DEPARTMENT OF THE ARMY TECHNICAL MANUAL

Operator and Organizational Maintenance Manual

CRANE-SHOVEL, BASIC UNIT, CRAWLER MOUNTED, 40 TON 2 CU YD, DIESEL DRIVEN (W/HARNISCHFEGER ENGINE MODEL 687C-18-ES) (W/CATERPILLAR ENGINE MODEL D333TA)

(HARNISCHFEGER MODEL 855BG)

(FSN 3810-606-8569)

This copy is a reprint which includes current pages from Changes 1 through 4.

HEADQUARTERS, DEPARTMENT OF THE ARMY

JANUARY 1969

SAFETY PRECAUTIONS

BEFORE OPERATION

Always provide a metallic contact between container, or nozzle, and fuel tank during fueling operations. This will prevent sparks from jumping between nozzle and filler neck and lessen fire hazard.

Before starting engine, assure that all operating levers and controls are in neutral position.

Keep revolving frame floor free from mud, grease, or ice to prevent injury by falling.

Replace all guards and shields immediately completing adjustment.

DURING OPERATION

Stop the crane-shovel unit before maintenance is to be performed around gears, sheaves, drums, or other moving parts.

Do not attempt to get on or off of the unit while it is in motion.

Do not give the operator a signal to raise a load until you are sure it is properly secured.

When the hook is not clearly visible by operator, use an intermediate signal man. Lift loads vertically to avoid swinging.

Always keep within maximum working radius for load being lifted.

Be sure there is adequate clearance before attempting to move under low objects. Keep the boom at least 10 feet from all electrical power lines. Assure that there is adequate clearance around unit before attempting to swing a load.

Do not travel unit with boom at high angle, or w hen carrying close to maximum load. Do not exceed capacity rating.

To move capacity loads beyond radius of unit, pick up the load, swing it ahead, set it down, then move around it. Repeat as often as necessary.

When traveling with a suspended load, secure load to the unit and prevent load from swinging out beyond boom point.

Keep lift height to a minimum when handling close to maximum load. Never leave the unit while dipper, bucket, or crane load, is in raised position. Lower to ground and disengage the engine clutch.

Always start or stop revolving frame swing s lowly and smoothly to avoid tilting the unit.

When operating as a shovel and digging from a bank, always inspect cut carefully for loose rock, frozen chunks of sand, or other evidence of conditions which might lead to slides or rock falls. Use all necessary precautions to insure safety of personnel. Avoid all careless operating habits which cause accidents to personnel.

When dumping into trucks, always spot truck s so swing will be over tailgate. Never swing a load over the cab, for a brake may loosen enough to allow load to fall on personnel.

Stop all operation before cleaning, adjusting, o r lubricating the crane-shovel unit.

If the boom contacts high tension wires, stay on the unit until boom is cleared or current is shut off, and keep all ground crew away from the unit.

Keep all ground personnel away from swinging area when making lifts, to avoid injury should clutch, brake, or slings fail.

Never operate with worn or frayed cables. Install new cables when wear or frayed condition indicates failure is imminent.

Assure that all hooks, slings, or ties, are in good condition, properly placed, and secure before lifting loads.

Never operate a shovel under overhanging embankments.

Stop operations at first sign of a slipping clutch or brake, and make proper adjustments to avoid dropping a load, or injury to personnel.

Always be alert to unusual noises, investigate immediately.

AFTER OPERATION

Always lower a crane load, bucket, dipper, or hoe to ground before stopping operations.

When stopping operations, disengage engine clutch and assure that all operating levers are in neutral.

Use extreme caution when removing radiator cap when engine is hot, to avoid a scalding injury.

CHANGE

NO. 4

HEADQUARTERS
DEPARTMENT OF THE ARMY
Washington D.C., *19 July 1991*

OPERATOR AND ORGANIZATIONAL MAINTENANCE MANUAL
CRANE-SHOVEL, BASIC UNIT, CRAWLER MOUNTED, 40 TON,
2 CU YD, DIESEL DRIVEN (W/HARNISCHFEGER ENGINE MODEL 687C-18-ES)
(W/CATERPILLAR ENGINE MODEL D333TA)
(HARNISCHFEGER MODEL 855BG)
NSN 3810-00-606-8569

TM 5-3810-206-12, 12 January 1969, is changed as follows:

Inside front cover. Add the following WARNING to the inside front cover:

WARNING
If NBC exposure is suspected, all air filter media should be handled by personnel wearing protective equipment. Consult your unit NBC Officer or NBC NCO for appropriate handling or disposal Instructions.

Page 2-30. Add the following paragraph at the bottom of the page:

2-13. AIR CLEANER/AIR FILTER NBC WARNING DECAL

A decal has been developed that warns of NBC exposure. It is to be positioned in a noticeable place on or near the air filter housing or air cleaner. You may order the decal using part number 12296626, CAGE 19207. Refer to TB 43-0219 for further information. (See *Figure 3-2; Figure 3-3; Figure 3-9: Figure 3-45;* and *Figure 3-46*).

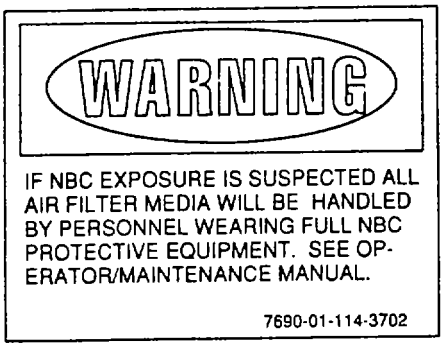


Figure 2-11.1. NBC Warning Decal

Add the following WARNING preceding paragraph 34*d* on *page 3-1*; after paragraph 3-6 on *page 3-19*; preceding paragraph 3-11 on *page 3-23*; preceding Table 3-3 on *page 3-42*; and preceding paragraph 3-57 on *page 3-65:*

WARNING
If NBC exposure is suspected, all air filter media should be handled by personnel wearing protective equipment. Consult your unit NBC Officer or NBC NCO for appropriate handling or disposal Instructions.

Page I-1. Add the entry "Air Cleaner/Air Filter NBC Warning Decal, paragraph 2-13, page 2-30" after the entry "Aids, cold weather starting".

By Order of the Secretary of the Army:

GORDON R. SULLIVAN
General, United States Army
Chief of Staff

Official:

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

Distribution:

To be distributed IAW DA Form 12-25-E (Block No. 0532) Unit, Direct Support and General Support maintenance requirements for TM 5-3810-206-12.

Changes in force: C 1, C 2, and C 3

CHANGE
No.3

HEADQUARTERS
DEPARTMENT OF THE ARMY
Washington D.C., *2 August 1990*

OPERATOR AND ORGANIZATIONAL MAINTENANCE MANUAL

**CRANE-SHOVEL, BASIC UNIT, CRAWLER MOUNTED, 40-TON,
2 CU YD, DIESEL DRIVEN (W/HARNISCHFEGER ENGINE MODEL 687C-18-ES)
(W/CATERPILLAR ENGINE MODEL D333TA)
(HARNISCHFEGER MODEL 855BG)
NSN 3810-00-606-8569**

TM 5-3810-206-12, 30 January 1969, is changed as follows:

*Cover and title page (page i).*The manual title is changed to read as shown above.
Inside front cover. Add the following WARNINGs to the inside front cover:

WARNING
Travel over flat, level, solid surfaces when moving the crane with the leads in the raised position. Never exceed 1-2 mph. Secure the leads to the crane before moving the equipment.

WARNING
Do not move the crane in high winds (15-20 mph) when the leads are in the raised position.

WARNING
Do not move the crane under overhead obstacles (e.g., trees, powerlines, bridges, etc.) with the leads in a raised position.

WARNING
Raise the outriggers (if equipped) 2-3 inches off the ground when moving the crane with the leads in the raised position.

WARNING
Attach tag lines to the leads before moving the crane. One person will hold each tag line to prevent the leads from swinging. Front and rear ground guides will be used when moving the equipment.

WARNING
When the leads are set over a pile, raise the outriggers 2-3 inches off the ground before driving the pile. Reset the outriggers on the ground before raising the leads.

WARNING
Personnel not directly involved with moving the crane and leads will remain at least 50 feet from the leads/equipment.

WARNING
Always use the load chart to determine the boom angle, length, and radius.

WARNING
Set the swing lock brake before attaching the boom to the leads.

Page 1-1, paragraph 1-*b*, is superseded as follows: You can help improve this manual. If you find any mistakes or if you know of a way to improve the procedures, please let us know. Mail your letter or DA Form 2028 (Recommended Changes to Publications and Blank Forms) direct to: Commander, U.S. Army Tank-Automotive Command, ATTN: AMSTA-MB, Warren, MI 48397-5000. A reply will be furnished to you.

By Order of the Secretary of the Army:

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

Official:

THOMAS F. SIKORA
Brigadier General, United States Army
The Adjutant General

Distribution:

To be distributed in accordance with DA Form 12-25-E (Blocks 0532, 0533) Operator and Unit maintenance requirements for TM5-3810-206-12.

Change
No. 2

HEADQUARTERS
DEPARTMENT OF THE ARMY
Washington. D.C., *7July 1972*

**Operator and Organizational Maintenance Manual
CRANE-SHOVEL, BASIC UNIT, CRAWLER MOUNTED,
40 TON 2 CU. YD., DIESEL DRIVEN (W/HARNISCHFEGER
ENGINE MODEL 687C-18-ES) (W/CATERPILLAR
ENGINE MODEL D333TA)
(HARNISCHFEGER MODEL 855BG)
FSN 3810-606-8569)**

TM 5-3810-206-12, dated 30 January 1969, is changed as follows:

Page *ii*. Change title of Appendix B as follows:

APPENDIX B. BASIC ISSUE ITEM LIST AND ITEMS TROOP INSTALLED OR AUTHORIZED

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

APPENDIX B

BASIC ISSUE ITEM LIST AND ITEMS TROOP INSTALLED OR AUTHORIZED

Section I. INTRODUCTION

1. Scope
This appendix lists basic issue items, items troop installed or authorized which accompany the Crane-Shovel, and required by the crew/operator for operation, installation, or operator's maintenance.

2. General
This basic issue items, items troop installed or authorized 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, in alphabetical sequence of items which at the descretion of the unit commander may accompany the end item, but are NOT subject to be turned in with the end item.

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 code is:

Code	*Explanation*
P	Repair parts. special tools and test equipment supplied from GSA/DSA or Army supply system and authorized for use at indicated maintenance levels.

(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 non-recoverable. Recoverability codes are:

Code	*Explanation*
R	Applied to repair parts (assemblies and components), special tools and test equipment which are considered

Code	*Explanation*
	economically reparable at direct and general support maintenance levels.
S	Repair Parts. special tools, test equipment and assemblies which are economically reparable at DSU and GSU activities and 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 2character 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 only). This column indicates the quantity of an item furnished with the equipment.

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

g. Illustration (BIIL only). This column is divided as follows:

(1) *Figure Number*. Indicates the figure number of the illustration in which the item is shown.

(2) *Item Number*. Indicates the callout number used to reference the item in the illustration.

Section III. ITEMS TROOP INSTALLED OR AUTHORIZED LIST

(1) SMR CODE	(2) FEDERAL STOCK NO.	(3) DESCRIPTION REF. NO. & MFR CODE / USABLE ON CODE	(4) UNIT OF MEAS	(5) QTY AUTH
PC	2590-045-9611	CASE ASSEMBLY: RIFLE	EA	1
PC	7720-559-9618	CASE, MAINTENANCE AND OPERATIONAL MANUAL	EA	1
PC	4210-889-2221	EXTINGUISHER. FIRE	EA	1

By Order of the Secretary of the Army:

BRUCE PALMER, JR.
General, U.S. Army
Acting Chief of Staff

Official:

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

Distribution:

To be distributed in accordance with DA Form 12-25B, (qty rqr block No. 350) Organizational maintenance requirements for Crane-Shovel Crawler: 40 Ton.

CHANGE

NO. 1

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, D.C., *2 January 1970*

**Operator and Organizational Maintenance Manual
CRANE-SHOVEL, BASIC UNIT, CRAWLER MOUNTED,
40 TON, 2 CU YD, DIESEL DRIVEN (W/HARNISCHFEGER
ENGINE MODEL 687C-18-ES) (W/CATERPILLAR ENGINE MODEL
D333TA) (HARNISCHFEGER MODEL 855BG) FSN 3810-606-8569**

TM 5-3810-206-12, 30 January 1969, is changed as follows:

Page 1-9. Delete figure 1-4.

Figure 1-5, Change caption to read: "Figure 1-4. Clamshell working ranges."

Page 1-10. Figure 1-6, change caption to read: "Figure 1-5. Dragline working ranges."

Page 1-11. Figure 1-7, change caption to read: "Figure 1-6. Shovel working ranges."

Page 1-12. Figure 1-8, change caption to read: "Figure 1-7. Backhoe working ranges."

After figure 1-7, add figure 1-8 as follows:

Page 3-97. Figure 3-88, change caption to read: "Figure 3-89. Swing brake hydraulic control, removal and installation."

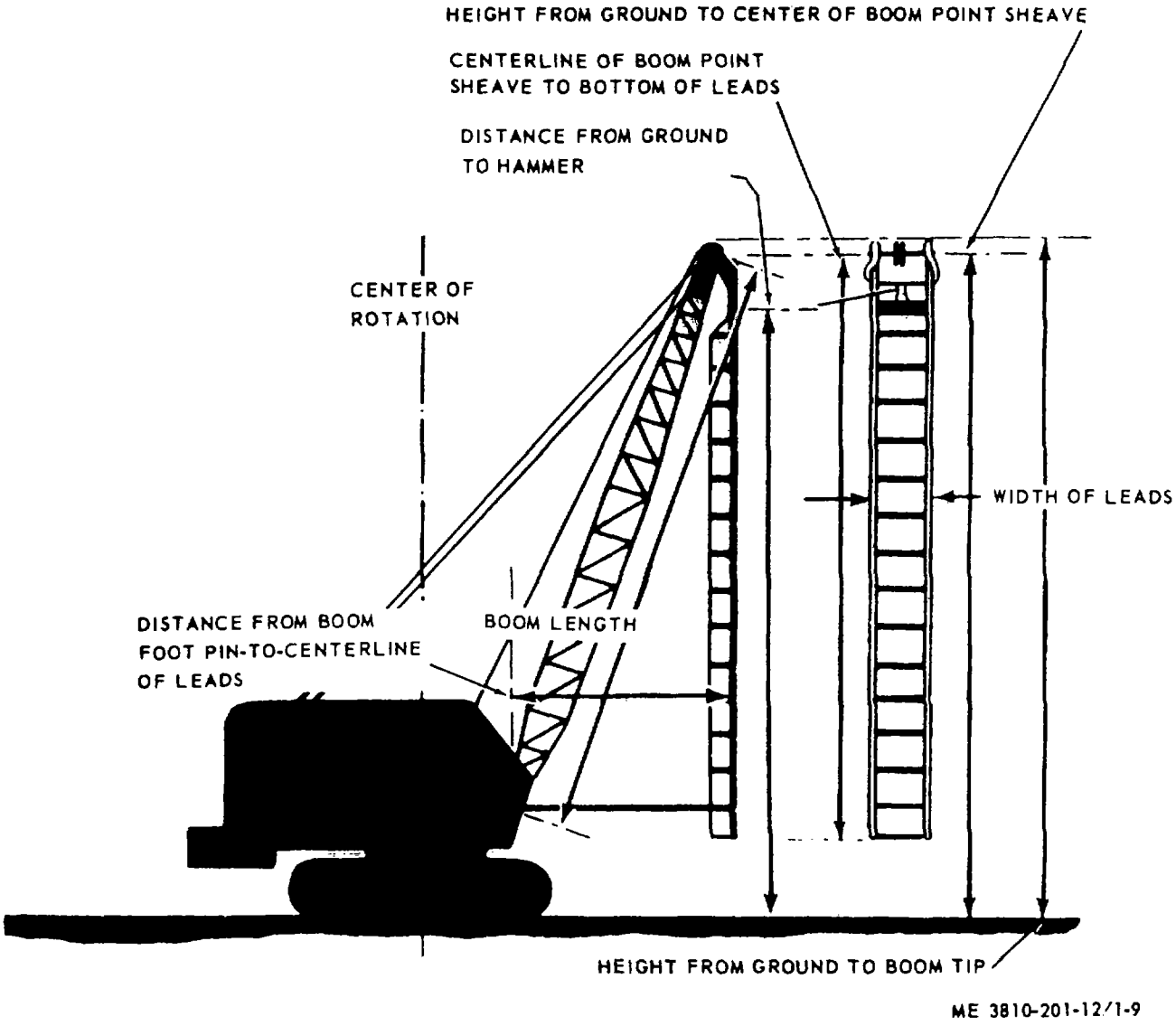


Figure 1-8. Piledriver clearance diagram.

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 II, (qty rqr block No. 350) Organizational maintenance requirements for Crane-Shovels, Crawlers, 40 Ton.

TECHNICAL MANUAL

No. 5-3810-206-12

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, D. C., 30 January 1969

OPERATOR AND ORGANIZATIONAL MAINTENANCE MANUAL

CRANE-SHOVEL, BASIC UNIT, CRAWLER MOUNTED, 40 TON, 2 CU YD, DIESEL DRIVEN (W/HARNISCHFEGER ENGINE MODEL 687C-18-ES) (W/CATERPILLAR ENGINE MODEL D333TA) (HARNISCHFEGER MODEL 855BG) (FSN 3810-606-8569)

***Supersedes TM 5-3810-206-10, 3 September 1963, C1, 28 April 1965, and TM 5-3510-206-20, 27 January 1964, C1, 21 April 1965.**

CHAPTER 1

INTRODUCTION

Section I. GENERAL

1-1. Scope

a. These instructions are published for the use of personnel to whom the Crane-Shovel is issued. They provide information on the operation and organizational maintenance of the equipment. Also included are descriptions of main units and their functions in relationship to other components.

b. Numbers in parentheses following nomenclature callouts on illustrations indicate quantity. Numbers preceding nomenclature callouts indicate preferred maintenance sequence of removal or disassembly, and reassembly or installation should be performed in reverse order.

c. Report all Equipment Improvement Recommendations as prescribed in TM 38-750.

1-2. Forms and Records

a. DA Forms and records used for equipment maintenance will be only those prescribed in TM 38-750.

b. Report of errors, omissions, and recommendations for improving this publication by the individual user is encouraged. Reports should be submitted on DA Form 2028 (Recommended Changes to DA Publications.) and forwarded direct to Commanding General, U.S. Army Mobility Equipment Command, ATTN: AMSMEMPP, 4300 Goodfellow Boulevard, St. Louis, MO. 63120.

Section II. DESCRIPTION AND DATA

1-3. Description

a. General. The Harnischfeger Model 855BG Crane-Shovel is a crawler mounted, two cubic yard, 40 ton capacity, diesel engine driven unit. The booms are interchangeable, enabling conversion to shovel, crane, clamshell, dragline, backhoe, or piledriver operation.

b. Revolving Frame. The revolving frame (fig. 1-1) upon which are mounted the engine, upper machinery, and gantry, revolves around a center gudgeon and a live roller circle mounted on the crawler. It carries four hook rollers (two in front and two at rear), which ride on the underside of the roller path, and prevents tipping of the rotating base. A counterweight is fastened at rear of revolving frame. A gantry frame which contains gantry sheaves and harness, is mounted on the revolving frame along with a collapsible high gantry which is provided for use in crane, clamshell, dragline, or piledriver service.

c. Cab. The cab (fig. 1-1) completely encloses all machinery on the revolving frame. It consists of rigid steel frame work and panels. Several hinged doors and sliding panels provide access for removal of engine or machinery. Framed glass windows in operator's compartment can be opened for ventilation or additional visibility. Hand levers and foot pedals in operator's compartment control all motions of revolving frame operating machinery (para 2-8), and are easily within reach of the operator from his adjustable seat.

d. Crawler Mounting. Crawler mounting (fig. 1-2) consists of two crawler tracks and the carbody. Each crawler track consists of forged steel side bars, (pinned together), with track shoes bolted on. Tracks are chain driven by the tread sprocket, and supported by a large idler roller and numerous track rollers. The carbody houses the propelling and steering mechanism.

e. Engine. The crane-shovel units are powered by six-cylinder diesel engines, which operates both deck machinery and crawlers, and are equipped with electrical starting motors. The engine may be either a Harnischfeger Model 687C 18-ES or a Caterpillar Model D333TA, therefore in this manual the component

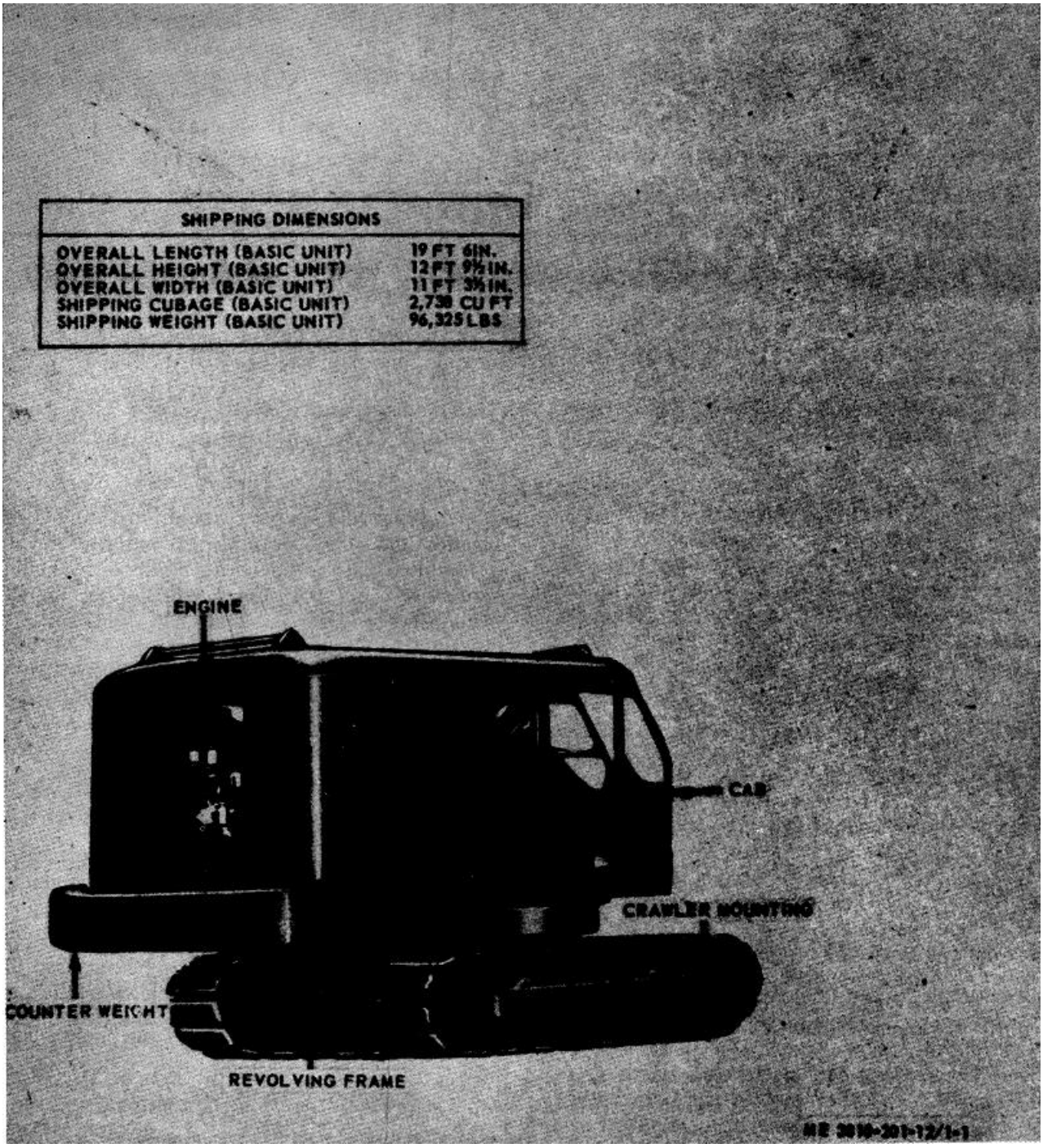


Figure 1-1. Crane-shovel basic unit, right 3/4 rear view, and shipping dimensions.

position on engine will be described in relation to radiator as front end, or flywheel as the rear end. As an example, on Model 687C-18-ES the starting motor is at rear on left side, the generator at front on right side. On Model D333TA, the alternator is. at front on left side, and starting motor at rear on right side. The cylinders are numbered from front to rear.

1-4. Identification and Tabulated Data

a. Identification. The crane-shovel basic unit has seven major identification plates which this paragraph locates and describes. Data contained on them is listed in b below.

(1) Corps of engineers identification plate. This plate is mounted at right of the transportation data plate ((7) below). It specifies the class, nomenclature, stock number, model number, manufacturer's name. and serial number.

(2) Manufacture's identification plate. This plate is mounted on right front of operator compartment

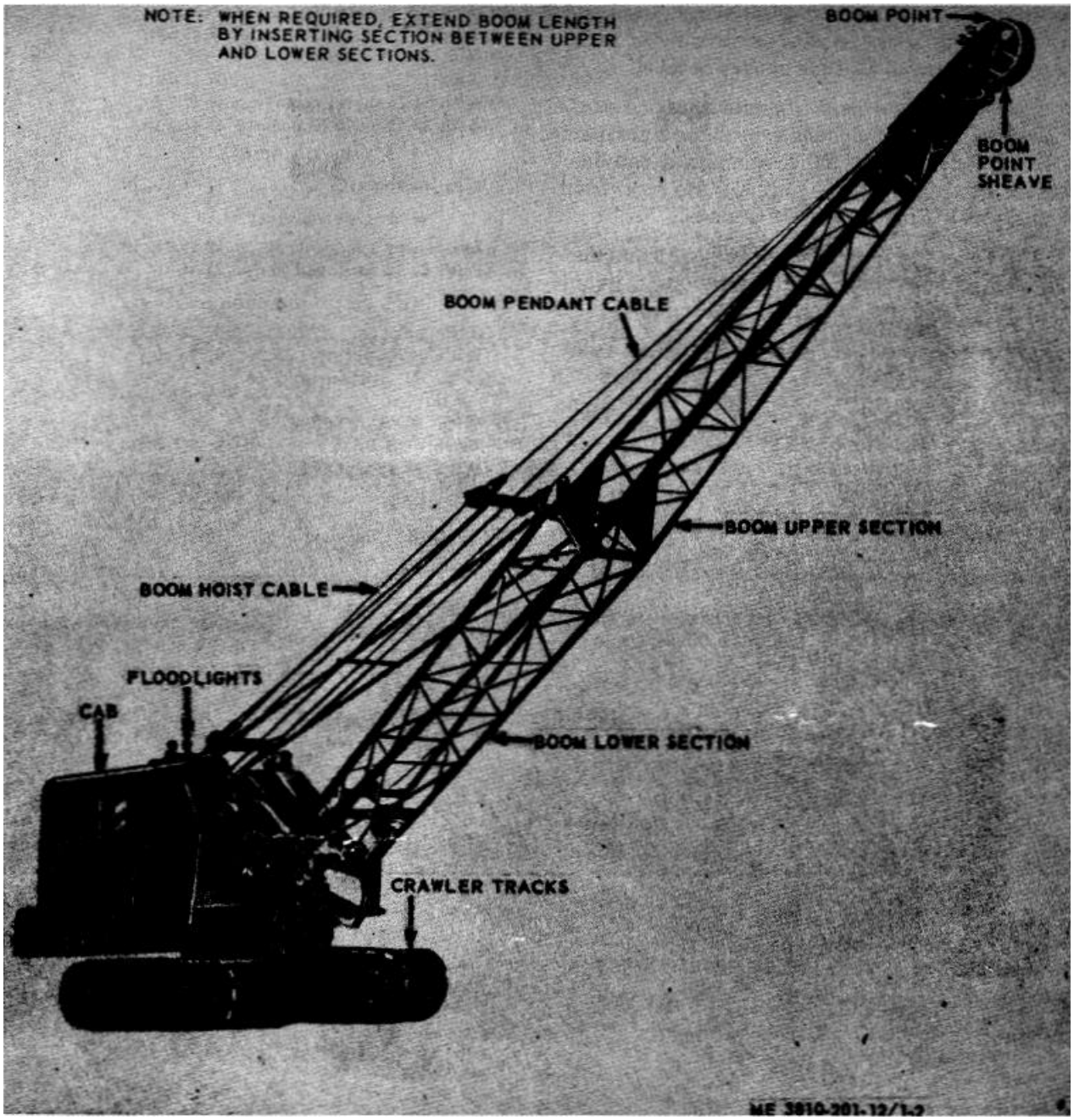


Figure 1-2. Crane-shovel basic unit, with crane boom installed.

directly below the front window. It gives the manufacturer's name, and the unit serial number.

(3) Engine identification plate.

(a) The model 687C-18ES engine identification plate is mounted on upper left side of flywheel housing and gives the manufacturer's name, model number, engine number, bore, stroke, horsepower, revolutions per minute, and firing order.

(b) The model D333TA engine identification plate is mounted on left hand side of No. 6 cylinder wall and gives manufacturer's name and engine serial number.

(4) *Engine specification plate*.

(a) The model 687C-18-ES engine specification plate is mounted on right side of valve cover, and gives engine model number, number of cylinders, displacement in cubic inches, valve lash, type of fuel, injection pump timing, and cooling system capacities.

(b) The model D333TA engine specification plate is mounted on fuel filter and gives model No., No. of cylinders, bore, stroke, high

idle engine rpm, full load engine rpm, rack setting, hp rating at sea level, and warning of turbocharger setting and altitude above sea level.

(5) *Rated load capacity identification plate*. This plate is mounted inside operator's compartment and is located on panel to right of cab door. It specifies operating radius, angles, boom lengths, and lifting capacity in pounds.

(6) *Loading identification plate*. This plate is located on right front side of revolving frame cab. It specifies position of slings for loading.

(7) *Transportation data plate*. This plate is located directly below the loading identification plate ((6) above). It specifies dimensions, cubage, tonnage, height, length, and weights of the crane-shovel unit.

b. Tabulated Data.

(1)General.

Manufacturer	Harnischfeger Corp.
Model	855BG
Designed for use as	Backhoe, clamshell, crane, dragline, piledriver, and shovel

(2)Engines.

(a)Model 687C-1 8-ES.

Manufacturer	P&H Diesel Division, Harnischfeger Corp.
Model	687C-18-ES
Cycle	2
Compression ratio	16 to 1
Displacement	522 cu in. (cubic inches)
Number of cylinders	6
Cooling	Liquid
Horsepower	190 HP (horsepower) at 1,700 rpm (revolutions per minute)
Idle speed	500 rpm
Rotation at flywheel end	Counterclockwise
Firing order	1-6-24-3-5
Governed full load speed	1,800 rpm
Weight	1 900 lbs (pounds)
Valve lash	0.012 in. cold
Injection pump timing	16 degrees below top center

(b) Model D333TA.

Manufacturer	Caterpillar Corp.
Model	D333TA
Bore	4.5 in (inch)
Stroke	5.5 in.
Number of cylinders	6
Displacement	522 cu in.
Horsepower (HP)	190 w/o (without) fan
Idle speed	600 rpm
Governed full load speed	2,000 rmp

(3)*Dimensions and weights*.

(a) Overall length.

(Less boom)	19 ft 6 in.
(With 50 ft crane boom)	67 ft 5 in.
(With 50 ft crane boom and 15 ft jib)	80 ft 4 in.
(With 50 ft dragline boom)	67 ft 5 in.
(With 50 ft clamshell boom)	67 ft 5 in.
(With 24 ft shovel boom)	47 ft 7 in.
(With 23 ft backhoe boom)	41 ft 1 in.

(b)Overall width.

(27% in. shoes)	11 ft 38½ in.

(c)Overall height.

(Less boom and gantry)	12 ft 9½,i in.
(With 23 ft backhoe boom)	21 ft

(d)Shipping cubage.

(Basic unit)	2,738 cu ft
(With 50 ft boom)	9,675 cu ft
(With 50 ft boom and 15 ft jib)	11,600 cu ft
(With 50 ft dragline boom)	9,675 cu ft
(With 50 ft clamshell boom)	9.675 cu ft
(With 24 ft shovel boom)	6,775 cu ft
(With 23 ft backhoe boom)	9,725 cu ft

(e) Operating Weights (approximate).

(Basic unit)	101,025 lbs
(Backhoe)	119,290 lbs
(Crane)	106,400 lbs
(Shovel)	118,600 lbs
(Clamshell)	107,000 lbs
(Dragline)	107,500 lbs
(Piledriver)	. 118,600 lbs

(4) *Personnel heater*.

Manufacturer	Hupp Corp., Detroit, Michigan
Model	H901-24V
Voltage	24 vdc (volts direct current)

(5)*Capacities*.

(a) Engine, model 687C-18-ES.

Crankcase	32 qt (quart)
Fuel filters:	
Primary	% pt (pint)
Secondary	1 pt
Cooling system	36 qt
Air cleaner	4% qt
Oil filters	2 qt

(b) Engine, Model D333TA.

Crankcase	22 qt
Cooling system	33.6 qt

(c) Crane capacities.

Fuel tank	90 gal (gallons)
Swing gear box (oil)	20 qt
Chain case	8 qt
12 Hydraulic cylinders	4 qt
7 Hydraulic cylinders	2 qt
Hydraulic tank	22 qt
Power transfer reduction gear case	8 qt
Horizontal vertical drive gear case	12 qt

(6) *Starter*.

(a) For Model 687C-18-ES.

Manufacturer	Delco Remy

Model	1113757
Volts	24 VDC
Rotation	Counterclockwise at drive end
New brush spring tension	24 to 28 oz (ounce(s))

(b) For model D333TA.

Manufacturer	Delco Remy
Model	1113771 or 1113818
Volts	24 VDC
Rotation at drive end	Clockwise
No load test:	
Volts	23.0
Maximum amps (amperes)	82.5 for 1113771 and 90 for 1113818
Minimum rpm	7,000
Lock test:	
Volts	3.5
Maximum amps	500
Minimum torque	26 ft lb (food pounds)
Minimum brush spring tension	80 oz

(7) *Generator (model 687C-18-ES).*

Manufacturer	Delco Remy
Model	1117497
Volts	24 VDC
Ground polarity	Shunt
Ground polarity control	Current-voltage regulator
Rated output	25 amps (amperes)
New brush spring tension	28 oz
Rotation	Clockwise (viewed from transmission end)

(8) *Alternator (model D333TA).*

Manufacturer	Delco Remy
Model	1117072
Brush spring tension	10 oz
Rotation (viewing drive end)	Clockwise
Circuit	A or B (normally B)
Field Current (80° F):	
Volts	24 VDC
Amps	3.6 to 4.0
Output (cold):	
Volts	28 VDC
Amps	61 amps
Approximate RPM	2,500

(9) *Generator regulator (model 687C-1 8-ES)*

Manufacturer	Delco Remy
Model	1118629
Volts	24 VDC
Circuit	B
Amperes	40
Ground	Negative

(10) *Alternator regulator (model D333TA).*

Manufacturer	Delco Remy
Model	9000591
Circuit	A or B (normally B)
Polarity	Either (A circuit for positive ground, B circuit for negative ground)
Voltage setting range	27.5 to 28.5 VDC (with adjusting screw at "O")

(11) *Fuel filter (primary).*

(a) For model 687C-1 8-ES.

Manufacturer	Zenith
Model	F471-2X712

(b) For model D333TA.

None used

(12) *Fuel filter (secondary).*

(a) For model 687C-18-ES.

Manufacturer	Fram
Type	Cartridge element
Model	F1125APBT4
Cartridge element	C1125PBT4

(b) For model D33STA.

Manufacturer	Caterpillar
Model	9H4729

(13) *Air cleaner*.

(a) For model 687C-18-ES.

Manufacturer	Donaldson
Type	Oil bath
Model	A14111

(b) For model DS3STA.

Manufacturer	Caterpillar
Type	Dry
Model	5L7680

(14) *Engine lubricating oil filter*.

(a) For model 687C-18-ES.

Manufacturer	Purolator
Model	WF500 (Assembly 64776)
Filter element	PC500 (Heavy duty senior type)

(b) For model D333TA.

Manufacturer	Caterpillar
Model	9M530
Filter element	5S484 (disposable type)

(15) *Batteries (2).*

Manufacturer	Unspecified
Volts (each battery)	12 (hook up in series for 24 VDC electrical system)

(16) Specific nut and bolt torque dam

(a) For model 687C-18-ES.

Starter motor mounting	71-75 ft-lbs
Generator mounting	35-39 ft-lbs
Exhaust manifold nut	50 ft-lbs
Fuel injector mounting nut	15-20 ft-lbs
Fuel injector stud	15 ft-lbs
Muffler mounting	83-93 ft-lbs
Pulley mounting	3035 ft-lbs
Fan mounting	15-19 ft-lbs
Water manifold mounting	-35-39 ft-lbs

(b) For model D33STA.

Fuel line nut torque	25-35 lbs
Valve cover retaining nut	12-18 ft-lbs
Glow plug	8-12 ft-lbs

(17) *General torque data*. The following general torque values are to be used unless otherwise specified.

SIZE	THREADS PER INCH	TORQUE FT-LBS, FOR STD. HEAT TREATED SAE GRADE E MIN-TENSILE STRENGTH 120,000 P.S.I.	TORQUE FT-LBS FOR SPECIAL HEAT TREATED SAS GRADE 8 MIN-TENSILE STRENGTH 150,000 P.S.I.
1/4	20	6-8	9-11
	28	8-10	10-12
5/16	18	16-18	17-20
	24	17-20	19-23
5/6	16	26-32	36-43
	24	3S-40	41 49
7/16	14	42-60	54-65
	20	50-60	64-77
1/2	13	67-80	81-97
	20	83-100	96-116

SIZE	THREADS PER INCH	TORQUE FT-LBS, FOR STD. HEAT TREATED SAE GRADE 5 MIN-TENSILE STRENGTH 110,000 P.S.I.	TORQUE PT-LBS FOR SPECIAL HEAT TREATED SAE GRADE MIN-TENSILE STRENGTH 150,000 P.S.I.
9/16	12	85-100	103-123
	18	100-120	122-146
5/8	11	117-140	164-192
	18	134-160	193-226
3/4	10	180-210	284-325
	16	216-250	337-385

(18) *Specific gravity temperature corrections for bottles*. Refer to table 1-1 for battery temperature corrections.

Table 1-1. Specific Gravity Temperature Correction for Batteries

Cranking power available	Temperature in degrees F -65°	-40°	-20°	-10°	0°	+20°	+40°	+80°	+100°	+110°	+120°
50%	1.277	1.267	1.259	1.255	1.251	1.243	1.236	1.220	1.213	1.209	1.205
58.3%	1.287	1.277	1.269	1.265	1.261	1.253	1.246	1.230	1.223	1.219	1.215
66.6%	1.297	1.287	1.279	1.275	1.271	1.263	1.256	1.240	1.233	1.229	1.225
75%	1.307	1.297	1.289	1.285	1.281	1.273'	1.266	1.250	1.243	1.239	1.236
83.3%	1.317	1.307	1.299	1.295	1.291	1.283	1.276	1.260	1.252	1.248	1.245
91.6%	1.82,7	1.317	1.309	1.305	1.301	1.294	1.286	1.270	1.262	1.258	1.256
100%	1.338	1.328	1.320	1.316	1.312	1.304	1.296	1.280	1.272	1.268	1.265

(19) Cable lengths, diameters, and use. Refer to table 1-2 for cable lengths for front end attachment to be used.

(20) Crane and jib working ranges. Refer to figure 1-3 for various crane and jib working ranges.

(21) Clamshell working ranges. Clamshell working ranges are illustrated in figure 14 and dimension of ranges are listed below.

