface between the inner and outer uprights is provided by strip bearings between the two outer channels of each of the two assemblies. The strip bearings are shim adjusted and attached to the top of the outer upright.

Of the latches, two are behind the upper crossmember of the inner upright and one is on the front of the box. Looking from the driver's seat, the right rear latch and the front latch are splined and pinned to a common shaft.

Welded to the front of the box is a block and bolted to the back of the upper crossmember of the carriage is another block. These are in line with each other and are called "lifting blocks". Also screwed into the back of the same crossmember is a lug.

When the inner upright is completely lowered, the right rear latch is engaged with the outer upright lug, and

is locked in position by the right rear latch. Under these conditions the inner upright is secured to the outer and will remain so until the right rear latch is rotated to unlock the left latch. This happens when the carriage ceases to free-lift.

During the free-lift stroke, the carriage rises to the top of the inner upright without any extension of the upright. At the end of the free-lift stroke, the carriage lug engages and rotates the front latch, which rotates the right rear latch, unlocking the left rear latch. At the same time, the lifting blocks make contact.

As the carriage continues to rise, it carries the inner upright with it. Raising the inner upright rotates the left rear latch, disengaging it from the lug. When the left rear latch is rotated, it looks the right rear latch, At this stage of operation, and until the carriage is lowered past this stage, the carriage is secured to the inner upright.

When the carriage is lowered, the outer upright lug engages and rotates the left rear latch, unlocking the left rear latch, When the right rear latch is free to rotate, so is the front latch. The front latch rotates and the carriage lug is disengaged as the carriage continues to lower,

B. REMOVAL

1. Be sure hoist cylinder is completely collapsed. Disconnect the pressure hose from hoist cylinder and uncouple the cylinder bleed back hose.

2. Remove the front wheels. Fasten an overhead hoist to the uprights to support and move them. All uprights should be secured together. Remove the hanger bearing caps, noting the shims located behind them. (Fig. 8)

3. Disconnect the tilt cylinders from the uprights by removing the pin retainers and the anchor pins (Fig. 8).

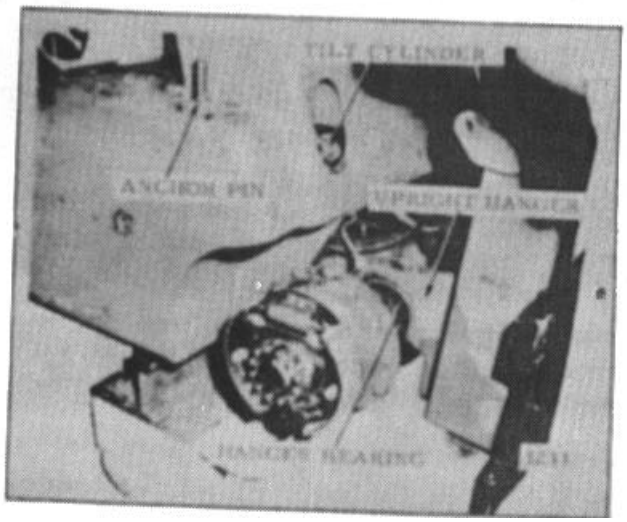


Figure 8.

4, Remove the carriage chain anchor pins and disconnect the load chains from the carriage.

5., Hoist the upright free of the truck and at the same time guide the carriage out of the bottom of the uprights.

C. DISASSEMBLY (Figs. 6 and 7)

1. With the upright assembly in a horizontal position, remove the snap ring from the front of each carriage chain anchor. Push the anchors out of the carriage crossmember.

2. Using a sling and a hoist, sling the carriage and pull it out of the inner upright.
(Fig. 9)

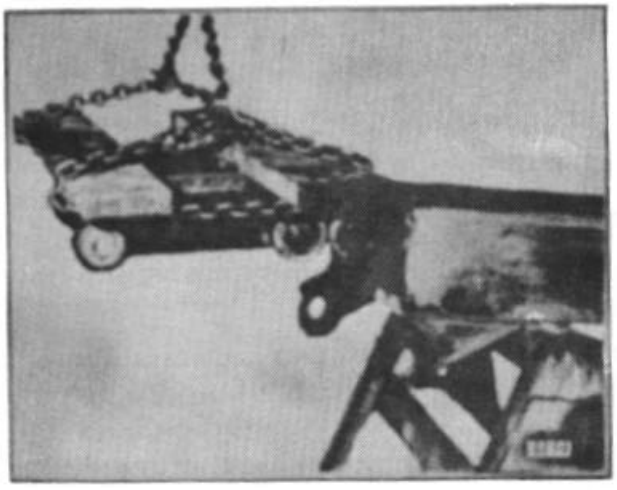


Figure 9.

3. Disconnect the load chains from the anchors on the hoist cylinders and pull them out the bottom of the upright assembly.

4. Attach a sling and a hoist to the cylinder, being careful not to bend the anchors.

5. Remove the lowering control valve from the bottom of the cylinder. Separate the crosshead from the cylinder. Hoist the cylinder out of the upright assembly.

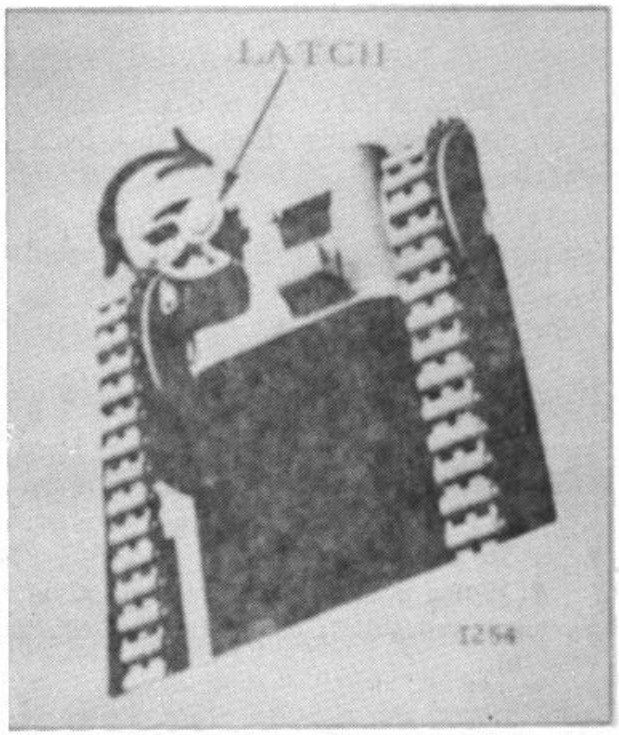


Figure 10.

6. Rotate the front latch clockwise, as indicated by the arrows in Figure 10, and at the same time, pull the inner upright out of the top of the outer until the lug on the outer can be removed. Remove the lug and spacer. (Fig. 11)

7. Remove the pad and bracket assembly from the outer upright.

8. Push the inner upright into the outer until the lower crossmembers contact each other.

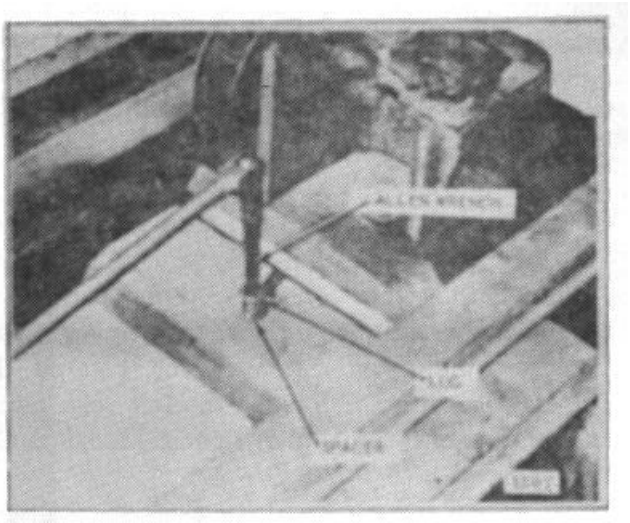


Figure 11.

9. Remove the snap ring, shims and load rollers from the bottom of the inner uprights (Fig. 12) and from the top of the outer. (Fig. 13)

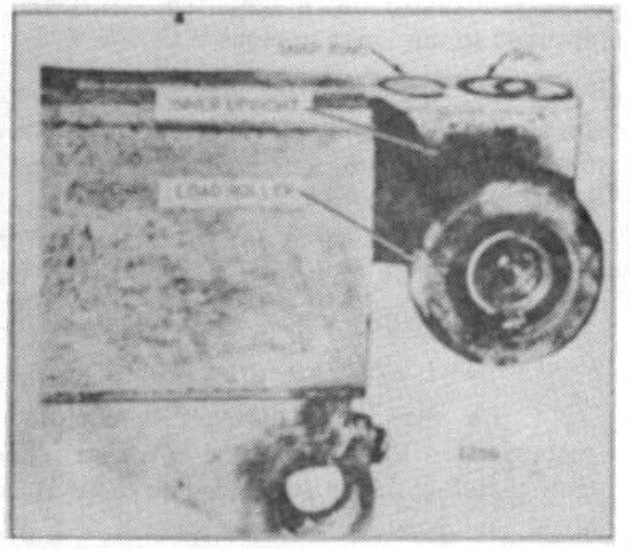


Figure 12.

NOTE:

To aid in assembling and adjusting, identify the shims as they are removed.

NOTE:

At this stage, all rollers may be removed without removing other units from the uprights. The strip bearings can be removed by prying the inner upright up enough to allow removal of the bearings.

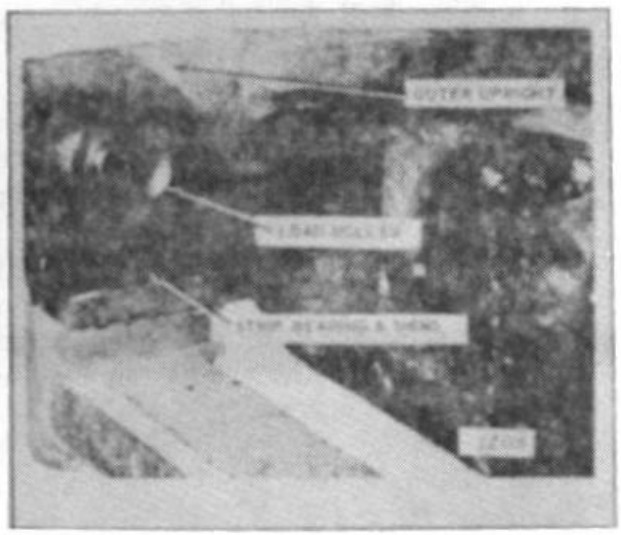


Figure 13.

10. Unscrew the crosshead stop screws from the bottom of the crosshead guide rails. Slide the crosshead out the bottom of the rails. Remove the snap ring retaining each chain sheave. Pull the sheaves from the crosshead shafts,

11. Remove the snap rings and pull the upper chain sheaves from the shafts on the box.

12. Unscrew the capscrews and remove the lockwashers and retaining plates securing the chain sheaves to an intermediate crossmember of the inner upright. Pull each sheave from its respective shaft.

13. Remove the snap rings from each side of the bearings in the sheaves that need new bearings. Press out the defective bearings.

NOTE:

Do not remove the latches unless they are defective, loose on the shafts, or the shafts and bushings are worn.

14. Match mark the front latch and shaft. Remove the spring an pin. Punch the shaft out r)of the latch, with a soft drift punch. Remove the remaining rear latch in the same manner.

NOTE:

Do not match mark the right rear latch and shaft. It is not necessary, and in doing so, confusion between front and rear latch may be caused.

15. Pull the inner upright out of the top of the outer upright, only if necessary.

D. CLEANING AND INSPECTION

1. All parts except the bearings may be steam cleaned or cleaned with solvent.

2. Check all sliding surfaces for roughness. Remove slight imperfections with sandpaper. If defects cannot be removed, replace the defective unit.

3. All welds should be carefully checked for cracks, especially around the stub shafts and hangers. Repair as necessary.

4. Inspect the strip bearings for wear. Replace the bearings, when the small indentations are nearly gone. If the O-rings will no longer retain the bearing strip, replace with new rings.

5. Check the fit of each latch shaft in the respective bushing. The latch should rotate without binding, Some side play is permissible as long as the latch function is not hindered.

6. Inspect roller surfaces and contacting surfaces for galling, unevenness and indications of sticking or stuck rollers. A defective roller is sometimes detected by long rough grooves or gouges on the rolling surfaces of the adjacent upright.

7. Make sure that all ground finishes, such as tilt cylinder rods, are free of rust, pits and nicks. In most cases, if these conditions exist, they can be dressed to a smooth finish with fine emery cloth or sand paper. Wipe clean and lubricate with light oil.

E. ASSEMBLY AND INSTALLATION

1. Install parts in the reverse order in which they were removed.

2. If latches have been removed, make sure these, or new ones, are installed on the splines as they were originally. Retaining pine must not interfere with latch operation, and latches must be tight on the shafts. Refer to "B", Figure 14.

3. Check latching mechanism, to make sure that the right rear latch locks around the lug at the top of the outer upright when the upright assembly is collapsed. The mentioned latch is locked in position by the right rear latch,

4. Shim the cylinder guide shoes so the crosshead will be centered in the inner up right and So they will slide freely on the guide rails, The total maximum clearance should not exceed 1/16 inch.

5. There should be 3/32 inch, plus or minus 1/16 inch vertical clearance, between the outer upright lug and its respective latch, when the upright is collapsed. (Fig. 14)

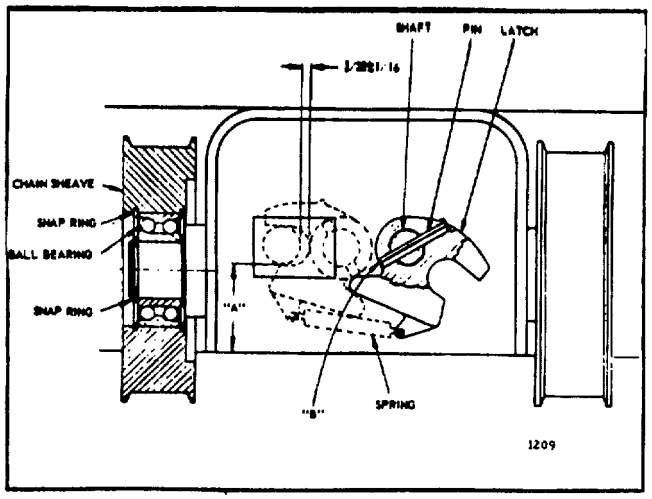


Figure 14.

6. Install all rollers, sheaves, bearings and shims in their original places.

7. Slide inner upright into outer upright, adjusting the rollers at the same time.

NOTE:

The load rollers should be adjusted as tight as possible and still allow the intermediate upright to lower under its own weight. The amount of shims between the load roller and stub shaft shoulder should be equal at this point on both sides of the upright. Sufficient shims must be added to fill the entire space between the load roller and its retaining snap ring.

8. Add or delete shims under the strip bearing at the top of the outer upright to hold the intermediate upright in line with the outer upright when the two are extended.

9. Apply a light coat of "Moly grease" to uprights wherever the sides of the load rollers make contact. Do not grease the rolling surfaces as the roller may slide instead of rotating during operation. (Figs. 15 and 16) Apply grease to the intermediate upright-to-strip bearing contacting surfaces.

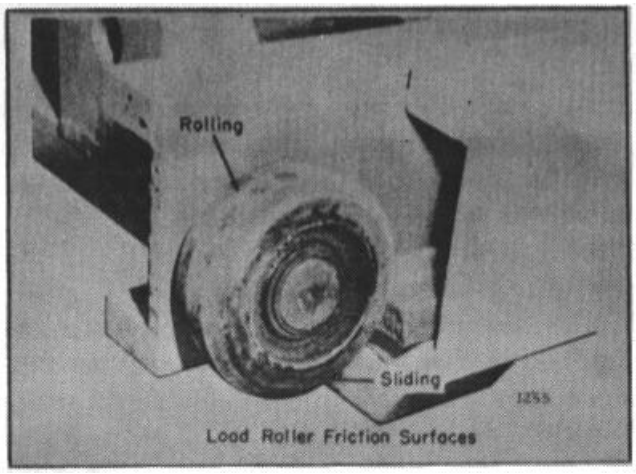


Figure 15.

10. Check the upright by extending the uprights and checking for binding, especially when the strip beargins of the intermediate upright pass the strip bearings of the outer upright. Binding at this point will cause excessive wear and may prevent the lowering

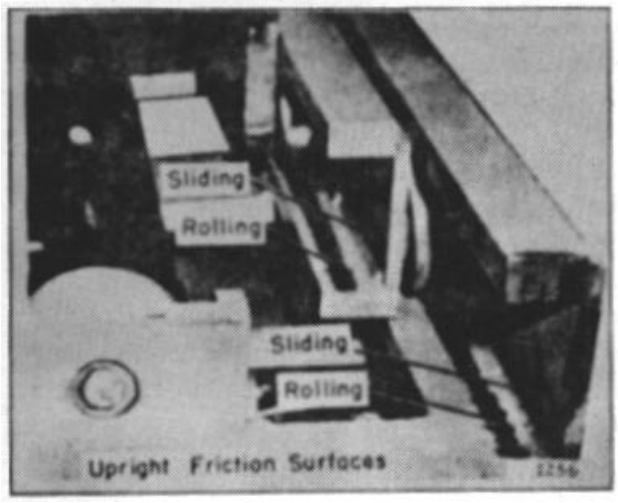


Figure 16.

of the uprights. Also, higher than normal hydraulic pressure will be needed to lift a given load.

F. INSTALLATION

Reverse removal procedure.

HOIST CYLINDER

A. GENERAL

The three-stage hoist cylinder used on the free lift and three-stage uprights is made up of four components: (1) Shell, (2) Primary Rod, (3) Secondary Rod, (4) Base. (Fig. 17)

The shell is threaded at both ends. A packing nut is screwed into the internal threads at the top and the base is screwed onto the external threads at the bottom. Relationship between base and shell is secured by a lock nut. Located near the top of the shell is a bleed screw and a leak-off fitting.

A bushing secured to the bottom of the primary rod and a packing nut at the top centers the rod in the shell. Self-adjusting packing at the top of the cylinder provides the necessary high pressure seal between the primary rod and outer shell.

The secondary rod is centered in the primary rod by a self-adjusting packing assembly secured to the bottom of the secondary rod and a bushing and seal assembly screwed into the top of the primary rod.

The outside diameters of both rods are chrome plated to retard oxidizing when exposed to the atmosphere.

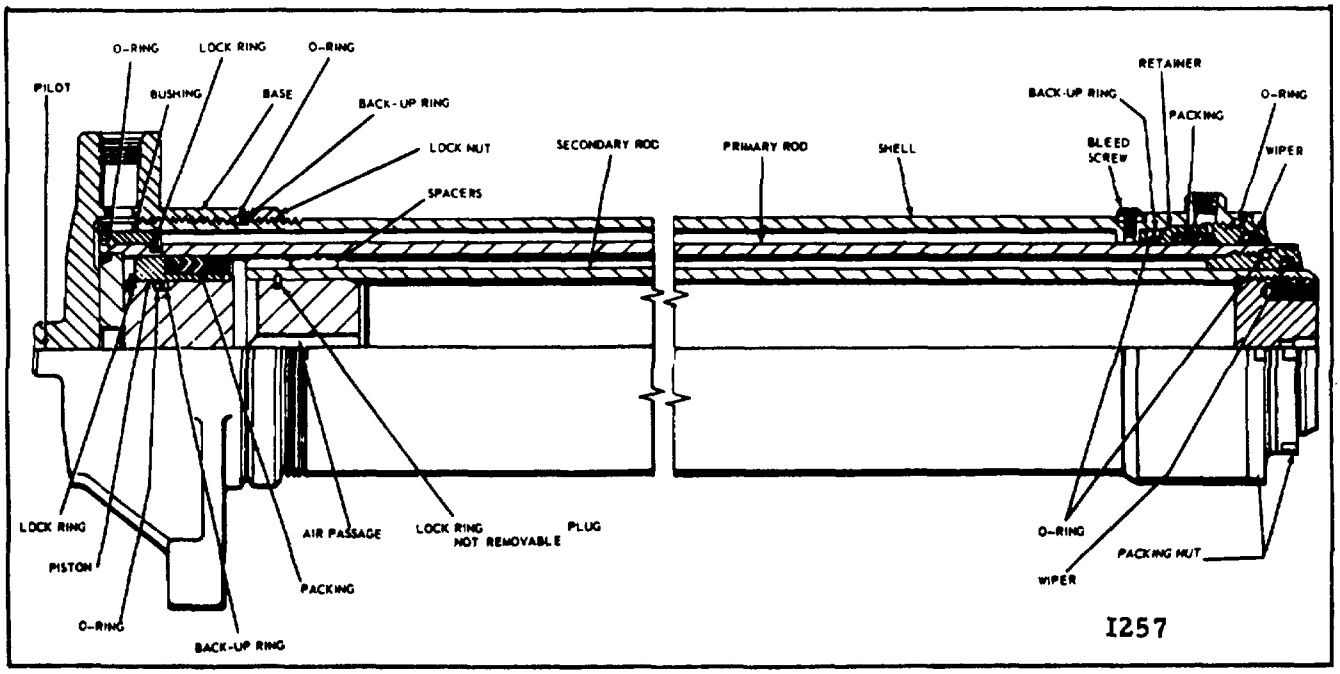


Figure 17.

In operation, oil enters the bottom of the hoist cylinder, by-passes the bottom bushing on the primary rod, then travels upward in the cavity between the outer shell and primary rod tot the packing at the top of the cylinder.

As pressure increases, the primary rod is forced out of the outer shell, carrying the secondary rod with it.

Not until the primary rod is fully extended does the hydraulic pressure force the se<ondary rod out. When this happens, air, which is between the primary and secondary rods, is forced into a passage to the center of the secondary rod. The passage is in the plug at the bottom of the rod.

During lowering, the primary rod enters the outer shell before the secondary rod is forced into the primary rod. If the lowering speed becomes too fast, the lowering control valve is acted upon to restrict the flow of oil leaving the cylinder. Consequently, the lowering speed is limited to a safe speed.

The lowering control valve is attached to the high pressure port in the base.

B. REMOVAL

1. Remove the carriage.

2. Raise and block the front of the truck high enough to enable the removal of the lowering control valve. Disconnect the two hydraulic hoses front the bottom of the cylinder. Remove the lowering control valve. Cap all hydraulic openings.

3. Attach a hoist slightly above the middle of the cylinder shell, and remove the slack from the slinging. Remove chain adjusting nuts from the bottom of the cylinder. Pull the anchors out of the base.

4. Unscrew the four capscrews securing the crosshead to the secondary rod. Secure the crosshead and guide assembly in a position above the cylinder.

5. Gradually lift the cylinder from the mounting pad, until the pilot is out of the pilot hole in the mounting pad.

NOTE:
It may be necessary to push in on the top and pull out on the bottom of the cylinder during lifting, in order to clear the fitting on the base of the cylinder.

C. DISASSEMBLY (Fig. 17)

NOTE:
If only the seals and packing are to be replaced, the entire cylinder assembly need not be disassembled.

1. With the cylinder in a horizontal position, pull the secondary rod out of the primary rod. Support the crosshead end of the rod.

NOTE:
A strap attached to the top of the secondary rod will aid in extracting the rod.

2. Using a spanner wrench, unscrew the bushing and seal assembly from the primary rod. Then, extract the secondary rod.

3. Support the secondary rod on both ends, being careful not to damage the packing assembly or the chromed surface. Slide the spacer rings, if so equipped, off the top end of the rod, and remove the spiral lock from the bottom. Pull the piston and packing off together.

NOTE:
If only the primary rod packing is to be serviced, it is not necessary to remove the base.