Operating radius (bin 450 boom angle)..... 40 ft
Operating radius (stockpile) (45' boom angle) 40 ft
Height from top of stock pile to boom point ..... 15 ft
Height of stock pile..... 25 ft
Width of stock pile (approximate)..... 60 ft
Height of bin..... 24 ft
Half width of bin ..... 12 ft
Boom length..... 60 ft

Table 1-2. Cable Lengths, Diameter, and Use

For	Boom length Ft.	In.	Cable type and size	In. Ft In.	Main guy cable In. Ft In.	Intermediate guy cable In. Ft In.	Drag-line	Clam-shell	Crane	Pile-driver
Boom	50	0	No. 4	3/4 x 290-0			X	X	X	
Hoist	60	0	No. 4	3/4 x 190-0	2-13/4 x 28-0		X	X	X	
	65	0	No. 4	3/4 x 310-0			X	X	X	
	66	0	No. 4	3/4 x 180-0	2-13/4 x 33-0		x	X	X	
	60	0	No. 4	3/4 x 390-0		2-3/4 x 20-0	X	X	X	X
	60	0	No. 4	3/4 x 240-0	2-1 1/4 x 38-0	2-3/4 x 20-0	X	X	X	
	65	0	No. 4	3/4 x 420-0		2-3/4 x 20-0	X	X	X	
	65	0	No. 4	3/4 x 240-0	2-1 1/4 x 43-0	2-3/4 x 20-0	X	X	X	
	70	0	No. 4	3/4 x 450-4		2-3/4 x 20-0	X	X	X	
	70	0	No. 4	3/4 x 240-0	2-1 1/4 x 48-0	2-3/4 x 20-0	X	X	X	
	76	0	No. 4	3/4 x 450-0	2-1 1/4 x 53-0	2-3/4 x 20-0	X	X	X	
	75	0	No. 4	3/4 x 240-0		2-3/4 x 20-0	X	X	X	
	80	0	No. 4	3/4 x 270-0	2-1 1/4 x 58-0	2-3/4 x 20-0	X	X	X	
	80	0	No. 4	3/4 x 240-0	2-1 1/4 x 63-0	2-3/4 x 20-0	X	X	X	
	85	0	No. 4	3/4 x 240-0	2-1 1/4 x 68-0	2-3/4 x 20-0	X	X	X	
	90	0	No. 4	3/4 x 240-0	2-1 1/4 x 73-0	2-3/4 x 20-0	X	X	X	
	95	0	No. 4	3/4 x 240-0	2-1 1/4 x 78-0	2-3/4 x 20-0		X	X	
	100	0	No. 4	3/4 x 240-0						
Hoist	50	0	No. 4	7/8 x 130-0						

*See footnotes At end of table.

Table 1-2. Cable Lengths, Diameter, and Use - Continued

For	Boom length		Cable type and size		Main guy cable	Intermediate guy cable	Drag-line	Clam-shell	Crane	Pile-driver
	Ft.	In.		In. Ft In.	In. Ft In.	In. Ft In.				
	50	0	No. 4	1 X 175-0					X*	
	55	0	No. 4	7/8 X 140-0			X			
	55	0	No. 4	1 X 190-0					X*	
	60	0	No. 4	7/8 X 150-0			X			
	60	0	No. 4	1 X 205-0					X*	
Hoist	65	0	No. 4	7/8 X 160-0			X			
	65	0	No. 4	1 X 220-0					X*	
	70	0	No. 4	7/8 X 170-0			X			
	70	0	No. 4	1 X 235-0					X*	
	75	0	No. 4	7/8 X 180-0			X			
	75	0	No. 4	1 X 250-0					X*	
	80	0	No. 4	7/8 X 185-0			X			
	80	0	No. 4	1 X 265-0					X*	
	85	0	No. 4	1 X 280-0			X			
	90	0	No. 4	1 X 296-0					X*	
	95	0	No. 4	1 X 310-0					X*	
	100	0	No. 4	1 X 325-0					X*	
Digging	50	0	No. 4	1 X 60-0					X*	
	56	0	No. 4	1 X 65-0					X*	
	60	0	No. 4	1 X 70-0			X			
	65	0	No. 4	1 X 75-0			X			
	70	0	No. 4	1 X 80-0			X			
	75	0	No. 4	1 X 85-0			X			
	80	0	No. 4	1 X 904-0			X			
Closing	50	0	No. 4	7/8 X 165-0			X			
	55	0	No. 4	7/8 X 175-0			X			
	60	0	No. 4	7/8 X 186-0				X		
	65	0	No. 4	7/8 X 195-0				X		
	70	0	No. 4	7/8 X 206-0				X		
	75	0	No. 4	7/8 X 215-0				X		
Holding	50	0	No. 4	7/8 X 130-0				X		
	65	0	No. 4	7/8 X 140-0				X		
Holding	60	0	No. 4	7/8 X 104-0				X		
	65	0	No. 4	7/8 X 160-0				X		
	70	0	No. 4	7/8 X 170-0				X		
	75	0	No. 4	7/8 X 180-0				X		
Tagline	50	0	No. 12	3/8 X 854-0				X		
	55	0	No. 12	3/8 X 854-0				X		
	60	0	No. 12	3/8 X 850-0				X		
	65	0	No. 12	3/8 X 850-0				X		
	70	0	No. 12	3/8 X 861-0				X		
Hammer	60	0	No. 4	7/8 X 145-0				X		
Pile	60	0	No. 4	7/8 X 175-0				X		
Line Hoist	100	0	No. 11	7/8 X 280-0						X
20 Ft Jib Guy	100	0	No. 4	2-3/4 X 22-0						X
Line 20 Ft				2-3/4 X 100-0					X	
Dump Cable			No. 4	3/4 X 18-0					X	
Shovel										
Hoist Cable			No. 4	1 X 95-0			X			
Boom Hoist Cable			No. 4	3/4 X 145-0						
Dipper Trip Cable			No. 12	5/16 X 35-0						
Trip Cable			No. 12	5/16 X 13-0						
Back hoe										
Hoist Cable			No. 4							
Boom Hoist Cable			No. 4							
Digging Cable			No. 4							

*Represents two part line

Note

Quantities Indicated on this chart are indicated only to define those cable used with various attachments and are not Intended to show quantity as reflected by the basic issue items list.

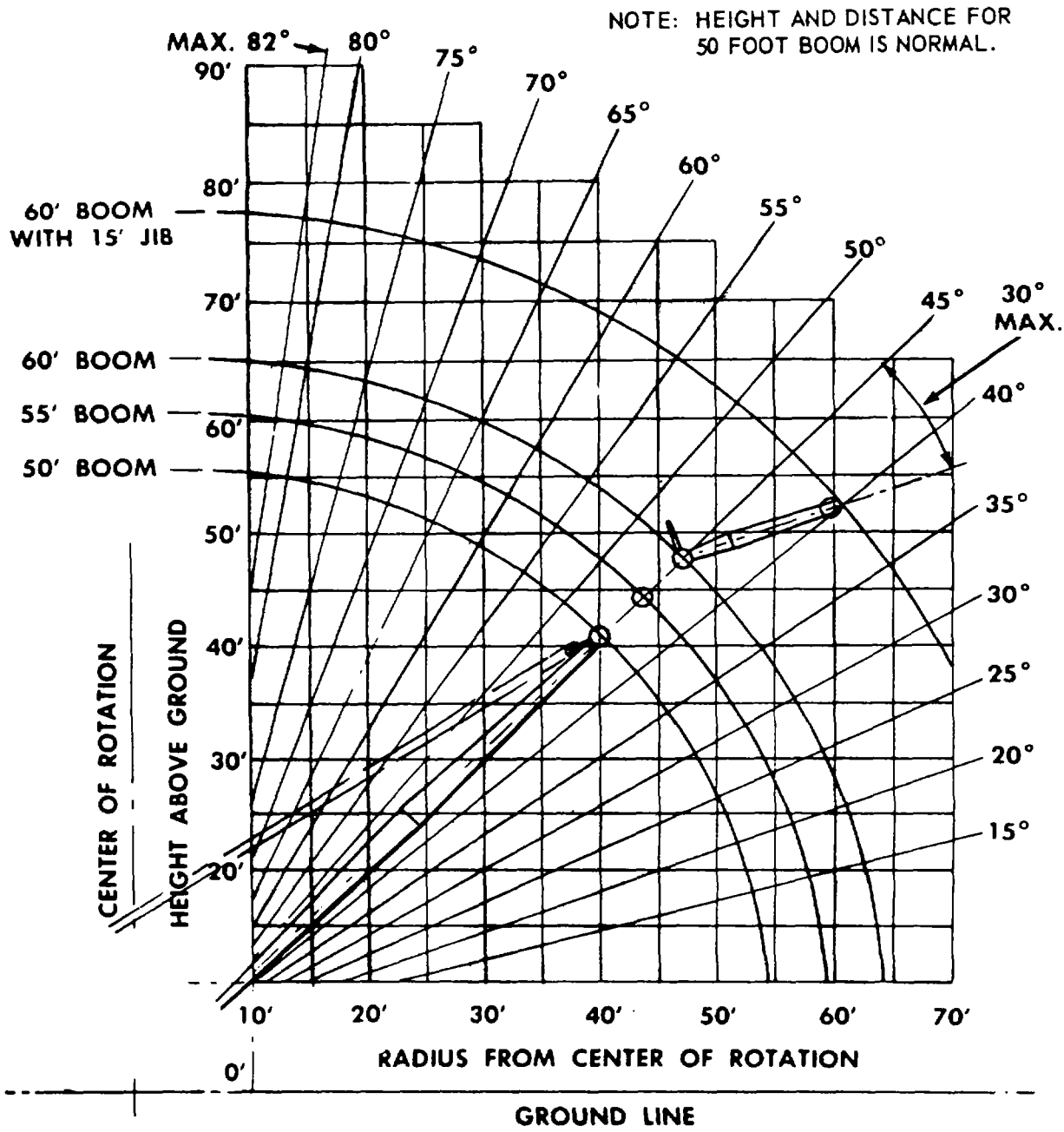


Figure 1-3. Crane and jib working ranges. ME 3810-201-12/1-4

(22) Dragline working ranges. Dragline working ranges are illustrated in figure 1-5 and dimensions are listed below.

Radius of boom point sheave clearance (456 boom angle) -	41 ft
Height of boom point sheave clearance (45° boom angle)	42 ft
Casting clearance (approximate)	15 ft
Depth of end or side cut (approximate)	25 ft
Digging reach (approximate	65 ft
Center of rotation to center of dump (approximate)	40 ft
Dumping height	26 ft 6 in.
Height	13 ft 6 in.
Boom length	50 ft
Boom angle	456

(23) Shovel working ranges. Shovel working ranges are illustrated in figure 16 and dimensions are listed below.

Digging radius (boom at 46° angle)	834 ft
Digging radius (boom at 600 angle)	31 ft
Clearance radius of boom point sheave (456 angle)	22 ft
Clearance radius of boom point sheave (60° angle)	17 ft

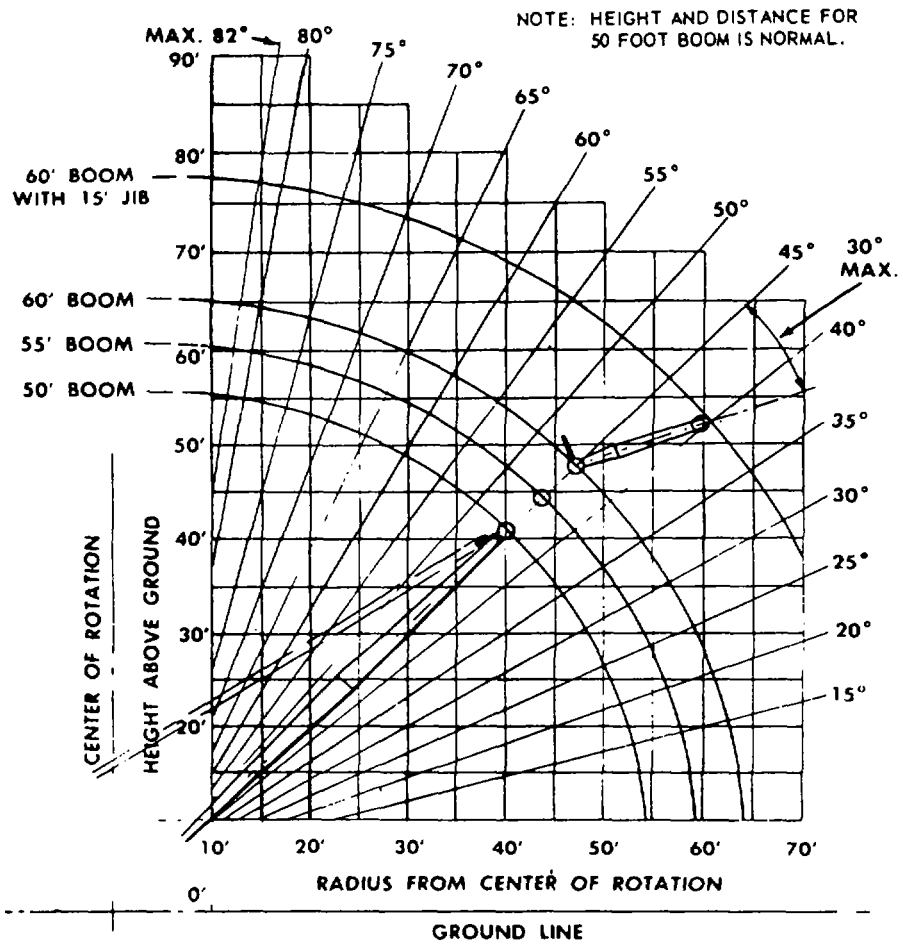


Figure 1-4. Clamshell Working ranges

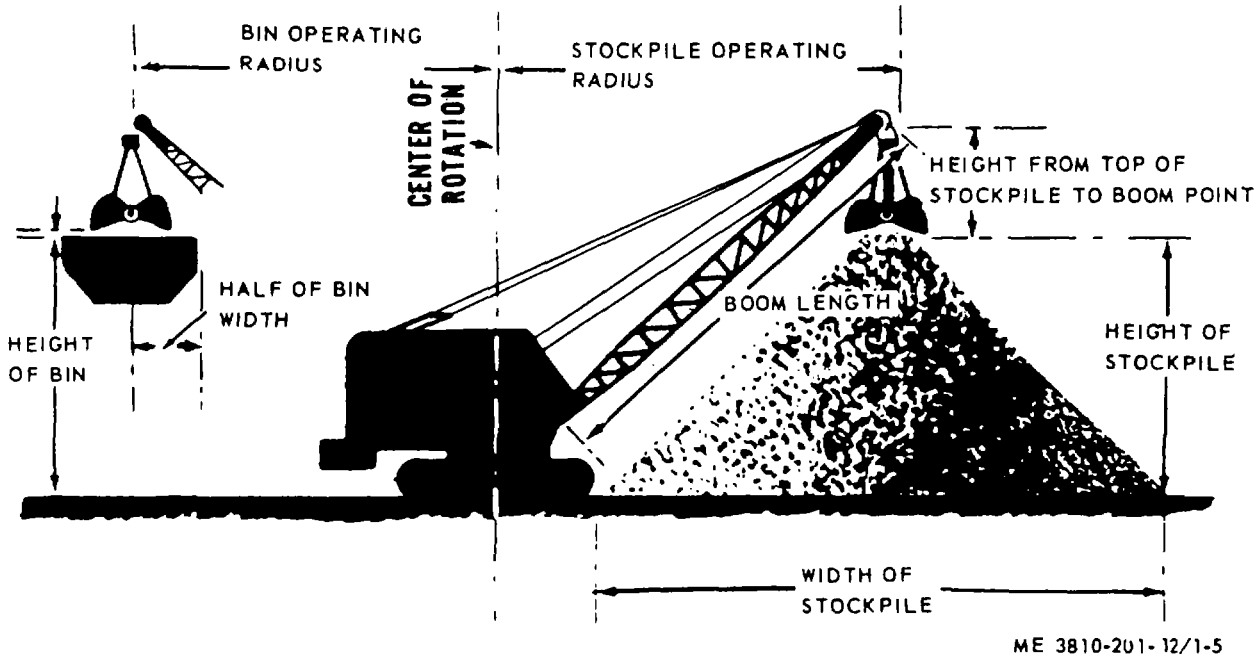


Figure 1-5. Dragline working range".

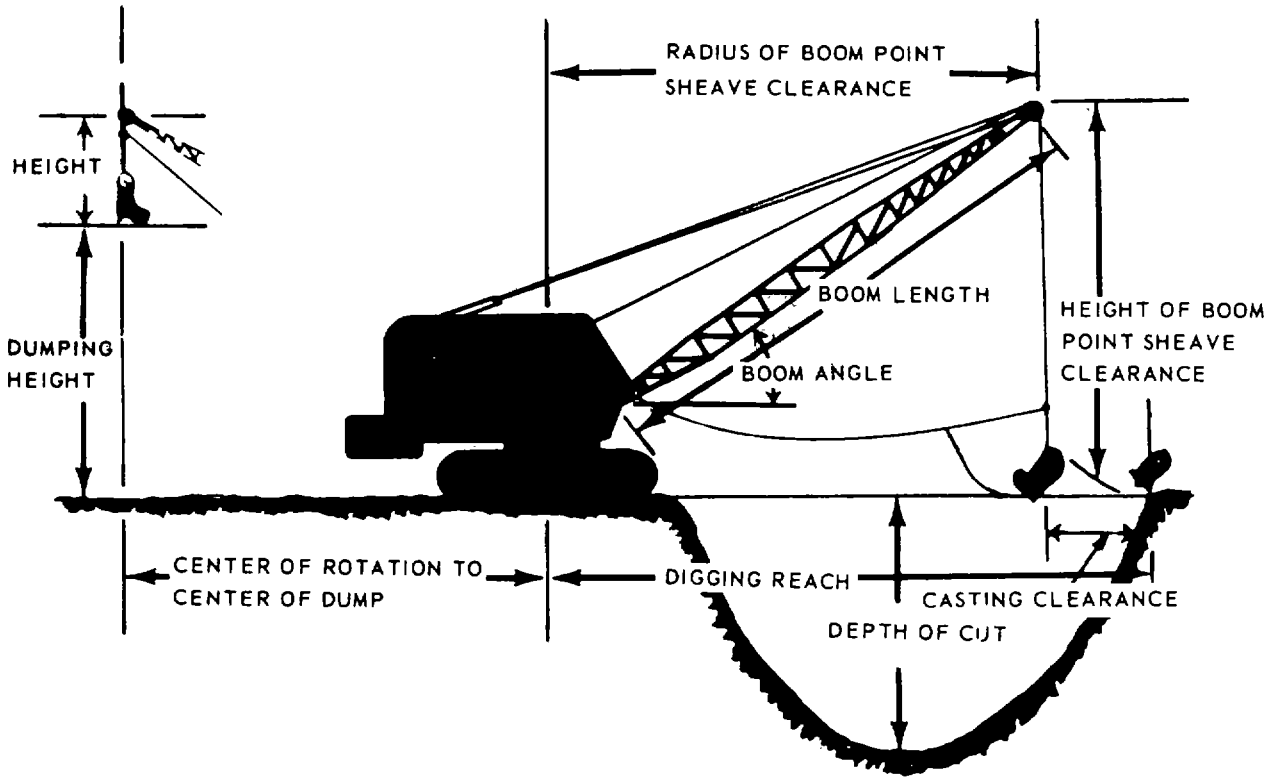


Figure 1-6. Shovel working ranges. ME 3810-201-12')6

Dumping radius (boom at 450 angle)	29 ft 3 in.
Dumping radius (boom at 600 angle)	26 ft 9 in.
Dumping height (boom at 456 angle)	18 ft 6 in.
Dumping. height (boom at 60° angle)	24 ft
Depth below floor lever (45° boom angle)	7 ft
Depth below floor lever (60° boom angle)	6 ft 6 in.
Floor lever radius (45° boom angle)	22 ft
Floor lever radius (60° boom angle)	20 ft
Digging radius at height of 8 ft (45° boom angle)	34 ft
Digging radius at height of 8 ft (60° boom angle)	31 ft
Height of cut (45° boom angle)	27 ft 3 in.
Height of cut (60° boom angle)	33 ft 6 in.
Clearance height of boom point sheave (45° boom angle)	24 ft 9 in.
Clearance height of boom point sheave (60° boom angle)	28 ft 6 in.
Dipper handle length	17 ft
Boom length	24 ft
Boom angle	45° or 60°

(24) *Backhoe working ranges*. Backhoe working ranges are illustrated in figure 1-7 and dimensions are listed below.

Radius at beginning of dump	- 11 ft
Radius at end of dump (maximum)	28 ft
Clearance dumping height (maximum)	29 ft
Dumping height at end of dump	26 ft 6 in.
Dumping height at start of dump-l4 ft	
Digging reach (maximum)	40 ft
Digging depth (maximum)	27 ft
Hoe stick length	9 ft
Boom length	28 ft

(25) *Piledriver clearances*. Piledriver clearances are illustrated in figure 1-8 and dimensions are listed below.

Boom length	50 ft
Distance from ground to hammer	47 ft 3 in. (maximum)
Centerline of boom point sheave	45 ft (minimum)
to bottom of leads	48 ft
Width of leads	3 ft
Height from ground to center	51 ft 9 in. (minimum)
of boom point sheave	55 ft (Maximum)
Height from ground to boom tip	55 ft 3 in.
Distance from boom foot pin-to	15 ft 3 in. (minimum)
center line of leads	-21 ft 3 in. (maximum)

(26) *General information*. Listed below are weights of materials per two cubic yards, in pounds, commonly handled with the clamshell bucket. These weights are approximate and should only be used as a general guide. Be sure to add bucket weight to determine total load lift.

Ash, dry	1,890 lbs
Cinders	2,971 lbs
Clay, compact	5,886 lbs
Clay, dry, in lumps	8,503 lbs

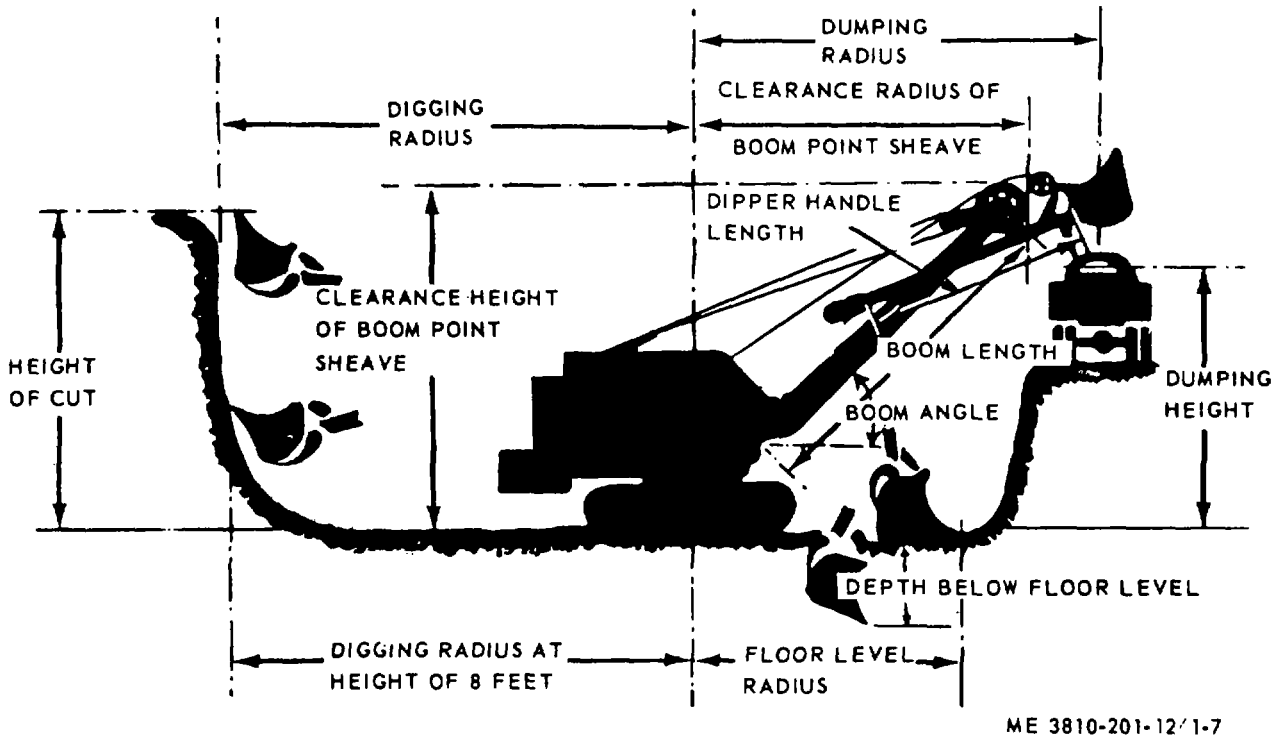


Figure 1-7. Backhoe working ranges.

Coal, anthracite	3,024 lbs
Coal, bituminous	2,971 lbs
Coke	1,458 lbs
Concrete, ready to pour	7,992 lbs
Earth, dry, loose	4,061 lbs
Earth, dry, packed	6,131 lbs
Earth, wet, mud	5,942 lbs
Gravel, loose, dry	5,942 lbs
Gravel, wet, packed	6,480 lbs
Gypaum, crashed	5,131 lbs
Iron ore (50% iron)	13,503 lbs
Limestone, 1 1/2-2 In. grade	4,589 lbs
Limestone, ruin of crusher	5,11 lbs
Sand, dry, loose	6,131 lbs
Sand, wet, packed	6,480 lbs

(27) *Wiring diagrams*. Refer to views A and B of figure 1-9 for wiring diagrams of electrical functions.

(28) *Maintenance and operating supplies*. Maintenance and operating supplies are listed in appendix B of this manual.

1-5. Difference in Models

a. General. This manual covers the Harnishchfeger crane-shovel unit model 855BG with serial number range from 21,426 through 21,550. No known differences exist between units of this model.

b. Engines. All crane-shovel units will be equipped with a model D333TA caterpillar engine, replacing the Harnishchfeger model 687C18-ES as that engine becomes unserviceable.

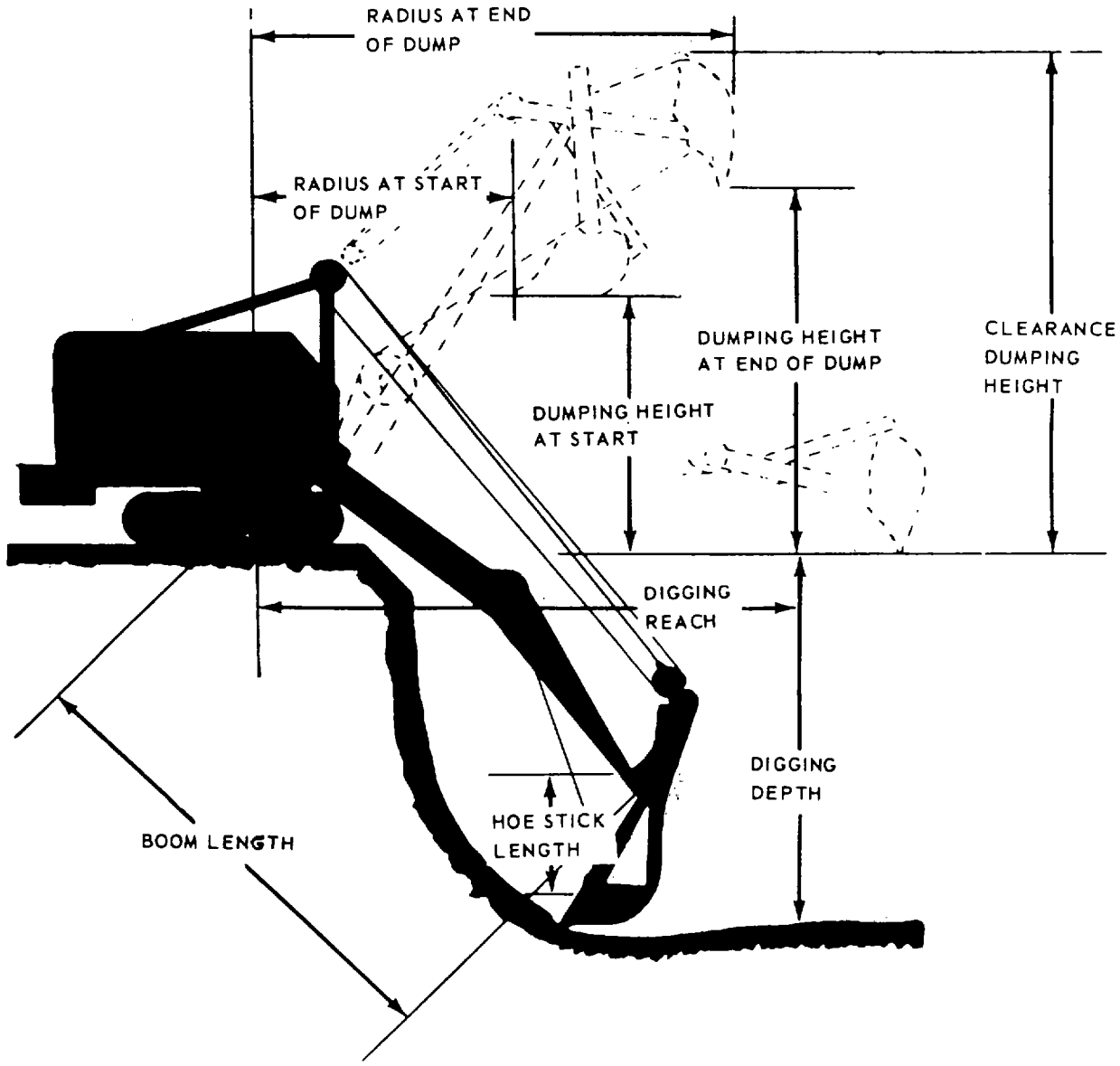
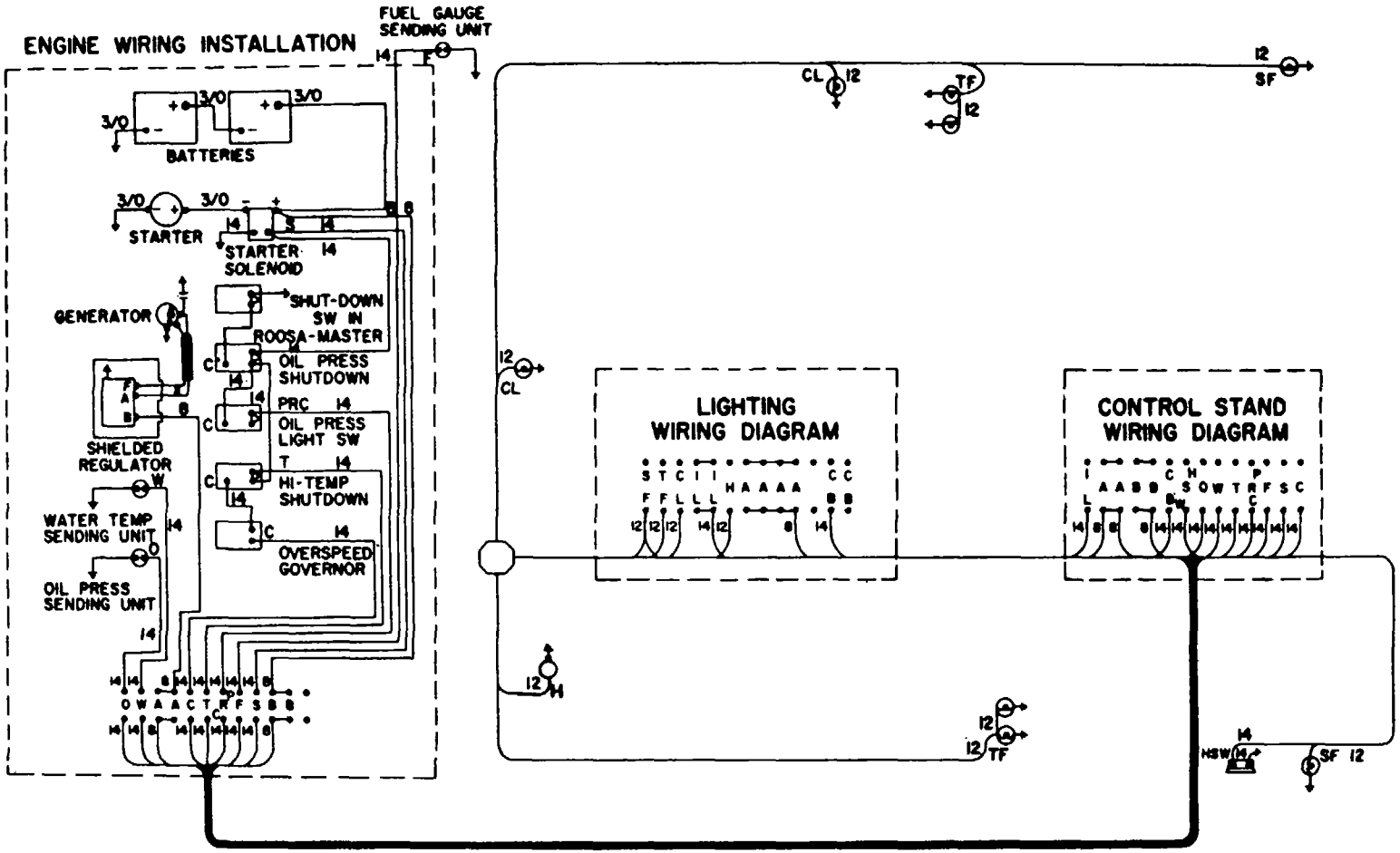


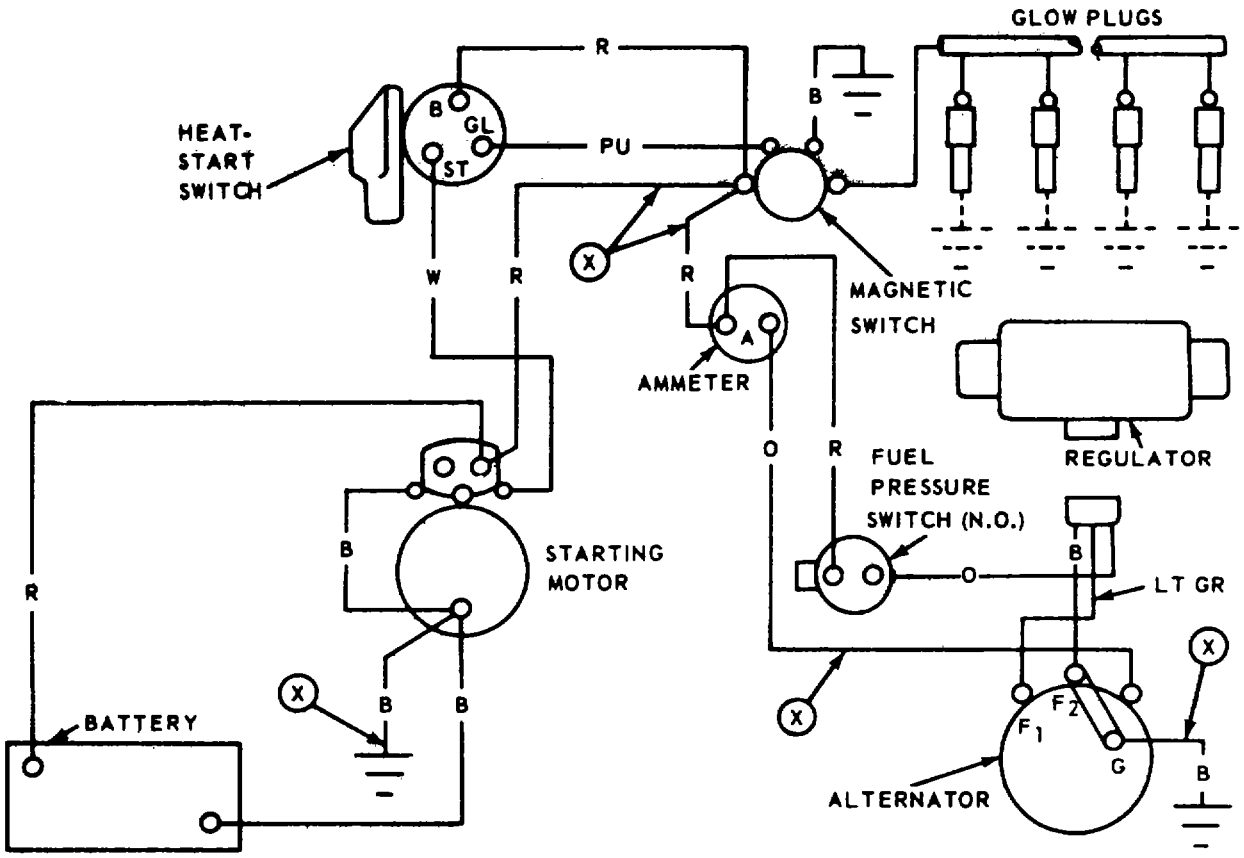
Figure 1-8 Piledriver clearance diagram.



LEGEND

½ GROUND	8 WIRE SIZE	A,B,ETC.TERMINALS	+ POSITIVE TERMINAL	TF UPPER FLOODLIGHTS
CL CAB LIGHTS	12 WIRE SIZE	HSW HORN SWITCH	- NEGATIVE TERMINAL	⬡JUNCTION BOX
3/0 WIRE SIZE	14 WIRE SIZE	PRC OIL PRESSURE INDICATOR LIGHT	SF LOWER FLOODLIGHTS	H HEATER

A. WITH ENGINE MODEL 687C-18NES



LEGEND			
COLOR CODE		SYMBOL	DESCRIPTION
B	BLACK		
W	WHITE	○	WIRING TERMINAL
R	RED		
O	ORANGE		
P	PINK		
PU	PURPLE		
BR	BROWN	⊣||	VISIBLE GROUNDING OF COMPONENTS
LT GR	LIGHT GREEN		
DK GR	DARK GREEN		
LT BL	LIGHT BLUE		
DK BL	DARK BLUE		
W/B	WHITE WITH BLACK STRIPE	--⊣||	INTERNAL GROUNDING OF COMPONENTS
THE WIRES MARKED (X) ARE TO BE WIRES WITH THE HEAVY GAUGE WIRE SUPPLIED IN THE WIRING KIT GROUP.			

8. ENGINE, MODEL D333TA ONLY.

ME 3810-206-12/1-9 (2)

Figure 1-9. Wiring diagram (sheet 2 of 2).

CHAPTER 2
INSTALLATION AND OPERATING INSTRUCTIONS

Section I. SERVICE UPON RECEIPT OF MATERIEL

2-1. Inspecting and Servicing the Equipment

a. General. When a crane-shovel unit is received by the organization, and after it has been unloaded from the carrier (para 2-3), it must be thoroughly inspected and serviced to insure that it is in good operating condition.

b. Visual Inspection.

(1) Inspect for damage that might have occurred during shipment.

(2) Inspect all components for loose mounting hardware or connections.

(3) Inspect all controls for freedom of movement through operating range, and that all handles or knobs are in place.

(4) Inspect engine compartment for loose or missing parts, or damage to air cleaner, manifold, muffler, fuel injection pump, or fuel lines.

(5) Inspect fuel tank for dents, cracks, or other damage. Insure removal of all preservative or barrier material.

(6) Inspect battery installation for tightness of cables and level of electrolyte.

(7) Inspect instruments for cracked or broken glass, and security of mounting.

(8) Inspect cab for broken windows or door glass.

(9) Inspect flood lights for serviceability, and test operation of switches on control panel.

(10) Report all discrepancies to proper authority.

c. Servicing the Equipment. After the equipment has been unpacked (para 2-4) and separately packed components have been installed (para 2-2), the equipment must be serviced as follows:

(1) Lubricate the crane-shovel in accordance with current lubrication order and paragraph 34.

(2) Perform all preventive maintenance checks and services (para 3-6).

Caution

Provide a metallic contact between service vehicle and fuel tank during fueling operation. Never operate engine while in refueling process Have serviceable fire extinguisher available while refueling.

(3) Fill the fuel tank.

(4) Fill engine crankcase with oil as specified in current lubrication order.

(5) Batteries may be shipped separately (para 2-2) or installed dry charged, with electrolyte shipped separately. Install batteries (para 3-75) if necessary, then fill with electrolyte until acid stands at least % inch above plates. For further service to batteries refer to TM 9-614w 200.