4. Push the primary rod toward the top about two inches. Remove dirt, nicks and burrs from the top of the primary rod. Pull the rod out of the bottom of the shell, being careful not to drag the rod over the inside surface of the shell.

NOTE:

A length of wood 2 x 2 maybe inserted into the top of the primary rod to aid in guiding the rod out of the shell.

5. Support the primary rod at both ends in a horizontal position. Remove the spiral lock from above the bushing at the bottom of the primary rod. Push the bushing toward the top of the rod and remove the ring from the rod. Slide the bushing off.

D. CLEANING AND INSPECTION

1. Clean all parts in solvent. Stand the secondary rod on end to allow oil and solvent to drain from above the packing.

2. Check packing for rounded, worn, scratched or torn lips. When installed in the primary bushing retainer, the packing should extend beyond the retainer. The secondary packing should extend beyond the piston. Replace packing if deteriorated, mutilated or if it does not extend beyond its respective retainer or piston.

3. Check the rods for nicks, burrs, scratches and rust. Slight defects may be removed with fine sandpaper. However, do not sand chrome plating off the outside of either rod. Chrome plating on the rods can be checked by applying copper sulfate to the rod. The rod will discolor where the chrome is gone and should be replated or replaced.

E. ASSEMBLY AND INSTALLATION (Fig. 17)

1. Assembly of the cylinder is in reverse of order in which it was disassembled. Lubricate all parts during assembly.

2. Install the base in its original position, being careful not to damage the O-ring and back-up ring.

3. Pour two pints of hydraulic oil with rust inhibitor additive into the cavity between the primary and secondary rods, before screwing the bushing into the top of the primary rod.

4. After the cylinder is installed, adjust the load chains.

THREE-STAGE UPRIGHT ASSEMBLY

A. GENERAL

Besides a three-stage hoist cylinder, a crosshead and guide assembly and a carriage, the three-stage upright is made up of three upright assemblies: (1) Inner Upright(2)Intermediate Upright (3) Outer Upright. The crosshead and guide assembly includes a crosshead, adapter plate, and a cylinder guide.

CARRIAGE

A. GENERAL

This is a hook-type assembly equipped with shim-adjusted canted load rollers. It is also equipped with a lug and lifting block that works in conjunction with the latching mechanism on the uprights. (Fig. 18)

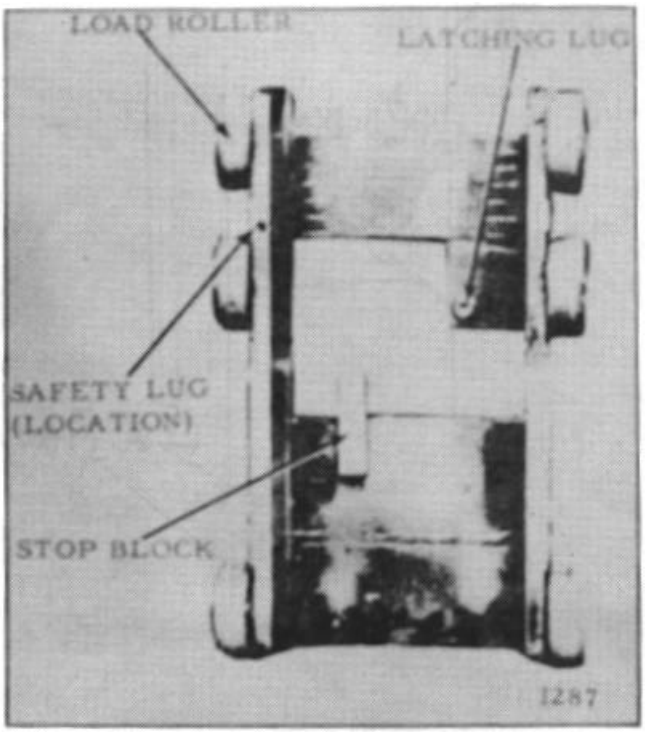


Figure 18.

The block lifts the inner upright while the lug triggers the latching mechanism, at the end of the carriage free-lift stroke. When the freelift stroke is completed, a latch on the inner upright is locked around the lug, securing the carriage to the inner upright.

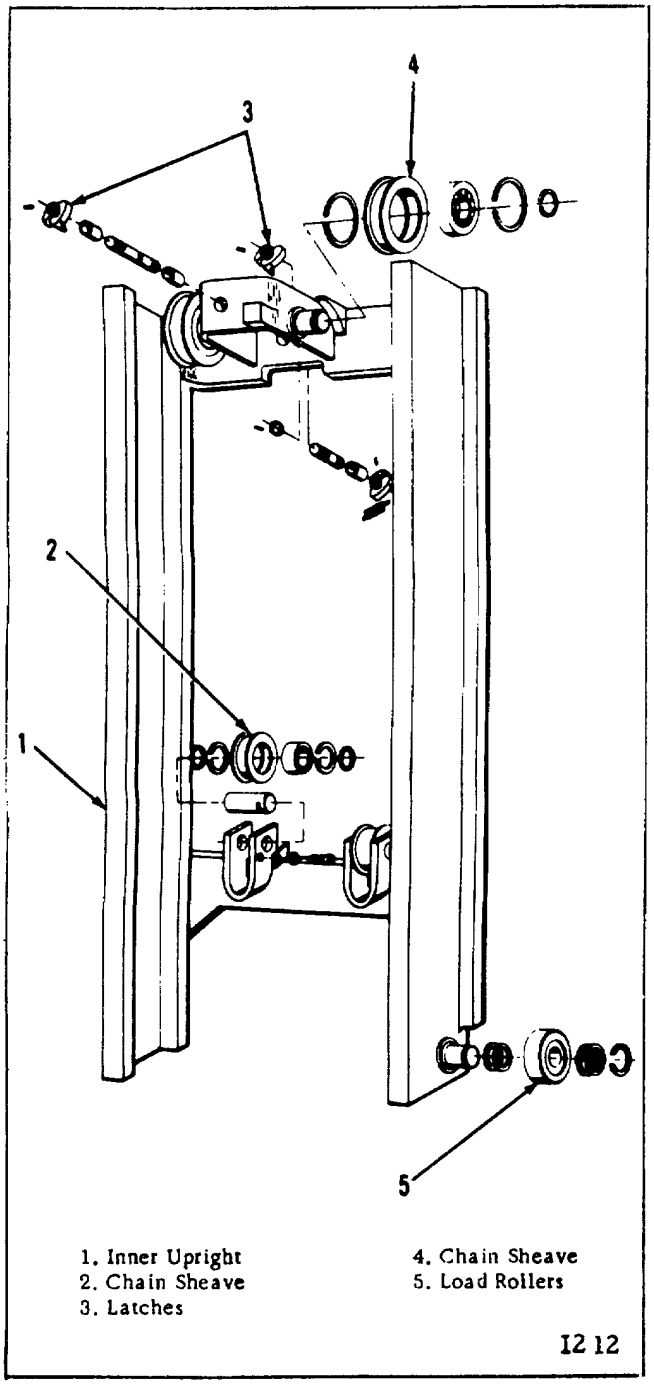


Figure 19.

B. SERVICING (Fig. 3)

For the removal, disassembly inspection and installation procedures, refer to FREE-LIFT UPRIGHT ASSEMBLY.

UPRIGHTS

A. GENERAL (Figs. 19, 20 and 21)

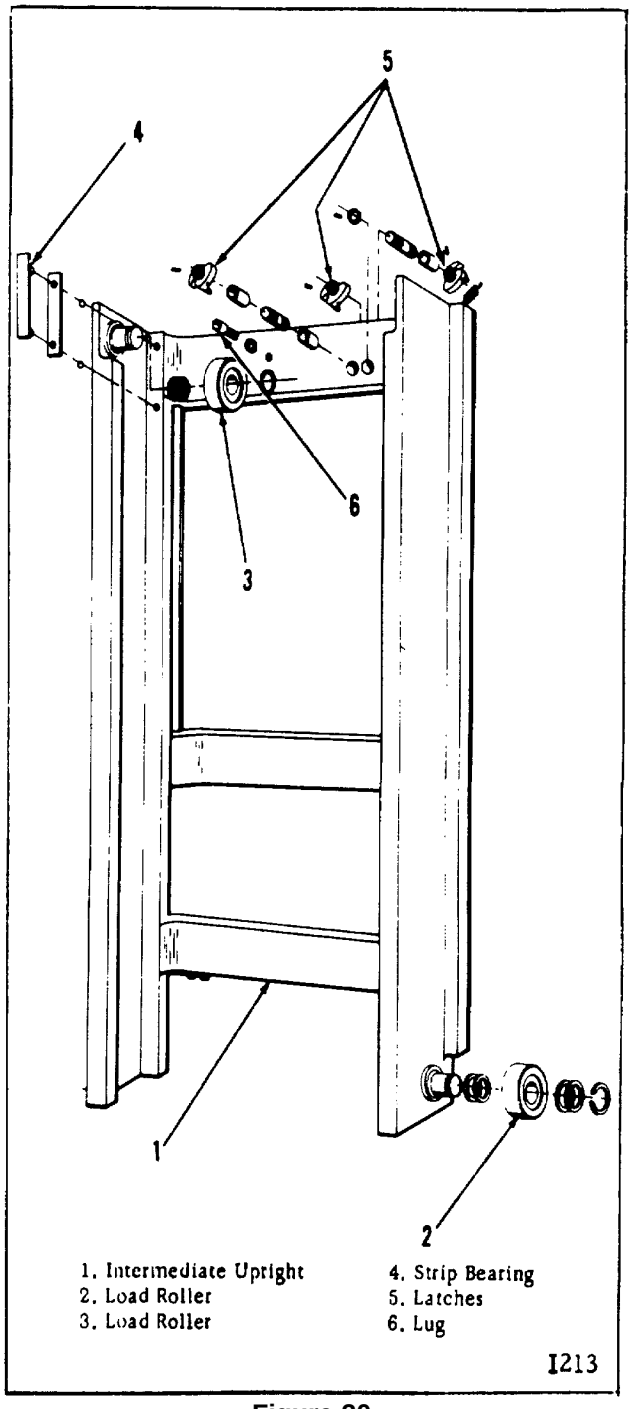


Figure 20.

Basically this assembly is made of three uprights: outer, inner and intermediate.

A latching mechanism is utilized to keep the uprights in the proper operating sequence. There are seven latches, all of which are located on the upper members of the inner and intermediate uprights.

Working in conjunction with the latches are five lugs (socket head capscrews). Two of these are located in front of the upper crossmembers of the intermediate and outer uprights. These, when engaged by latches, secure the three uprights together. The remainder of the lugs, one on the back of the crosshead, one on the adapter plate (Fig. 21) and one on the back of the upper crossmember of the carriage (Fig. 18) trigger the latching mechanism at the proper time to release one upright from the other. A sixth lug, located on the back of the left vertical member of the carriage, is a safety lug and does not function with the latch mechanism.

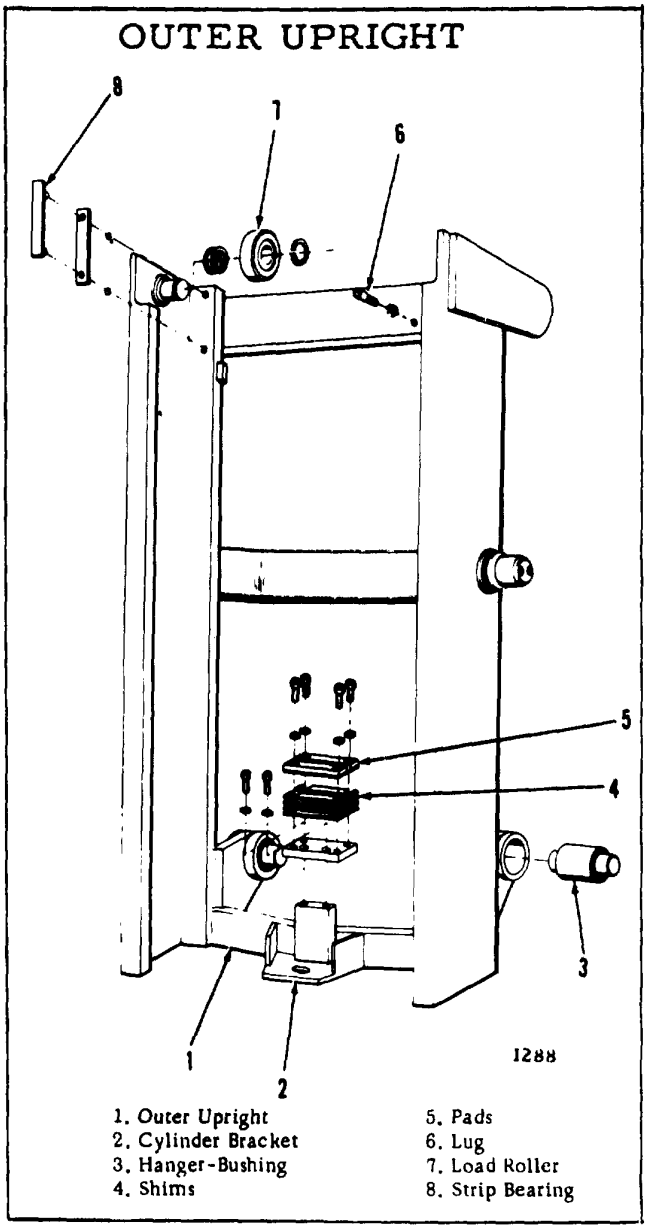


Figure 21.

Inner Upright: Besides the latches, the inner upright has two load rollers, four chain sheaves and a box. The box is welded to the front of the upper crossmember. (Fig. 19) The two load rollers are located at the bottom of the upright, one on each outer side. Located on each side of the box is a chain sheave. The other two sheaves are located on the lower crossmember. The brackets to which these sheaves are attached have guards that prevent the load chains from jumping off the sheaves under certain operating conditions.

Of the four latches on the inner upright, two are located in back of the upper crossmember, one Is in the box, and the other is in front of the box.

Looking from the driver's seat, the two right latches (front and rear) are splined and pinned to a common shaft. The same is true for the left latches. The latch in the box is in line with a lug on the crosshead. The latch on the front of the box is in line with a lug on the carriage.

Welded on the front of the box is a block. This block is a stop, which when contacted by a block on the carriage, prevents further raising of the carriage.

Intermediate: Of the three latches on the intermediate upright, two are on the back of

the upper crossmember and one is on the front.

The front latch and the right rear latch are splined and pinned to a common shaft. Also on the front of the same crossmember is a lug. (Fig. 20)

Situated on the inside front face at the top of each rear channel flange is a shim-adjusted strip bearing. In front of these bearings are two load rollers. Two more rollers are located at the bottom, one on the outer side of each channel.

Welded to the back of each channel is a cylinder guide rail. Sliding on the rails is a cylinder guide. The guide is shim-adjusted to the rails to slide freely with minimum looseness. (Fig. 22)

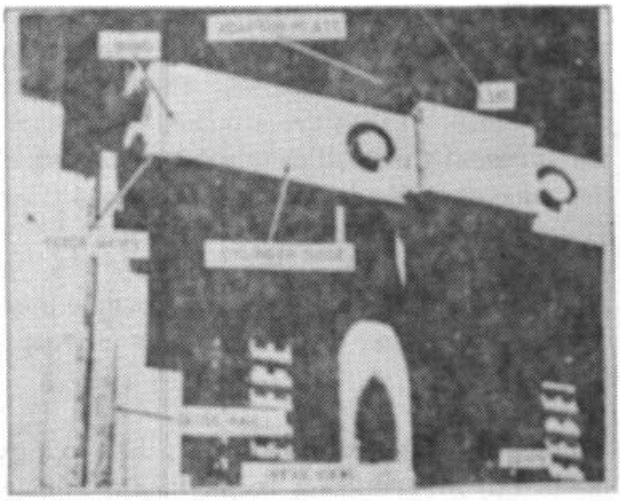


Figure 22.

Outer Upright: A shim-adjusted strip bearing is located on the front face at the top of each rear channel flange. (Fig. 21) Directly in front of each strip bearing is a load roller. In the same vicinity and attached to the back is a stop plate. This plate is in line with the stop block on the intermediate upright.

Located on the front of the upper crossmember is a lug, which works in conjunction with the latching mechanism.

The hoist cylinder is supported by the lower crossmember. Attached to the crossmember and positioned in back of the cylinder are two shim-adjusted pads on which the inner and intermediate uprights rest. (Fig. 23)

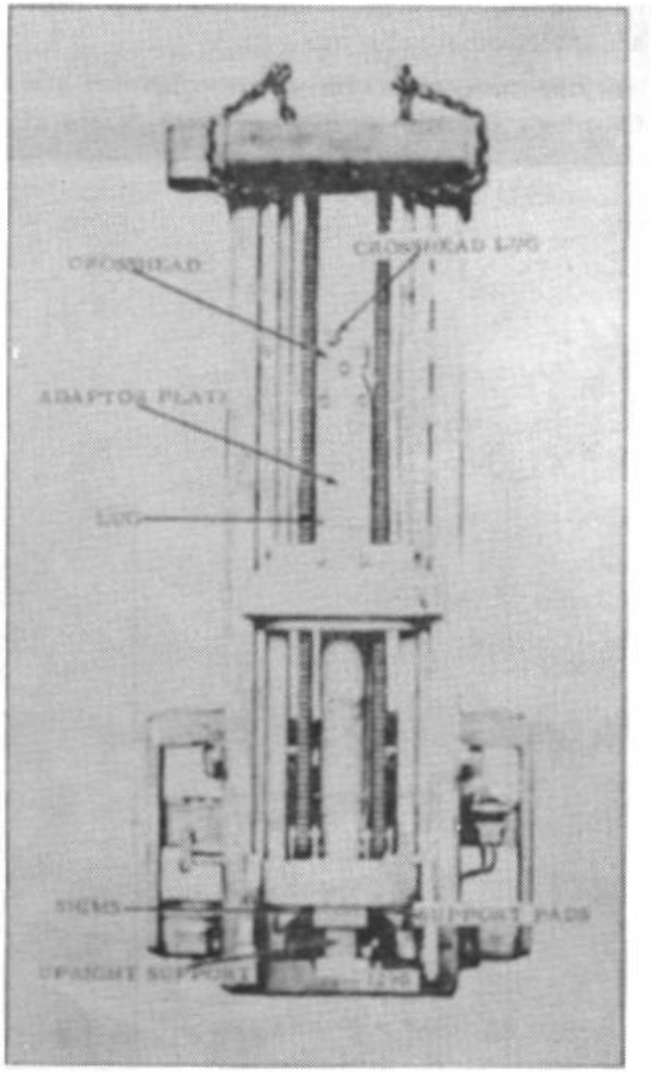


Figure 23.

In the lowered position: The carriage is free to travel up; the inner upright is latched to the intermediate; the intermediate upright is latched to the outer. The left latch engages the intermediate upright and a right latch engages the outer upright. Each latch is locked in position by the adjacent latch.

At the beginning of the first stage of operation, the

primary and secondary rods are forced out of the cylinder shell. The guide and crosshead assembly, being attached to the top of the secondary rod, moves up. At this time the carriage, which travels twice as fast as the crosshead, is free-lifting.

The carriage will free-lift until the top lug on the back of the crosshead engages and rotates the latch in the box. (Fig. 24) Also, at the same time, a shoulder on the back of the crosshead contacts the upper crossmember of the inner upright. (Fig. 25) Since the left latch is now free to rotate, it does so while the inner upright rises. The right latch will rotate until it rests against and locks the left latch around the top lug on the crosshead.

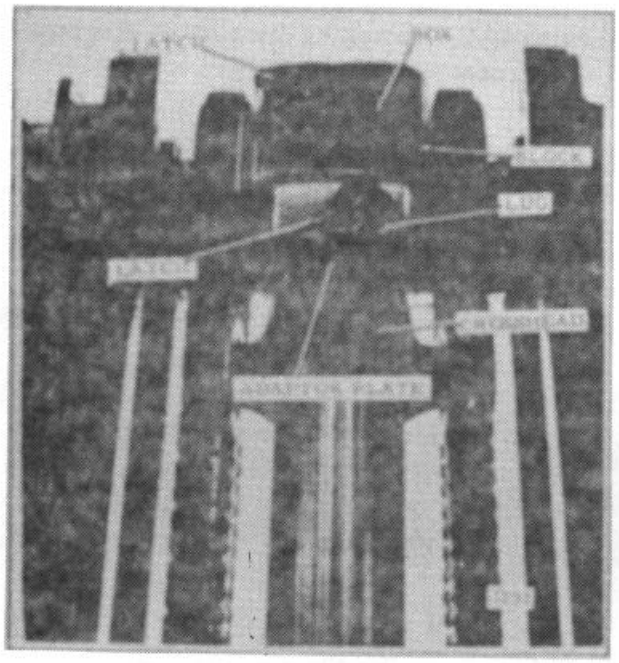


Figure 24.

The second stage begins after the inner upright is free to rise. At this time, the crosshead is latched to the inner upright, and the intermediate upright is latched to the outer. The inner upright is free to rise. The secondary rod in the cylinder will move out of the primary rod when the primary rod reaches the end of its travel.

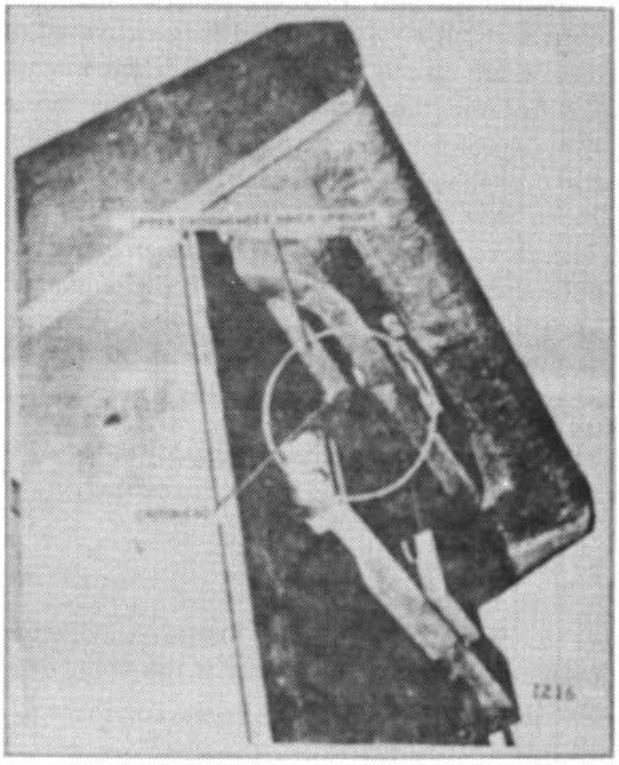


Figure 25.

As the inner upright is extended, the cylinder guide makes contact with the upper crossmember on the intermediate upright. (Fig. 26)

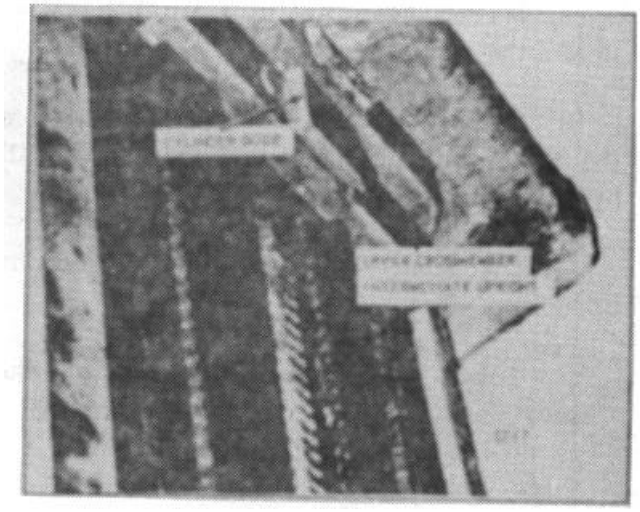


Figure 26.