(6) Service cooling system (TB ORD 651) with water, or proper mixture of anti-freeze solution. For cold weather operation requirements see paragraph 2-14.

2-2. Installation of Separately Packet Components

a. General. Components packed separately are boxed, crated, or secured on or about the basic unit on carrier. After unloading (para 248b) and unpacking has been accomplished, these components are installed as follows:

b. Floodlights. Insure packing material has been removed, then install a floodlight in single mounting bracket on left or right front of cab (fig. 1-2) by removing one locknut, inserting stud through bracket and reinstalling locknut.

Install remaining floodlights in a similar manner.

c. Batteries. After batteries and electrolyte have been unpacked (para 2-48), install batteries in box (para 375).

(1) Remove vent plugs (caps) from battery cells and fill each cell with electrolyte, until it stands at least 8/8 inch above plates. Install caps after checking that vent holes are clear of any obstruction.

Warning

Avoid spilling of electrolyte. Wash off all spilled electrolyte with fresh water, from battery, skin, or clothing. Serious burns may result, if this warning is ignored.

Caution

Avoid flash currents when installing battery cables by installing ground cable first. Serious damage to instruments can occur, should this caution be ignored.

(2) Install ground cable to negative post on battery, then secure remaining end to stud on engine mounting frame.

(3) Install battery cable to positive post on battery, then secure remaining end to positive terminal of starting motor solenoid. For further service to batteries refer to paragraph 3-75, and TM 9-6140-200-15 (Operation and Organizational, Field and Depot Maintenance of Storage Batteries, Lead Acid type).

Note

After batteries have been installed for about three or four hours, recheck electrolyte level in all cells. Add electrolyte, if necessary, until it stands at least % inch above plates.

(4) Place cover on battery box and secure with two catches (para 3-75).

d. Front End Attachments. Not all of the front end attachment components will be boxed or crated. Most will be secured to carrier with blocking, cribbing, and hold-down bolts (para 2-3).

After unloading, the proper front end attachment will be installed (para 2-4).

2-3. Installation or Setting Up Instructions

a. General. Crane-shovels are shipped partially disassembled and processed for limited storage.

Definite services described below are required before they can be put into operation. The operator and crew requires assistance from organizational maintenance personnel in performing these services.

b. Unloading the Equipment.

(1) Preparation for unloading. Remove all blocking, hold-down cables, supports, or cribbing, from front end attachments, accessories, or crane-shovel unit (fig. 2-1 through 2-3).

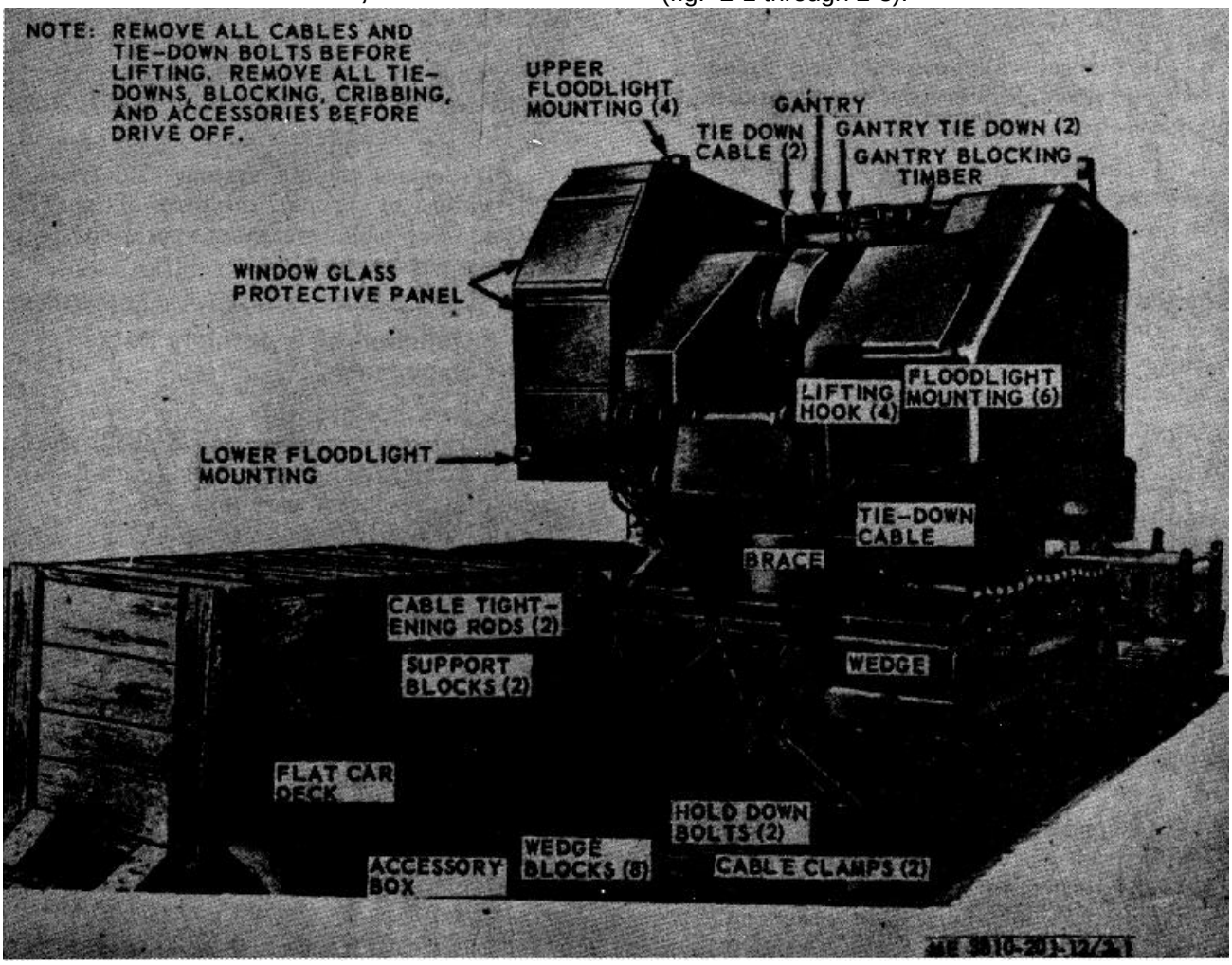


Figure 2-1. Crane-shovel basic unit, and accessories loaded and blocked for shipment, front view.

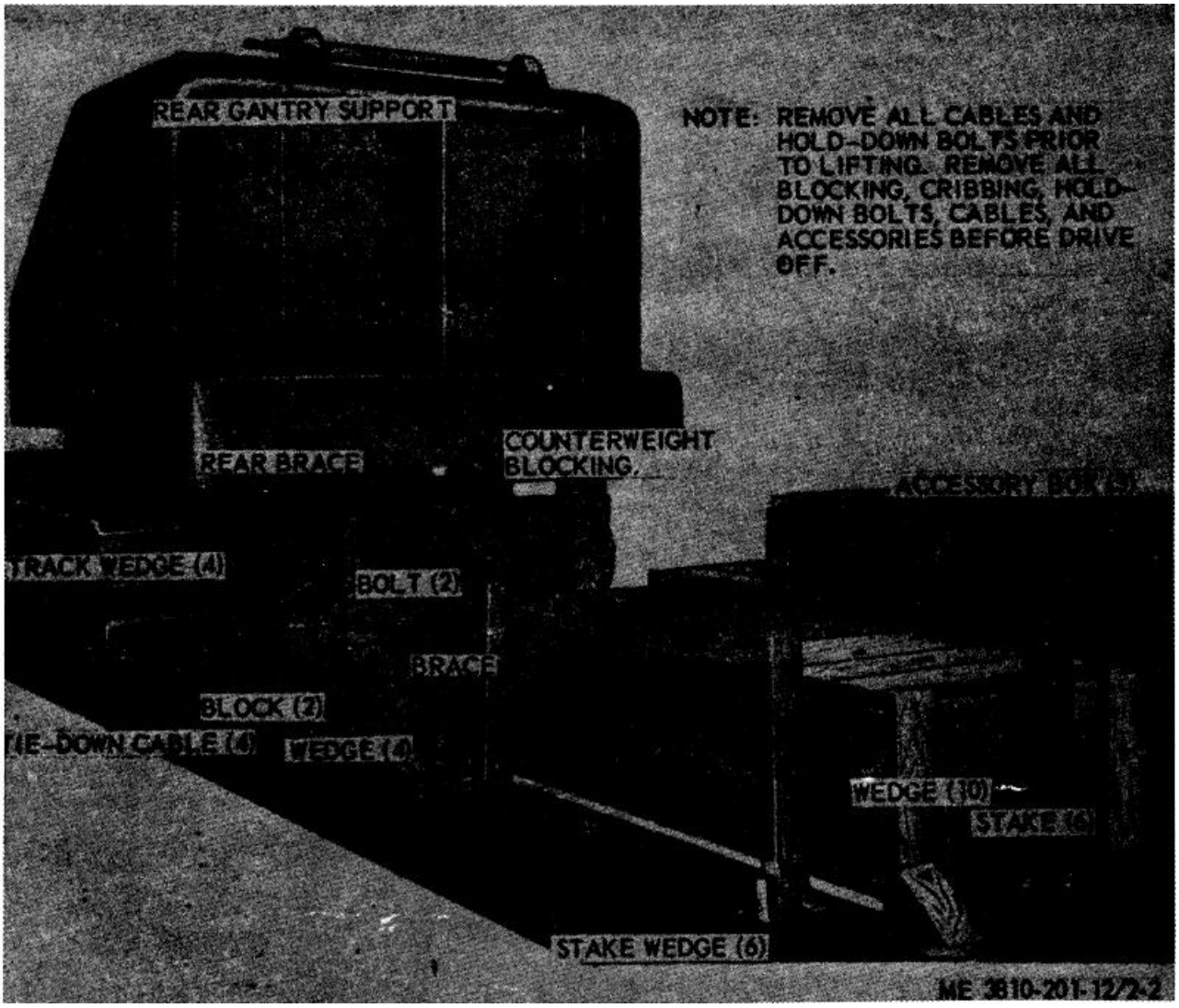


Figure 2-2. Crane-shovel basic unit, and accessories loaded and blocked for shipment, rear view.

(2) *Unpacking the equipment*. When craneshovel unit is to be set up for immediate operation remove anti-rotation bars (para 2-5); protective paneling from cab windows and openings; barrier materials; preservatives; pressure sensitive tape from instruments or engine components, and unpack crates or boxes containing components of front end attachment to be installed.

Caution

Always use a nail puller to open boxes, or crates, and avoid damage to contents.

(3) *Unloading by lifting.*

(a) Position lifting device capable of lifting 109,00 0 pounds along side carrier.

(b) Assure that all hold-down bolts and tiedown. cables have been removed; position suitable slings in lifting eyes of crane-shovel; over hook of lifting device (fig. 2-4), and attach a tag line to prevent crane-shovel from twisting or turning.

Warning

Keep all personnel not engaged in unloading procedure well back from working area to avoid possible injury.

(c) Lift crane-shovel unit (on signal), swing it away from carrier, and lower to level ground.

(d) Remove lifting slings from eyes of crane-shovel unit and hook of lifting device.

(4) *Unloading by drive off method.*

(a) Position flatcar on a siding with an end ramp, preferably earthen, or where a suitable ramp (fig. 2-5) may be constructed.

(b) Block all flatcar wheels to prevent car moving away from ramp.

(c) Perform steps (1) and (2) of b above.

(d) Perform preventive maintenance checks and services (para 36).

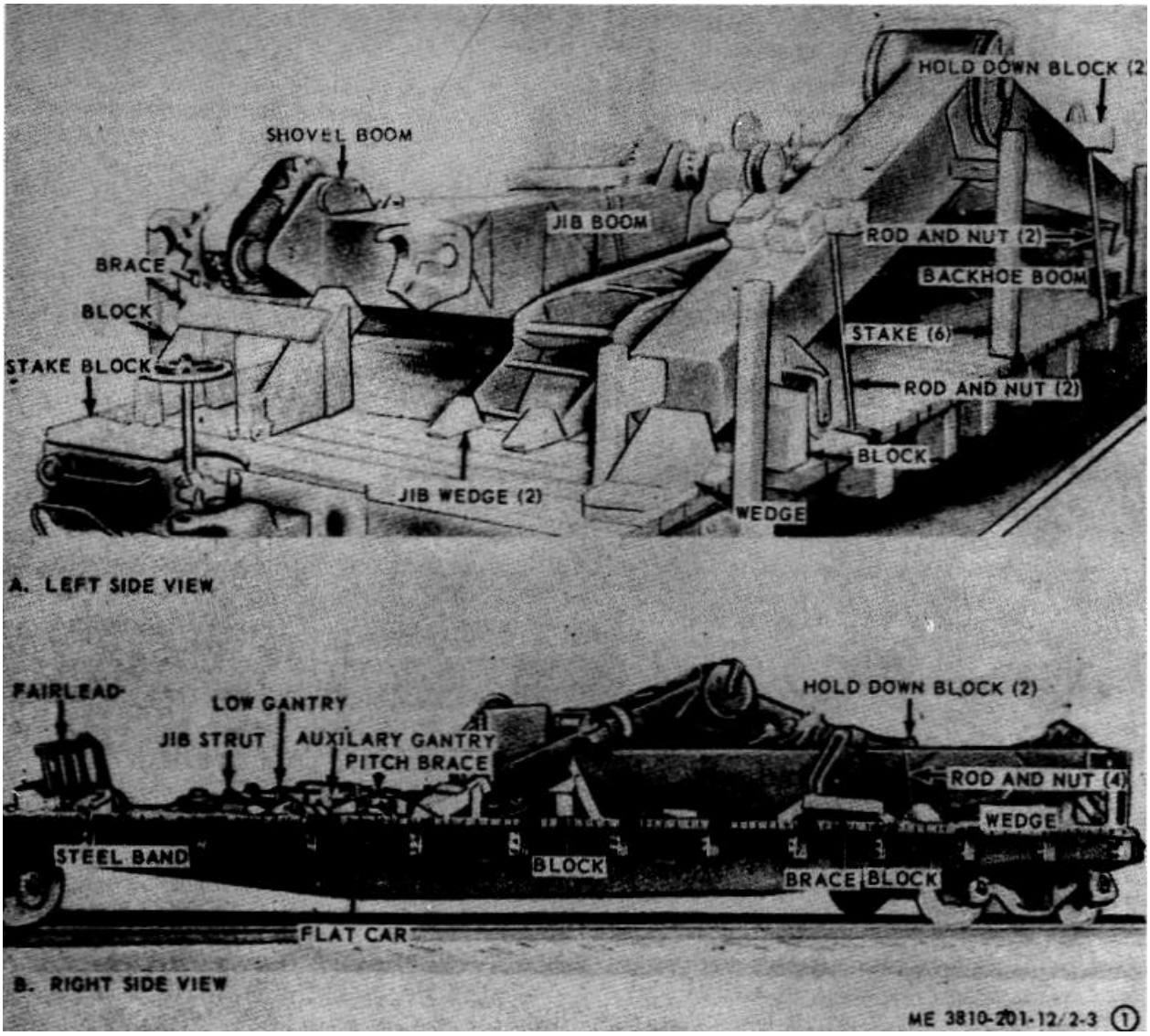


Figure 2-3. Front end attachments loaded and blocked for shipment (sheet 1 of 2).

(e) Assure that crane-shovel has been inspected and serviced (para 2-1) then start engine (para 2-10), and drive crane-shovel off flatcar to a suitable area near by where selected front end attachment may be installed.

c. Setting Up Instructions for Crone Operation.

(1) *Description*. The equipment required for crane operation consists of a 50 foot boom, boom backstop, boom hoist guy cables, boom hoist cable, snatch block, hook block, boom angle indicator and boom harness sproader (cross-over).

(2) *Crane front end attachment installation*. With crane boom cribbed as illustrated in figure 2-6, move basic unit into position and connect boom by installation of two boom foot pins. Install pins with head out and secure each with a cotter pin. Complete crane installation as follows:

(a) Refer to view A of figure 2-7 and reeve boom hoist cable, connect cable to dead end socket and secure with cable clamps.

(b) Refer to view C of figure 2-7 and reeve main hoist cable through hook block, connect to dead end socket, and secure with cable clamps.

(c) Raise boom (para 2-21c) to operating position and install boom backstop (fig. 2-8).

(d) When jib boom is required, install as directed in paragraph 4-21, and reeve as shown in view B of figure 2-7.

2-4. Equipment Conversion

a. General. The crane-shovel basic unit is normally equipped as a crane, but, front end attach-

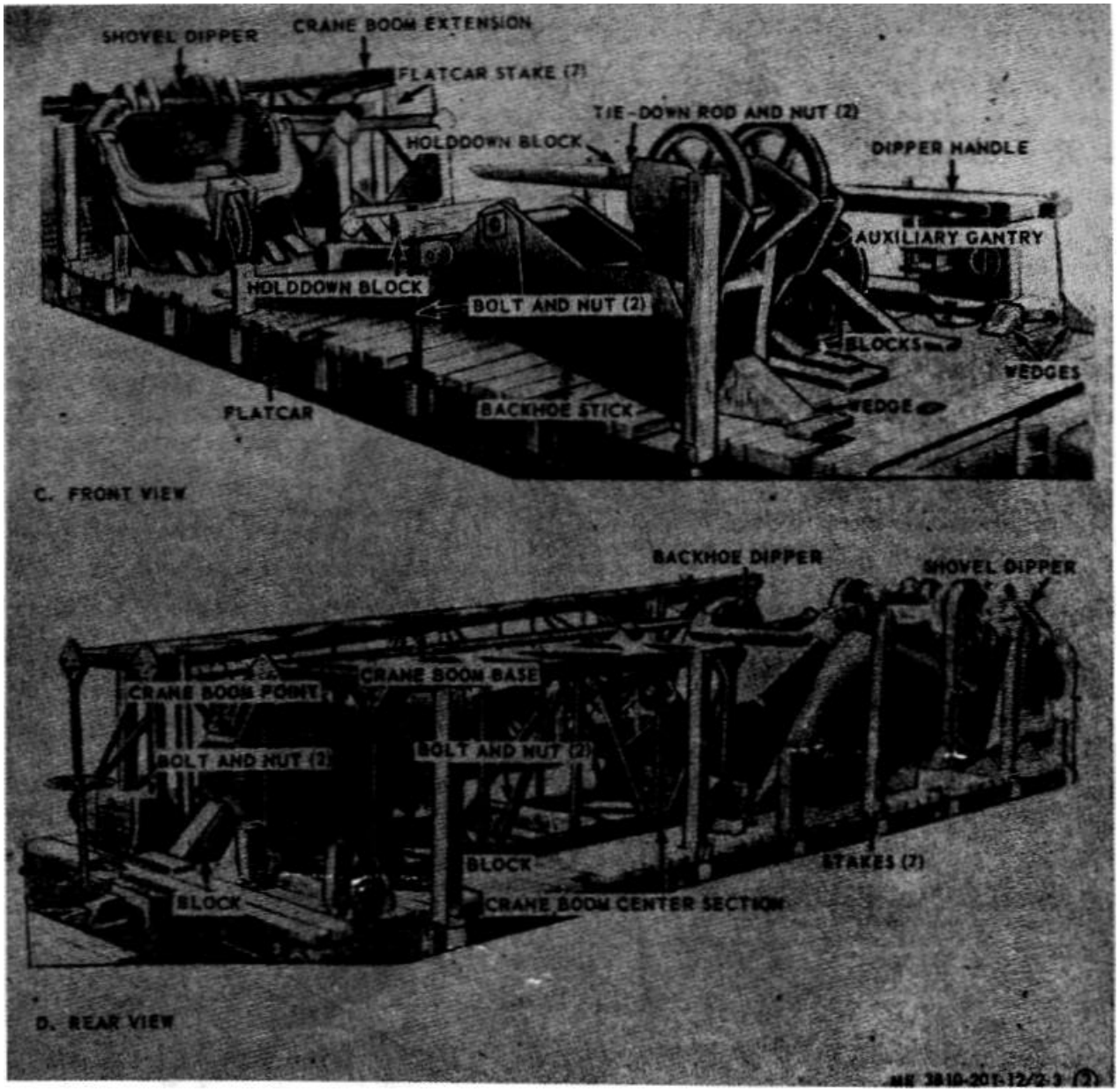


Figure 2-3. Front end attachments loaded and blocked for shipment (sheet 2 of 2).

ments are available for conversion into backhoe, clamshell, dragline, piledriver, and shovel front operating units. The conversion instructions below will assume that basic unit has been in operation as a crane, and will list the different components required for converting to new front end attachment.

Note

Crane boom of 50 foot length, without center section, or jib boom.

b. Clamshell Front End Attachment. The attachment requires clamshell lagging, tagline winder, closing and holding cables, and clamshell bucket

(1) *Installation*.

(a) Raise hook block to near boom point sheave, then lower crane boom to horizontal position.

(b) Remove clamps from hoist cable at dead end socket (view C, fig. 27); remove hook block, then remove hoist cable from drum. Remove cable from right hand drum if necessary.

Note

Organizational maintenance personnel will remove, or install, all drum lagging.

(c) Remove crane lagging (para 3-124) and install clamshell lagging, then wind holding cable on right hand drum, and closing cable on left hand drum. Refer to table 1-2 for size and length of cables.

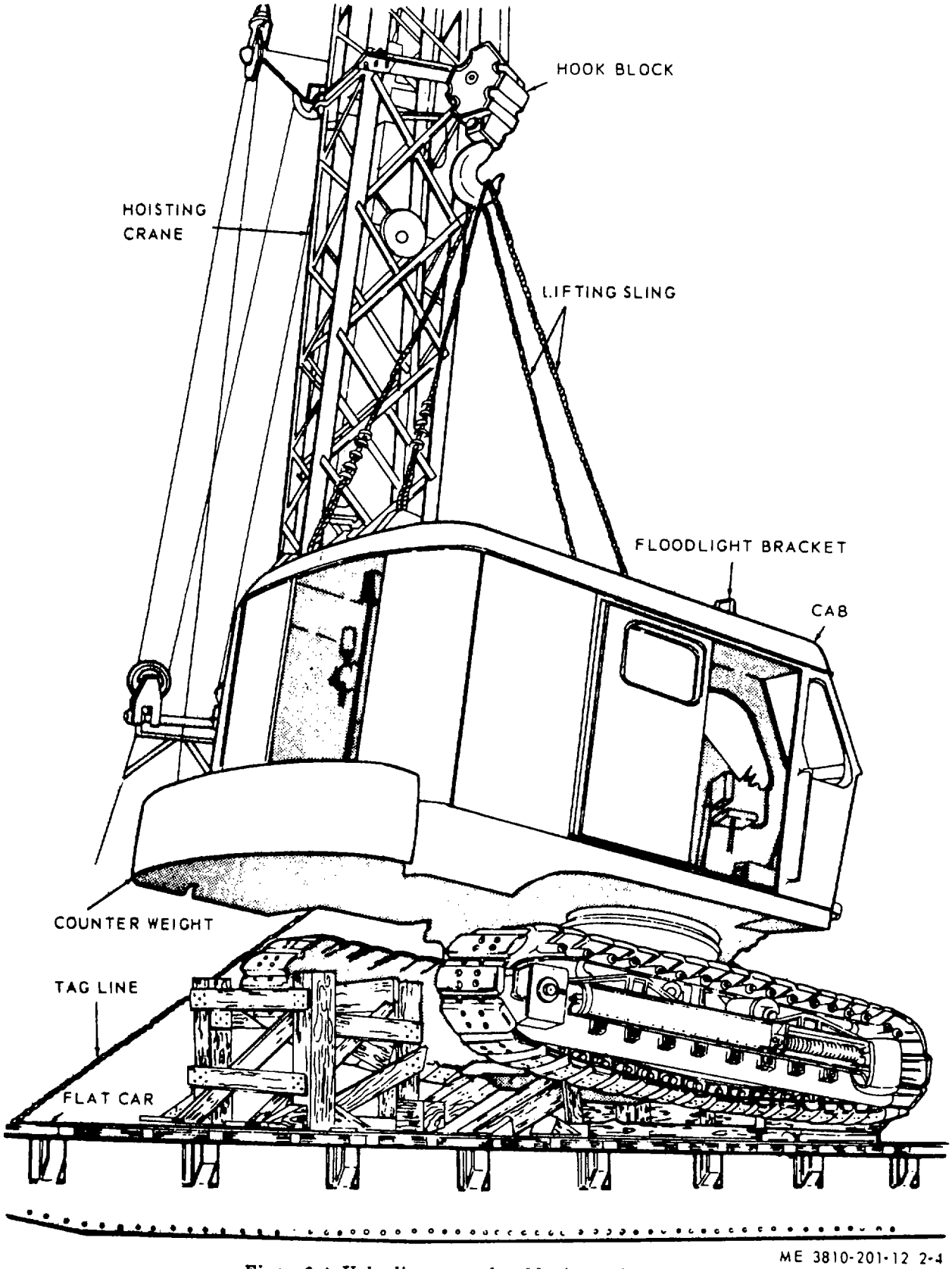


Figure 2-4. Unloading crane-shovel basic unit by lifting.

NOTE

MATERIAL USED FOR RAMP CONSTRUCTION MUST BE OF HARDWOOD AND FREE OF KNOTTY DEFECTS BETWEEN SUPPORTS. RAMP BASE, RAMP RUNNERS, AND RAMP SUPPORTS MUST BE OF 6 INCH BY 6 INCH TIMBER, AND OF A LENGTH TO ASSURE NO MORE THAN A 30 DEGREE ANGLE OR SLOPE. PLACE THREE OF THESE RAMPS UNDER EACH TRACK AND CROSS SUPPORT THEM (ALL CROSS SUPPORTS MAY BE OF 2 INCH BY A INCH DIMENSION), FOR STABILITY.

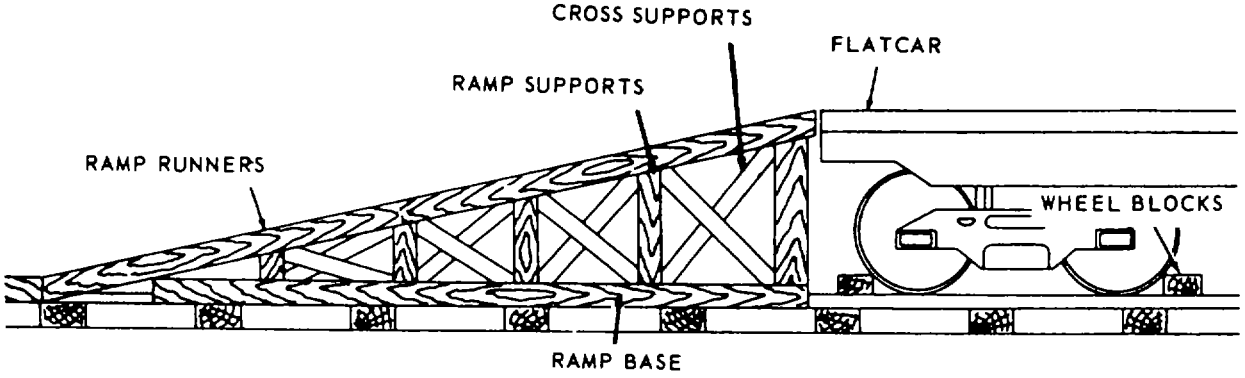


Figure 2-5. End ramp construction. ME 3810-201-12/2-5

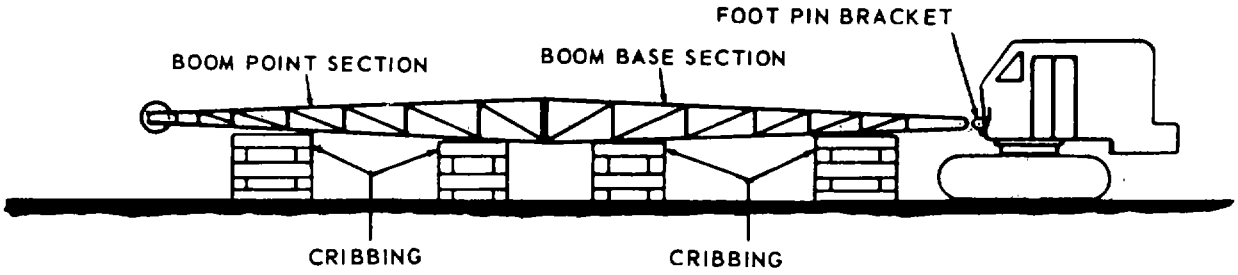


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Figure 2-6. Crams boom, positioned for real or installation

(d) Position clamshell bucket under boom point, reeve holding cable (fig. 2-9) and connect to dead end socket at clamshell bucket. Secure with cable clamps.

(e) Reeve closing cable in similar manner.

(f) Install tagline winder (para 4-14); unwind and connect tagline to clamshell chain, and secure with cable clamps.

(g) Raise crane boom to proper height (fig. 2-10).

(2) *Removal*. Remove clamshell front end attachment by reversing steps (a) through (g) above and revert to crane operation.

c. Dragline Front End Attachment. This front end attachment requires installation of dragline lagging, fairlead, dragline bucket, dragline cable, and hoist cable.

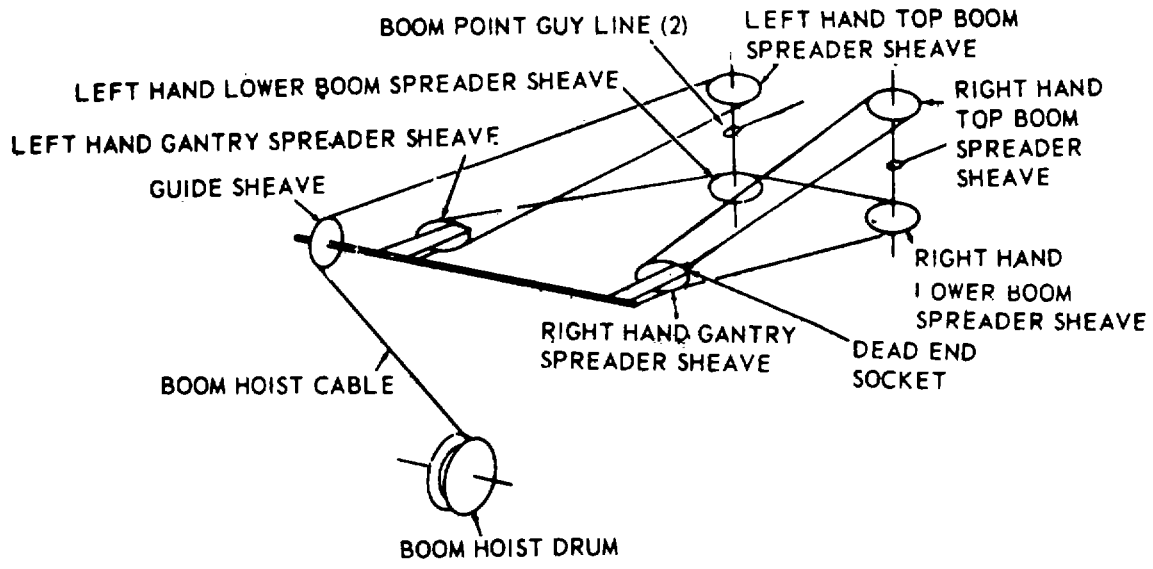
(1) *Installation*

(a) Raise crane hook block to near boom point sheave then lower crane boom to horizontal position (fig. 2-11).

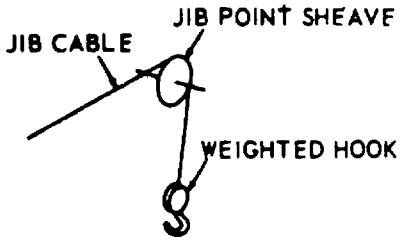
(b) Remove clamps from hoist cable at dead end socket (view C, fig. 2-7); remove hook block, then unwind and remove hoist cable from right hand drum. Remove cable from left hand drum.

Note

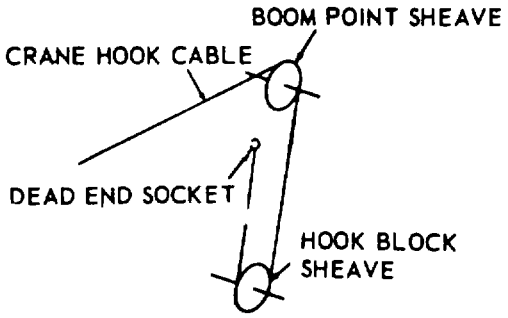
Organizational maintenance personnel will remove and install lagging.



A. BOOM HOIST CABLE REEVING



B. JIB CABLE REEVING



C. CRANE HOOK REEVING

ME 3810-201-12/2-7①

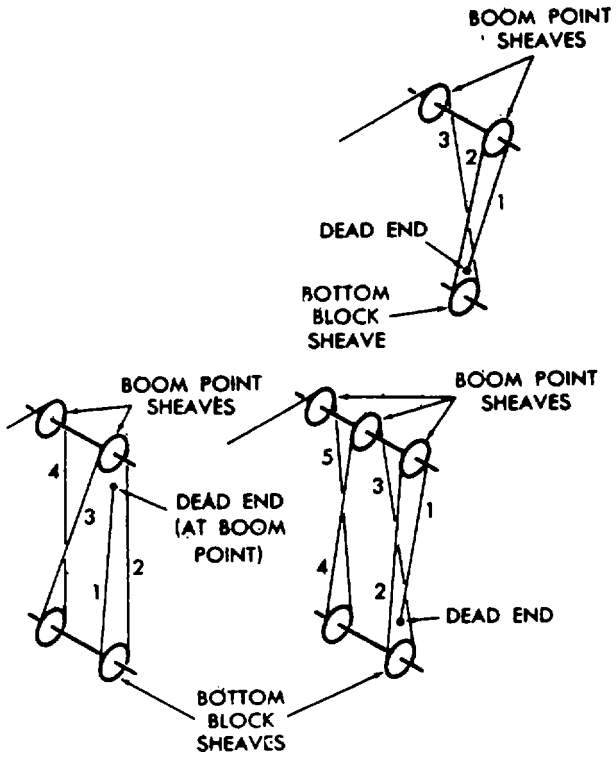
Figure 2-7. Cow boom and jib boom removal or sheet 1 of 2).

(c) Remove crane lagging (para 3-124); install dragline lagging, then install digging (drag) cable (table 1-2) on left hand drum (fig. 2-12).

(d) Install dragline hoist able (table 1-2) on right hand drum.

(e) Instill fairlead (para 4-16).

(f) Position dragline bucket under boom



D. CRANE HOOK REEVING (CONT'D)

ME 3810-201-12/2-7 (2)

Figure 2-7. Cam boom and jib boom diagram (sheet 2 of 2).

point reeve dragline hoist cable (fig. 2-12), then connect at dead end socket on dragline bucket bridle and secure with cable clamps.

(g) Reeve drag (digging) cable (fig. 2-12), connect to dead end socket on dragline bucket, and secure with cable clamps.

(h) Raise boom to normal operating position (fig. 2-11).

(i) Raise dragline bucket from ground.

(2) *Removal.* Remove dragline front end attachment by reversing steps la) through (i) above and revert to crane operation.

d. Pile Driver Front End Attachment. For this attachment, pile adapters; pile leads catwalk; drop hammer; boom center (extension) section; boom hoist cable; hammer cable, and pile cable are required.

(1) *Installation*.

(a) Lift hook block to near boom point sheave then lower crane boom (para 2-12c) to horizontal position on cribbing (fig. 2-6); remove clamps from hoist cable at dead end socket (view C, fig. 2-7); remove hook block, and wind hoist cable on drum.

(b) Loosen tension on boom hoist cable (view A, fig. 2-7), remove cable end from dead end socket, and rewind on cable drum slowly while guiding cable through sheave.

(c) Remove boom hoist cable from drum and replace with pile driver boom hoist cable (table 1-2).

(d) Separate boom point section from base section (para 4-18) and install center (extension) section as shown in figure 2-11.

(e) Reeve boom hoist cable (view A, fig. 2-7) and connect to dead end socket. Secure with proper clamps.

(f) With 60 foot boom installed, remove crane hoist cable from left hand drum and install pile cable (table 1-2) and reeve as shown in figure 2-18. Make loop and secure with cable clamps.

(g) Position piledriver adapters and spacers on boom point pin (fig. 2-14).

(h) Install bolts and nuts securing adapters to pile leads.

(i) Remove cable from right hand drum and install drop hammer cable (table 1-2) and reeve as shown on figure 2-13, over boom point sheave, down through pile leads, then connect at

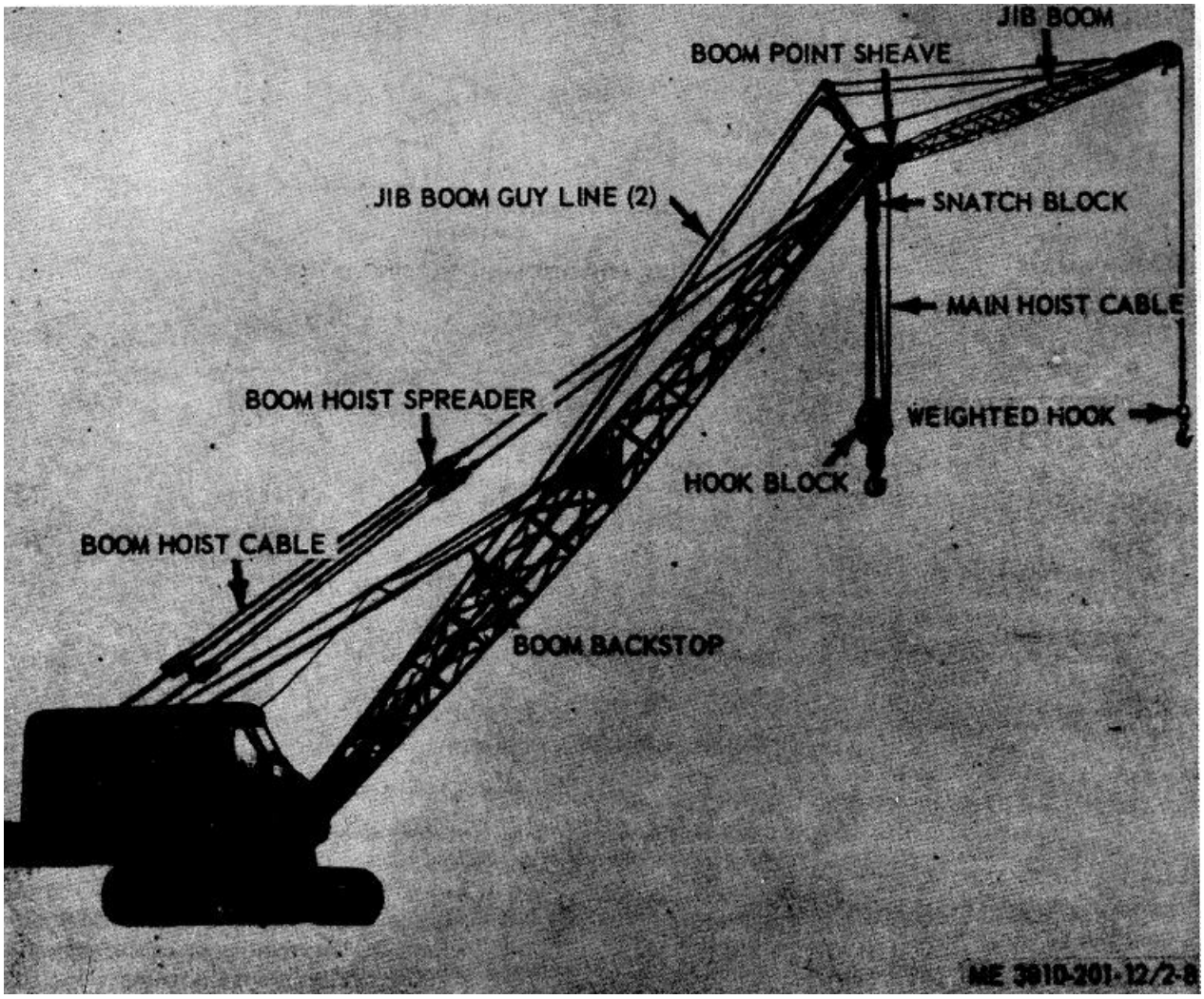


Figure 2-8. Crane front end attachment, with jib boom installed.

dead end socket at drop hammer and secure with cable clamps.