At the same time the lug on the adapter plate engages and rotates the front latch on the intermediate upright, unlocking the rear latch. With the rear latch free to

rotate, the intermediate upright will be pushed up by the cylinder guide. The second stage will continue until a lug on the back of the carriage engages and rotates the front latch, unlocking the left rear latch of the inner upright. This releases the crosshead from the inner upright.

The third stage begins when the crosshead is unlatched from the inner upright and rises until the cylinder is fully extended. When this occurs, the center load rollers of the carriage are at the top of the inner upright.

The sequence of events during lowering of the upright is the reverse of the foregoing.

B. REMOVAL

1. Remove the load arms. Loosen the cylinder guide screws only if the hoist cylinder is to be removed,

2. Attach a hoist to the top of the upright assembly, making sure that the inner, intermediate and outer uprights are secured by the slinging, Remove slack from the slinging,

3. Mark hanger caps to facilitate installation in the original position.

4. Disconnect the hydraulic lines from the bottom of the hoist cylinder. Cap all hydraulic openings.

5. Disconnect the tilt cylinders from the upright.

6. Lower the upright assembly from the frame.

C. DISASSEMBLY

1. Place the upright assembly in a horizontal position and support it on both ends of the outer upright.

2. Remove the safety lug from the back of the carriage.

3. Disconnect the load chains from the carriage and slide the carriage out of the bottom of the inner upright, using a sling and a hoist to support it when the load rollers clear the channels.

4. Remove the chain adjusting nuts from the chain anchors. Pull the anchors and chains off their respective rollers.

5. Remove the lowering control valve from the bottom of the cylinder, and the screws attaching the cylinder guide to the crosshead.

6. Attach a hoist to the cylinder, and remove the slack from the slinging. Slide the cylinder toward the top of the uprights far enough to disengage the hoist pilot from the hole in the mounting pad. Lift the cylinder and crosshead assembly out.

7. Remove the guide stop screws from the bottom of the guide rails, Slide the cylinder guide towards the bottom of the upright until it is clear of the guide rails, Lift the guide out, It is not necessary to remove the guide shoes from the guide unless they are worn or need adjusting.

8. Working with the two rear latches on the inner upright, rotate the left latch while pulling out on the inner upright. Release the left latch when the lug disengages the right latch.

9. Pull inner upright out far enough to enable removing the lug that locks the inner upright to the intermediate and the pad near the bottom of the uprights. Remove the pad and the lug.

10. Slide the inner upright down. Remove the load rollers from the bottom of the inner upright and the load rollers from the top of the intermediate upright.

11. With the aid of a hoist and sling, slide the inner upright out of the top of the intermediate upright.

12. Remove the strip bearings and shims from the top of the intermediate upright channels. Identify bearings and shims so that they may be installed in their original positions during assembly.

13. Remove the intermediate upright in the same manner in which the inner upright was removed, using steps 8 through 12 as a guide.

14. Remove the chain sheaves only if inspection reveals that they are defective.

D. CLEANING AND INSPECTION

Refer to FREE-LIFT UPRIGHT ASSEMBLY.

E. ASSEMBLY AND INSTALLATION

1. Install parts in reverse of order in which they were removed.

2. If latches have been removed, make sure these are installed in the splines as they were originally. Retaining pins must not interfere with latch operation, and latches must be tight on the shafts. Refer to "C", Figure 27.

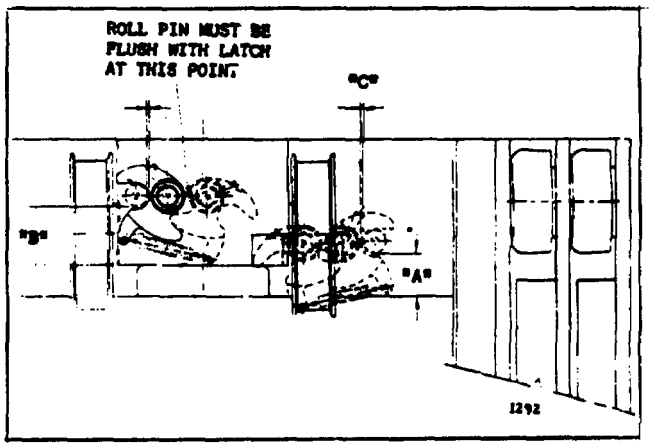


Figure 27.

3. Check latching mechanism. Make sure that the right rear latch on the intermediate upright locks around its respective lug at the top of the outer upright, and that the right rear latch on the inner upright locks around the lug on the intermediate upright, when the upright assembly is collapsed. Both of these latches should be locked in position by the left latch of each upright.

4. Adjust the cylinder guide shoes with crosshead centered in inner upright. Shim guides so that they will slide freely the full length of the guide rails with a maximum total clearance of 1/16 inch.

5. There should be 3/32 plus or minus 1/16 inch vertical clearance between the lugs on the outer and the intermediate uprights and their respective latches, with uprights collapsed. Refer to "C", Figure 27. If not as specified, transpose load roller shims as necessary.

6. After installation and with upright fully collapsed, measure the distance from the bottom of the upper crossmember on the inner upright. The distance should be 1-11/32 inches. Refer to "A", Figure 27. If not as specified, add or delete shims under the resting pad of the inner upright. To decrease the distance, add shims. To increase the distance, remove shims.

7. Measure and adjust, if necessary, the distance from the bottom of the lug at the top of the outer upright to the bottom of the upper crossmember of the intermediate upright. The distance should be 1-7/8 inches. Refer to "B", Figure 27. If not as specified, add or delete shims under the intermediate upright resting pad, as necessary.

HOIST CYLINDER

This assembly is the same as its free-lift counterpart. Refer to FREE-LIFT UPRIGHT ASSEMBLY.

TILT CYLINDERS

A. GENERAL

Two double-acting cylinders are used to control the tilt angle of the upright. Each cylinder is equipped with self-adjusting chevron packing. Before servicing the cylinder, precautions should be taken to insure cleanliness, as with all types of hydraulic equipment.

B. REMOVAL

NOTE:
If both cylinders are to be removed, place a 2 x 6 inch block beneath the outer upright channels.

1. Remove the cotter pin and anchor pin at the upright. (Fig. 28)

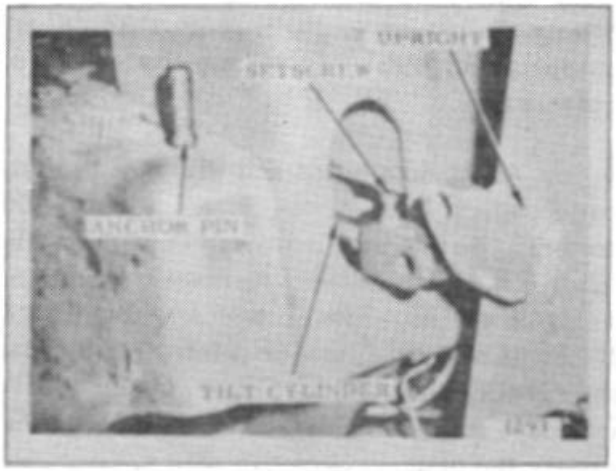


Figure 28.

2. Remove the floor plates. (Fig. 29) Disconnect the hydraulic lines at the cylinders and cap all openings to prevent foreign matter from entering the system.

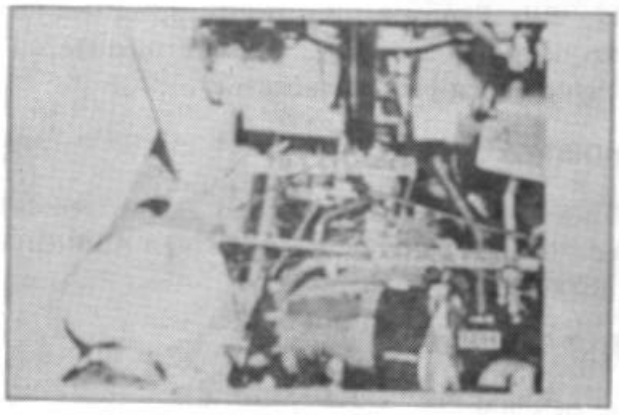


Figure 29.

3. Remove cotter and anchor pin from the anchor point on the main frame.

4. Lift the cylinder from the truck.

C. DISASSEMBLY (Fig. 30)

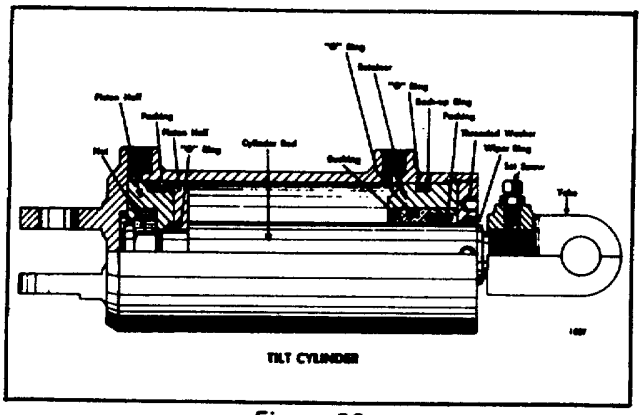


Figure 30.

1. Loosen set screw. (Fig. 31) Unscrew the threaded washer. (Fig. 32) Pull the piston rod and packing gland assembly from the shell. (Fig. 33)

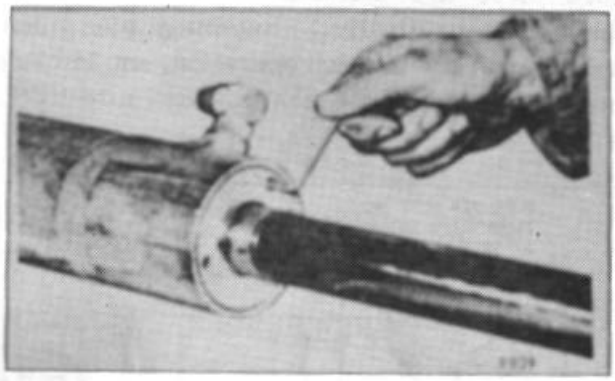


Figure 31.

Figure 32.

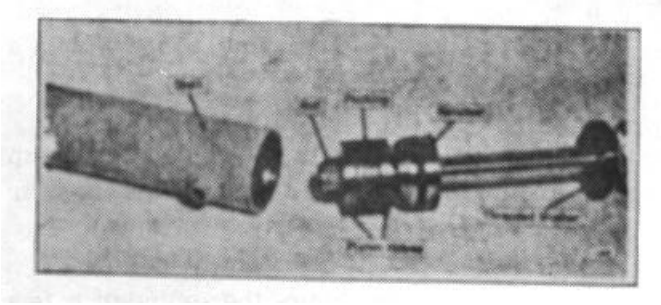


Figure 33.

2. Remove the nut from the end of the piston rod.

3. Slide the rear piston half off the rod. Remove packing and front piston half. For exploded view of packing assembly, see Figure 34.

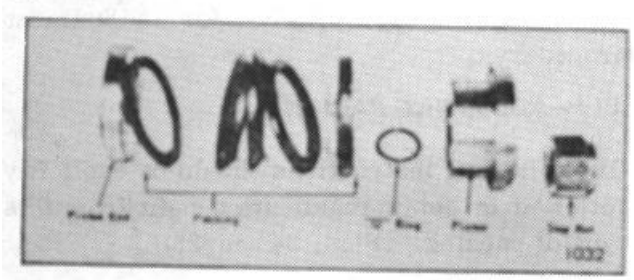


Figure 34.

4. Remove bushing and retainer from the rod. Push the bushing from the retainer. Remove the packing from the bushing. For exploded view of bushing and retainer assembly, see Figure 35.

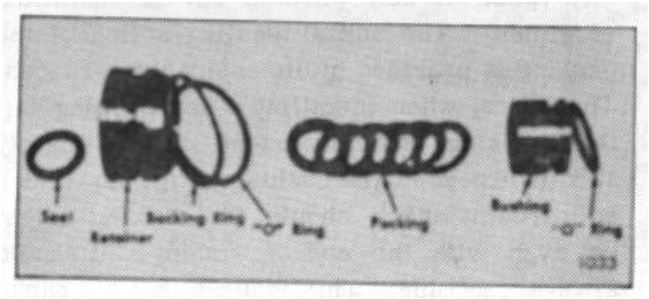


Figure 35.

D. CLEANING AND INSPECTION

1. Clean all parts in solvent.

2. Check the packing for rounded, worn, scratched or torn lips. When installed in the primary bushing retainer, the packing should extend beyond the retainer. The secondary packing should extend beyond the piston. Replace packing if deteriorated, mutilated or if it does not extend beyond its respective retainer or piston.

3. Check the rods for nicks, burrs, scratches and rust. Slight defects may be removed with fine sandpaper. However, do not sand chrome plating off the outside of either rod. Chrome plating on the rods can be checked by applying copper sulphate to the rod. The rod will discolor where the chrome is gone and should be replated or replaced.

E. ASSEMBLY

Use new O-ring, packing and wiper.

NOTE
Packing should be replaced in sets.

1. Lubricate all parts and inside of cylinder with hydraulic oil.

2. Press wiper in the wiper bore of threaded washer.

3. Push threaded washer on the rod, do not make contact between wiper and rod threads.

4. Install O-ring on bushing.

NOTE
Do not stretch to facilitate easier installation. Do not cut or damage ring on sharp edges. Make sure the ring is not twisted after installation.

5. Place packing in counterbore of bushing with lips toward the bottom of the bore.

6. Place back-up ring and O-ring on the retainer. The back-up ring should be toward the larger diameter of the retainer.

7. Hand press the bushing into the retainer

Make sure the O-ring starts in evenly and is not pinched or cut during assembly.

NOTE

With the bushing seated in the retainer and a new packing set in place, the packing may extend beyond the end of retainer about 1/16 of an inch. (Fig. 36)

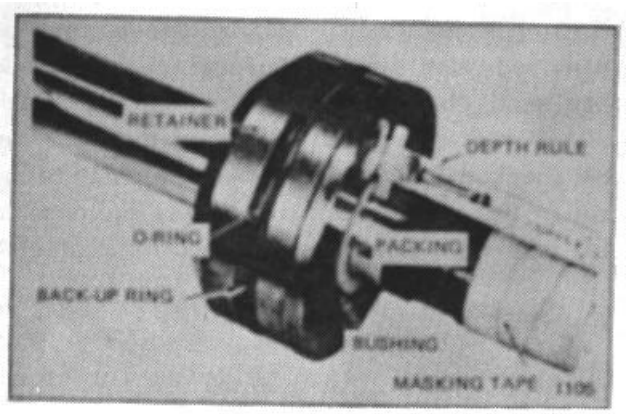


Figure 36.

8. Push bushing and retainer assembly on the piston rod from the piston end of the rod. Pushing from the opposite end may damage packing lips.

9. Place flat piston half in position on the rod. Install packing on the remaining half, with lips away from the flange.

10. Place O-ring on rod, at a position halfway between rod threads and piston half.

11. Slide piston half with packing on the rod until contact is made with the O-ring.

12. Make sure the O-ring starts in the piston counterbore evenly and continues to move in as the piston is pushed into position next to the previously installed piston half.

13. Secure piston in position with nut.

14. Slide threaded nut toward the piston end until retainer and bushing contact the piston.

15. Push the piston into the cylinder bore until retainer makes contact with the cylinder.

16. Work the retainer into position with a steady, even pressure.

CAUTION

Make sure the O-ring and back-up ring are not damaged as they pass the chamfer of the cylinder bore.

17. Turn washer into the cylinder a few turns. Push piston back and forth a few times to eliminate any slight mis-alignment. Turn threaded washer all the way into the cylinder. Tighten set screw.

F. INSTALLATION

Use reverse of removal procedure. Refer to UPRIGHT ADJUSTMENTS for adjustment procedures.

SELF-ADJUSTING PACKING

The following instructions should be explicitly followed to obtain maximum benefit from this type of packing. (Figs. 34 and 35)

1. The stack height (A), Figures 37 and 38, of the packing should be such as to fit just snug in the installed position. There should not be any excessive preloading of the packing. However, the bushing may extend approximately 1/16 inch beyond the retainer, especially when a new packing set is installed. (Fig. 36) The initial sealing action of the packing is provided by dimensional tolerances. Therefore, when installing a new packing set, the packing should extend approximately 1/8 inch beyond the bushing. (Fig. 39) Under no circumstances should the packing height be even with the end of bushing. It should always protrude. This insures that the packing lips will seal on the initial surge.

2. Any excessive preloading of the packing will give a corresponding shortening of the packing life.

3. The self-adjusting feature of the retainer assembly or piston will give extra sealing action at the

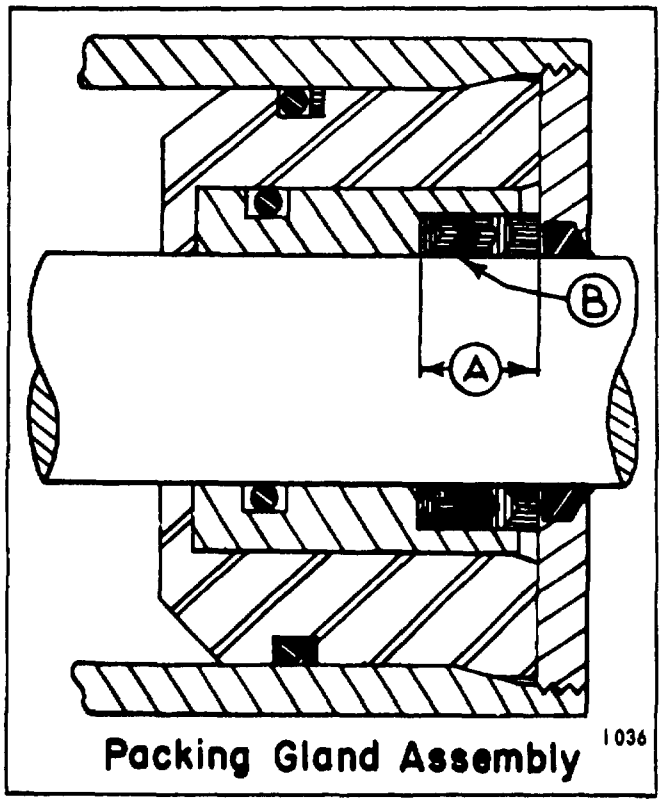


Figure 37.

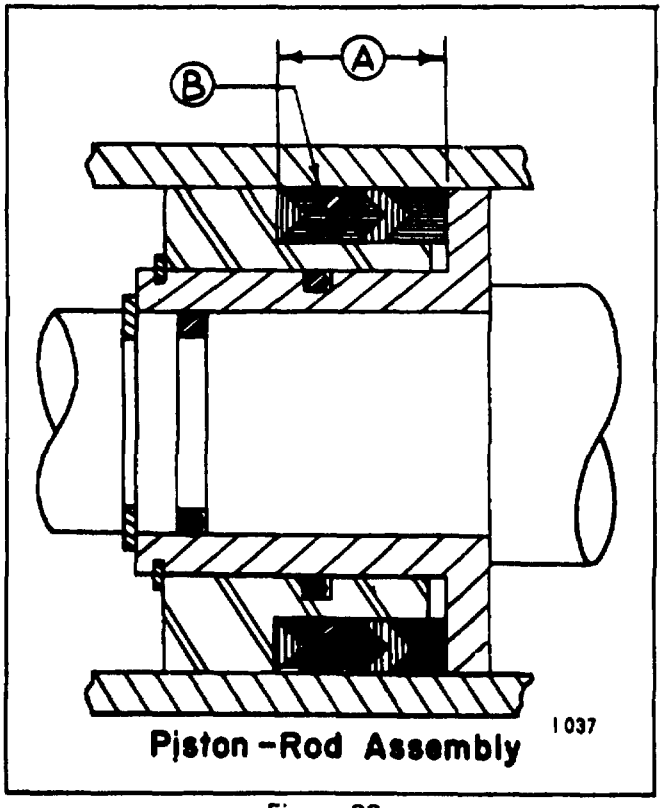


Figure 38.

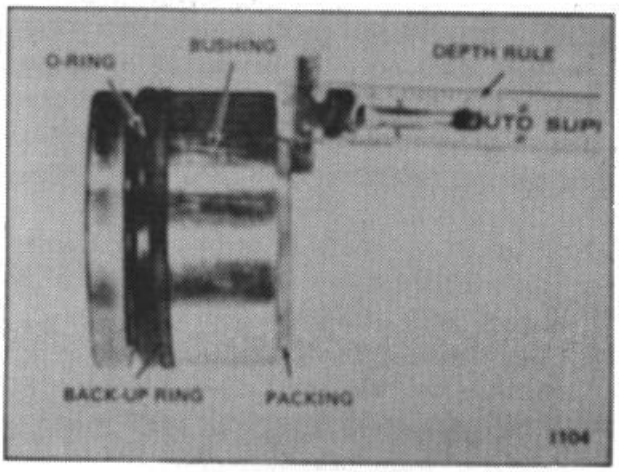


Figure 39.

higher pressures. The neophrene packing (B), Figures 37 and 38 is to provide extra sealing action at low pressure.

UPRIGHT ADJUSTMENTS

A. TILT CYLINDER

Since the tilt cylinders are mounted individually, it is important that the yoke on each cylinder be properly adjusted to prevent binding in the tilting mechanism when the cylinder pistons bottom at the end of their stroke. A hole is provided in the yoke end of the piston rods to facilitate turning the rod to make this adjustment. (Fig. 38)

1. Loosen set screw.

2. Actuate tilt lever until one of the cylinders reaches the end of its stroke, or bottoms.

3. Adjust other cylinder until it bottoms.

NOTE

The rod may have to be turned a little to line up the flat with the set screw. Be sure the rod threads are fully engaged with the yoke.

B. CARRIAGE

NOTE

The following applies to the standard and free-lift hoist assemblies. All that is required of the three-stage

hoist carriage is that the center of the carriage load roller be at least 1/4 inch above the bottom of the inner upright. The uprights must be collapsed and a rated load imposed upon the load arms, when checking roller position.

1. Place the truck on level ground with the uprights vertical.

2. Fully extend the uprights making certain the carriage stop does not contact the stop at the top of the inner upright. A minimum clearance of 1/4 inch must be maintained at this point with equal tension on the chains. On free-lift models, this adjustment must be made at the end of the free-lift or primary stroke.

CAUTION

After the above adjustment has been made, never shorten the chains by further adjustment.

3. Lower the carriage all the way down. If the load arms are resting on the ground, make no further adjustments. However, if the heels of the load arms do not touch the ground, the chains may be lengthened until the heels touch.

4. Periodic rechecks should be made to compensate for wear and chain stretch by repeating steps 1 through 3.

5. The carriage stops are not designed to withstand the pressure exerted by the hoist cylinder. These stops are merely to prevent the upright from lowering if the load arms are still beneath a stacked load.

CAUSE	REMEDY
<u>No Motion Of Hydraulic Cylinders</u>	
1. No oil or insufficient oil being supplied to cylinder	1. Check the hydraulic system for: defective pump or pump drive; vacuum or pressure leak in lines; low relief setting; relief valve stuck open; low reserve oil level; disconnected control valve linkage. Repair defective unit. Cold oil or unspecified oil in system: allow oil to warm before working truck; drain system and fill with specified oil.
2. Load too heavy	2. Reduce load.
<u>Slow Motion</u>	
1. Insufficient oil being supplied to cylinder	1. Refer to "No motion of hydraulic cylinders," Remedy 1.
2. Worn cylinder-piston packing	2. Replace packing.
3. Linkage between handlever and plunger worn or broken	3. Repair or replace linkage.
4. Structural warpage, clearance too close, lack of lubricant	4. Check upright alignment, repair, adjust and lubricate uprights as necessary.
<u>Spongy Or Jerky Action</u>	
1. Air in system	1. Check reserve oil level, fill tank as necessary. Check inlet side of pump for vacuum leaks. Tighten connections; repair or replace connection or hose as necessary.
2. Sticky relief valve	2. Remove and check the relief valve in the manual control valve. Repair or replace parts as necessary. If foreign particles were the cause of malfunction, check reserve oil for contamination. Whenever reserve oil is contaminated it should be replaced, the filters serviced, making sure the sealing surfaces are mating properly and the filter elements are not ruptured.
3. Bent or deformed cylinder-piston rod or plunger.	3. Disassemble, check and repair cylinder assembly.