(j) Raise boom until pile leads are above drop hammer; position pile leads so that hammer guides inside pile leads will enter grooves in hammer sides, then lower pile leads.

(k) Raise drop hammer up into pile leads.

(l) Position pile follower under pile leads; lower hammer to rest on pile follower; place pile follower cables over hooks on hammer, then raise hammer and pile follower to top of pile leads.

(m) Install catwalk at boom foot, then at pile leads (fig. 2-14), and secure with bolts, lockwashers and nuts.

(2) *Removal*. Remove piledriver front end attachment by reversing steps (a) through (m) above and revert to crane operation.

e. Backhoe Front End Attachment. Items required for backhoe operations are: auxiliary gantry, boom, backhoe stick, pitch brace, dipper, backhoe lagging, and cables. Convert as follows:

(1) *Installation*.

(a) Remove crane boom (para 4-13) and crane lagging (para 3124).

Note

Removal of lagging above, and installation of lagging below, will be accomplished by organizational maintenance personnel.

(b) Install backhoe lagging (para 3 124).

(c) Move crane shovel into position (fig. 2-15) and connect backhoe boom by installing foot pins. Secure with cotterpins.

(d) Install auxiliary gantry and secure with gantry pins.

(e) Install backhoe digging cable (table 1-2) on drum lagging (fig. 2-16) and reeve through guide sheaves (view C) to dead end socket, and secure end with cable clamps.

(f) Install boom hoist cable (table 1-2) and reeve as shown in view A of figure 2-16. Connect

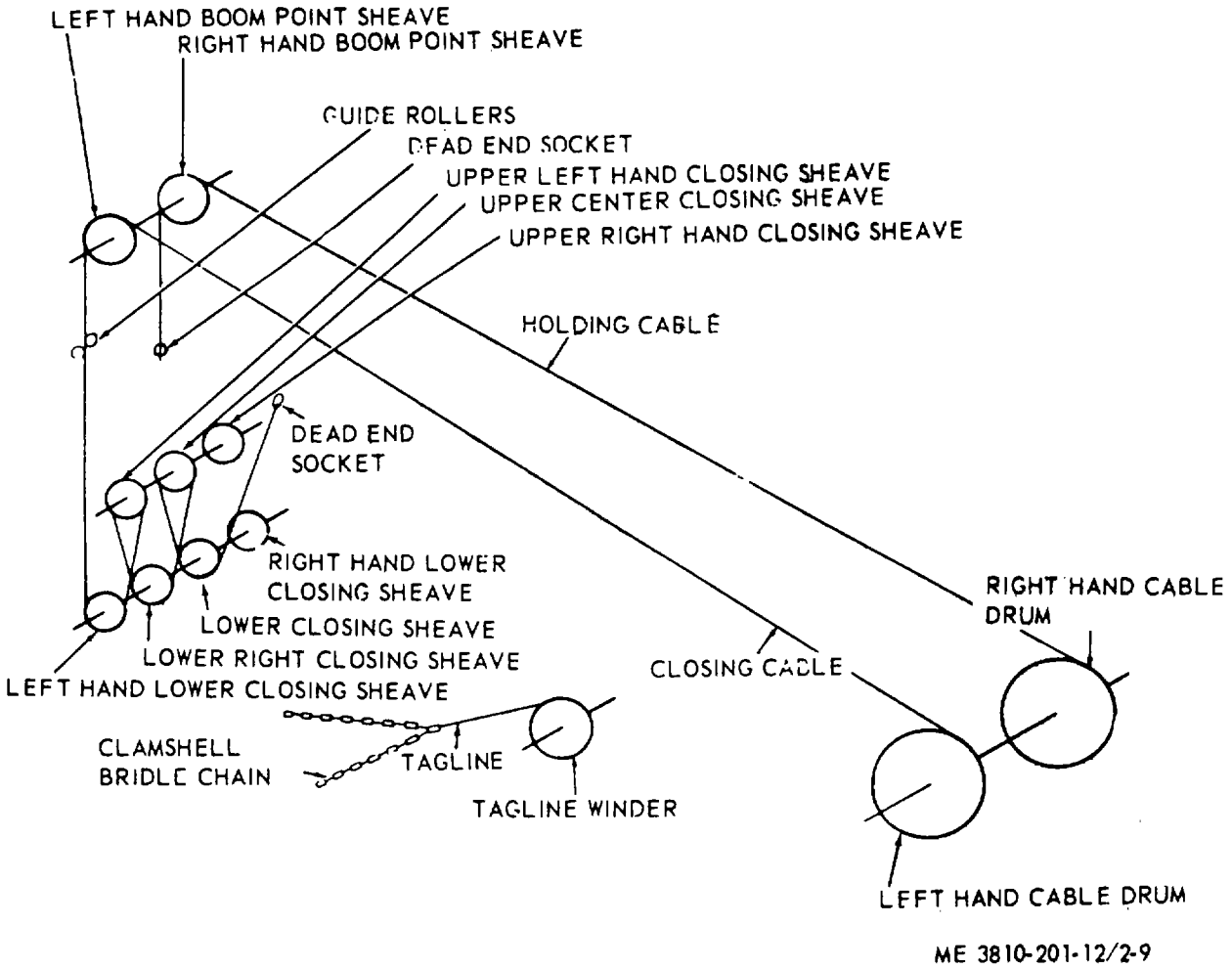


Figure 2-9. Clamshell front end attachment reeving diagram.

cable in dead end socket and secure with cable clamps.

(g) Install hoist cable (table 1-2) and reeve as shown in view B of figure 216. Connect cable in dead end socket and secure with cable clamps.

(h) Raise gantry, insure that pitch brace is properly installed (para 4-29b), then remove backhoe front end attachment from cribbing.

(2) *Removal.*

(a) Extend backhoe dipper and build cribbing under boom foot (fig. 2-15).

(b) Position blocking between boom and backhoe stick.

(c) Build cribbing under boom point, then lower boom to cribbing so that dipper rests on ground and boom is horizontal.

(d) Remove clamps from cable at dead end socket (view A, fig. 2-16), then slowly rewind cable on drum as it is carefully guided through the sheaves.

(e) Remove clamps from digging cable (view C) at dead end socket, then slowly rewind cable on drum as it is carefully guided through the sheaves.

(f) Remove clamps from hoist cable (view B) at dead end socket, then slowly rewind an drum as it is carefully guided through the sheaves.

(g) Remove cotterpins from boom foot pins (fig. 2-15); remove pins from brace and auxiliary gantry, then back basic unit away from backhoe front end attachment slowly until machine is clear.

(h) Remove cables from drums (views A, B and C, fig. 2-16); remove backhoe lagging (para 3-124); install crane lagging, then install crane cables (table 1-2).

(i) Install crane front end attachment (para 2-3c).

f. Shovel Front End Attachment. Installation of shovel front end attachment (fig. 2-18) re-

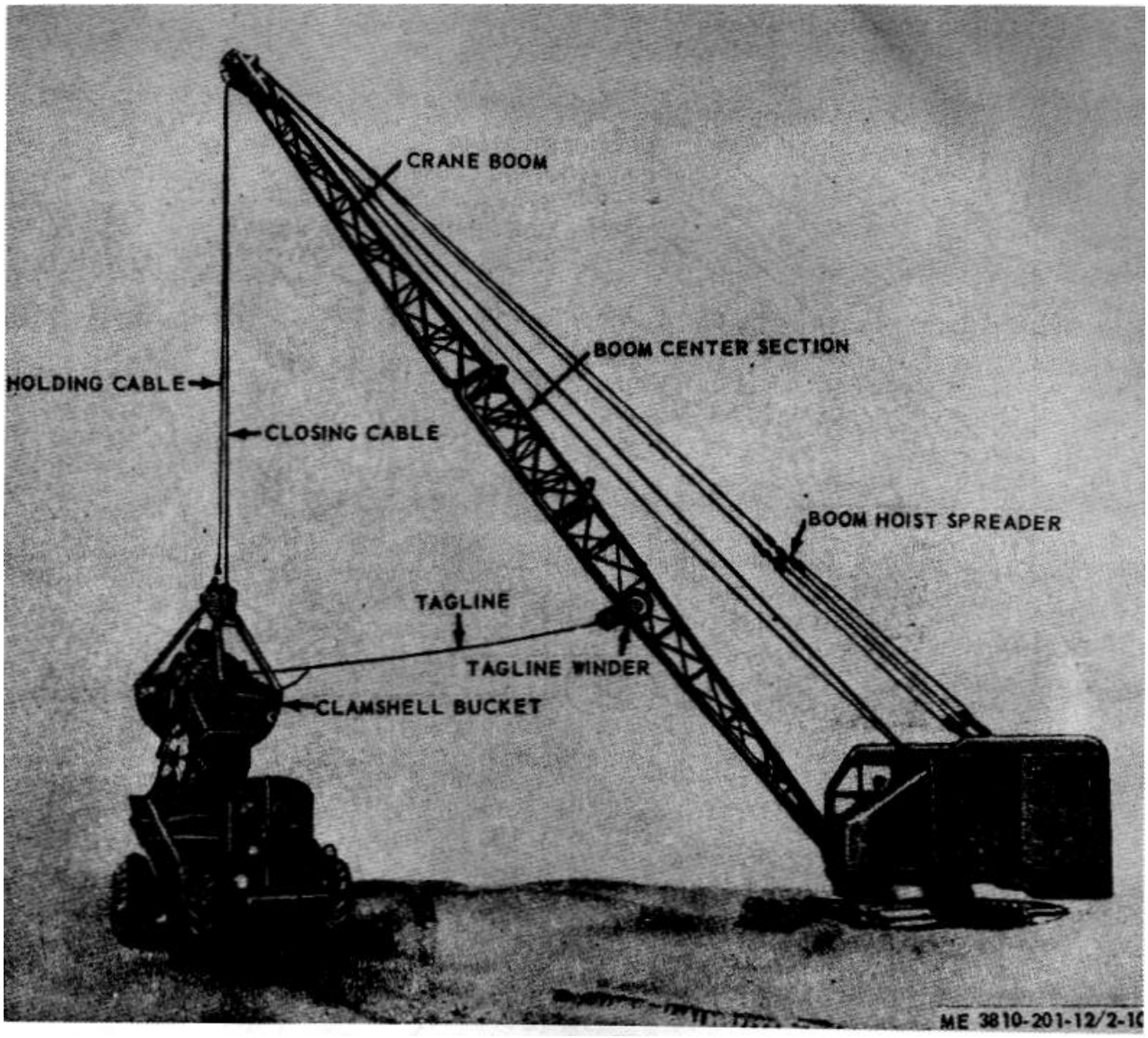


Figure 2-10. Clamshell front end attachment, installed view.

quires organizational maintenance personnel to install shovel sprocket, planetary pinion gear and crowd chain. The shovel will be installed at organizational maintenance with assistance from the operator. See figure 2-19 for cable reeving, and paragraph 4-2 for installation instruction.

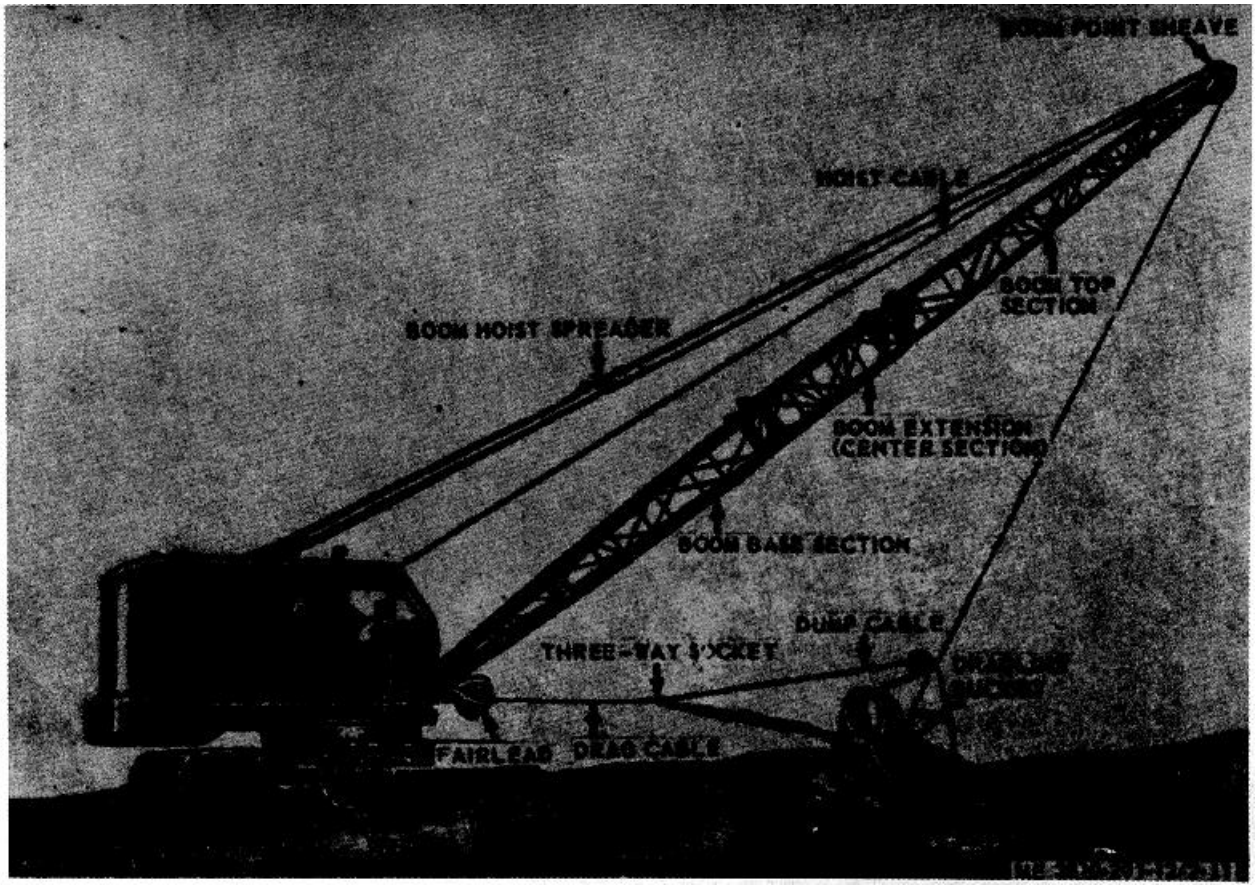


Figure 2-11. Dragline front end attachment, installed view.

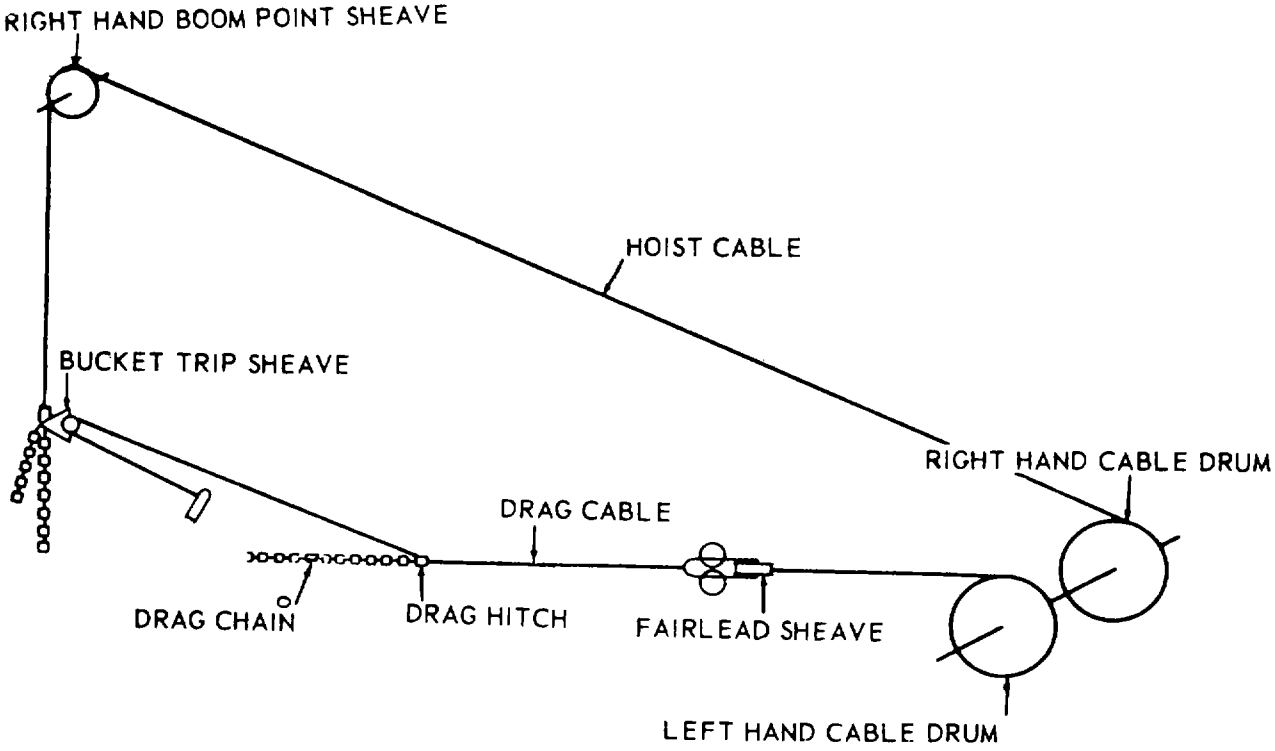


Figure 2-12. Dragline front end attachment reeving diagram.

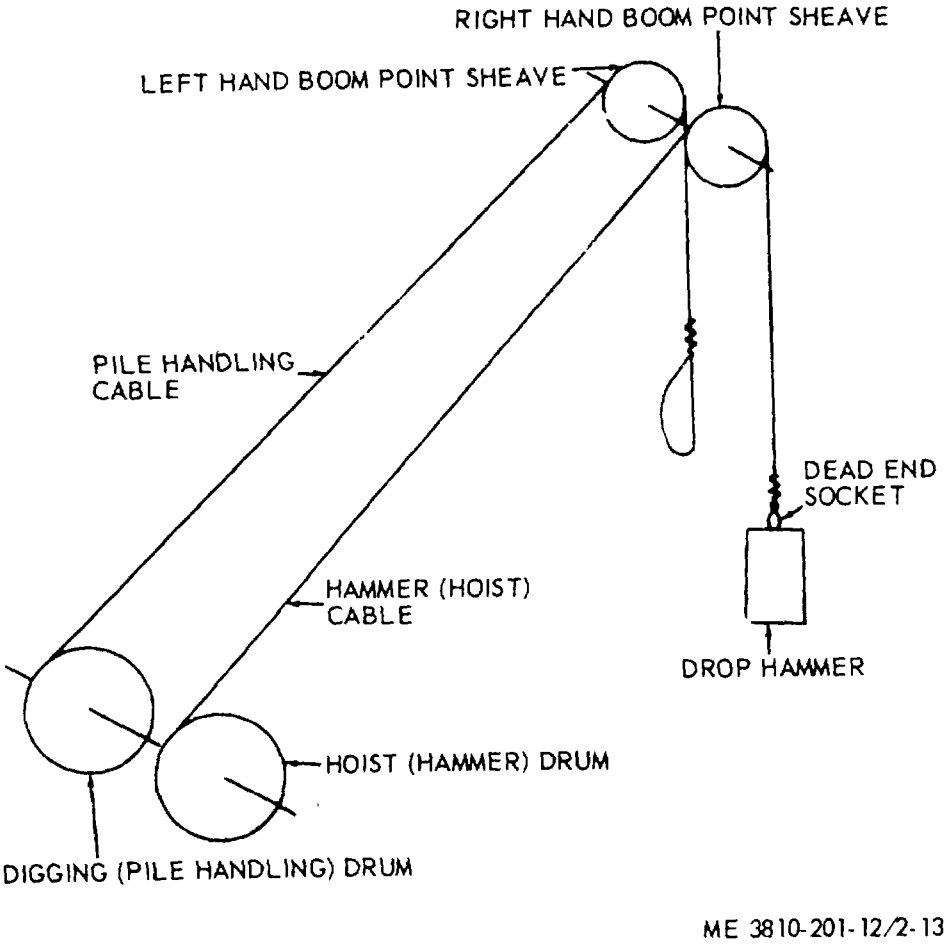


Figure 2-13. Piledriver font end attachment, reeving diagram.

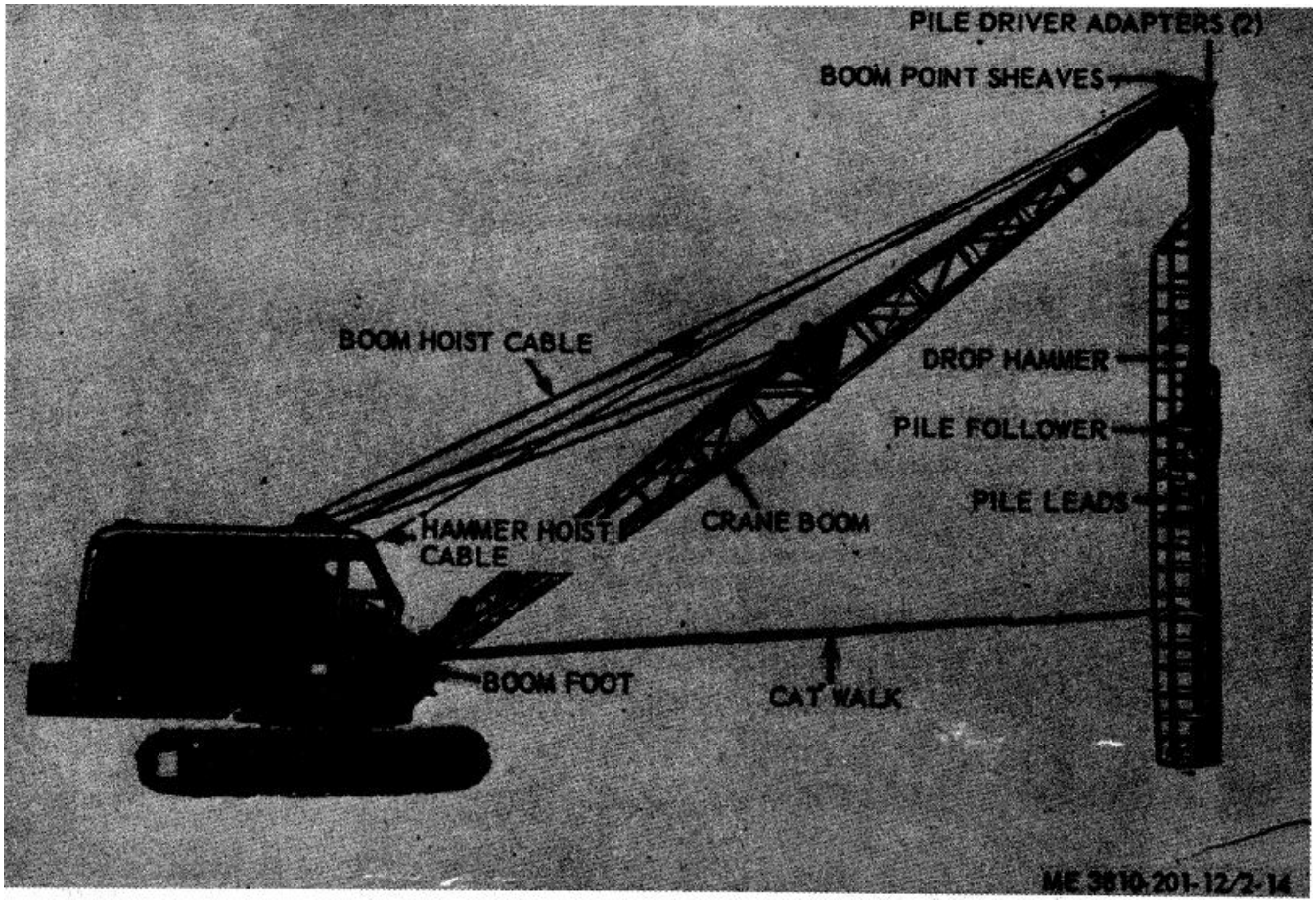


Figure 2-14. Piledriver front end attachment, installed view.

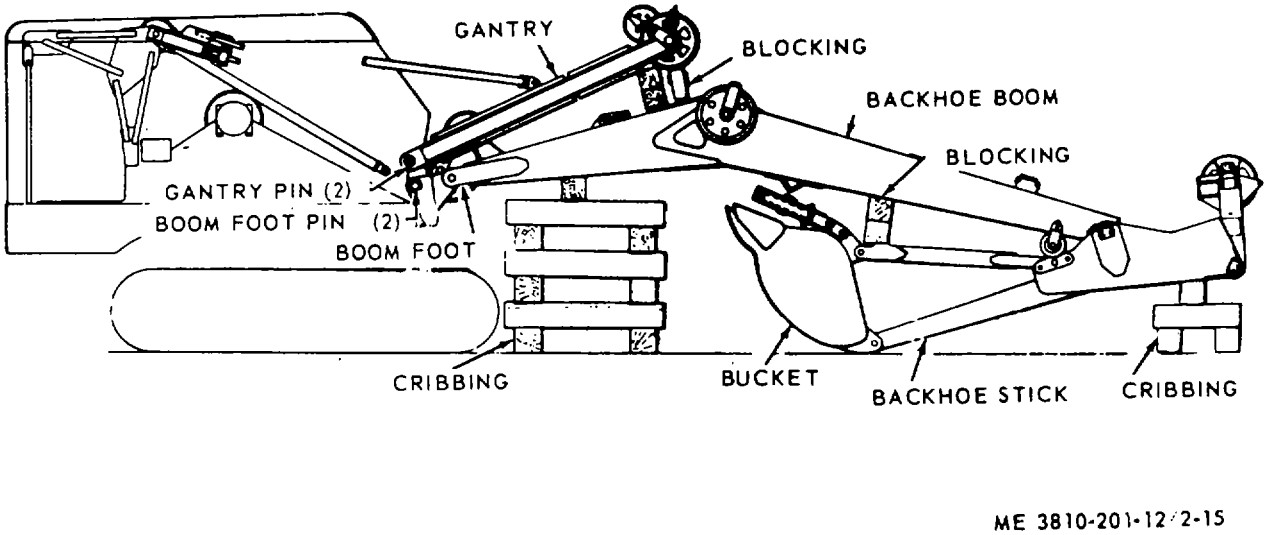


Figure 2-15. Backhoe front end attachment, prepared for removal and installation.

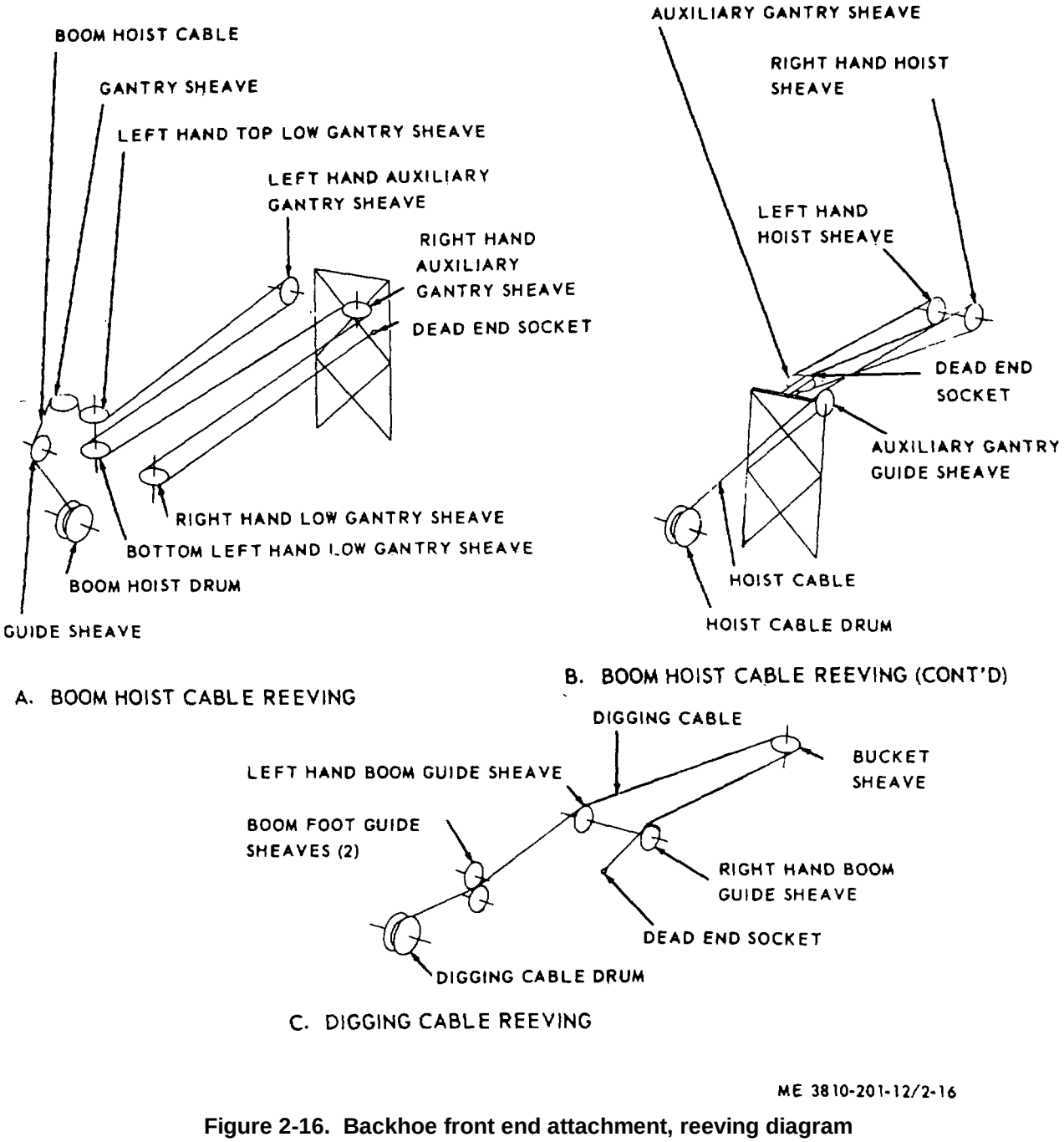


Figure 2-16. Backhoe front end attachment, reeving diagram

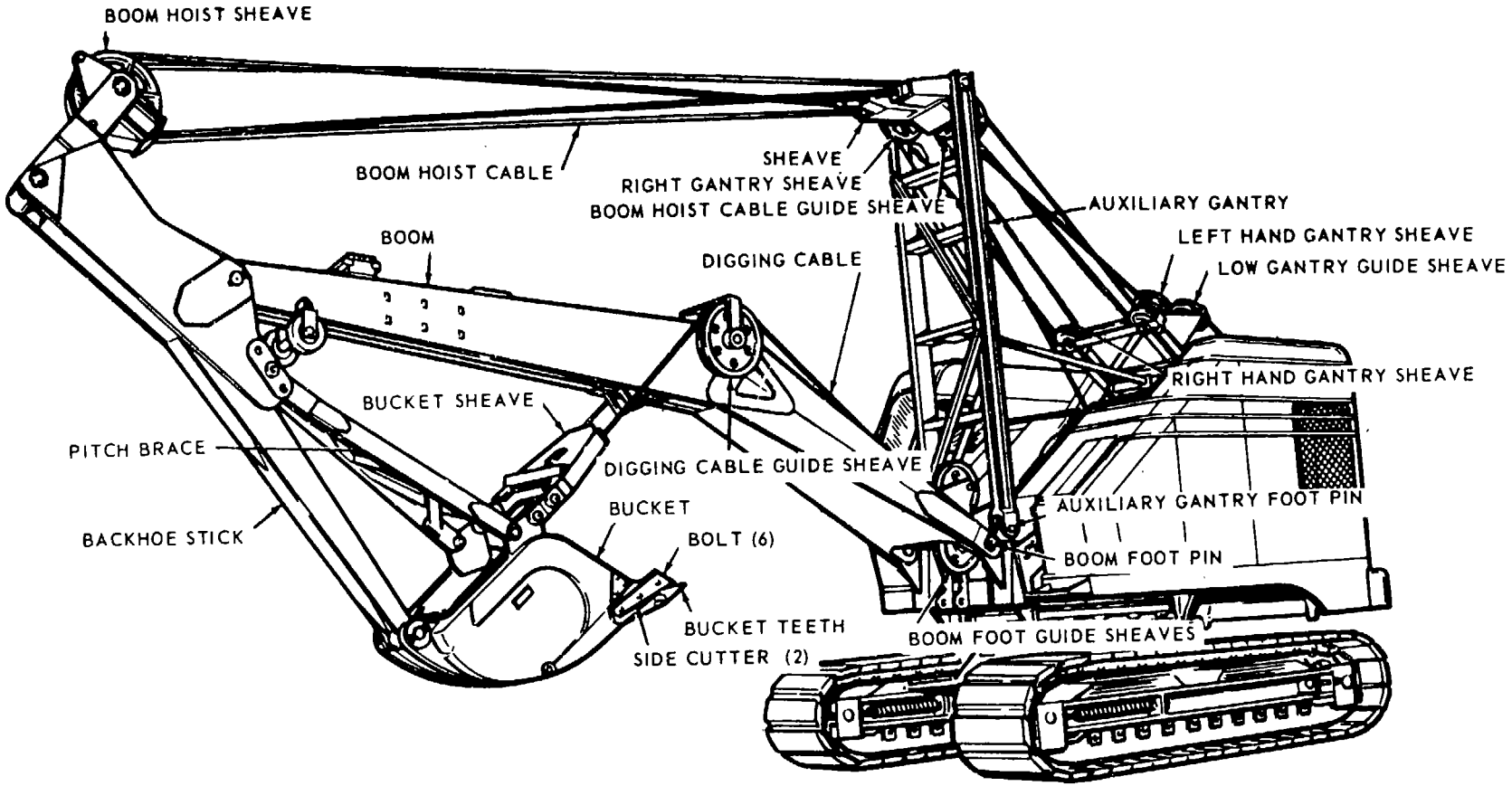


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Figure 2-17. Backhoe front end attachment, installed view.

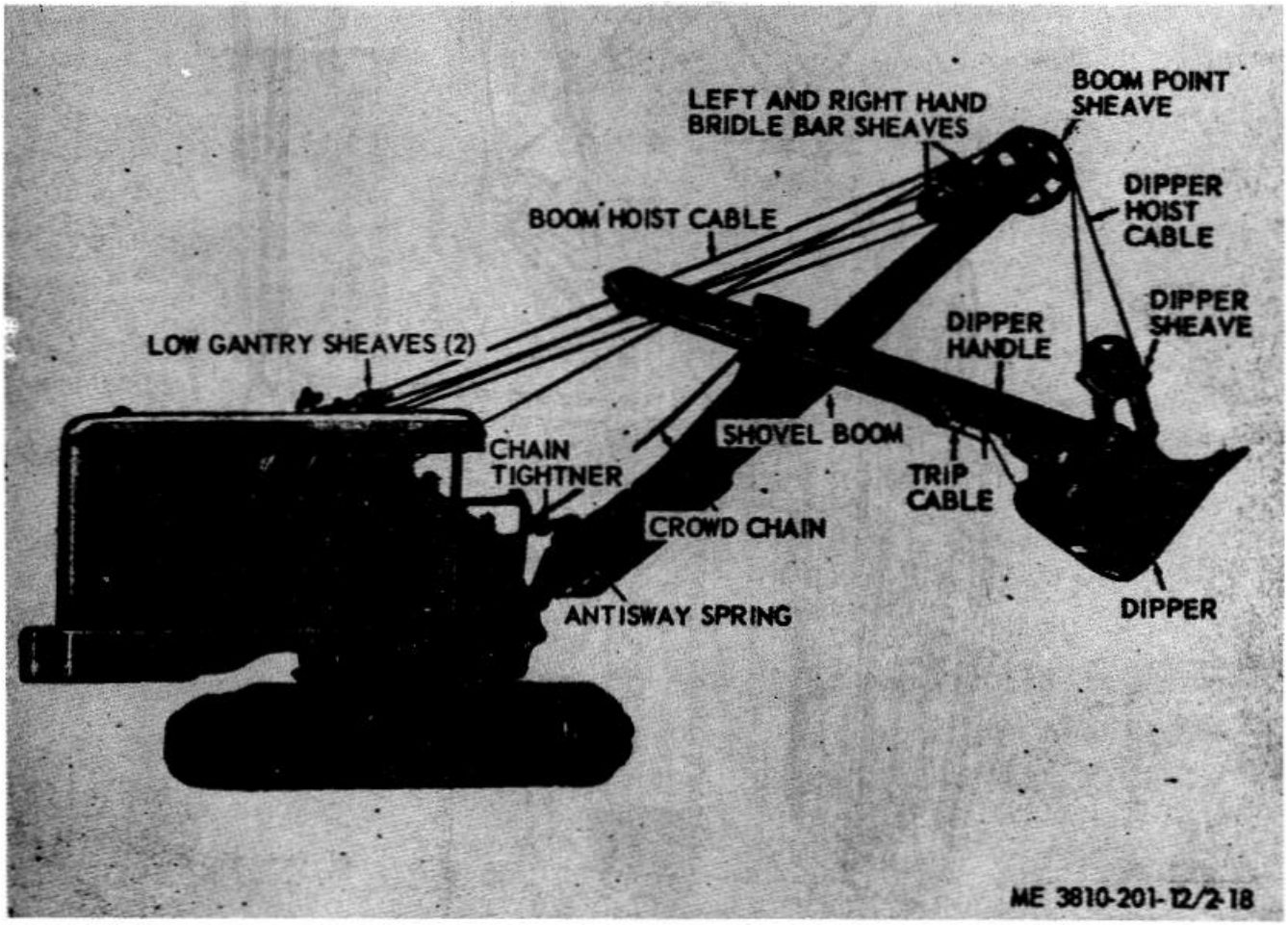


Figure 2-18. Shovel front end attachment, installed view.

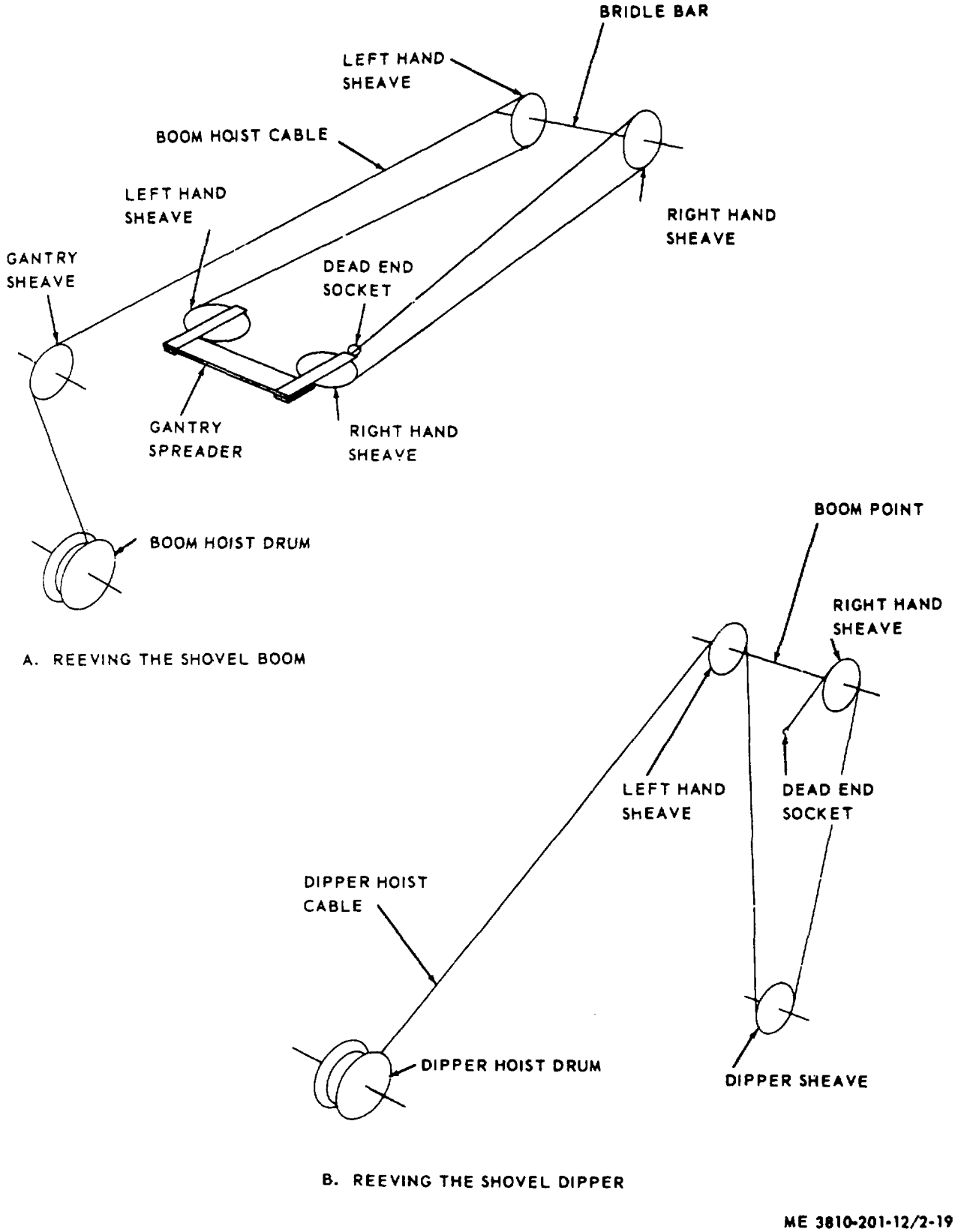


Figure 2-19. Shovel front end attachment, reeving diagram.