TROUBLESHOOTING

CAUSE	REMEDY
4. Strip bearings or thrust plugs improperly adjusted or insufficient lubrication.	4. Delete shims from strip bearings until smooth operation is attained. Unscrew each thrust plug equally, until smooth operation is attained. Lubricate sliding surfaces.
5. Too many shims behind load rollers on carriage.	5. Delete shims until smooth operation is attained.
6. Latching mechanism improperly adjusted. This condition is sometimes accompanied with a scraping and/or popping noises	6, Check: Adjustment, latches and bushings for wear, allen-head screws on carriage and cylinder for wear or looseness. Repair as necessary. Add or delete pad-bracket shims as necessary to maintain proper latch-to-latch clearance. Adjust horizontal clearance with thrust plugs.
<u>Inner Upright Raises Before End Of Free-Lift Travel</u>	
1. Allen-head screw on upper crossmember of outer upright missing or broken.	1. Install new screw.
2. Rear latch broken or turning on shaft.	2. Install new latch and/or pin.
3. Shaft turning in front latch (nearest to channel) or latch broken	3. Install new latch and/or pin.
4. Latching mechanism not locking Free-up mechanism. Add or delete pad-to-bracket shims. Adjust horizontal clearance between latches. Check for worn or broken parts; replace as necessary.	4. Check and replace spring if necessary.

NOTE

Whenever the latching mechanism is found to be broken or worn excessively, always check uprights and carriage load rollers for binding and maladjustments.

<u>Uprights Fail To Lower Or Will Not Lower Completely (No Load)</u>	
1. Uprights binding, too many shims between strip bearings and uprights or carriage and load rollers.	1. Delete shims as necessary to allow smooth lowering.

CAUSE	REMEDY
2. Damaged hoist cylinder.	2. Repair or replace cylinder.
3. Latching mechanism in wrong position, defective or will not release	3. Check and change position of latching mechanism as necessary. During free-lift: The inner latch should be locking the outer latch in position; the rear latch should engage the allen-head screw on the upper crossmember of the outer upright. Check entire mechanism for sheared pins, broken screws, worn bushings and maladjustment. Rotate inner latch by hand. The latch should return to rest position quickly, when released, if it does not, the shaft is binding or the spring has not enough tension. Repair latching as necessary.

NOTE

Generally, there is no latch-to-latch contact made throughout the entire lifting and lowering sequence. However, due to binding under certain conditions, the inner upright may attempt to move out of phase. This is prevented by the latching mechanism and at this time there is a latch-to-latch contact.

<u>Inner Upright Will Not Raise At The End Of The Free-Lift Stroke</u>	
1. Allen-head screw on the hoist cylinder and/or its mating latch broken	1. Replace. Check: The carriage load rollers for excessive binding; latching mechanism for freedom of operation and worn bushings. Replace parts and adjust as necessary to restore normal latch function,
<u>Load Drops Slightly - (Tilt And Hoist Cylinders Control Valve Plunger In Neutral</u>	
1. Scored check valve in control valve	1. Reseat check valve. Replace control valve parts as necessary.
2. Oil by-passing tilt cylinder	2. Replace packing and other cylinder parts as necessary.
3. Oil leakage past plunger	3. Replace plunger or control valve assembly, if necessary.
4. Oil leakage at hydraulic connections or defective hoses	4. Tighten fittings. Replace fittings and/or mating component or hoses as necessary.

APPENDIX 1

BASIC ISSUE ITEMS LIST

Section I. INTRODUCTION

1-1. Scope.

This appendix lists items which accompany the fork lift truck or are required for installation, operation, or operator's maintenance.

1-2. General.

This Basic Issue Items List is divided into the following sections:

a. Basic Issue Items - Section II. A list of items which accompany the fork lift truck and are required by the operator/crew for installation, operation, or maintenance.

b. Maintenance and Operating Supplies - Section III. A listing of maintenance and operating supplies required for initial operation.

1-3. Explanation of Columns.

The following provides an explanation of columns in the tabular list of Basic Issue Items, Section II.

a. Source, Maintenance, and Recoverability Codes (SMR):

(1) Source code, indicates the selection status and source for the listed item. Source codes are:

Code	Explanation
P	Repair parts which are stocked in or supplied from the GSA/DBA, or Army supply system and authorized for use at indicated maintenance categories.
M	Repair parts which are not procured or stocked, but are to be manufactured in indicated maintenance levels.
A	Assemblies which are not procured or stocked as such, but are made up of two or more units. Such component units carry individual stock numbers and descriptions, are procured and stocked separately and can be assembled to form the required assembly at indicated maintenance categories.

Code	Explanation
X	Parts and assemblies which are not procured or stocked and the mortality of which normally is below that of the applicable end item or component. The failure of such part or assembly should result in retirement of the and item from the supply system.
X1	Repair parts which are not procured or stocked. The requirement of such items will be filled by use of the next higher assembly or component.
X2	Repair parts which are not stocked. The indicated maintenance category requiring such repair parts will attempt to obtain them through cannibalization. Where such repair parts are not obtainable through cannibalization, requirements will be requisitioned, with accompanying justification, through normal supply channels.
C	Repair parts authorized for local procurement. Where such repair parts are not obtainable from local procurement, requirements will be requisitioned through normal supply channels accompanied by a supporting statement of nonavailability from local procurement.
G	Major assemblies that are procured with PEMA funds for initial issue only as exchange assemblies at DBU and GSU level. These assemblies will not be stocked above OS and DS level or returned to depot supply levels.

(2) Maintenance code, indicates the lowest category of maintenance authorized to install the listed item. The maintenance level code is:

Code	Explanation
C	Operator/crew

(3) Recoverability code, indicates whether unserviceable items should be returned for recovery or salvage. Items not coded are expendable. Recoverability codes are:

Code	Explanation
R	Applied to repair parts (assemblies and components) which are considered economically repairable at direct and general support maintenance levels. When the maintenance capability to repair these items does not exist, they are normally disposed of at the GS level. When supply considerations

Code	Explanation
	dictate, some of these repair parts may be listed for automatic return to supply for depot level repair as set forth in AR 710-50. When so listed, they will be replaced by supply on an exchange basis.
S	Repair parts and assemblies which are economically repairable at DSU and GSU activities and which normally are furnished by supply on an exchange basis. When items are determined by a GSU to be uneconomically repairable they will be evacuated to a depot for evaluation and analysis before final disposition.
T	High dollar value recoverable repair parts which are subject to special handling and are issued on an exchange basis. Such repair parts are normally repaired or overhauled at depot maintenance activities.
U	Repair parts specifically selected for salvage by reclamation units because of precious metal content, critical materials, or high dollar value reusable casings or castings.

b. Federal Stock Number. This column indicates the Federal stock number assigned to the item and will be used for requisitioning purposes.

c. Description. This column indicates the Federal item name and any additional description of the item required.

d. Unit of Measure (U/M). A 2 character alphabetic abbreviation indicating the amount or quantity of the item upon which the allowances are based, e.g., ft, ea, pr, etc.

e. Quantity Incorporated in Unit. This column indicates the quantity of the item used in the assembly group. A "V" appearing in this column in lieu of a quantity indicates that a definite quantity cannot be indicated (e.g., shims, spacers, etc.).

f. Quantity Furnished With Equipment. This column indicates the quantity of an item furnished with the equipment.

g. Illustration. NOT APPLICABLE.

1-4. Explanation of Columns in the Tabular List of Maintenance and Operating Supplies - Section III.

a. Component Application. This column identified the component

application of each maintenance or operating supply item.

b. Federal Stock Number. This column indicates the Federal stock number assigned to the item and will be used for requisitioning purposes.

c. Description. This column indicates the item name and brief description.

d. Quantity Required for Initial Operation. This column indicates the quantity of each maintenance or operating supply item required for initial operation of the equipment.

e. Quantity Required for 8 Hours Operation. This column indicates the estimated quantities required for an average 8 hours of operation.

f. Notes. This column indicates the informative notes keyed to data appearing in a preceding column.

SECTION II. BASIC ISSUE ITEMS

(1) SMR Code	(2) Federal Stock Number	(3) Description	(4) Unit of meas	(5) Qty inc in unit	(6) Qty furn with equip	(7) Illustration (a) Fig No.	(7) Illustration (b) Item No.
PC	7510-889-3494	Binder, Looseleaf	EA	1			
PC	7520-559-9618	Case, Maintenance and Operation Manuals	EA	1			
PC	4210-889-2221	Extinguisher, Fire, 2 1/2 lb. Fed. Spec. 0-E95	EA				
		Department of the Army Technical Manual TM 10-3930-607-15	EA	1			
		Department of the Army Lubrication Order LO 10-3930-607-12	EA	1			

SECTION III. MAINTENANCE AND OPERATING SUPPLIES

(1) COMPONENT APPLICATION	(2) FEDERAL STOCK NUMBER	(3) DESCRIPTION	(4) QUANTITY REQUIRED F/INITIAL OPERATION	(5) QUANTITY REQUIRED F/8 HRS OPERATION	(6) NOTES
AIR CLEANER	.....	drum as follows:			(1) Includes quantity of oil to fill engine oil system as follows: 4 qt - Crankcase 1 qt - Oil filter
	9150-265-9435(2)	OE 30	1/2 qt	(3)	
	9150-265-9428(2)	OE 10	1/2 qt	(3)	
	9150-242-7603(2)	OES	1/2 qt	(2)	
CRANKCASE	.....	OIL LUBRICATING: (1)			
		OE 30	4 1/2 qt	(3)	(2) See C9100-IL for additional data and requisitioning procedures.
		OE 10	4 1/2 qt	(3)	
		OES	4 1/2 qt	(3)	
DRIVE AXLE GEARCASE		OIL LUBRICATING, GEAR: 5 gal drum as follows:			(3) See current L.O. for grade application and replenishment intervals.
	9150-577-5847(2)	GO 140	21 pt	(3)	
	9150-577-5844(2)	GO 90	21 pt	(3)	
	9150-257-5440(2)	GOS	21 pt	(3)	(4) Fuel tank capacity
HYDRAULIC BRAKE CYLINDER	9150-252-6375(2)	BRAKE FLUID: Automotive 1 gal can as follows: HBA	1/2 PT		
HYDRAULIC RESERVOIR		OIL LUBRICATING: 55 gal drum as follows:			
	9150-265-9430(2)	OE 10	32 qt	(3)	
	9150-242-7605(2)	OES	32 qt	(3)	
RADIATOR	.....	WATER	10 qt		
		ANTIFREEZE 5 gal can as follows:			
	6850-224-8730	ETHYLENE GLYCOL, type 1	6 qt		
		ANTIFREEZE: 55 gal drum as follows:			

SECTION III. MAINTENANCE AND OPERATING SUPPLIES

(1) COMPONENT APPLICATION	(2) FEDERAL STOCK NUMBER	(3) DESCRIPTION	(4) QUANTITY REQUIRED F/INITIAL OPERATION	(5) QUANTITY REQUIRED F/8 HRS OPERATION	(6) NOTES
	6850-174-1806	Arctic grade	10 qt		
FUEL TANK	.....	FUEL, GASOLINE: bulk as follows:			
	9130-160-1818(2)	Automotive combat 91A	8 gal (4)		
	9130-160-1830(2)	Automotive combat 91C	8 gal (4)		
TRANSMISSION	.....	OIL LUBRICATING: 55 gal drum as follows:			
	9150-265-9430(2)	OE 10	13 qt	(3)	
	9150-242-7605(2)	OES	13 qt	(3)	
GREASE POINTS		Grease, Automotive and Artillery: 5 lb can as follows:			
	9150-190-0905(2)	GAA			

APPENDIX 2

MAINTENANCE ALLOCATION CHART

Section I. INTRODUCTION

2-1. General

a. This. section provides a general explanation of all maintenance and repair functions authorized at various maintenance levels.

b. Section II designates overall responsibility for the performance of maintenance functions on the identified end item or component. The implementation of the maintenance functions upon the end item or component will be consistent with the assigned maintenance functions.

c. Section III not applicable.

d. Section IV not applicable.

2-2. Explanation of Columns in Section II.

a. Group Number, Column 1. The assembly group is a numerical group assigned to each assembly in a top down breakdown sequence. The applicable assembly groups are listed on the MAC in disassembly sequence beginning with the first assembly removed in a top down disassembly sequence.

b. Assembly Group, Column 2. This column contains a brief description of the components of each assembly group.

c. Maintenance Functions, Column 3. This column lists the various maintenance functions (A through K) and indicates the lowest maintenance category authorized to perform these functions. The symbol designations for the various maintenance categories are as follows:

C - Operator or crew

O - Organizational maintenance

F - Direct support maintenance

H - General support maintenance

D - Depot maintenance

The maintenance functions are defined as follows:

A - INSPECT. To determine serviceability of an item by comparing its physical, mechanical, and electrical characteristics with established standards.

B - TEST. To verify serviceability and to detect electrical or mechanical failure by use of test equipment.

C - SERVICE. To clean, to preserve, to charge, and to add fuel, lubricants, cooling agents, and air. If it is desired that elements, such as painting and lubricating, be defined separately, they may be so listed.

D - ADJUST. To rectify to the extent necessary to bring into proper operating range.

E - ALIGN. To adjust specified variable elements of an item to bring to optimum performance.

F - CALIBRATE. To determine the corrections to be made in the readings of instruments or test equipment used in precise measure- ment. Consists of the comparison 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 with the certified standard.

G - INSTALL. To set up for use in an operational environment such as an emplacement, site, or vehicle.

H - REPLACE. To replace unserviceable items with serviceable like items.

I - REPAIR. Those maintenance operations necessary to restore an item to serviceable condition through correction of material damage or a specific failure. Repair may be accomplished at each category of maintenance.

J - OVERHAUL. Normally, the highest degree of maintenance performed by the Army in order to minimize time work in process is consistent with quality and economy of operation. It consists of that maintenance necessary to restore an item to completely serviceable condition as prescribed by maintenance standards in technical publications for each item of equipment. Overhaul normally does not return an item to like new, zero mileage, or zero hour condition.

K - REBUILD. The highest degree of materiel maintenance. It consists of restoring equipment as nearly as possible to new condition in accordance with original manufacturing standards. Rebuild

is performed only when required by operational considerations or other paramount factors and then only at the depot maintenance category. Rebuild reduces to zero the hours or miles the equipment, or component thereof, has been in use.

d. Tools and Equipment, Column 4. This column is provided for referencing by code the special tools and test equipment, (Section III) required to perform the maintenance functions (Section II).

e. Remarks, Column 5. This column is provided for referencing by code the remarks (Section IV) pertinent to the maintenance functions.

SECTION II - MAINTENANCE ALLOCATION CHART

(1) GROUP NO.	(2) ASSEMBLY GROUP	(3) MAINTENANCE FUNCTION A INSPECT	B TEST	C SERVICE	D ADJUST	E ALIGN	F CALIBRATE	G INSTALL	H REPLACE	I REPAIR	J OVERHAUL	K REBUILD	(4) TOOLS AND EQUIPMENT	(5) REMARKS
01	ELECTRICAL SYSTEM													
	Battery Cables			O					O					
	Battery		O	C					O					
	Spark Plugs		O	O	O				O					
	Ignition Coil		O						O					
	Alternator		O						O	O				
	Voltage Regulator		O						O					
	Starting Motor		O						O	F				
	Distributor				O				O	O				
O2	FUEL SYSTEM													
	Air Cleaner			C					O					
	Carburetor			O					O	F				
	Fuel Filter			O					O					
	Fuel Pump		O	O					O					
	Governor				O				F	F				
	Valve, TCV			O					O					
	Accelerator pedal and linkage				O				O					
	Fuel tank			C					O	H				
O3	COOLING SYSTEM													
	Fan Belt				O				O					
	Thermostat		O						O					
	Radiator		O	O					O	H				

SECTION II - MAINTENANCE ALLOCATION CHART

(1) GROUP NO.	(2) ASSEMBLY GROUP	(3) MAINTENANCE FUNCTION											(4) TOOLS AND EQUIPMENT	(5) REMARKS
		A INSPECT	B TEST	C SERVICE	D ADJUST	E ALIGN	F CALIBRATE	G INSTALL	H REPLACE	I REPAIR	J OVERHAUL	K REBUILD		
	03 Cooling system- cont.													
	Water Pump	O							O					
O4	WHEELS													
	Wheel Assembly								O	H				
	Tires	O							H					
O5	STEERING													
	Drag Link				O				O	O				
	Tie rod				O				O	O				
	Gear Assembly				F				F	H				
O6	BRAKES													
	Hand Brake Cable				O				O					
	Hand Brake Lever				O				O					
	Pedal				O				F					
	Master Cylinder			O					O	F				
	Wheel Cylinder								O	F				
	Brake Shoes				O				O					
O7	HYDRAULIC LIFT													
	Components													
	Hydraulic Pump		F						F	F				
	Control levers and Linkage				O				F					

SECTION II - MAINTENANCE ALLOCATION CHART

(1) GROUP NO.	(2) ASSEMBLY GROUP	(3) MAINTENANCE FUNCTION											(4) TOOLS AND EQUIPMENT	(5) REMARKS
		A INSPECT	B TEST	C SERVICE	D ADJUST	E ALIGN	F CALIBRATE	G INSTALL	H REPLACE	I REPAIR	J OVERHAUL	K REBUILD		
	07 Hydraulic lift- cont.													
	Control Valve								F	F				
	Tilt Cylinder				O				O	F				
	Lift Cylinder								F	F				
	Mast Assembly								F	F				
	Lines and Fittings	O							O					
	Oil Filter			O					O					
	Carriage Assembly								F	F				
	Oil tank breather			O					O					
O8	FRONT AXLE													
	Front axle Assembly			O	F				F	F				
	Differential			O					F	H				
O9	REAR AXLE													
	Rear Axle Assembly				F				F	F				
010	EXHAUST SYSTEM													
	Muffler and Pipes	O							O					
O11	TRANSMISSION													
	Oil Filter			O					O					
	Control Valve		F						F	F				

SECTION II - MAINTENANCE ALLOCATION CHART

(1) GROUP NO.	(2) ASSEMBLY GROUP	(3) MAINTENANCE FUNCTION											(4) TOOLS AND EQUIPMENT	(5) REMARKS
		A INSPECT	B TEST	C SERVICE	D ADJUST	E ALIGN	F CALIBRATE	G INSTALL	H REPLACE	I REPAIR	J OVERHAUL	K REBUILD		
011	Transmission - con't.													
	Torque Converter			O					F					
	Transmission Assembly		F	C					F	F	H	D		
O12	ENGINE													
	Engine Assembly	O	O	C	O				F	O	H	D		
	Manifold	O							O					
	Breather			O					O					
	Oil Filter			O					O					
	Flywheel Assembly								F	H				
	Timing Gears	F							F					
	Oil Pump	F							F					
	Cylinder lead								O	F				
	Crankshaft								H	D				

☆U.S. GOVERNMENT PRINTING OFFICE: 1984 444 604 0

RECOMMENDED CHANGES TO EQUIPMENT TECHNICAL PUBLICATIONS

THEN...JOT DOWN THE DOPE ABOUT IT ON THIS FORM. CAREFULLY TEAR IT OUT, FOLD IT AND DROP IT IN THE MAIL.

SOMETHING WRONG WITH PUBLICATION

FROM: (PRINT YOUR UNIT'S COMPLETE ADDRESS)

DATE SENT

PUBLICATION NUMBER	PUBLICATION DATE	PUBLICATION TITLE

BE EXACT PIN-POINT WHERE IT IS

PAGE NO.	PARA-GRAPH	FIGURE NO.	TABLE NO.

IN THIS SPACE, TELL WHAT IS WRONG AND WHAT SHOULD BE DONE ABOUT IT.

PRINTED NAME, GRADE OR TITLE AND TELEPHONE NUMBER	SIGN HERE

DA FORM 1 JUL 79 2028-2

PREVIOUS EDITIONS ARE OBSOLETE.

P.S.--IF YOUR OUTFIT WANTS TO KNOW ABOUT YOUR RECOMMENDATION MAKE A CARBON COPY OF THIS AND GIVE IT TO YOUR HEADQUARTERS.

The Metric System and Equivalents

Linear Measure

1 centimeter = 10 millimeters = .39 inch
1 decimeter = 10 centimeters = 3.94 inches
1 meter = 10 decimeters = 39.37 inches
1 dekameter = 10 meters = 32.8 feet
1 hectometer = 10 dekameters = 328.08 feet
1 kilometer = 10 hectometers = 3,280.8 feet

Weights

1 centigram = 10 milligrams = .15 grain
1 decigram = 10 centigrams = 1.54 grains
1 gram = 10 decigram = .035 ounce
1 decagram = 10 grams = .35 ounce
1 hectogram = 10 decagrams = 3.52 ounces
1 kilogram = 10 hectograms = 2.2 pounds
1 quintal = 100 kilograms = 220.46 pounds
1 metric ton = 10 quintals = 1.1 short tons

Liquid Measure

1 centiliter = 10 milliters = .34 fl. ounce
1 deciliter = 10 centiliters = 3.38 fl. ounces
1 liter = 10 deciliters = 33.81 fl. ounces
1 dekaliter = 10 liters = 2.64 gallons
1 hectoliter = 10 dekaliters = 26.42 gallons
1 kiloliter = 10 hectoliters = 264.18 gallons

Square Measure

1 sq. centimeter = 100 sq. millimeters = .155 sq. inch
1 sq. decimeter = 100 sq. centimeters = 15.5 sq. inches
1 sq. meter (centare) = 100 sq. decimeters = 10.76 sq. feet
1 sq. dekameter (are) = 100 sq. meters = 1,076.4 sq. feet
1 sq. hectometer (hectare) = 100 sq. dekameters = 2.47 acres
1 sq. kilometer = 100 sq. hectometers = .386 sq. mile

Cubic Measure

1 cu. centimeter = 1000 cu. millimeters = .06 cu. inch
1 cu. decimeter = 1000 cu. centimeters = 61.02 cu. inches
1 cu. meter = 1000 cu. decimeters = 35.31 cu. feet

Approximate Conversion Factors

To change	*To*	*Multiply by*	*To change*	*To*	*Multiply by*
inches	centimeters	2.540	ounce-inches	Newton-meters	.007062
feet	meters	.305	centimeters	inches	.394
yards	meters	.914	meters	feet	3.280
miles	kilometers	1.609	meters	yards	1.094
square inches	square centimeters	6.451	kilometers	miles	.621
square feet	square meters	.093	square centimeters	square inches	.155
square yards	square meters	.836	square meters	square feet	10.764
square miles	square kilometers	2.590	square meters	square yards	1.196
acres	square hectometers	.405	square kilometers	square miles	.386
cubic feet	cubic meters	.028	square hectometers	acres	2.471
cubic yards	cubic meters	.765	cubic meters	cubic feet	35.315
fluid ounces	milliliters	29,573	cubic meters	cubic yards	1.308
pints	liters	.473	milliliters	fluid ounces	.034
quarts	liters	.946	liters	pints	2.113
gallons	liters	3.785	liters	quarts	1.057
ounces	grams	28.349	liters	gallons	.264
pounds	kilograms	.454	grams	ounces	.035
short tons	metric tons	.907	kilograms	pounds	2.205
pound-feet	Newton-meters	1.356	metric tons	short tons	1.102
pound-inches	Newton-meters	.11296			

Temperature (Exact)

°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

PIN: 028286-000