Section II. MOVEMENT TO A NEW WORKSITE

2-5. Dismantling for Movement

a. General. When it is necessary to move the crane shovel to another worksite, it may be driven under its own power, or it may be transported by rail. Method of movement will depend on destination and distance involved.

b. Movement for Short Distance. The crane shovel is never dismantled for short distance movements. Proceed as follows:

(1) Perform preventive maintenance checks and services (para 3-6).

(2) Insure that all tools and equipment to be moved with crane-shovel are clean, serviceable, and properly stowed.

(3) Start engine (para 2-10) and drive crane-shovel to new worksite.

c. Dismantling for Long Distance Movement.

Refer to the appropriate paragraphs in chapter 4 and remove the front end attachment now installed on crane-shovel.

d. Preparation for Loading.

(1) Position flatcar on siding with permanent ramp, preferably an earthen end ramp, or where an end ramp may be constructed (fig. 2-5).

(2) Block all wheels of flatcar, and clear deck of previous blocking, tie-downs, or other debris.

e. Loading by Drive-On.

(1) Perform preventive maintenance checks end services (para 3-6).

(2) Start engine (para 2-10); drive crane shovel slowly and carefully up ramp onto flatcar, and position it as shown on figures 2-1 or 2-2.

f. Loading by Lifting.

(1) Position lifting device at flatcar, capable of lifting a minimum of 102,000 pounds.

(2) Place lifting slings over lifting device hook and attach to crane shovel lifting eyes (fig. 2-4).

(3) Attach tagline to keep crane shovel from twisting or turning during lifting process.

Warning

Keep all personnel not engaged in loading procedure back and away from working area to avoid injury, should slings break during lift.

Caution

Do not allow crane shovel to turn or twist during lift. The added stress on lifting slings might cause them to break and drop crane-shovel, causing excessive damage to the equipment.

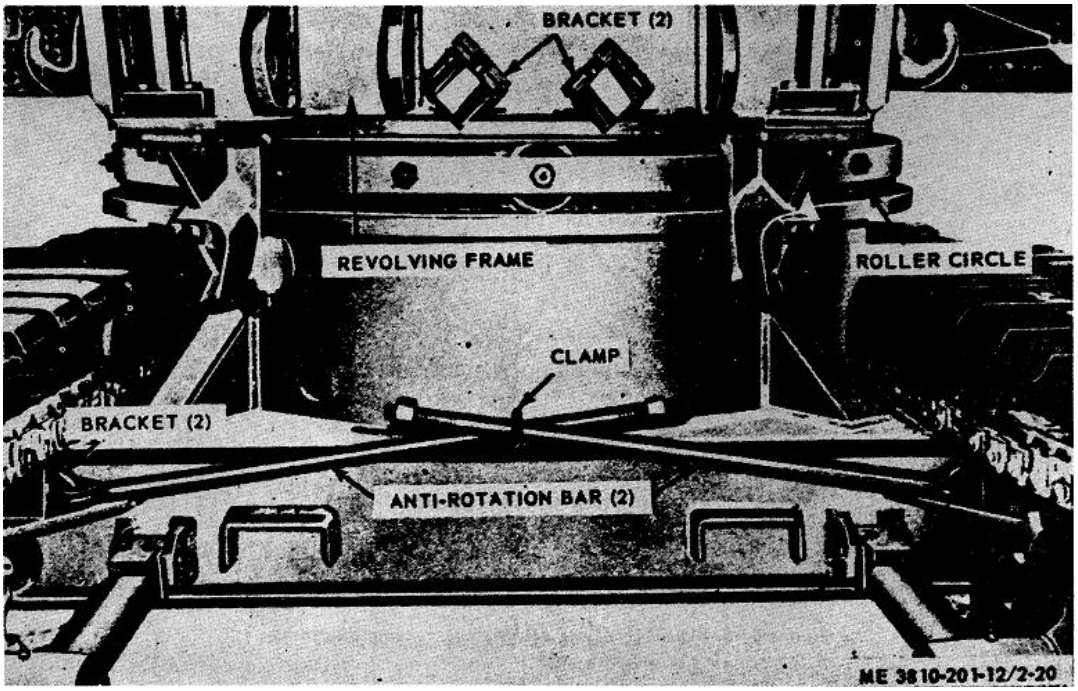


Figure 2-20. Anti-rotation bars, stowed.

(4) Lift the crane shovel (on signal) and swing it over flatcar then lower and position it as shown on figures 2-1 or 2-2.

g. Preparation for Storage and Shipment.

(1) Prepare crane shovel for temporary storage as directed in TM 740-93-1.

(2) Remove anti-rotation bars from their stowed position (fig. 2-20), and install (fig. 2-21), to prevent cab and platform movement.

(3) Remove floodlights (para 3-170) and pack them in a box, protected by ample quantities of cushioning material.

(4) Install blocks, cribbing, hold-downs, and wedges as shown on figures 2-1 and 2-2. Refer to Section 1 (General Rules) and the applicable figure(s) in Section 4 of the Association of American Railroads Rules Governing the loading of commodities on open top cars for detailed instructions.

(5) Position accessory boxes on flatcar and secure as illustrated on figures 2-1 and 2-2. Refer to Section 1 (General Rules) and the applicable figure(s) in Section 4 of the Association of American Railroads Rules governing the loading of commodities on open top cars for detailed instructions.

(6) Load and secure front end attachments in the manner shown on figure 2-3. Refer to Section 1 (General Rules) and the applicable figure(s) in Section 4 of the Association of American Railroads Rules governing the loading of commodities on open top cars for detailed instructions.

2-6. Reinstallation After Movement

For installation after movement instructions, refer to paragraph 2-3.

Section III. CONTROLS AND INSTRUMENTS

2-7. General

This section describes the various controls and instruments and provides operator/crew sufficient information to insure proper operation of the crane-shovel.

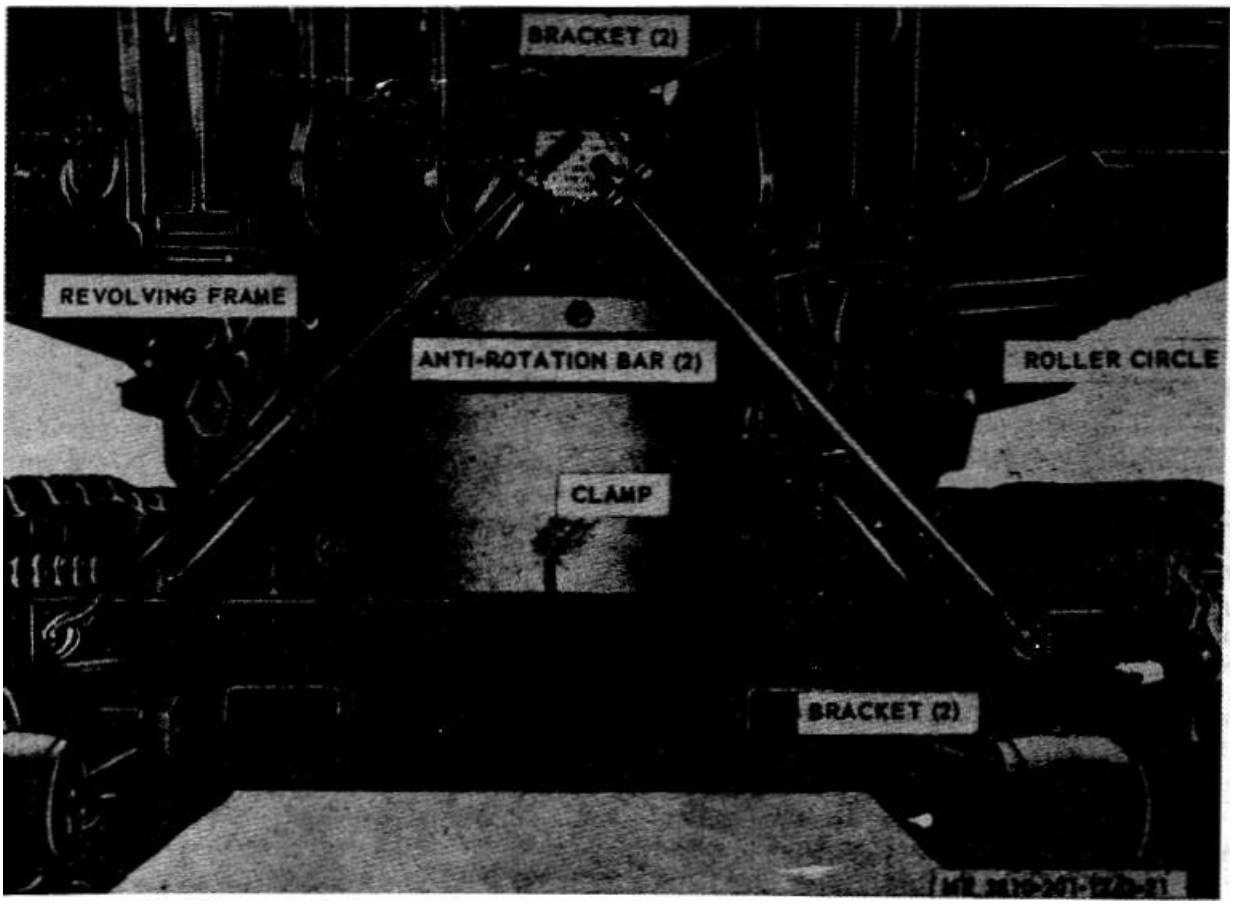


Figure 2-21. Anti-rotation bars, installed.

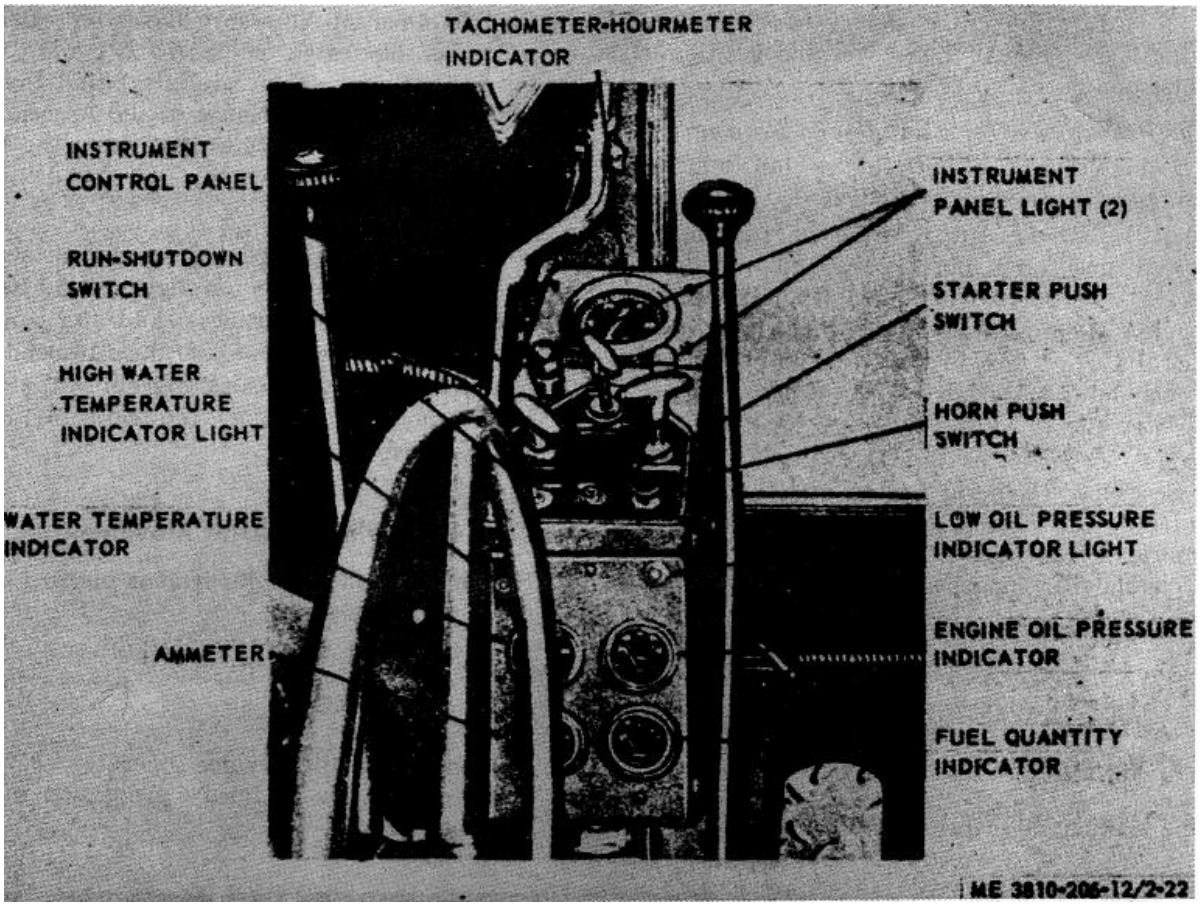


Figure 2-22. Instrument control stand.

2-8. Controls and Instruments

a. General. The following instruments and controls are identified on illustrations indicated.

b. Tachometer (Time Totalizing Meter).

(1) The tachometer-hour meter is located at top of instrument panel (fig. 2-22) and indicates speed (in revolutions per minute) at which engine is operating.

(2) The hour meter portion of tachometer is calibrated to register engine hours at 1,411 rpm. Operation at other speeds subject to interpolation.

c. Instrument Panel Lights. Two panel lights (fig. 2-22) illuminate instrument panel on control stand. Two others illuminate lighting control box area.

d. Boom Hoist Pawl Control Handle. The boom hoist pawl control handle (fig. 2-23) enables operator to engage or disengage pawl from boom hoist drum ratchet. Push down to engage. To release pawl from engagement with the ratchet, raise boom slightly by pulling boom hoist lever toward operator, to take pressure off the pawl, then pull up on handle.

e. Swing Brake Hydraulic Control Handle. This handle (fig. 2-23) locks swing brake. To apply swing brake, push swing brake lever (fig. 2-24) forward, then push down on hydraulic control handle and turn it 1¼ turn clockwise to lock. To release swing brake, turn hydraulic control handle 1/4 turn counterclockwise then pull up.

f. Propel Brake Hydraulic Control Handle. This handle (fig. 2-23) locks propel brake. To apply, push hoist clutch and propel brake lever away from operator, then push down on hydraulic control handle and turn ¼/4 turn clockwise to lock. To release propel brakes, turn the handle counterclockwise one quarter turn and pull up.

g. Horn Push Switch. When depressed, horn push switch (fig. 2-22) completes electrical circuit and horn sounds warning. When pressure is released, horn shuts off.

h. Run-Shutdoum Switch (Applicable to Engine Model 687C-18-ES Installation Only). Moving this switch (fig. 2-22) to RUN energizes

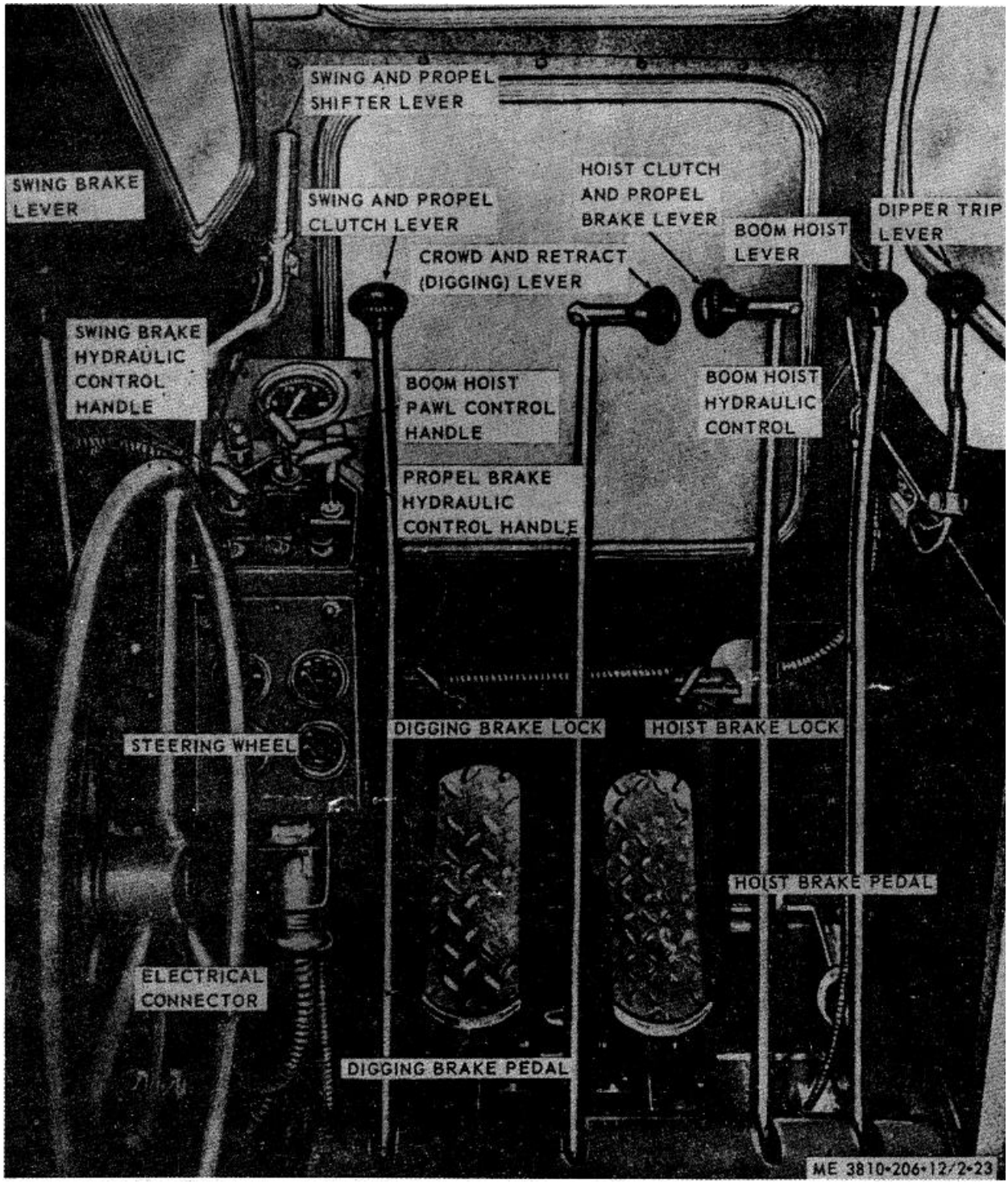


Figure 2-23. Crane operating control handles and levers.

starter circuit; fuel shutoff solenoid in fuel pump cover; the low oil pressure /water high temperature warning light switch circuits, and governor overspeed microswitch circuit. Before engine starts, low oil pressure warning light will be red. If this red light does not go out within 15 seconds after engine starts, move switch to SHUTDOWN and investigate. If either light becomes red during normal engine operation, stop engine (para 2-11), move switch to SHUTDOWN and investigate. If governor overspeed microswitch (normally closed) opens because engine speed reaches 1,935 rpm ± 15 rpm, open circuit will deenerigize solenoid in fuel pump cover and shut off fuel supply, stopping engine. Always move this switch to SHUTDOWN after engine has been stopped (para 2-11).

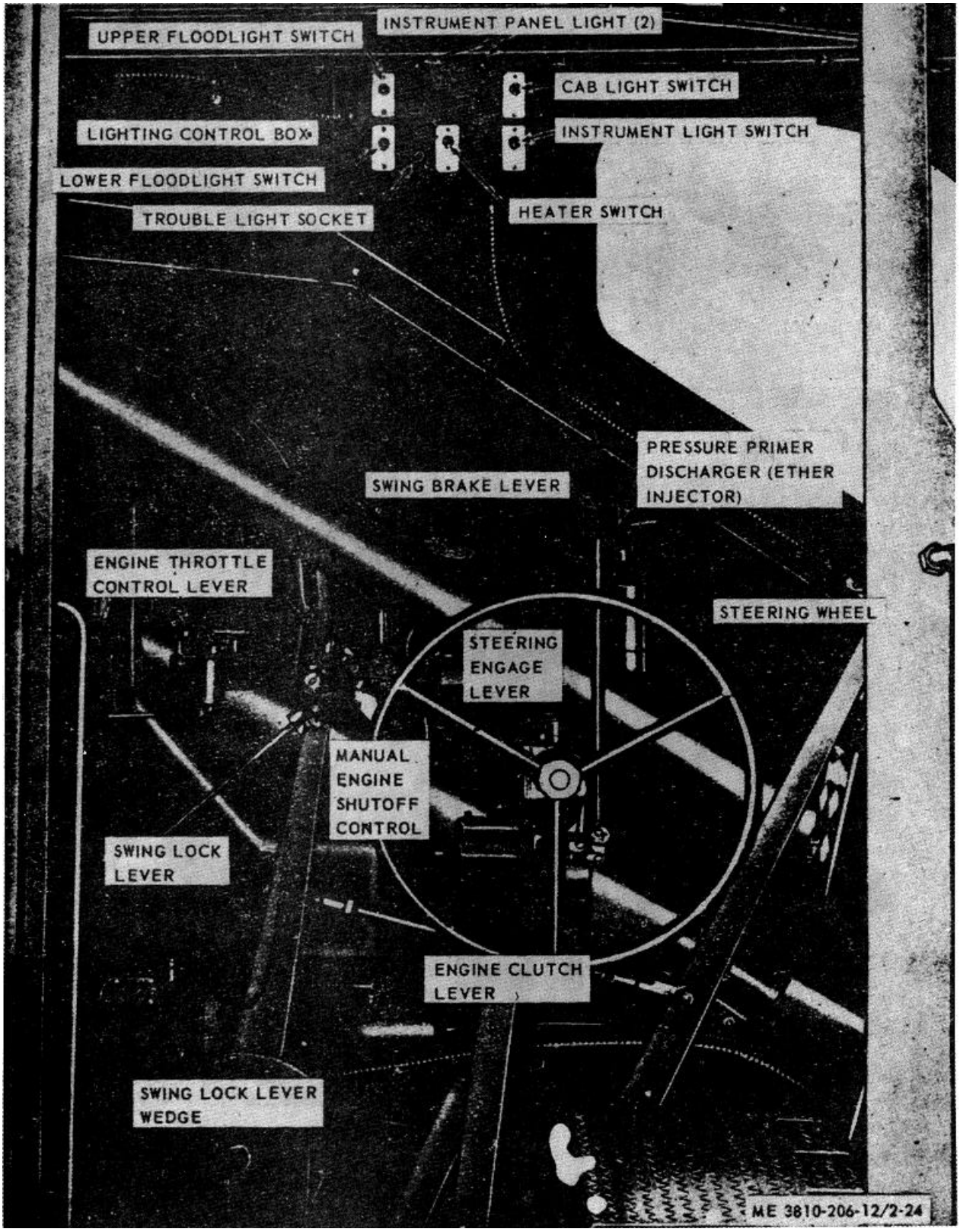


Figure 2-24. Crane, engine, and lighting controls.

i. Starter Push Switch. After moving RUNSHUTDOWN switch to RUN, depressing this switch (fig. 2-22) will cause starter solenoid to engage starter, and start engine.

j. Low Oil Pressure Indicator (Warning) Light. This light (fig. 2-2) when ON, (red) warns operator that engine oil pressure is below safe operating level, and that he should stop

engine (para 2-11) for an investigation of cause(s).

k. Hot Engine Indicator (Warning) Light. This light (fig. 2-22) when ON, (red) warns operator that cooling system is defective, and that The should stop engine (para 2-11) for an investigation of cause(s).

l. Engine Oil Pressure Indicator. This indicator (fig. 2-22), when engine is operating, indicates pressure in lubrication system. The pressure indication at idle speed should be 15 psi or above. Normal operating pressure at governed speed is 35 psi.

m. Engine Water Temperature Indicator. This indicator (fig. 2-22), when engine is operating, indicates temperature of coolant. Normal operating temperature should range between 160°F and 180°F. If operating temperature is not reached in a reasonably short time, stop engine (para -1 1) and determine cause(s).

n. Ammeter. The ammeter (9g. 2-22), while engine is operating, gives reading of battery condition. When pointer is at zero (dial center) battery is fully charged and generator (alternator) is supplying required current for operation. Rate of battery discharge (current use) is indicated by distance pointer is left of zero. Rate of charge (after starting) will be indicated by distance pointer is to right of zero.

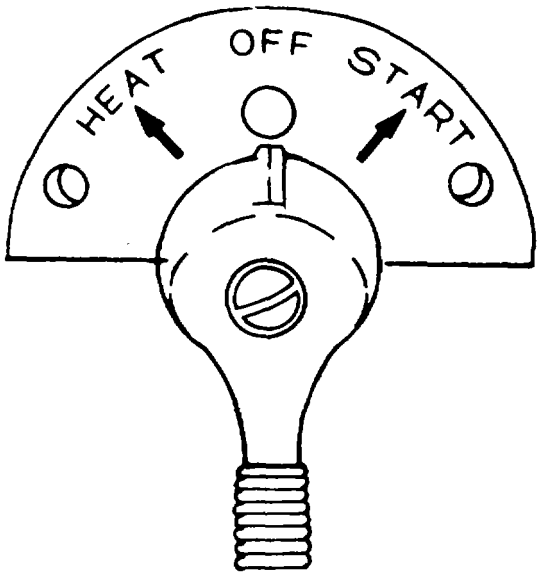
o. Indicator Fuel Level. Located on operators instrument panel (fig. 2-22), it indicates quantity of fuel in tank.

p. Pressure Primer Discharge (Ether Injector). Located on left side panel behind steering wheel (fig. 2-24), the ether injector forces ether vapor into air intake manifold while trigger is held down, as an aid to starting in cold weather (para 2-25). Release pressure on trigger to stop ether vapor entry (after engine is running).

q. Heat-Start Switch (On Models With DS3STA Engine). This switch (fig. 2-25) is also an aid to cold weather starting (para 2-25) for the model D333TA engine, and will replace starter push switch (fig. 2-22) on operator's instrument panel as D333TA engines are installed. Refer to paragraph 225 for operating instructions.

r. Swing Lock Lever Wedge. This wedge (fig. 2-24) must be installed when swing lock is disengaged (para *ab* below), to prevent swing lock from engaging while crane-shovel is in operation.

s. Instrument Panel Light Switch. This switch (fig. 2-24), mounted on lighting control box, is



ME 3810-201-12/2-25

Figure 2-25. Heat-start switch.

a two position toggle switch that controls all four instrument lights for ON-OFF function.

t. Cab Light Switch. Located on lighting control box (fig. 2-24), this two position toggle switch turns interior cab lights ON and OFF.

u. Upper Floodlight Switch. Located on lighting control box (fig. 2-24) this two position toggle switch turns the duel floodlights ON and OFF. Floodlights are mounted on top front of cab, and act as headlights when crane is traveling.

v. Lower Floodlight Switch. Located on lighting control box (fig. 2-24) this two position toggle switch turns single floodlights, mounted on either side of boom foot, ON and OFF.

w. Heater Control Valve. These two valves (fig. 226) located on left side of engine, controls flow of heated coolant from engine to personnel heater.

x. Dipper Trip Lever. This push-pull type lever (fig. 2-23) mounted on right side of operator's compartment, controls opening of dipper door when operating with shovel front end attachment. Pull this lever toward operator to open dipper door. Release lever the instant dipper door opens.

y. Engine Throttle Control Lever. Located on left compartment panel at rear of operator's seat

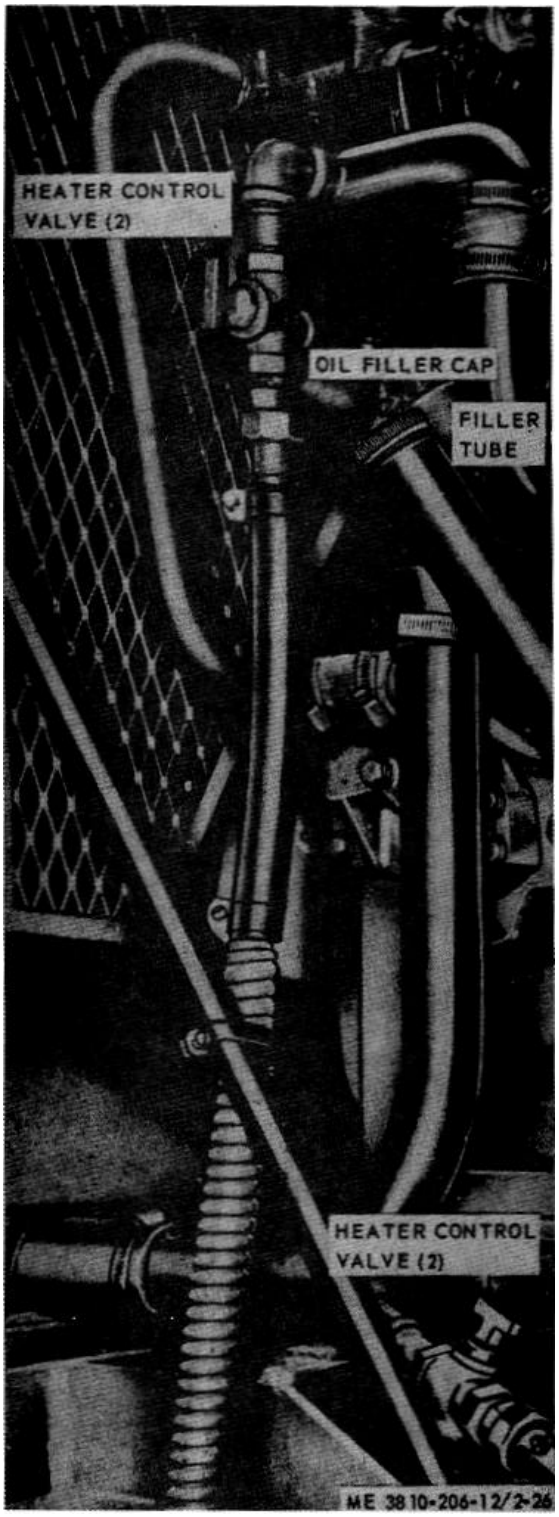


Figure 2-26. Heater control valves.

(fig. 2-24) is used to set engine speed. Move forward to increase speed, back to idle.

z. Manual Engine Shut Off Control. Located below throttle control lever (fig. 2-24) this control shuts off fuel flow to injector pump. Pull to stop engine (para 2-11), then after engine stops, push in.

aa. Steering Gear Engaging Lever. Located behind steering wheel (fig. 2-24), this lever should always be up as illustrated, except when steering wheel is to be used. Moving lever downward engages steering wheel with steering gear.

ab Swing Lock Lever. This lever type control for locking machine so it will not swing during transportation, or prolonged storage. Lever is illustrated in the unlocked position. To lock, remove wedge; grasp trigger lever and squeeze together while moving lever forward. (It may require swinging machinery deck a little left or right before the lock will engage ring gear). Let wedge hang on its chain.

Note

Anti-rotation bars (para 2-5g) must also be installed for transportation and storage.

ac. Swing Brake Lever. Located between steering wheel and pressure primer discharger (fig. 2-24), push this lever forward to apply hydraulic pressure to swing brake. To lock the swing brake, push lever forward and set brake, then push swing brake hydraulic control handle in and turn one quarter turns clockwise. Release by turning counterclockwise 1/4 turn and pulling up.

ad. Swing and Propel Shifter Lever. This lever, located at left of steering wheel (fig. 2-24) and along side instrument control stand, shifts motive power to propel or swing. Move shifter lever fully forward to travel machine, fully to the rear for swing motion.

ae. Hoist Brake Lock. Turning this lever to the left (fig. 2-23) (after applying hoist brake) will lock hoist brake in applied position. Move right to release.

af. Digging Brake Lock. Moving this lever to right (fig. 2-23) after applying digging brake, will lock digging brake in the applied position.

ag. Digging Brake Pedal. This pedal (fig. 2-23) located on floor in front of lever stand, near instrument control stand, applies brake to left hand or digging drum.

ah Hoist Brake Pedal. Located ,on floor in front of lever stand to right of digging brake pedal (fig. 2-23), this pedal applies brake to right hand or hoist drum.

ai. Swing and Propel Clutch Lever. This lever (fig. 2-23) when used in conjunction with swing and propel shifter lever (ad above) will swing or

propel the machine. With swing shifter lever pulled back in swing position, pull swing clutch lever toward operator to swing right, push toward front to swing' left. With propel shifter lever moved forward in propel position, push propel clutch lever forward to travel forward, or pull toward operator for reverse.

Caution

When traveling over 100 feet, or longer distances, the crawler idler sprockets must be at front of crane-shovel, and must point in direction of forward travel.

aj. Crowd (Digging) and Retract Clutch Lever. This lever (fig. 2-23) is a push-pull type. lever which rotates left hand (digging) crowd drum. Pull toward operator to wrap cable on the drum. Push away from operator to run cable off drum (when planetary pinions are installed). With shovel front end attachment and sprocket installed, pull lever toward operator to crowd shovel into bank, push lever away from operator to retract dipper from bank after it is loaded.

ak. Hoist Clutch and Propel Brake Lever. This lever (fig. 2-23) when pulled toward operator engages clutch on hoist drum and wraps cable on drum. When this lever is pushed away from operator, it applies the propel brake. To lock propel brake in applied position, push down on

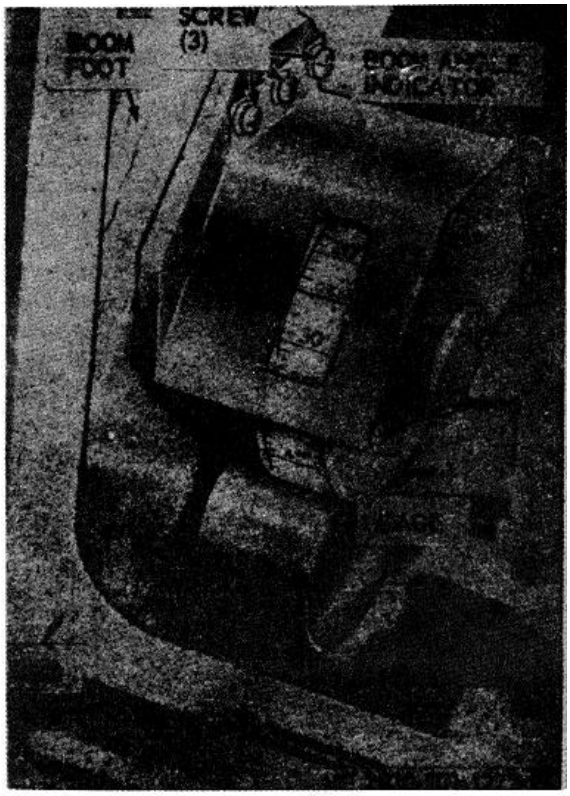


Figure 2-27. Boom angle (radius) indicator, installed view.

propel hydraulic control handle (e above) and turn clockwise.

al. Boom Hoist Clutch Lever. This lever (fig. 2-23) located at extreme right of lever stand, when pulled toward operator, will wrap cable on boom hoist drum and raise boom (or auxiliary gantry, when used with backhoe). Push this lever away from operator to release boom hoist brake and allow boom to lower by gravity. Re

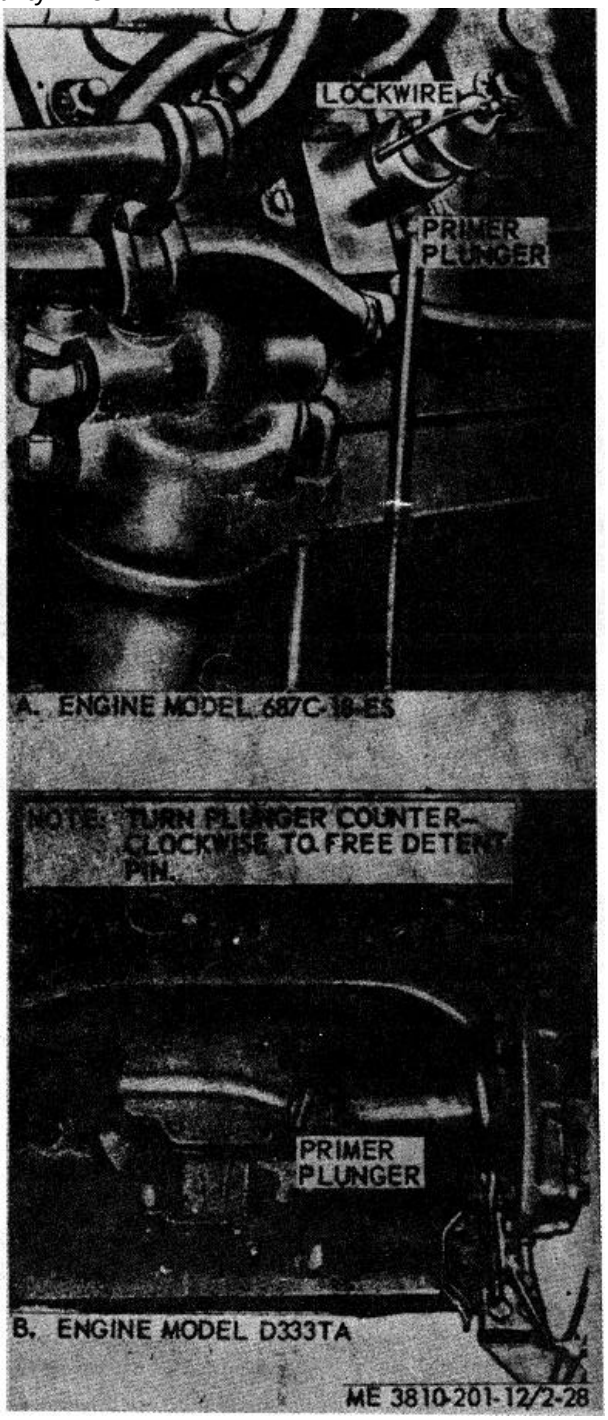


Figure 2-28. Primer pump.

turn lever to neutral position to set boom hoist brake and hold boom in new position.

am. Boom Hoist Hydraulic Control Handle. This handle (fig. 2-23) must be squeezed toward boom hoist clutch lever to close the pressure retaining valve connected to boom hoist hydraulic line and lock hoist. Clutch lever can then be pumped (moved to and from operator more than once), to engage boom hoist clutch more firmly on the drum.

an. Boom Angle (Radius) Indicator. This indicator (fig. 2-27), pendulum type, is mounted on right hand foot of crane boom, and is used in conjunction with capacity plate mounted on right cab panel directly behind cab door, to determine crane safety capacity at any given boom length, or angle.

ao. Engine Clutch Lever. This lever (fig. 2-23), located at lower left rear of operator's seat between swing lock lever and cab left side panel, is a pull-up, push-down type lever, that engages or disengages engine from machinery. Pull up to engage. Push down to disengage.

Note

There is an auxiliary clutch lever mounted on power take-off housing that operator may use in the event the engine clutch lever does not function properly.

ap. Primer Pump. This pump (fig. 2-28) on engine model 687C-18-ES (view A), D333TA (view B) is used as starting aid in temperatures below -40'F, or after a prolonged idle period. Releasing plunger and pumping in and out a few strokes, fills fuel filter and lines, so that fuel transfer pumps will be able to instantly send fuel to injectors.

Section IV. OPERATION UNDER USUAL CONDITIONS

2-9. General

a. The instructions in this section are published for the information and guidance of personnel responsible for operation of the craneshovel.

b. The operator must know how to perform every operation of which the crane-shovel is capable. This section gives instructions on starting and stopping the crane-shovel, operation of the crane-shovel, and on coordinating the basic motions to perform the specific tasks for which the equipment is designed. Since nearly every job presents a different problem, the operator may have to vary given procedures to fit the individual job.

2-10. Starting the Engine

a. Preparation for Starting.

(1) Perform required preventive maintenance checks and services (para 36).

(2) Insure that all brakes are set (para 2-8) and that engine clutch lever (fig. 2-24 and para 2-28) is disengaged.

(3) Position engine throttle control lever at half throttle, and move run-shutdown switch (fig. 2-22) from shutdown to ON.

(4) If engine has not been run for several days, prime fuel system with primer pump (fig. 2-28).

b. Starting.

(1) *Model 687C-18-ES.*

(a) Depress start push switch (fig. 2-22) for 15 seconds or until engine starts, then release switch.

(b) If engine does not start within 15 seconds, let starter rest while fuel system is reprimed, then repeat step (a) above.

Caution

When engine fails to start on third try, let starter rest for several minutes, then repeat step (a).

(c) After engine starts, insure that there is sufficient oil pressure to turn off low oil pressure warning light (fig. 2-22). If light does not go out within 15 seconds, stop engine (para 2-11) and determine cause(s). Report deficiencies to organizational maintenance personnel.

(2) *Model D333TA.*

(a) When starting at an ambient temperature below + 60°F, turn heat-start switch (para 2-8) to HEAT for time listed in table 2-1 after ambient temperature, then move switch to START for 10 seconds, or until engine starts. As soon as engine starts, move switch to HEAT position until engine is running smoothly.

(b) If engine does not start after 10 seconds of cranking, repeat step *(a)* above.

(c) When engine fails to start on second try, let starter rest for at least three minutes, then repeat step *(a)* above.

Table 2-1. Use of Cold Weather Starting Aids

Ambient temperature	Glow plug Use ether injection beat time as Indicated below	
Above +60 F	None	No
Between +60 F and +32 F	One minute	No
Between +32 F and +20 F	Two minutes	Yes
*Between +20 F and 0 F	Two minutes	Yes
*Below F		Yes

Non-winterized units will require preheating of crankcase oil and coolant at these temperatures.

(d) After engine starts, turn HEATSTART switch to HEAT until engine runs smoothly; insure that there is enough oil pressure to turn off low oil pressure warning light (fig. 2-22). If light does not go out within 15 seconds, stop engine (para 2-11) and determine cause(s). Report deficiencies to organizational maintenance personnel.

Caution

Do not turn HEAT-START switch to HEAT while the engine is warm and running.

c. Cold Weather Starting. Starting the diesel engine at ambient temperatures of + 40°F or lower requires use of an ether starting aid. For operating instructions on use of cold weather starting aids, refer to paragraph 2-25.

2-11. Stopping the Engine

a. Preparation for Stopping.

(1) Lower load until it rests on ground.

(2) Apply swing and propel brakes and lock with hydraulic control levers (para 2-8).

(3) Disengage engine clutch lever (fig. 2-24)

(4) Move engine throttle control lever to closed position (fig. 2-24) and allow engine to idle for 5 to 10 minutes.

b. Stopping the Engine.

(1) Pull the manual engine shutoff control (fig. 2-24) out and stop engine. When engine is stopped, push shutoff control in

(2) Move RUN-SHUTDOWN switch (fig. 2-22) to SHUTDOWN.

(3) Turn all light switches OFF (fig. 2-24).

(4) Perform preventive maintenance checks and services (para 3-6).

Warning

Be sure that dipper; bucket; clamshell; hammer, or crane load is lowered to ground when halting operations, or leaving the crane shovel. After brake drums cool, brakes may slip and allow load to fall. Injury or death, and damage to equipment, could occur should this warning be ignored.

2-12. Operation of Equipment

a. General. This paragraph will describe all modes of operation, assuming that operator has inspected and serviced the machinery; the craneshovel is at an operational site; the engine has been started (para 2-10); clutch has been engaged; unit has reached proper operating temperature, and the crane-shovel is ready to begin the assigned task(s).

b. Swinging.

Caution

If work requires repeated short swings, make one complete (360°) swing to right every hour, to prevent excessive wear on rollers of turntable roller circle.

(1) Raise load from its resting place by pulling hoist clutch and propel brake lever (fig 2-23) toward operator, and at same time release hoist brake pedal. When load is at proper height, return hoist lever to neutral and apply hoist brake pedal to hold load in position.

(2) Remove swing lock lever wedge (fig. 2-24), pull swing lock lever back to disengaged position, then install wedge behind lever to prevent accidental movement of swing lock lever.

(3) Move swing and propel shifter lever (fig. 2-23) back toward operator until it engages upper notch on quadrant to engage swing gear.

(4) Release swing brake by turning swing brake hydraulic control handle (fig. 2-23) one quarter turn counterclockwise, then pulling handle up.

(5) To swing right, pull swing and propel clutch lever (fig. 2-23) toward operator. To swing left, push lever away from operator.

Note

When using a long boom, or when load is suspended from a long cable, operate engine at lowest practical throttle setting to prevent load from swinging wide of boom point when stopping.

(6) To stop swinging, in either direction, return swing and propel clutch lever to neutral. To stop load from passing desired point, apply swing and propel clutch lever in the opposite direction.

Note

If accurate stopping of load is necessary, or if revolving frame has a tendency to drift, apply swing brake lever (fig. 2-23) and lock with swing brake hydraulic control handle. This will hold revolving frame in a fixed position while the load is lowered.

(7) Lower load by releasing hoist brake pedal. The rate of load descent can be regulated by varying pressure applied to hoist brake pedal. When load is at rest, release pressure on hoist brake pedal.

(8) Repeat steps (1) through (7) as necessary.

c. Boom Raising or Lowering. With boom in a horizontal position, assure that boom hoist cable is properly reeved, then proceed to raise as follows:

(1) To raise boom pull back on boom hoist clutch lever (fig. 2-23) to engage boom hoist clutch. (Squeeze the boom hoist hydraulic control handle against boom hoist clutch lever, and pump

lever for a second short stroke to engage the clutch more firmly on boom hoist drum)

(2) Pull boom hoist pawl control handle out to remove pawl from engagement with gear on boom hoist drum.

(3) Pull boom hoist clutch lever toward operator and raise boom. As boom approaches proper position, slow down by moving clutch lever toward neutral, and as boom angle indicator (para 2-8) shows proper angle, move clutch to neutral, which sets brake, stopping the boom.

(4) To lock and maintain booms stationary position, push boom hoist pawl control handle down and engage pawl in teeth of gear on boom hoist drum.

(5) In preparation for lowering boom, pull boom hoist clutch lever back toward operator just enough to take drum pressure off pawl; pull boom hoist pawl control handle out to disengage pawl, then move hoist clutch lever back to neutral.

(6) Lower boom by moving boom hoist clutch lever away from operator. Boom will fall by gravity. Operator will control rate of boom descent by moving clutch lever back toward neutral. Leave clutch lever in neutral when boom is in desired position.

Caution

When lowering boom to a horizontal position, never lower it below plane of crane-shovel. When the ground level in front of crane-shovel is lower than crawler tread, build up cribbing under boom point to keep it horizontal. Booms have collapsed under lifting stress applied at this critical angle.

d. Traveling. For traveling the crane-shovel more than 100 feet, revolving frame must be positioned with boom foot over crawler so that idler sprockets lead in forward travel. Swing revolving frame (b above) into proper position when necessary, then travel as follows:

(1) Remove wedge from in front of swing lock lever (fig. 2-24), grasp trigger-lever and squeeze together while moving swing lock lever forward. (It may require swinging the revolving frame a little left or right before lock will engage ring gear).

(2) Move the swing and propel shifter lever (fig. 2-23) forward to engage forward notch on quadrant.

(3) To travel forward, push the swing and propel clutch lever (fig. 2-23) away from operator. To travel in reverse, pull lever back towards operator. For information on how to steer, refer to e below.

(4) When travel is completed, move swing and propel shifter lever (fig. 2-23) back to engage rear notch on quadrant.

(5) If further operation is to be performed, grasp trigger-lever and squeeze together while moving swing lock lever backward, then install swing lock lever wedge in front of lever.

e. Steering.

(1) Engage steering wheel with steering gear by turning steering gear engaging lever (fig. 2-24) to the down position.

(2) There are four different positions (or combinations) of the propel clutches and brakes possible by turning steering wheel as follows:

(a) Position number one. Turn steering wheel counterclockwise as far as it will go. This will mechanically set both propel brakes and disengage both of the jaw clutches. This position is used when digging, or when machine is parked for a prolonged period.

(*b) Position number two*. Starting with wheel in position number one, turn wheel about one and one half turns clockwise. This will set the left hand brake and engage the right hand jaw clutch. The crane-shovel will turn, to the left when the swing/propel lever is pushed away from the operator.

(c) Position number three. Starting with wheel in position number one, turn wheel two turns clockwise. This will release both propel brakes, and engage both jaw clutches. The craneshovel will travel straight ahead when the swing/ propel lever is pushed away from operator.

(d) Position number four. Turn steering wheel clockwise as far as it will go. This will set the right hand brake and engage the left hand jaw clutch. The crane-shovel will turn to the right when the swing/propel lever is pushed away from operator.

Note

All travel directions are given with the front of the crawler (idler sprocket toward front) under the front end of the upper revolving machinery.

(3) When travel is completed, and craneshovel is in position for next task, disengage, steering wheel by lifting engaging lever (fig. 2-24) up.

f. Operation of Front End Components. Operation of the various front end components are properly de scribed in the section devoted to auxiliary materiel used in conjunction with the crane-shovel as listed below.

Crane operation (para 2-28)
Clamshell operation (para 2-29)
Dragline operation (para 230)
Shovel operation (para 2-31)
Backhoe operation (para 2-32)
Piledriver operation (para 2-33)
Jib boom operation (para 2-34)

Section V. OPERATION UNDER UNUSUAL CONDITIONS

2-13. General

This section contains instructions for operating the crane-shovel under special conditions that are unusual, and not all of which are encountered in any one operating area..

2-14. Operation in Extreme Cold

a. General. As temperatures drop below freezing, metal and rubber parts become progressively more brittle, and a relatively minor shock or jar can cause serious damage. Generally, craneshovels assigned work in extremely cold areas are winterized to take care of these problems, but when conditions are encountered always remember to warm machine up slowly and carefully, and start all operations in low speed. Avoid jerky handling and sharp impacts.

Warning

Do not touch metal parts with bare hands during extreme cold, or serious and painful injury may occur.

b. Lubrication.

(1) When temperature are below 0°F keep crane-shovel in a heated enclosure while not in use. If this is impossible, drain engine oil immediately after halting operations for the day and store oil in a warm place. If there is no warm place available for storage of oil, preheat oil to approximately 180°F before returning it to crankcase.

Caution

Be sure a tag is placed conspicuously in operator's compartment warning personnel that crankcase is empty.

(2) Refer to current lubrication order LO 53810-20612 and use proper lubricants a described in key for the temperature expected.

c. Cooling System.

(1) The cooling system must be inspected and serviced with anti-freeze as directed in TB ORD 65; (Use of Anti-freeze Solution and Cleaning Compounds in Engine Cooling Systems)

(2) Manufacture a cover out of card board and cover enough of radiator core to assure coolant temperature will rise to 160°F (minimum operating temperature).

d. Electrical System.

(1) Keep electrolyte at least 8/8 inch above plates and batteries fully charged (table 1-1).

Caution

Do not add water to batteries in subzero temperatures, unless engine is run for at least one hour after addition. The water will freeze unless charging generator (or alternator) has an opportunity to mix or convert to electrolyte.

(2) Remove batteries from crane-shovel and keep in heated storage area when not in use.

e. Controls. Operation of control levers will be sluggish during extreme cold. Do not force levers into first operation until after slow warming of engine has thinned lubricant. Apply levers slowly and allow friction to assist in warming of clutches, brakes, and fluids.

f. Fuel System.

(1) Keep fuel tank as full as possible (refuel frequently) during cold weather to minimize condensation. If presence of water in fuel supply is suspected, use suitable strainer while refueling.

(2) Drain condensate from fuel tank fre quently (para 3-14*b*).

(3) Service primary fuel filter more frequently (on models with engine 687C-18ES) (para 3-13).

(4) Service secondary fuel filter more frequently (para 3-13).

g. Crawlers.

(1) When subzero temperatures are expected, remove accumulations of mud from crawlers when halting operations for the day.

(2) When parking crane-shovel overnight in subzero temperatures never park in a muddy area without cleaning off mud, and placing crane crawlers upon planks.

Caution

When crawlers are frozen (in areas that were muddy when crane shovel was parked), be sure and thaw mud and ice from sprockets, chain and track shoes, to avoid damage when traveling away from parking area, or to new worksite.

2-15. Operation in Extreme Heat

a. Cooling System.

(1) Assure that system is clean, free flowing, and remove all obstructions to air passage through radiator core.

(2) Check coolant level frequently, and add water as required.

(3) Check fan belt adjustment frequently.

(4) Keep cab sliding panels open, to insure more air circulation around engine.

(5) Keep water pump and drive well lubricated (LO 5-3810-206-12).

b. Engine.

(1) Check oil level frequently. Add oil when necessary (LO -5-3810-206-12).

(2) If engine becomes overheated from lack of water, allow it to cool before adding water, then run engine at fast idle while adding water.

c. Electrical System.

(1) Do not allow batteries to overheat in service. Open battery box cover in extreme heat, and allow air to circulate around batteries.

(2) Check electrolyte more frequently in hot weather, and add water unless stands at least 3/8 inch above plates.

d. Lubrication. Lubricate more frequently in hot weather, changing lubricants when required by LO 5-3810-206-12.

2-16. Operation in Dusty or Sandy Areas

a. Inspection and Lubrication. Fine sand or dust has a tendency to penetrate into bushings and bearings. Inspect, clean and lubricate at more frequent intervals (paras 3-3 and 3-4, and LO 5-3810-206-12).

b. Fuel System. Keep fuel tank cap on tight, and wipe free of sand and dust before removing to refuel. Service fuel filters more frequently (para 3-13) to remove sand and grit. Service air cleaners (para3l1) more frequently.

c. Turntable Roller Path. Do not allow lubricant to accumulate on roller path. Clean frequently under dusty or sandy conditions, to prevent excessive wear.

d. Brakes and Clutches. Inspect all clutch and brake bands frequently. Use compressed air and remove all sand or dust, or wipe clean. Failure to keep bands clean will result in worn bands, scored drums, and unsatisfactory operation.

e. Open Gears. Wash contaminated lubricant from all open gears and relubricate frequently, to eliminate excessive wear from sand and grit accumulations.

f. Cables. Keep all unused cables in boxes. Clean and lubricate operating cables more frequently, to prevent excessive wear and insure satisfactory operation.

g. Crawlers. Inspect crawler and carbody frequently for excessive lubricant that results in accumulation of sand or- dust. Pay particular attention to drive chains, sprockets, or gears, that wear easily. Clean and relubricate frequently (LO 5-3810-201-12).

217. Operation Under Rainy or Humid Conditions

a. Fuel System.

(1) Wipe away all moisture from filler cap and neck before removing to service fuel tank.

(2) Keep fuel tank full to minimize condensation.

(3) Drain condensate from tank daily (para 3-14*b*).

(4) Drain fuel filters frequently (para 3-13).

b. Bare Metal. Check crane-shovel carefully for signs of corrosion. Wipe all moisture from bare metal parts, and coat with lubricating oil, grease, or an approved rust preventive. If painting is required, report the condition to organizational maintenance.

c. Electrical System. Keep electrical components, connectors, and wiring clean and dry. Coat battery terminals with a light coat of grease to prevent corrosion.

d. Lubrication. Lubricate and service craneshovel more frequently (LO 5-3810-206-12). Refer to paragraph 3S4 for detailed lubrication instructions.

2-18. Operation in Salt Water Areas

a. Electrical System. Keep electrical connections clean and dry. Coat battery terminals with grease to prevent corrosion.

b. Bare Metal. Check all bare metal surfaces. Wipe dry, and lubricate with oil or grease. If painting of surface is necessary, report condition to organizational maintenance.

c. Lubrication. Refer to paragraph 3-4; current lubrication order (LO 5-4810-206-12), and lubricate more frequently.

d. Cooling System. Do not use salt water in the crane-shovel cooling system.

2-19. Operation in Snow

a. General. Operation in snow combines conditions found in extreme cold, and humid conditions. Accumulations of snow turns to ice, and is damaging to gears, or chains, and will contaminate fuel system.

b. Fuel System.

(1) Wipe all snow away from fuel filler cap before servicing crane-shovel fuel tank.

(2) Drain condensate from fuel tank frequently (para 3-14*b*).

(3) Keep fuel tank full to minimize condensation.

c. Crawlers. Remove all accumulations of snow from crane-shovel crawler to prevent snow from turning to ice and causing damage.

d. Parking. When possible, lay boards on snow and drive crawlers up on them, then use compressed air to blow away all snow accumulations from gears; chains; sprockets; cable drums; sheaves of bucket, hook block or boom.

2-20. Operation in Mud or Deep Water

a. General.

(1) When operating in mud, or water, check footing of crane-shovel frequently to avoid tipping.

(2) When fording a body of water be careful of hidden boulders or deep holes. Use dipper or weighted hook block to feel the way across, stopping crane travel to swing from side-to-side to detect boulders. Lower dipper or hook to measure depth of water and avoid dangerous holes.

b. Lubrication. Lubricate crane-shovel immediately after washing or fording. Keep all operating mechanism thoroughly lubricated (LO 5-3810-206-12).

2-21. Operation at High Altitude

a. With Model 687C-1 8-ES Engine. The blowers on this engine operate satisfactorily at higher altitudes without special attention. Service of air cleaner (para 3-11) more frequently, will assure full flow of air for combustion.

b. With Model DSSSTA Engine. This turbocharged engine operates best when operating at altitude specified on warning plate installed on valve cover. The highest altitude at which the engine may be safely operated, without resetting, is listed on this plate. The engine must be reset for higher altitudes. It may be operated at a lower altitude without danger of engine damage, but at less than maximum performance.

2-22. Operation Below Sea Level

a. With Model 687C-18-ES Engine. This engine will operate satisfactorily at altitudes below sea level without special adjustment.

b. With Model D33STA Engine. This turbocharged engine will operate at altitudes below sea level without danger of damage to engine but with reduced efficiency. Long periods of operation at low altitudes should not be attempted without reporting details to proper authority, so that required adjustments may be accomplished.

Section VI. OPERATION OF AUXILIARY MATERIEL USED IN CONJUNCTION WITH CRANE-SHOVEL

2-23. General

This section furnishes information on operation of auxiliary materiel used on, or with the craneshovel. Cold weather starting aids, fire extinguisher, heaters, trouble light, and front end attachments are covered in succeeding paragraphs.

2-24. Fire Extinguisher (Dry Chemical Type)

a. Description. The dry chemical type fire extinguisher is suitable for use on all types of fire, and is effective in areas where ambient temperature is -25°F and above. When winterized, (pressurized with nitrogen) the fire extinguisher may be used in temperatures below - 25°F. This extinguisher is a 2 1/2 pound, stored pressure, lever-operated fire extinguisher.

b. Operation.

(1) Remove fire extinguisher from its mounting bracket on inside of cab, at right of operator's seat.

(2) Lift handle; press lever, and direct sweeping motion.

c. Maintenance.

(1) Inspect for broken seal.

(2) Replace cylinder that has been used, or that does not weigh in accordance with marking on cylinder.

2-25. Cold Weather Starting Aids

a. General. Units with engines model 687CES-18, and some units with engine model D333TA installed, are equipped with pressure primer discharger (fig. 2-24) for use in cold weather starting. Model D333TA engines also have glow plugs installed, and in this instance both glow plugs and propane injection is used for cold weather starting (table 2-1).

b. Cold Weather Starting Operation.

(1) *Operating the pressure primer discharger.* Prepare for starting as directed in paragraph 2-10, then proceed as follows:

(a) Move engine throttle control lever (fig. 2-24) to half throttle position.

(c) Press on operating-lever which allows gas pressure in cylinder to force propane into intake manifold.

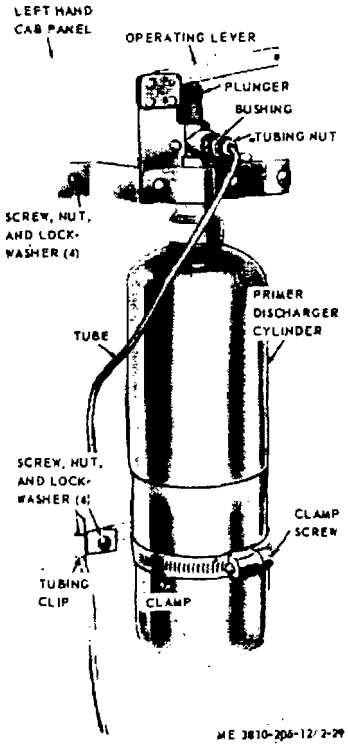


Figure 2-29. Pressure primer discharger.

(d) Depress starter push switch (fig. 2-22) simultaneously with operating lever of pressure primer discharger and hold for 15 seconds, or until engine starts.

(e) If engine does not start in 15 seconds, let starter motor rest for at least 30 seconds then repeat steps (a) through (d) above.

(f) When engine starts, decrease throttle control lever to a low idle until engine oil pressure reaches normal operating pressure, then run engine at half throttle for at least five minutes before applying a load.

Caution

Use only enough propane to start the engine, or to keep it running if it begins to stall.

(2) Operating the glow plugs (on engines model DSSSTA).

(a) Refer to table 2-1 for time required, then move HEAT-START switch (fig. 2-15) to HEAT.

(b) After plugs have heated the required time, move HEAT-START switch to START and hold for 10 seconds, or until engine starts. As soon as engine starts, move switch to HEAT position until engine is running smoothly, then move switch to' OFF.

(c) If engine does not start after 10 seconds of cranking, repeat steps (a) through (b) above.

(d) If engine fails to start on second try, let starter motor rest for three minutes, then repeat step (a) above.

(e) After engine has started, move HEAT-START switch to HEAT position until engine is running smoothly, and insure that there is enough oil pressure to turn off low oil pressure warning light. If warning light does not go out within 15 seconds, step engine (para 2-11) and determine causes(s). Report deficiencies to organizational maintenance.

Caution

Do not turn HEAT-START switch to HEAT when engine is warm and running.

(3) *Operating glow plugs and pressure primer discharger simultaneously.*

(*a*) Refer to table 2-1, compare ambient temperature with time required, then move HEAT-START switch to HEAT.

(*b*) After glow plugs have heated the allocated time, press operating handle of pressure discharger; release propane into intake manifold, and at same time move HEAT-START switch to START.

(*c*) After engine starts, move HEATSTART switch to HEAT until engine is running smoothly, then move switch to OFF.

Note

Starting crane-shovel units at ambient temperature of +20'F or lower may require preheating of crankcase oil and coolant

2-26. Personnel Heater

a. General. These crane-shovel units are equipped with a hot water type heater, mounted just behind operator on floor of cab.

b. Fan and Heater Controls. A fan control toggle switch is mounted on lighting control box in the cab (fig. 2-24). Two control valves (fig. 2-26) controls flow of heated coolant from engine to heater.

c. Operation.

(1) Before attempting to use heater, be sure that the two valves at engine are open (fig. 2-26).

(2) Start heater fan by moving toggle switch (fig. 2-24) up to ON.

(3) In warm weather, heater fan may be used to circulate air in the cab, by leaving water flow control valves (fig. 2-26) closed.

2-27. Trouble Light

a. Description. The trouble light is a drop cord type, 24 Vdc, and is stowed in the cab.

b. Operation. Remove light from stowed position and plug into trouble light socket on lighting panel (fig. 2-24).

2-28. Operation of Crane Front End Attachment

a. Perform preventive maintenance checks and services (para 3-6); start engine (para 2-10); engage engine clutch (fig. 2-24), then raise boom (if necessary) (para 2-12*c*.).

b. Lower hook block by releasing pressure on the digging (main hoist) brake pedal; moving crowd and retract clutch lever away from operator (fig. 2-23), and allow hook block to drop slowly to center of load to be lifted. Swing revolving frame (para 2-12b), or travel craneshovel (para 2-12*d*) when necessary to center hook over load.

c. When hook block is in desired position, return crowd and retract clutch lever to neutral, apply main hoist (digging) brake pedal and hold.

d. After load is safely attached, allow ground crew to clear load, then pull back on crowd and retract clutch lever (fig. 2-23), at the same time release main hoist (digging) brake pedal.

e. When load is sufficiently high to swing safely, return crowd and retract clutch lever to neutral position, and at same time apply main hoist (digging) brake pedal to hold load in position.

f. Swing revolving frame to desired position (para 2-12*b*).

Note

Engage swing and propel clutch lever (fig. 2-23) slowly so that swing motion will start and stop smoothly.

g. Lower load by moving crowd and retract clutch lever away from operator releasing main hoist (digging) brake pedal, and control rate of load descent by varying the pressure applied to main hoist (digging) brake pedal. When load is in proper position, move crowd and retract clutch lever to neutral and apply main hoist (digging) brake pedal.

Note

If it is necessary to unload at a greater or lesser radius, the boom may be raised or lowered as required (para 2-12*c*) or, crane-shovel may be traveled (para 2-12*d*). If boom is lowered, load must be hoisted simultaneously to prevent load from lowering too fast and causing damage. If traveled for less than 100 feet, it is not necessary to put idler sprockets under boom foot.

h. When load is solidly at rest, release main hoist (digging) brake pedal and give ground crew slack to unfasten hitch.

i. When load is unhitched, pull back crowd and retract clutch lever to raise hook block clear, and hold in position with main hoist (digging) brake pedal.

Note

Travel, or adjust boom if necessary, in reverse order to change made as a result of note above.

j. Swing revolving frame to spot for next load (para 2-12*b*).

k. Repeat steps a through j cycle as necessary.

l. Disengage engine clutch (fig. 2-24); stop engine (para 2-11), then perform preventive maintenance checks and services (para 3-6).

2-29. Operation 6f Clamshell Front End Attachment

a. Perform preventive maintenance checks and services (para 36); start engine (para 2-10), then engage engine clutch (fig. 2-24).

b. Raise the open clamshell bucket from ground by releasing digging brake pedal and hoist brake pedal (fig. 2-24), and at the same time pulling back on the crowd and retract clutch lever and the hoist and propel clutch lever.

Note

The above clutch levers are side-by-side, and may be controlled with one hand, if desired. If the clamshell bucket starts to close in mid air, release pressure on crowd and retract clutch lever just enough to reopen bucket.

c. When bucket is high enough to clear obstructions, return crowd and retract and hoist and propel clutch levers (fig. 2-24) to neutral and at the same time apply digging and hoist brake pedals to hold open bucket in position.

d. Swing revolving frame in desired direction (para 2-12*b*).

e. Release digging brake pedal and hoist brake pedal and lower open clamshell bucket to stockpile. The rate of bucket descent is controlled by pressure on hoist brake pedal. Allow closing (digging) line to run free when lowering bucket.

Note

If necessary to force bucket teeth into hard material, a long fast drop of bucket from tip of boom to stockpile will do the job.

f. As soon as bucket enters material, apply digging and hoist brake pedals to prevent cables overrunning.

g. Release digging brake pedal, and at the same time pull crowd and retract clutch lever toward operator to close the bucket. To adjust digging depth, slack off on hoist brake pedal as bucket closes and digs into material.

h. When bucket is closed, pull the hoist clutch lever toward operator, and at same time release hoist brake pedal. As bucket rises it may be necessary to slack off on hoist clutch lever to avoid opening bucket in mid air.

i. Raise bucket high enough to clear obstructions; release crowd and retract clutch lever and the hoist clutch lever, and at the same time apply

pressure to digging brake and hoist brake pedals to hold bucket in position.

j. Swing the revolving frame to desired dumping position (para 2-12*b*), then release digging brake pedal to open bucket.

*k. Swing the open bucket back to loading point and repea*t steps b through 1 working cycle as often as necessary.

l. When though with work for the day, lower bucket to ground and disengage engine clutch (fig. 2-24).

m. Stop engine (para 2-11) and perform preventive maintenance checks and services (para 3 6).

2-30. Operation of Dragline Front End Attachment

a. Perform preventive maintenance checks and services (para 3-6); start engine (para 2-10), and engage engine clutch (fig. 2-24).

b. Raise or lower boom (if necessary) (para 2-12*c*) to between 40 and 45° angle, the normal angle for dragline operation.

c. Release digging brake pedal, allow bucket to trip, then lower bucket to work area by releasing pressure on hoist brake pedal. When bucket touches ground apply hoist brake pedal to prevent cable overrunning.

d. To fill dragline bucket, pull crowd and retract clutch lever toward operator, slipping hoist brake as required to allow bucket to level out when filled.

e. When bucket is loaded return crowd and retract clutch lever to neutral and apply slight pressure to digging brake pedal, then pull hoist and propel clutch lever toward operator. The slight pressure on digging brake keeps bucket level and prevents it from dumping its load.

f. When bucket is high enough to clear obstructions, swing to dumping area (para 2-12*b*), at the same time slipping digging brake to allow bucket to swing out under boom point.

g. When bucket has reached the desired position for dumping, release all pressure on digging brake pedal.

h. Swing bucket (para 2-12*b*) out over digging position and repeat above working cycle as often as necessary.

Note

Working or digging area can be enlarged beyond boom point by "casting" bucket.

i. To cast bucket beyond boom point, pull crowd and retract clutch lever toward operator and bring bucket toward boom foot, as bucket is hoisted to half boom height. Swing boom toward work area (para 2-12b) then apply swing brake to hold boom is desired position.

i. Release pressure on digging brake pedal and hoist brake pedal simultaneously. Apply pressure to both brake pedals to prevent cables from overrunning as bucket reaches ground.

k. Repeat steps c through S, i and j above as necessary.

l. When work for day is through, lower bucket to ground, and disengage engine clutch (fig. 2-24).

m. Stop engine (para 2-11) and perform preventive maintenance checks and services (para 3-6).

2-31. Operation of Shovel Front End Attachment

a. Perform preventive maintenance checks and services (para 3-6); start engine (para 2-10), and engage engine clutch (fig. 2-24).

b. Travel (para 2-12d) to bank as shown in figure 1-7. When positioning crane-shovel near bank, keep about 11/4 to 11/2 times dipper length between crawlers and edge of bank.

c. Lower dipper by releasing hoist brake pedal (fig. 2-23). Control speed of lowering dipper by varying pressure on hoist brake pedal.

d. To crowd dipper into bank, extend dipper stick by pulling crowd and retract clutch lever toward operator, then returning lever to neutral.

e. To load dipper from bank, move hoist clutch lever toward operator, then just a moment later, pull crowd and retract clutch lever toward operator.

Note

The dipper should slice a thin layer from bank rather than digging in.

f. When dipper is loaded, move crowd and retract clutch lever away from operator and retract dipper from bank.

g. When dipper is high enough to clear obstacles, return hoist clutch to neutral and apply hoist brake pedal, then swing dipper (para 2-12*b*) over unloading area. Apply swing brake (fig. 2-23) when dipper is in unloading position, then move dipper trip lever to open dipper door and dump load.

h. Swing dipper back to loading area (para 2-12*b*) then position crane-shovel for digging, and repeat above work cycle as necessary.

i. When work is finished for the day, lower dipper to ground, and disengage engine clutch (fig. 2-24).

j. Stop engine (para 2-11) and perform preventive maintenance checks and services (para 3-6).

2-32. Operation of Backhoe Front End Attachment.

a. Perform preventive maintenance checks and services (para 3-6); start engine (para 2-10), and engage engine clutch (fig. 2-24).

Note

Observe that the position of auxiliary gantry (fig. 2-17) is almost vertical, and the backstop is almost closed. Adjust position, if necessary, as described for raising or lowering of boom (para 2-12c).

b. Take up slack in hoist cable and digging cable by moving hoist clutch and propel brake lever and crowd and retract clutch lever (fig. 2-23) toward operator. Move clutch levers back to neutral when cable tension is equal.

c. To raise backhoe dipper boom and extend dipper, pull the hoist clutch and propel brake lever (fig. 2-23) toward operator, at the same time move crowd and retract clutch lever away from operator allowing digging cable to run out. Control slack in digging cable by varying pressure on digging brake pedal.

d. Continue raising of backhoe boom and dipper extension until dipper is over the work area; then return both clutch levers to neutral; hold digging cable tight with pressure on digging brake pedal; allow backhoe boom and dipper to lower, controlling rate of descent by pressure on hoist brake pedal.

e. Fill dipper by pulling crowd and retract clutch lever toward operator, at same time keeping tension on hoist cable by applying pressure on hoist brake pedal.

Note

Depth of backhoe dipper cut is controlled by tension on hoist brake pedal. If hoist cable goes slack, dipper will dig in instead of slicing material from the cut. The pitch brace between dipper and stick is adjustable to three positions. For normal operation brace pin is usually set in center hole. For very deep excavation, set brace pin in lower hole. Where maximum height of lift is required for dumping, set brace pin in upper hole.

f. Stop travel of backhoe dipper before dipper sheave (fig. 2-17) strikes boom, by returning crowd and retract clutch lever to neutral and applying pressure to digging brake pedal.

g. Raise dipper out of cut and to dumping height by holding pressure on digging brake pedal (keeping dipper close to boom), and moving hoist clutch and propel brake lever toward operator. When dipper is at proper height return clutch lever to neutral and apply pressure to hoist brake pedal.

h. Swing revolving frame (para 2-12*b*) to dumping area.

i. Dump load by moving hoist clutch and propel brake lever toward operator, at the same time moving crowd and retract clutch lever away from operator, keeping pressure on digging brake pedal to prevent overrunning of digging cable. When load is dumped and stick is extended return hoist clutch and propel brake lever and crowd and retract clutch lever to neutral, then apply pressure to both brake pedals to hold backhoe in position.

j. Swing revolving frame (para 2-12*b*) back to work area.

k. Repeat the above work cycle as necessary.

l. When work is through for the day lower dipper to the ground, and disengage engine clutch (fig. 2-24).

m. Stop engine (para 2-11) and perform preventive maintenance checks and services (para 3-6)

2-33. Operation of Piledriver Front End Attachment

a. Perform preventive maintenance checks and services (para 34;); start engine (para 2-10), and engage engine clutch (fig. 2-24).

b. Attach pile follower cable (fig. 2-14) to hooks on hammer, then lift hammer and pile follower by moving hoist clutch lever toward operator. When hammer reaches top of hammer guides, return hoist clutch lever to neutral, apply hoist brake pedal, and set hoist brake lock (fig. 2-23) to hold hammer in raised position.

c. Run pile handling cable off drum by moving crowd and retract clutch lever away from operator, and at same time applying pressure to digging brake pedal to prevent pile cable from overrunning. Attach pile handling cable to upper end of a pile and raise it into position within pile leads by moving crowd and retract clutch lever toward operator, return clutch to neutral and apply digging brake when pile is within pile leads.

d. Position pile in desired location by moving crane as required (swing, para 2-12*b*, travel, para 2-12*d*), then lower point of pile to ground by slowly moving crowd and retract lever away

from operator, at same time applying digging brake pedal to prevent cable overrunning drum.

e. Wrap a heavy chain around pile and leads to hold pile within leads, then remove pile handling cable from pile.

Note

the chain should be sufficiently loose not to bird pile when driving begins.

f. Lower hammer and pile follower by releasing hoist brake lock and pressure on hoist brake pedal Allowing hammer and pile follower to drop slowly to top of pile. Position pile in follower then remove pile follower cables from hooks on hammer.

g. To drive the pile, raise hammer by pulling hoist clutch lever toward operator. As hammer reaches top of pile leads, return hoist clutch to neutral, and apply hoist brake pedal immediately after hammer hits pile follower to prevent hammer cable overrunning the drum. Repeat this step until pile is driven.

h. Position another pile and repeat the above operating cycle as often as necessary.

i. When work is through for the day, lower hammer to rest on pile follower, and disengage engine clutch (fig. 2-24).

j. Stop engine (para 2-11) and perform preventive maintenance checks and services (para 3-6).

2-34. Operation of Jib Boom Front End Attachment

a. When jib boom is installed to crane boom (fig. 24) and reeved (fig. 2-7), the job hoist line (or whip line) is operated as described below.

b. Position boom with jib over center of load (by swinging revolving frame, para 2-12*b* above, or traveling, para. 2-12*d* above).

c. Lower weighted hook by releasing hoist brake lock (fig. 2-23) and allowing hook to drop by gravity, controlling rate of descent by varying pressure on hoist brake pedal.

d. After load is attached to hook, lift load by moving hoist clutch and propel brake lever (fig. 2-23) toward operator.

e. When load is at proper height to clear all obstacles, move hoist clutch and propel brake lever to neutral and apply hoist brake pedal and lock with hoist brake lock.

f. Complete handling of load in similar manner to crane operation (para 2-28 above).

CHAPTER 3
OPERATOR AND ORGANIZATIONAL MAINTENANCE INSTRUCTIONS

Section I. OPERATOR'S AND ORGANIZATIONAL MAINTENANCE REPAIR PARTS, TOOLS, AND EQUIPMENT

3-1. Tools and Equipment a. Basic issue tools and repair parts issued with or authorized for the crane-shovel basic unit are listed in the Basic Issue Items List, Appendix B of this manual.

b. The special tools required to perform operator and organizational maintenance on the craneshovel are listed in table 3-1, and Appendix C.

References and illustrations indicating the use of these tools are listed in the table. No special equipment is required by operator, crew, or organizational maintenance personnel for performing maintenance on the crane-shovel basic unit.

3-2. Organizational Maintenance Repair Parts Organizational maintenance repair parts are listed and illustrated in TM 5-3810-206-20P.

Tale 3-1. Special Tools

Item	FSN or part number	Ref		Use
		Fig	Par.	
PULLER, SHEAR WASHER	5120-690-7948		3-124	Changing of lagging on hoist drums

Section II. LUBRICATION

3-3. General Lubrication Information

a. This section contains instructions which are supplemental to, and not specifically covered in the lubrication order.

b. Refer to lubrication order LO 5-3810-206-12 for normal information on lubrication points and intervals.

3-4. Detailed Lubrication, Information

a. General. Keep all lubricants in closed containers and store in a clean dry place, away from external heat. Allow no dust, dirt, or other foreign material to mix with the lubricant. Keep all lubrication equipment clean and ready for use at all times.

b. Cleaning. Keep all external parts not requiring lubrication clean of lubricants. Before lubricating the crane-shovel, clean all lubricating points (fig. 3-1) to prevent contaminates from entering housing under applied pressure. After lubrication, wipe excess grease from all lubrication points to prevent accumulation of foreign matter.

c. Operation After Lubrication. Start engine (para 2-1) and operate the crane-shovel immediately after lubrication. Inspect lubrication oil filters for leaks, then stop engine (para 2-11) and check all oil levels. Add oil, if necessary, to bring level up to full mark on dipstick level gage. Check for any additional leaks and correct them if found.

d. OES Oil.

(1) The crankcase oil level must be, checked frequently, as oil consumption may increase.

(2) The oil may require changing more frequently, because contamination by dilution and sludge formation will increase during cold weather operation.

e. Engine Air Cleaners. The air cleaners may be oil bath, or dry type depending on type of engine installed in crane-shovel. Service as follows:

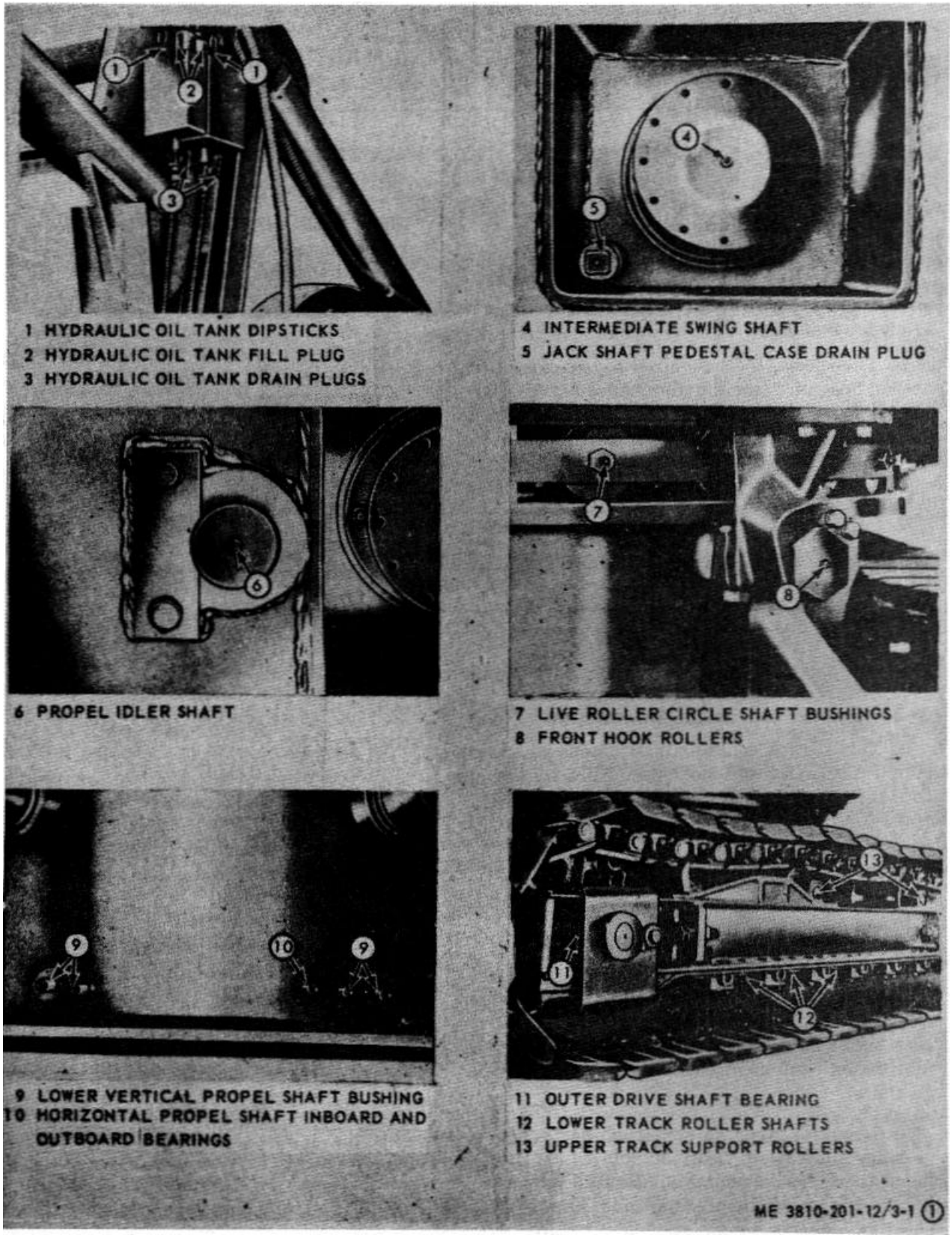
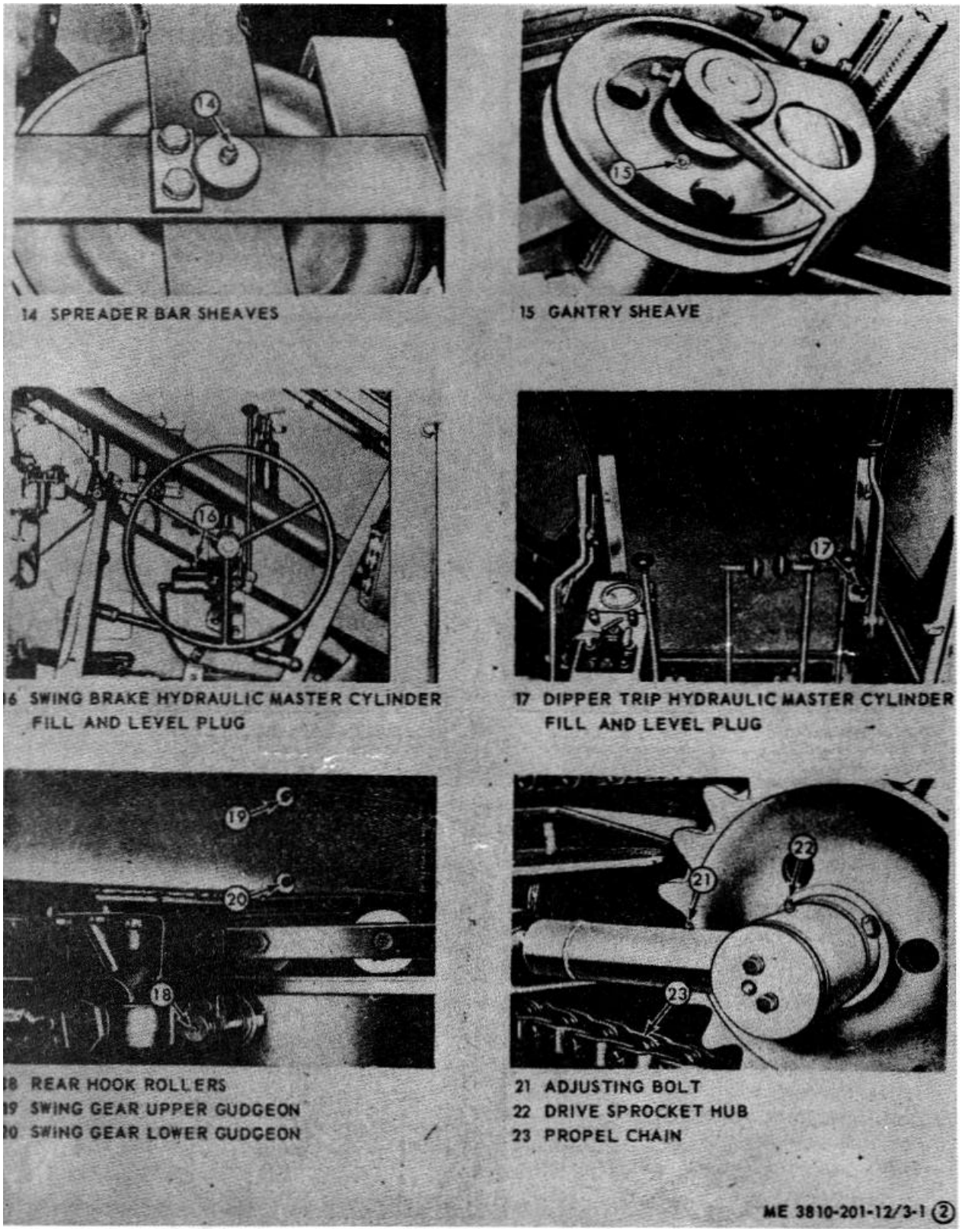


Figure 3-1. Lubricating point identification (sheet 1 of 14).



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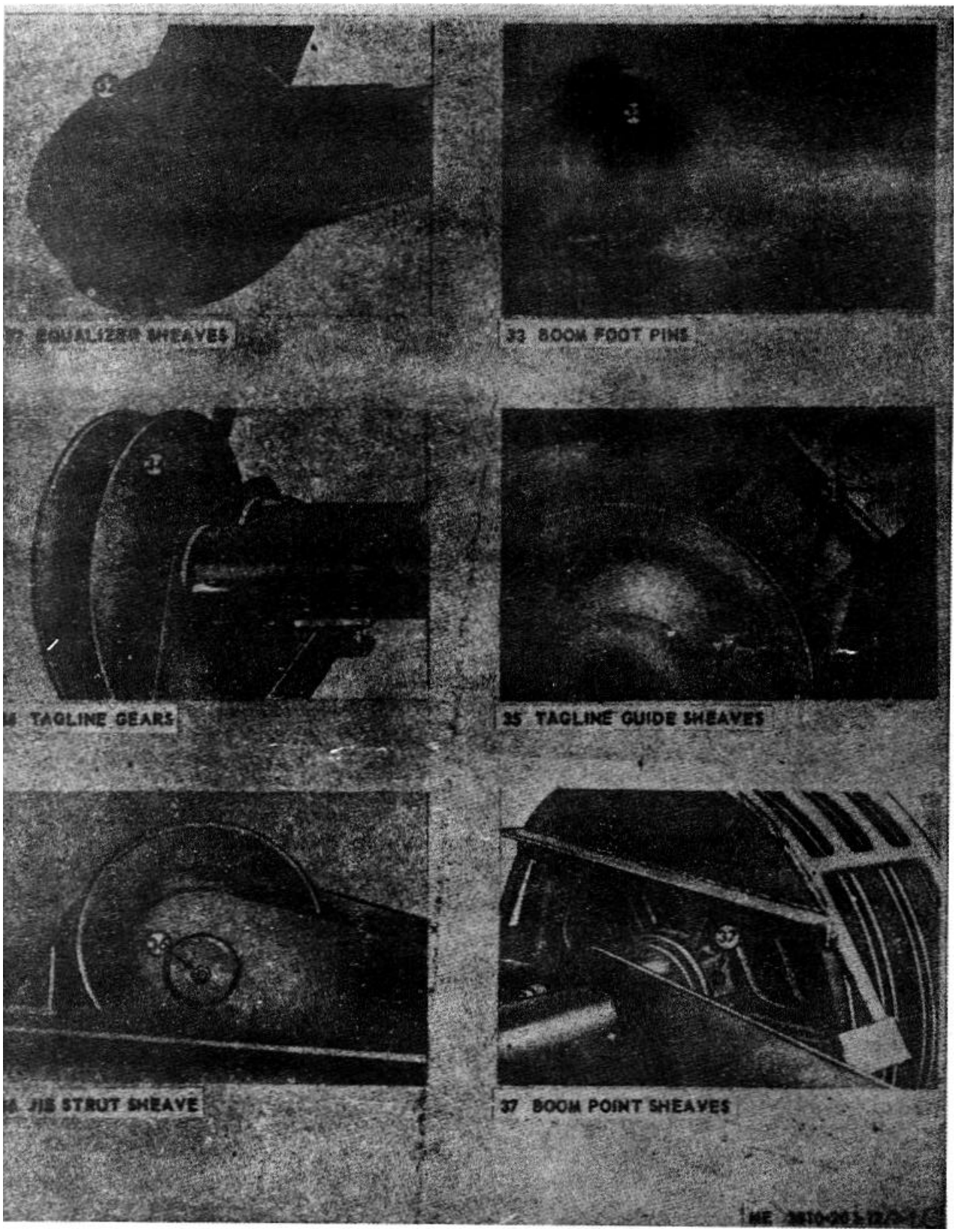

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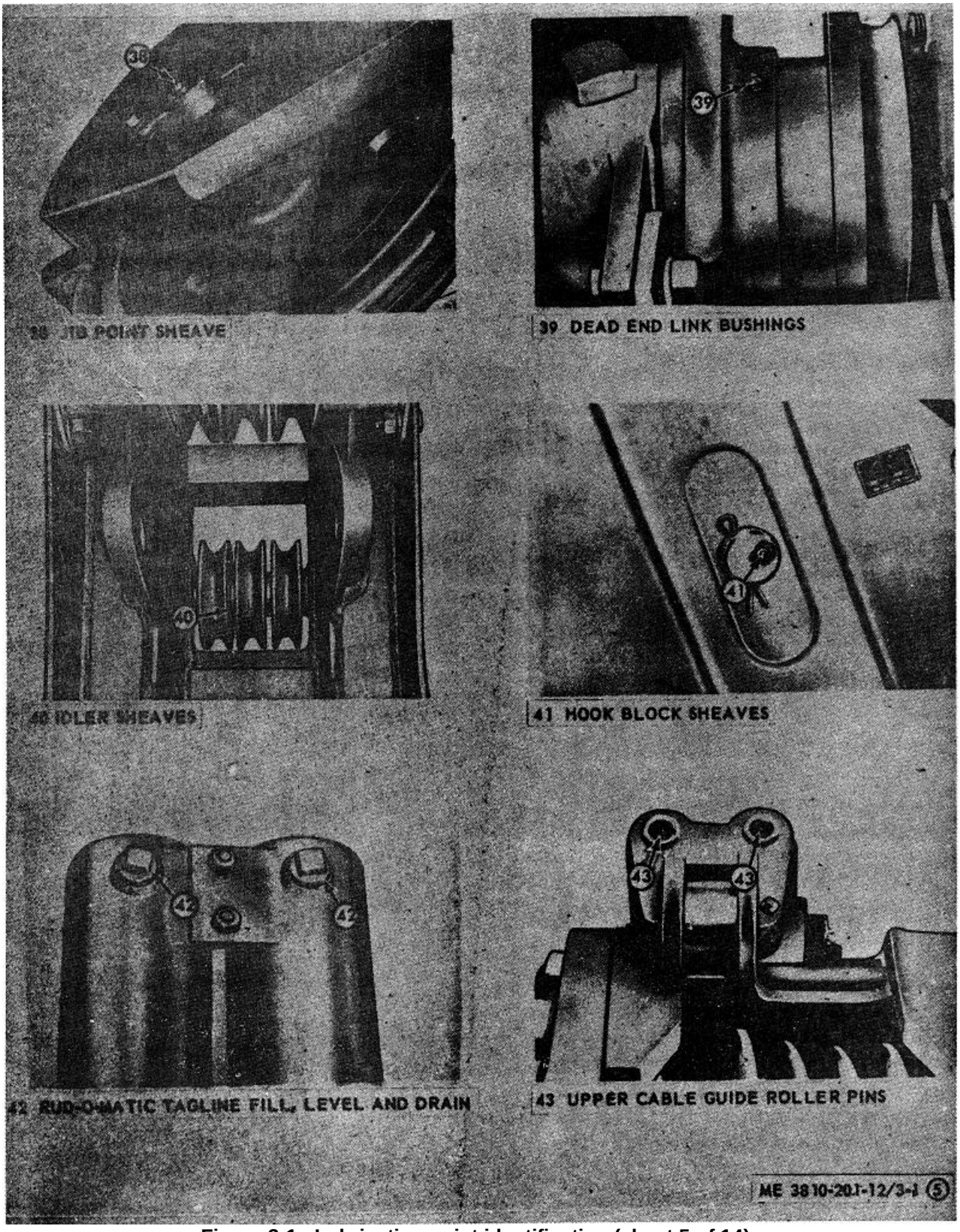

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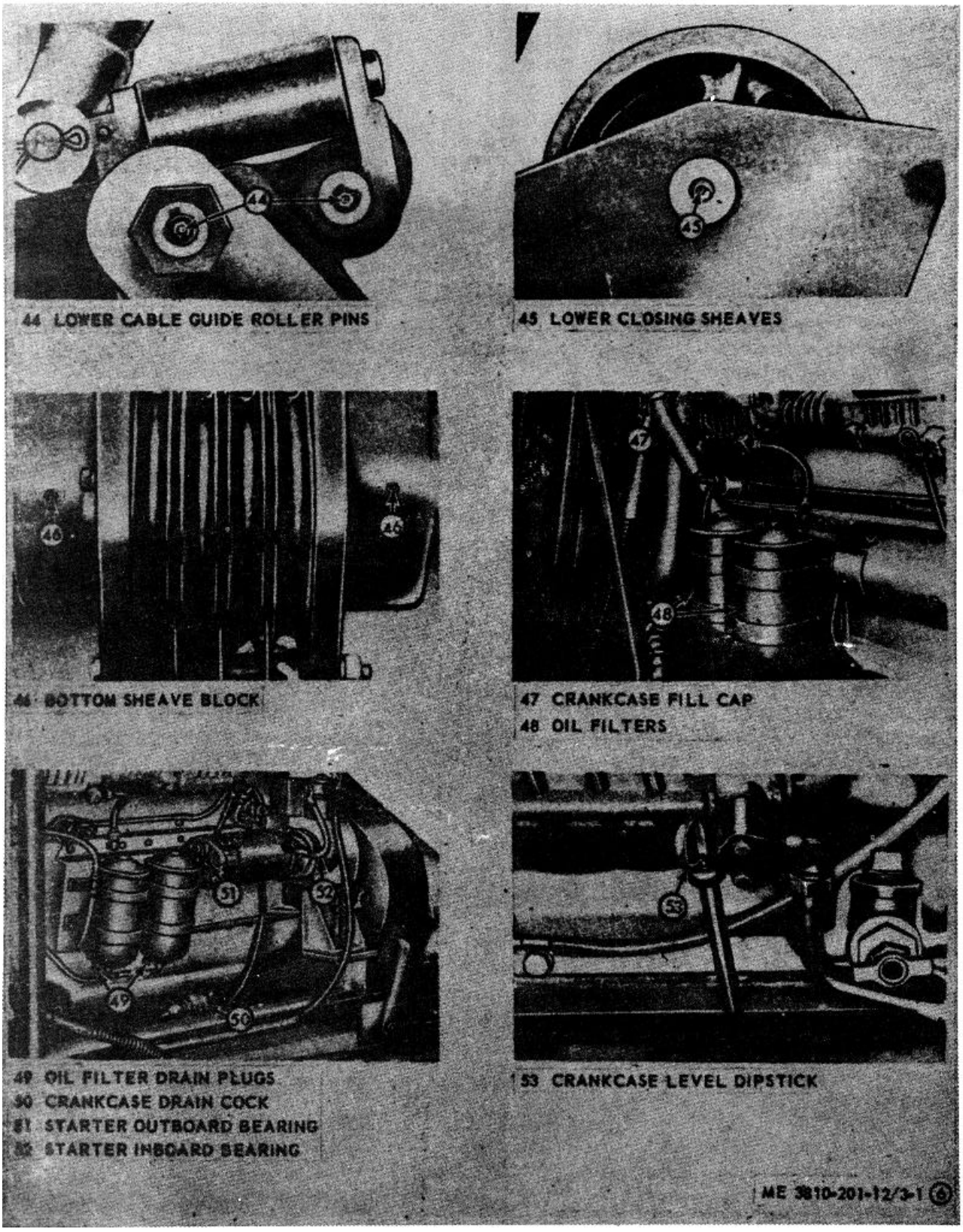

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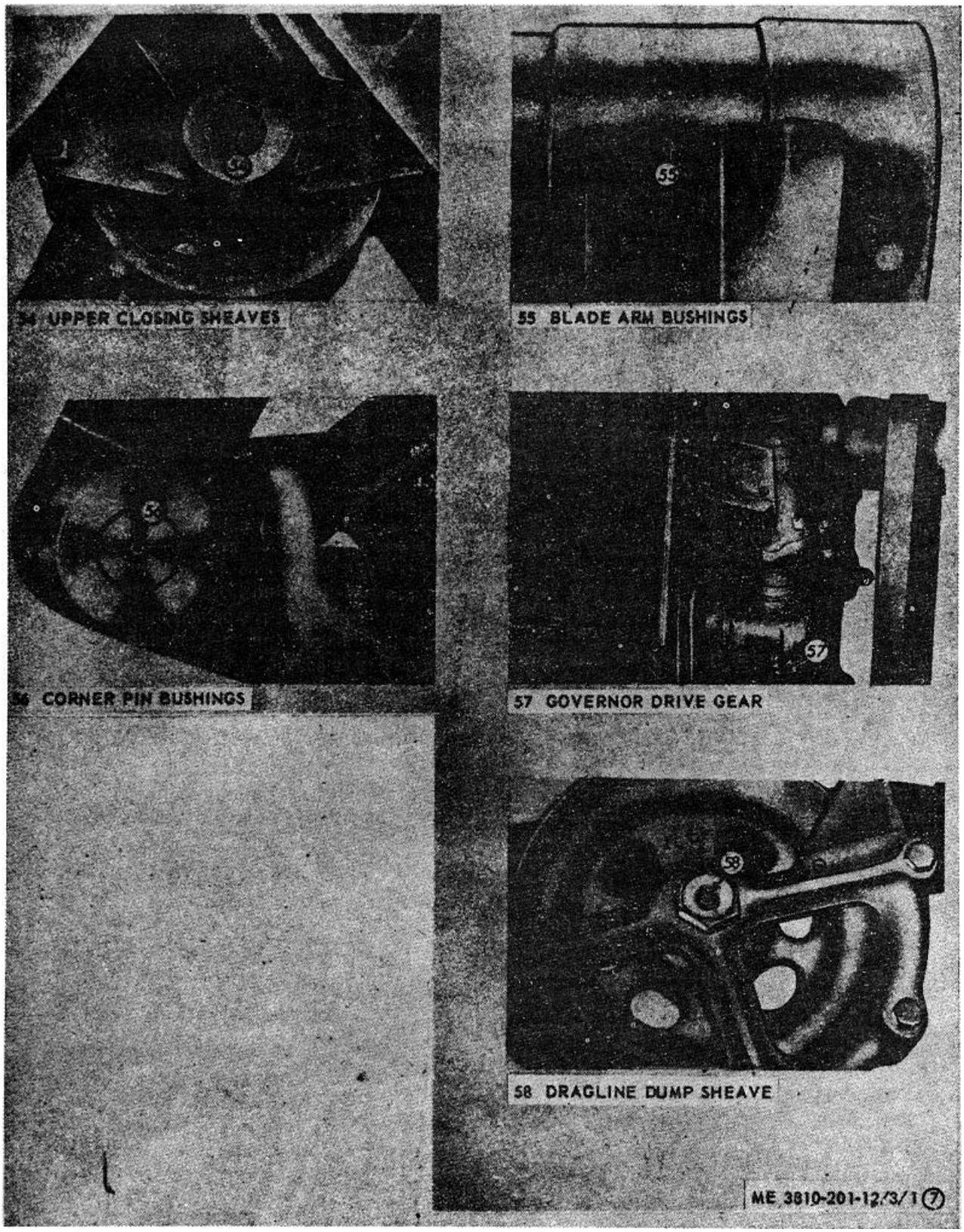


Figure 3-1. Lubricating point identification (sheet 7 of 14).

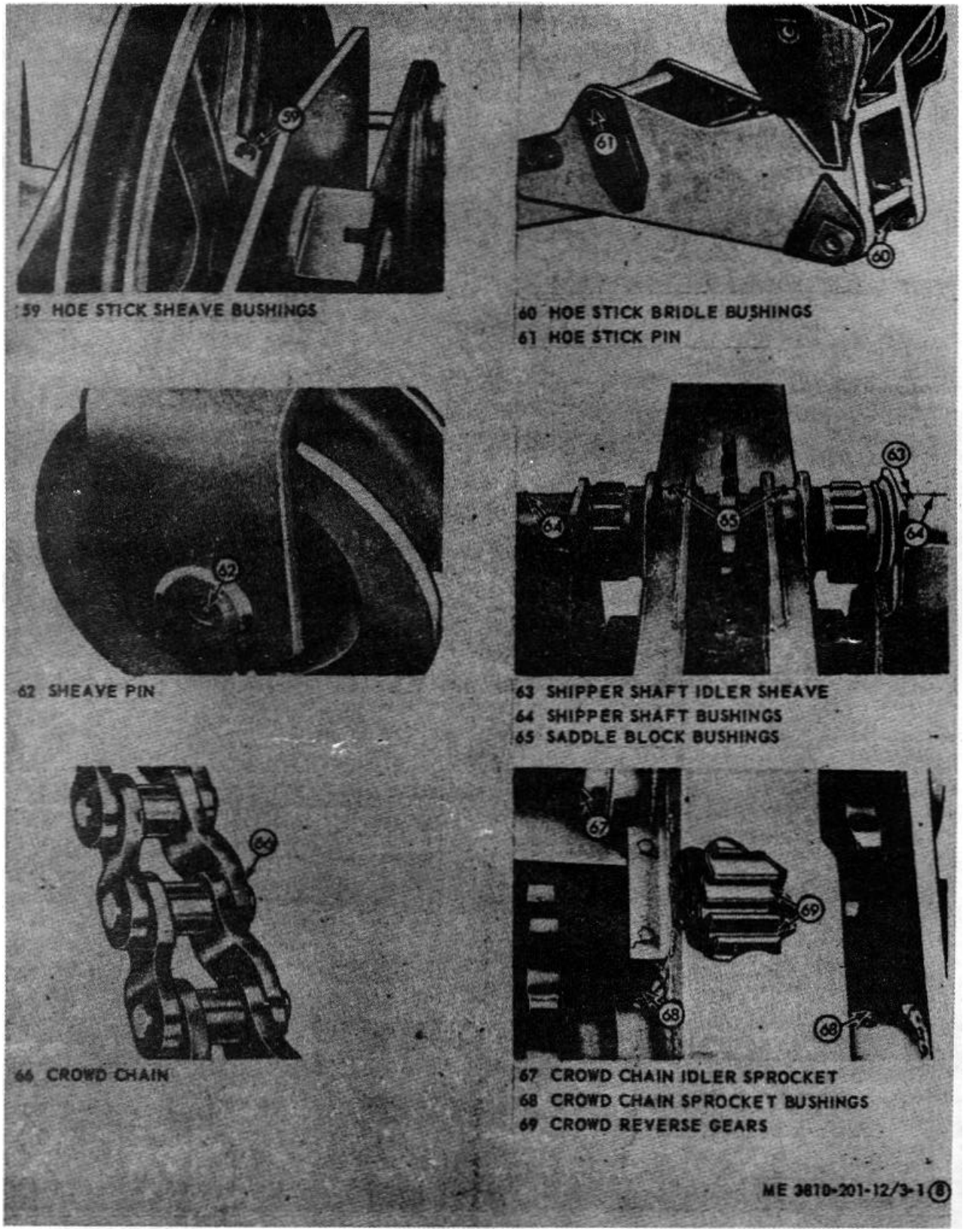
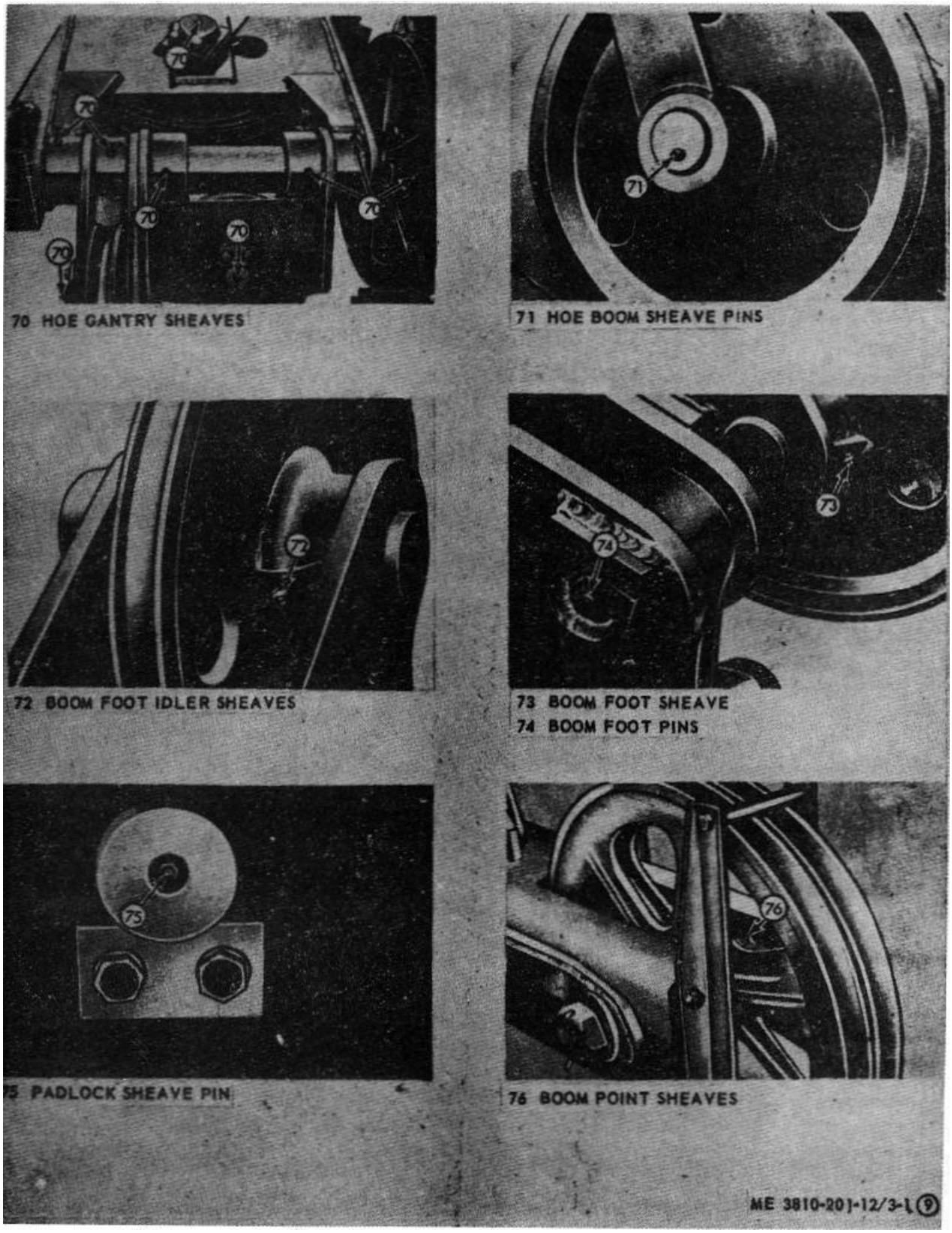


Figure 3-1. Lubricating point identification (sheet 8 of 14).



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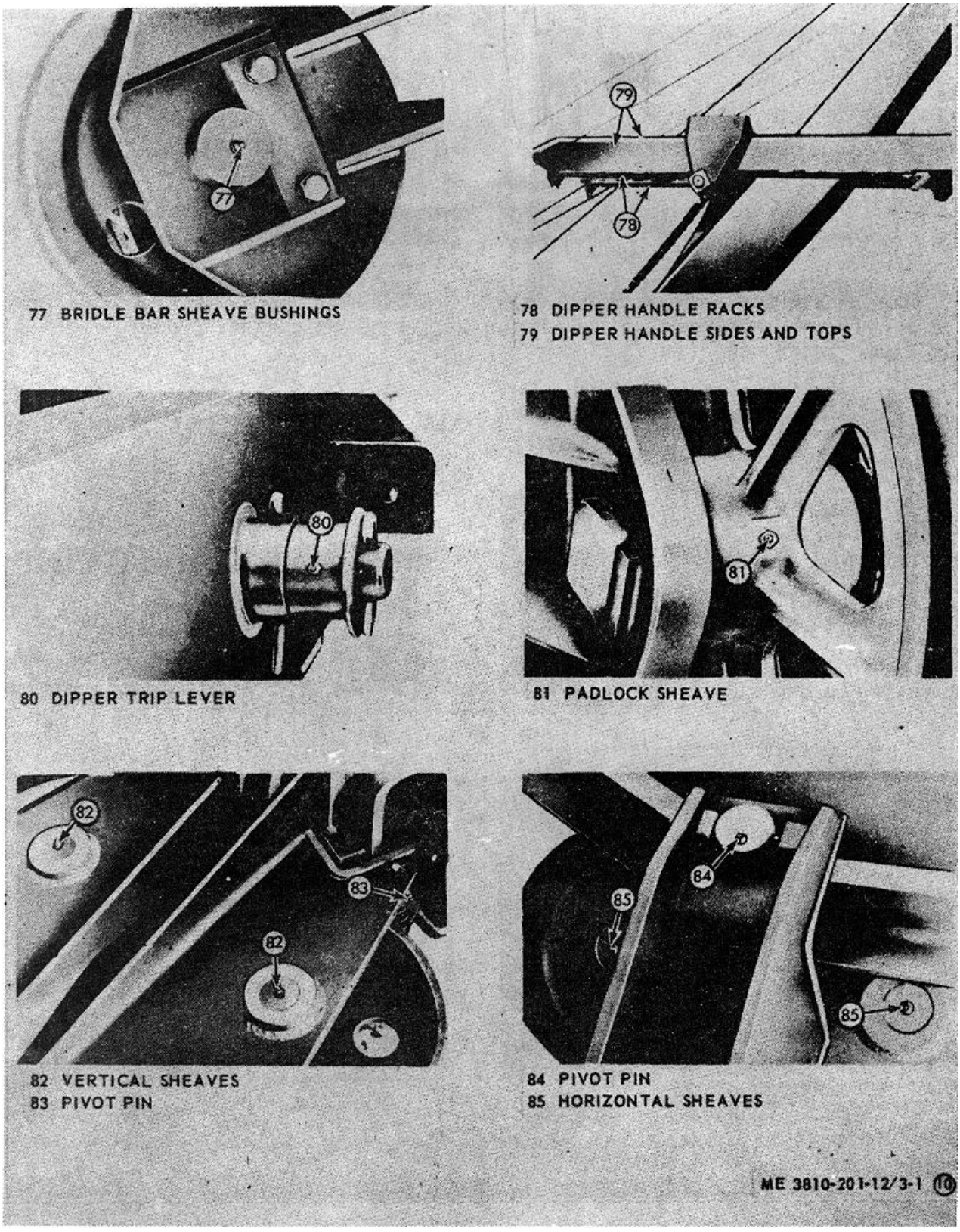


Figure 3-1. Lubricating point identification (sheet 10 of 14).

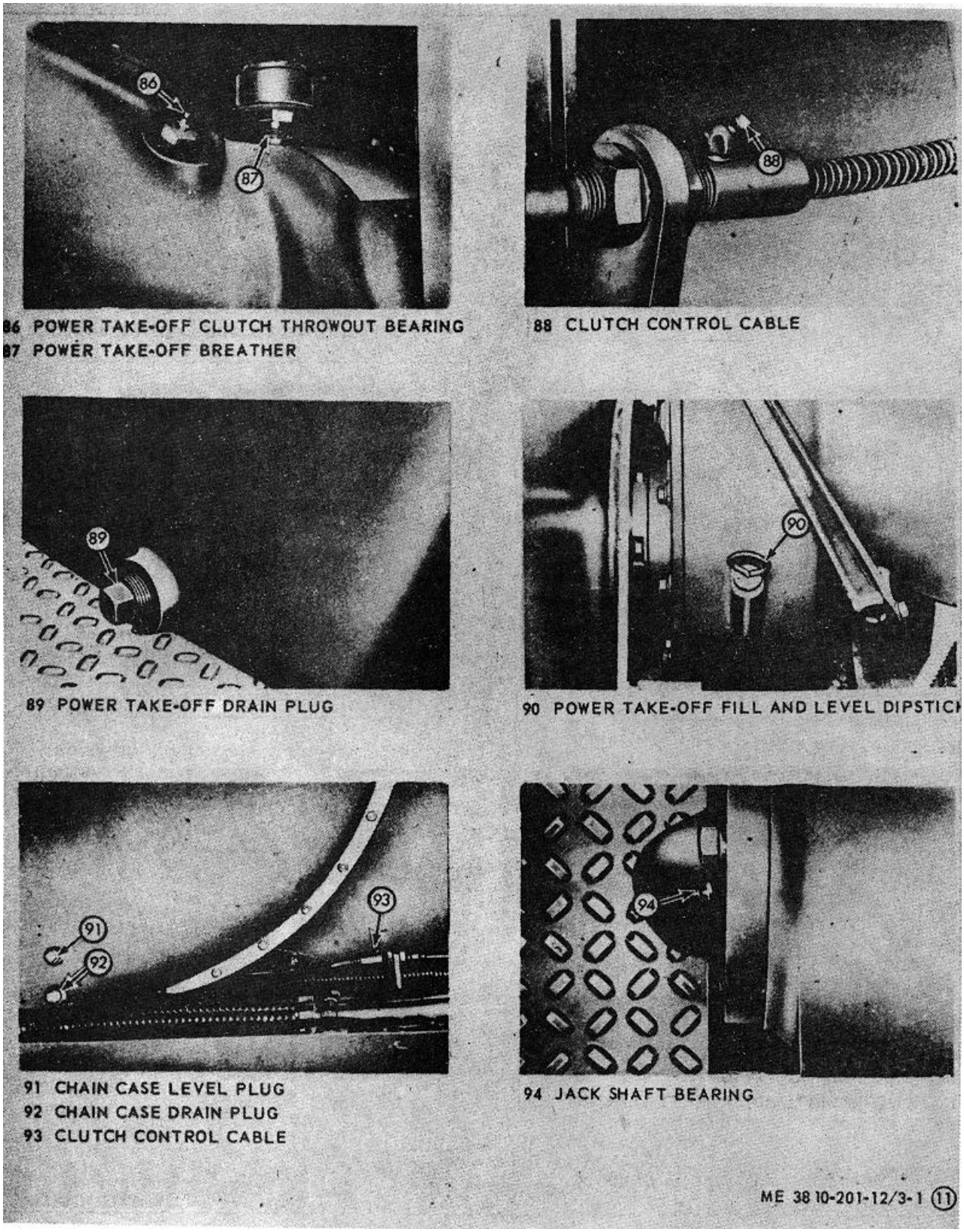
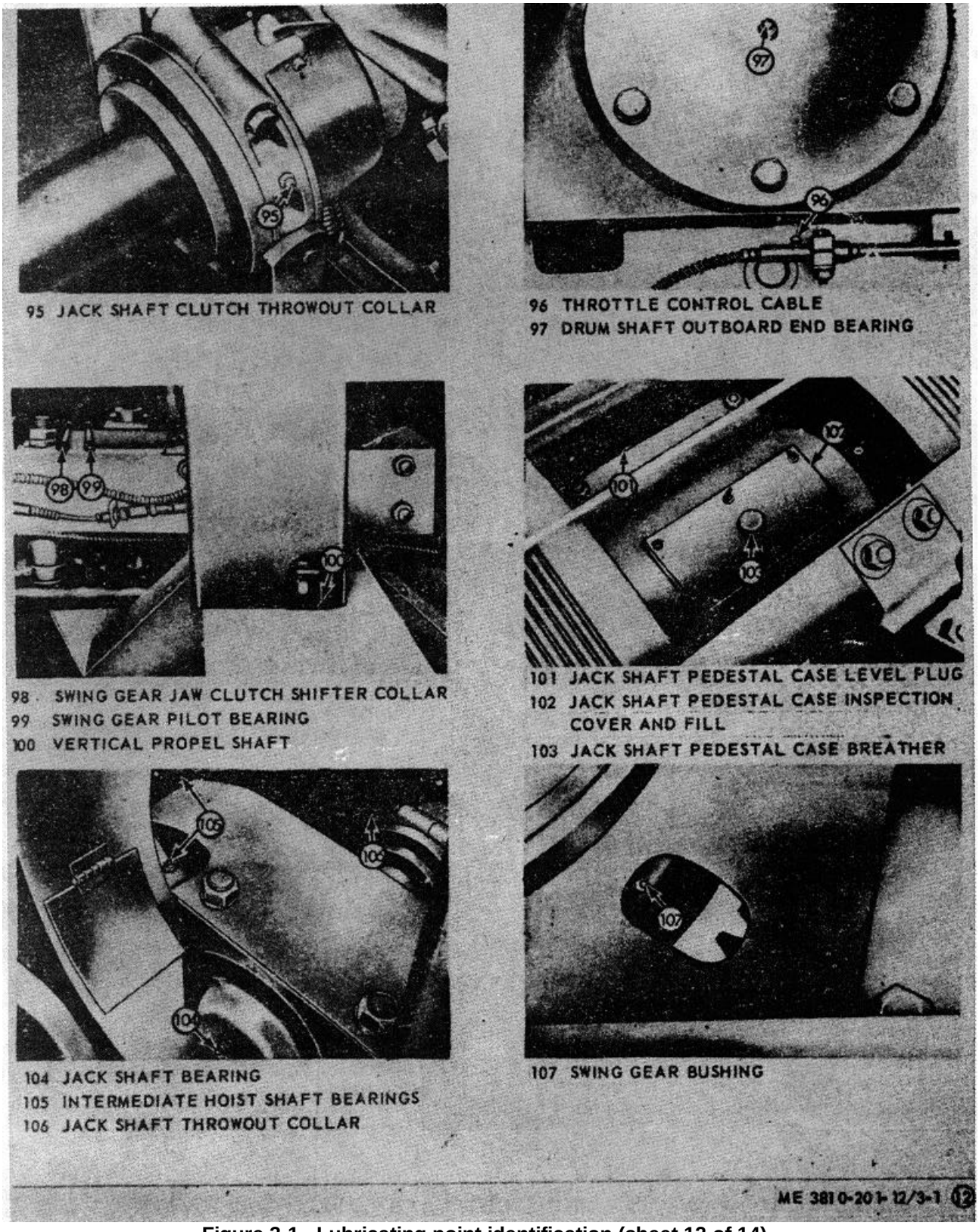


Figure 3-1. Lubricating point identification (sheet 11 of 14).



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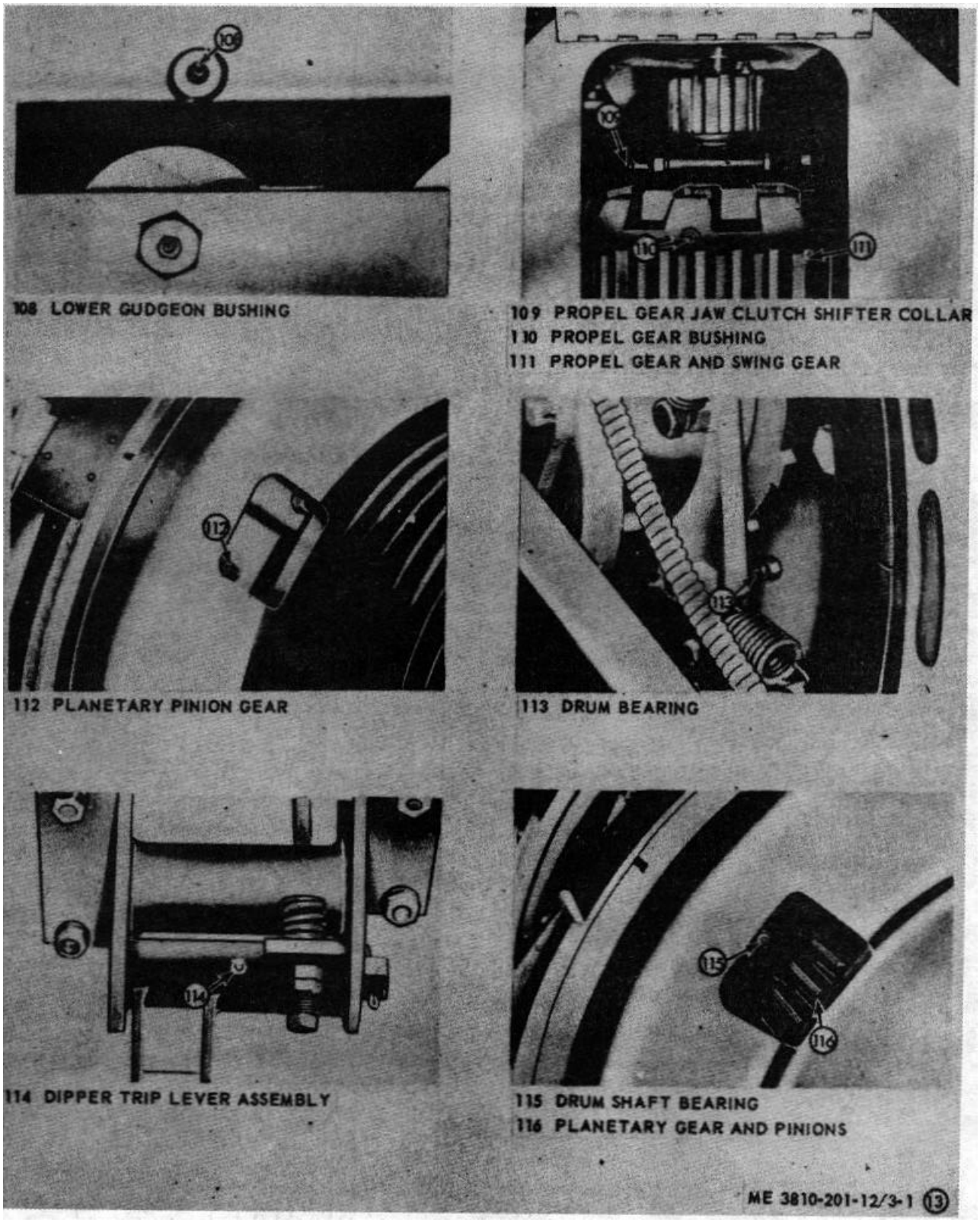

Figure 3-1. Lubricating point identification (sheet 13 of 14).

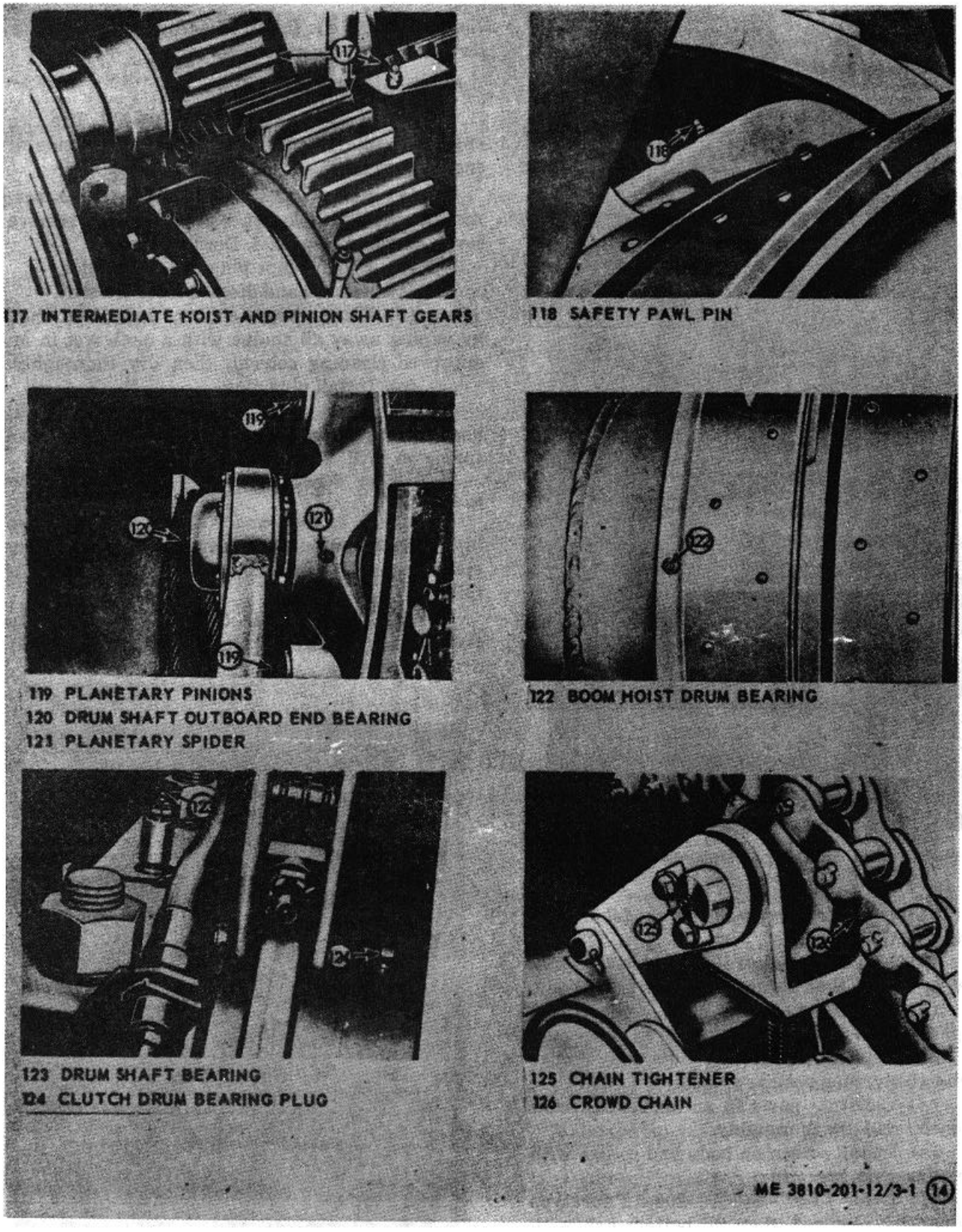

Figure 3-1. Lubricating point identification (sheet 14 of 14).

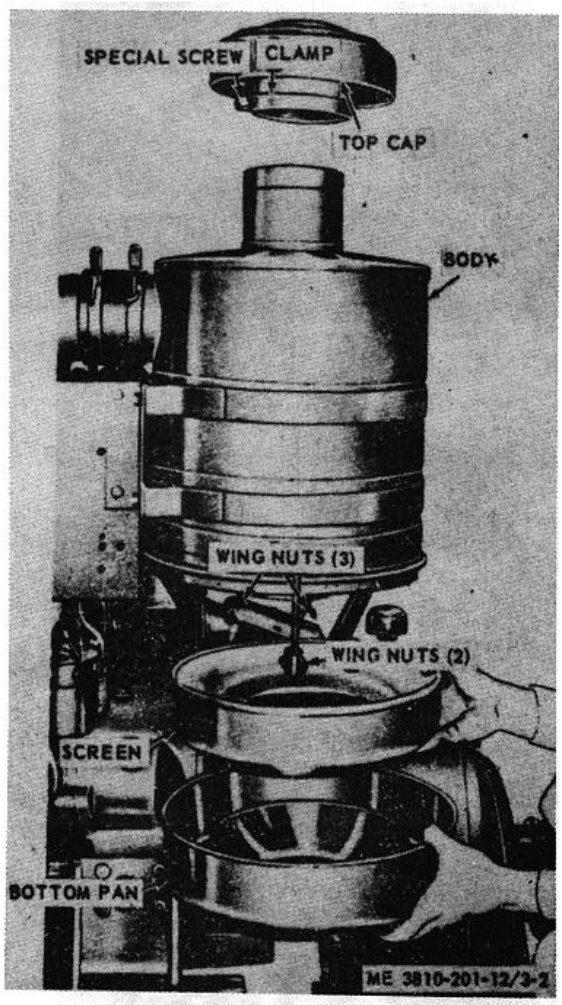

Figure 3-2. Air cleaner service (engine 687C-18-ES).

(1) *Service for crane-shovel model 855BG (engine 687C-18-ES).*

(*a*) Refer to figure 3-2, loosen special screw in clamp, then remove top cap from body.

(*b*) Loosen two wing nuts; remove bottom pan from body, then empty old oil from pan.

(*c*) Remove three wing nuts that secure screen to body, then remove screen.

(*d*) Clean all parts in an approved cleaning solvent and dry thoroughly.

(*e*) Install screen on body and secure with three wing nuts.

(*f*) Refer to LO 5-3810-206-12 for type and quantity required, then fill bottom pan with oil.

(*g*) Install bottom pan over screen, then tighten the two wing nuts.

(*h*) Install top cap on body and secure by tightening special screw in holddown clamp.

(2) *Service for crane-shovel model 855BG (engine D333TA).* Refer to paragraph 3-11*b* for service of dry type air cleaner.

f. Engine Oil Filter Service.

(1) *For engine model 687C-18-ES.* The two engine oil filters are located on left hand side of engine at rear of cab. Service as follows:

(*a*) Refer to LO 5-3810-206-12 for correct interval, then loosen bolt (fig. 3-3); remove cover, spring, and gasket. Discard gasket.

(*b*) Remove pipe plug and drain filter.

(*c*) Remove and discard filter element.

(*d*) Clean cover, spring, and filter shell by wiping away all sludge with a cloth wet in an approved cleaning solvent, then dry thoroughly.

(*e*) Install pipe plug.

(*f*) Insert new filter element in shell; position gasket in cover, then install cover and spring on shell. Secure by tightening bolt.

Note.

Service remaining filter in a similar manner.

(2) *For engine model D333TA.* These two filters are mounted on a common base that is installed on left hand side of engine. Service as follows:

(*a*) Refer to LO 5-3810-206-12 for interval, then remove drain plug (fig. 3-4) and drain the filters.

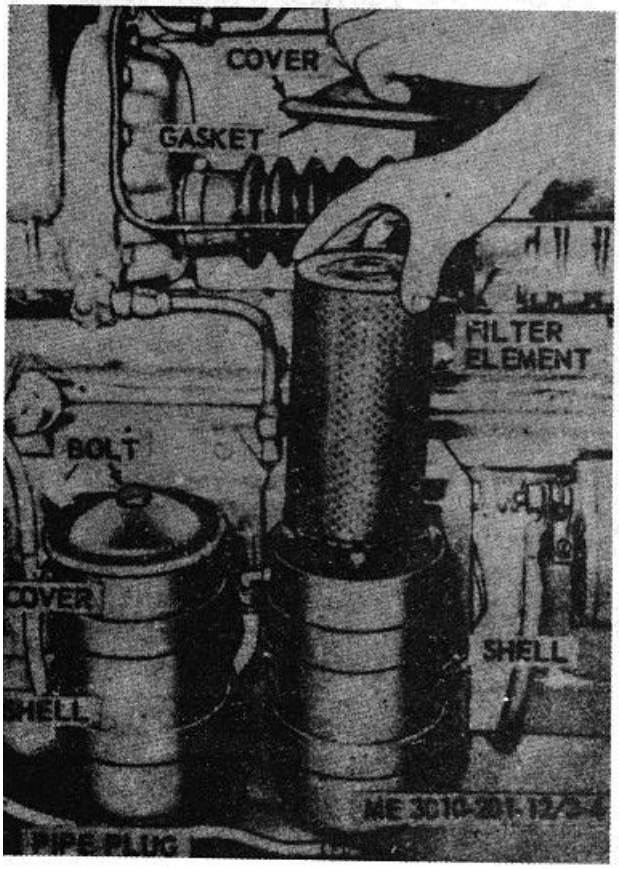

Figure 3-3. Engine oil filter service for model 687C-18-ES.

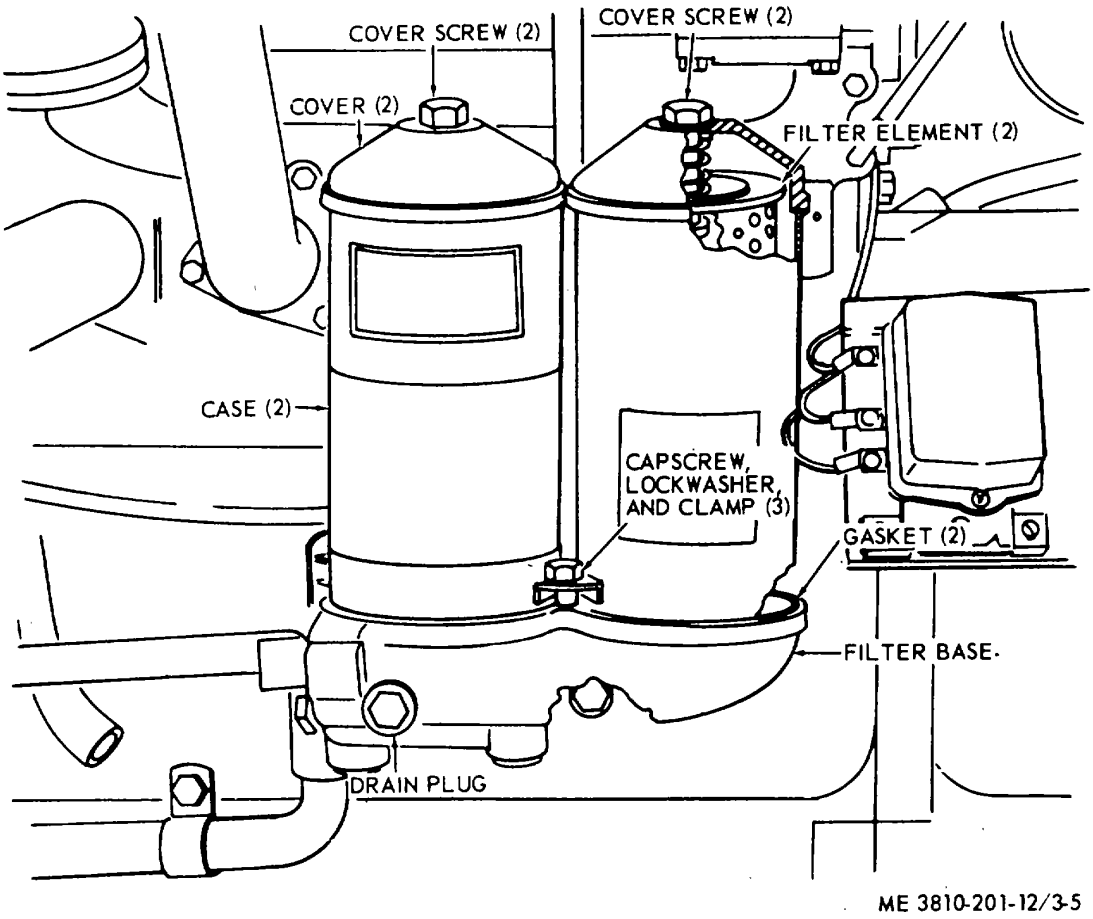

Figure 3-4. Engine oil filter service for engine model D333TA.

(*b*) Loosen the two cover screws; remove cover from both cases, then remove and discard used filter element from both cases.

(*c*) Remove three capscrews, lockwashers, and clamps, then remove both cases from filter base.

(*d*) Remove both gaskets from filter base.

(*e*) Clean all removed parts in an approved cleaning solvent, dry thoroughly, then use a cloth dampened with solvent and wipe all sludge from filter base.

Note

Discard all unserviceable gaskets.

(*f*) Install drain plug in filter base; install serviceable gasket in both case grooves in filter base, then position cases on base and secure with clamp, lockwasher, and capscrew (3).

(*g*) Install new filter element in both cases, then position cover on case and secure with cover screw.

(*h*) After engine oil filters are serviced fill crankcase; (LO 5-3810-206-12) start engine (para 2-10), and run for about five minutes at a fast idle. Inspect oil filters for leaks, then stop

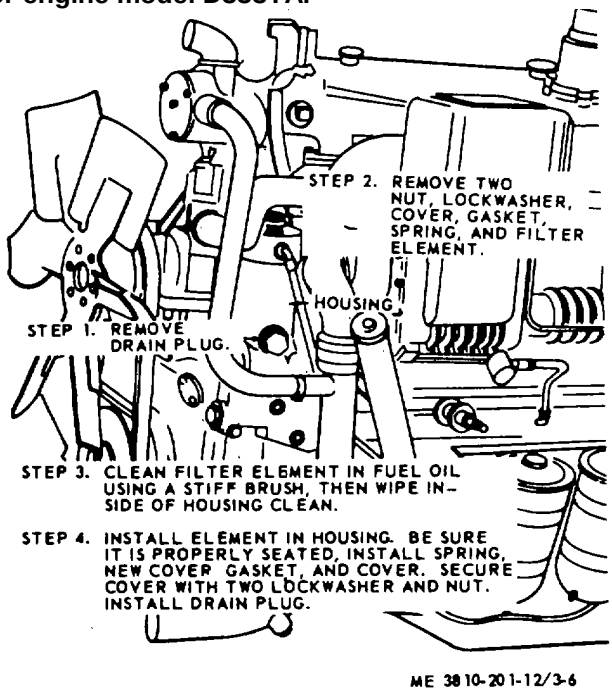

Figure 3-5. Engine oil strainer service (model 687C-18-ES only).

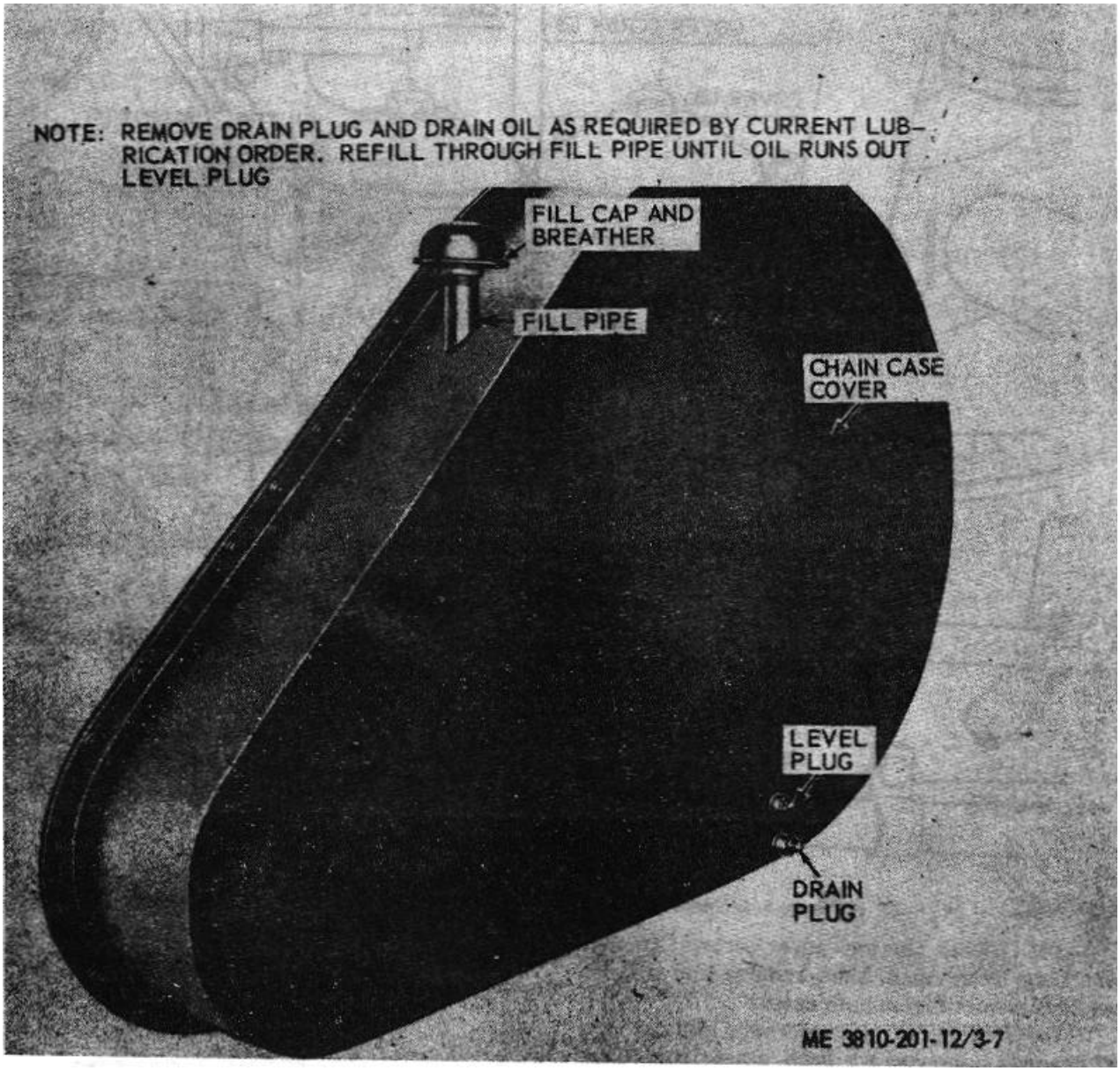

Figure 3-6. Chain case fill cap and breather service.

engine (para 2-11) and check oil level. Add oil when necessary.

g. Engine Oil Strainer Service (Model 687C18-ES Only).

(1) Remove drain plug (fig. 3-5) and drain oil strainer.

(2) Remove two nuts, lockwashers, and cover.

(3) Remove cover gasket and the element spring, then lift filter element from housing. Discard cover gasket.

(4) Clean all parts in an approved cleaning solvent and dry thoroughly.

(5) Visually inspect element spring for break or other defect, such as loss of tension. Replace a defective spring.

(*6*) Position filter element in housing; position spring on filter element; position new gasket on cover, then place cover on housing and secure with two lockwashers and nuts.

h. Chain Case Fill Cap and Breather Service.

(*1*) Refer to LO 5-3810-206-12 for interval, then remove fill cap (fig. 3-6), wash in an approved cleaning solvent, and dry thoroughly with low pressure compressed air.

(*2*) Inspect breather portion of fill cap for damage to filter screen wire, and assure removal of all foreign matter.

(*3*) Replace a defective fill cap breather.

(*4*) Refer to current lubrication LO 5 3810-206-12 for instructions on changing of oil in chain case.

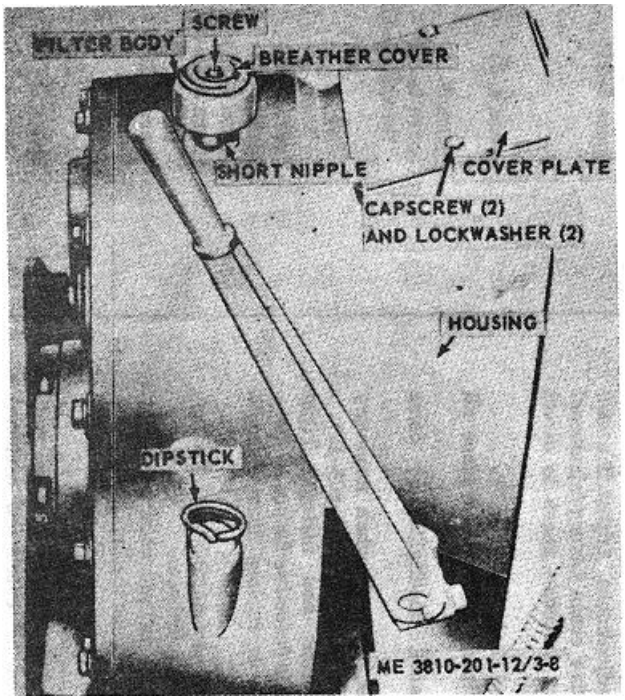

Figure 3-7. Power take-off breather service and cover removal.

i. Power Take-Off Breather Service and Cover Removal.

(1) Refer to current lubrication order LO 53810-20612 for correct interval, then remove and service power take-off breather as directed below.

(2) Refer to figure 3-7, remove screw and breather cover, then remove filter body from short nipple by turning body counterclockwise. Cover short nipple with a clean cloth to prevent entry ,of contaminating material into power takeoff.

(3) Clean all parts in an approved cleaning solvent then dry thoroughly with low pressure compressed air.

(4) Inspect filter wire mesh for damage, or other defect to body. Replace a defective filter body.

(5) Install in reverse order.

(6) Refer to lubrication order LO 5-3810-206-12 for interval and lubricant, then change as required.

j. Starter Motor Inboard Beating Service. Refer-to LO 5-3810-206-12 for correct interval and lubricant, then service as described below.

(1) Remove starter motor (para 3-81).

(2) Clean the starter motor and bendix drive with an approved cleaning solvent. Use care not to allow solvent inside motor, then dry thoroughly.

(3) Inspect all parts visually for signs of wear or damage. Replace a defective starter motor.

(4) Lubricate as directed in LO 5-3810-206-12.

(5) Install starter motor (para 3-81).

Section III. PREVENTIVE MAINTENANCE CHECKS AND SERVICES

3-5. General

To insure that the crane-shovel is ready at all times, it must be inspected systematically so that defects may be discovered and corrected before they result in serious damage or failure. The necessary preventive maintenance checks and services to be performed are listed and described in paragraph 3-6. The item numbers indicate the sequence of minimum inspection requirements. Defects discovered during operation of the unit will be noted for future correction, to be made as soon as operation has ceased. Stop operation immediately if a deficiency is noted during operation which would damage the equipment if operation were continued. All deficiencies and shortcomings will be recorded together with the corrective action taken on DA Form 2404 (Equipment Inspection and Maintenance Worksheet) at the earliest possible opportunity.

3-6. Preventive Maintenance Checks and Services

Table 3-2 contains a listing of the minimum inspection requirements for preventive maintenance checks and services. This table indicates by an X in the appropriate column (before, during, after, weekly, monthly, or quarterly) when the inspection should be performed. A quarterly interval for the crane-shovel unit is equal to three months, or 500 hours of operation, whichever occurs first.

Table 3-2. Preventative Maintenance Checks and Services

Item Number	Interval						B-Before operation D-During operation A-After operation W-Weekly M-Monthly Q-Quarterly		
	Operator				Org.				
	Daily				M	Q	Items to be inspected	Procedure	Reference
	B	D	A	W					
1	X		X				Engine Fuel	Check fuel level. Add fuel when necessary.	(para 2-1*c*)
						X	Tank	Check for leaks in tank or fittings. Replace a defective fuel tank.	(para 3-67)
2				X			Batteries	Check level of electrolyte. Proper level is 3/8 inch above plates. Add water when necessary. (In freezing weather run engine at least an hour after adding water). Assure that ground and battery cables are tight, and that no corrosion is forming on cables or posts. Assure that specific gravity of electrolyte is 1.250 or more.	(para 3-16)
								Charge weak battery. Replace defective battery.	(para 3-75)
3	X						Track and Hook Rollers	Visually inspect for loose hardware, excessive wear, or improper adjustment Adjust track; proper adjustment is 1 ½ inch minimum sag. Adjust hook rollers.	(para 3-37)
						X		Replace defective hook rollers. Replace track	(para 3-35) (para 3-118 and (para 3-134) 3-119)
4		X					Crown Chain Tightener, and reverse System	Check operation and adjustment. Adjust if necessary. Report defective chain to organizational maintenance. Report defective gears to direct support maintenance.	(para 3-31)
						X		Replace defective crowd chain.	(para 4-3)
5	X	X					Lighting	Check all lighting. Clean all lenses, replace all defective lamps.	(para 3-15)
						X		Replace defective panel, floodlights, or dome lights.	(para 3-173 through 3-175)
6	X		X				Engine Oil	Check engine oil level. Add oil when necessary (See Lubrication Order LO 5-3810-206-12).	
						X		Check external oil lines and fittings Tight loose fittings. Replace defective fitting or hose.	(para 3-61)
7				X			Engine Fuel Filters	Drain sediment. Clean or replace filter element.	(para 3-13) (para 3-13)
						X		Inspect fuel lines for leaks or defective fittings. Replace defective fitting or hose	(para 3-70 or para 3-71)
8	X						Radiator	Check coolant level. Add coolant when necessary. (Proper level in 2 inches below filler cap). Drain, flush, neutralize, and refill when necessary.	(para 3-19)
						X		Check for proper anti-freeze solution, clean radiator grill and core of all entrapped material. Correct all coolant leaks in hose or fittings.	(para 3-100)

								Report a defective radiator to direct support maintenance.	
9		X					Engine Clutch	Check for adjustment. Adjust if necessary.	(para 3-9)
						X		Check lever and linkage for defects. Replace defective parts.	(para 3-103)
10				X			V Belts	Check adjustment of fan, generator, or alternator drive belts, Correct adjustment will allow belt to depress "A to % inch midway between pulleys.	(para 3-20 through 3-22)
						X		Replace defective belts.	(para's 3-99, 3-79 and 380)
11	X						Fire Extinguisher	Check that extinguisher is in proper location and that seal is unbroken.	(para 2-24)
						X		Inspect for full charge, loose mounting, or broken seal.	(para 2-24)
12	X	X					Instruments	Check that no glass is broken and after starting engine check that all are operating correctly. Normal readings are as follows:	(para 2-8)
								TACHOMETER: with engine 687C-18-ES 1,700 rpm with engine D333TA 2,000 rpm	(para 3-142).
								OIL PRESSURE-15 to 35 psi	(para 3-145)
								WATER TEMPERATURE-160^{o} to 180^{o}F----	(para 3-149)
								AMMETER-at 0, or in charge area	(para 3-144 or
						X		Replace defective instruments	(para 3-142, 3-144, 3-150 and 3-149)
13	X						Hydraulic System	Check fluid level in reservoir. Service hydraulic reservoir. Visually inspect lines and cylinders for leaks. Report defects to organizational maintenance.	(para 3-18)
						X		Replace defective lines, fittings, or cylinders.	(para 3-113 through 3-119)
14		X					Control Pedals and Levers	Check for proper operation and adjustment. Report defects to organizational maintenance.	(para 2-8)
						X		Adjust, repair, or replace control levers, pedals, or linkage.	(para's 3-115 through 3-119)
15				X		X	Hoist Cables	Inspect for excessive wear or fraying of strands. Replace defective cables.	(para 3-39)
16	X						Main Hoist and Boom Hoist	Visually inspect for frayed cables, excessive wear, or kinks. Replace defective cables. Inspect brake and clutch bands on hoist drums. Adjust as necessary. Report defective clutch or brakes to organizational maintenance.	(para 3-39) (para 3-26 through 3-28)
						X		Replace defective clutch or brake linings	(para's 3-124, 3-125 and 3-131)
17		X					Jackshaft	Check swing clutches for excessive wear and adjustment. Adjust as necessary.	(para 3-25)
						X		Replace defective clutch shoes as required.	(para 3-212)

Table 3-2. Preventative Maintenance Checks and Services

Item Number	Interval						B-Before operation D-During operation / A-After operation W-Weekly / M-Monthly Q-Quarterly		
	Operator				Org.				
	Daily				M	Q	Items to be inspected	Procedure	Reference
	B	D	A	W					
18						X	Engine Valve Mechanism	Every 1,000 hours check valve adjustment. Correct setting for model 687C-18-ES is 0.012 inch (Hot) 0.014 inch (Cold). Model D333TA is: Intake 0.015” HOT 0.017” COLD Exhaust 0.025” HOT 0.028” COLD	(para 3-56) (fig. 3-34) (fig. 3-35)

Section IV. OPERATOR'S MAINTENANCE

3-7. General

This section contains information necessary for operator/crew maintenance of the crane-shovel, as authorized by the maintenance allocation chart.

3-8. Engine Inspection and Service

a. Inspection. Visually inspect engine compartment for cleanliness. Investigate all accumulations of oil, dirt, or dust, to assure that no lubricant or coolant leakage exists. Assure that all external lines, fittings, or accessories are securely mounted and that no hardware or accessory is missing. Report all defects to organizational maintenance.

b. Service.

(1) Refer to current lubrication order LO 5-3810-206-12 for interval and type of lubricant to service engine crankcase.

(2) Refer to paragraph 3-4 for service instructions on oil filters, air cleaner, or oil strainer.

3-9. Engine Clutch Adjustment

a. General. The engine clutch, when engaged, transfers power from engine to power take-off output shaft which actuates the operating mechanisms. A drive chain connects engine drive sprocket. Clutch control is through adjustable linkage from lever at operator's station to power takeoff. The clutch is in need of adjustment when it will not pull the load; it gets hot, or clutch control lever jumps out of the engaged position.

b. Adjusting the Engine Clutch.

(1) Refer to figure 3-7, remove two capscrews, lockwashers, and cover plate from housing.

(2) Disengage the clutch (para 2-8) and turn pressure plate until lock (fig. 3-8) is up.

(3) Remove screw, lockwasher, and lock spring from the adjusting ring.

(4) Unlock the adjusting ring by turning lockpin 14 turn counterclockwise.

(5) Turn the adjusting ring clockwise to tighten clutch, counterclockwise to loosen.

(6) Test clutch by engaging clutch control lever. When the clutch is properly adjusted, a distinct pressure is required to engage clutch control lever.

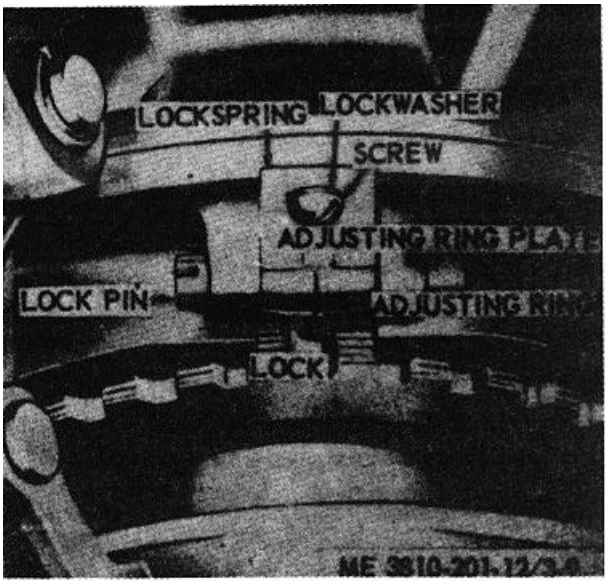

Figure 3-8. Engine clutch adjustment.

(7) When adjustment is correct, lock adjusting ring by turning pin 1/4 turn clockwise.

(8) Position lock spring in the adjusting ring and secure with lockwasher and screw.

(9) Position cover plate (fig. 3-7) on housing and secure with two lockwashers and capscrews.

3-10. Engine Oil Filter Service

Refer to paragraph 384f and service engine oil filters.

3-11. Engine Air Cleaner Service

a. Oil Bath Type. Refer to paragraph 3-4c and service oil bath type engine air cleaners.

b. Dry Type. The rear mounted dry type engine air cleaner, used on engines model D333TA, contains a replaceable filter element which can be removed for cleaning by compressed air, or by washing. Service as follows:

(1) Loosen two wing nuts (fig. 3-9) and remove cover from air cleaner.

(2) Remove filter element and packing from body.

(3) Loosen screw and remove inlet screen from body.

(4) Clean all removed parts in an approved cleaning solvent and dry thoroughly, then use a damp cloth to wipe accumulation of dust from body.

RESCREEN & SQUARE HALFTOMES

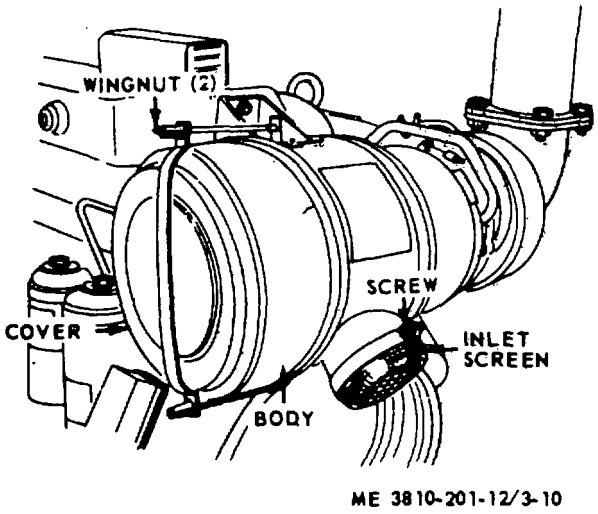

Figure 3-9. Air cleaner service for engine model D333TA.

Caution:

When compressed air is used to clean, or dry filter element, do not blow dust from body while it is installed on turbocharger. Accumulations of dust might be blown into turbocharger and cause damage.

(5) Insert packing into body, then place filter element in position with open end toward turbocharger.

(6) Install cover and secure by tightening two wing nuts.

(7) Position screen over intake and secure by tightening screw.

3-12. Engine Oil Strainer Service (Model 687C-18-ES Only)

Refer to paragraph 3-4*g* and service engine oil strainer.

3-13. Fuel Filter Service

a. General.. The fuel filters strain all fuel prior to its entering the injectors, removing water and foreign matter that would clog the injectors. Engine model 687C-18-ES has both primary and secondary filters. Engine model D333TA has only one filter.

b. Primary Fuel Filter Service (Model 687C-18-ES Only)

(1) Remove nut and gasket (fig. 3-10) which secures bowl to filter head and remove bowl and washer.

(2) Remove nut that secures filter element to stud in filter head, then remove filter element.

(3) Clean all parts in an approved cleaning solvent and dry thoroughly with compressed air or lint free cloth. Be sure that screen of filter element is free of all sludge or foreign matter.

(4) Visually inspect all parts for cracks, holes, or excessive wear. Repair by replacing defective parts.

(5) Install filter element on stud and secure with nut.

(6) Place washer on bowl, position bowl

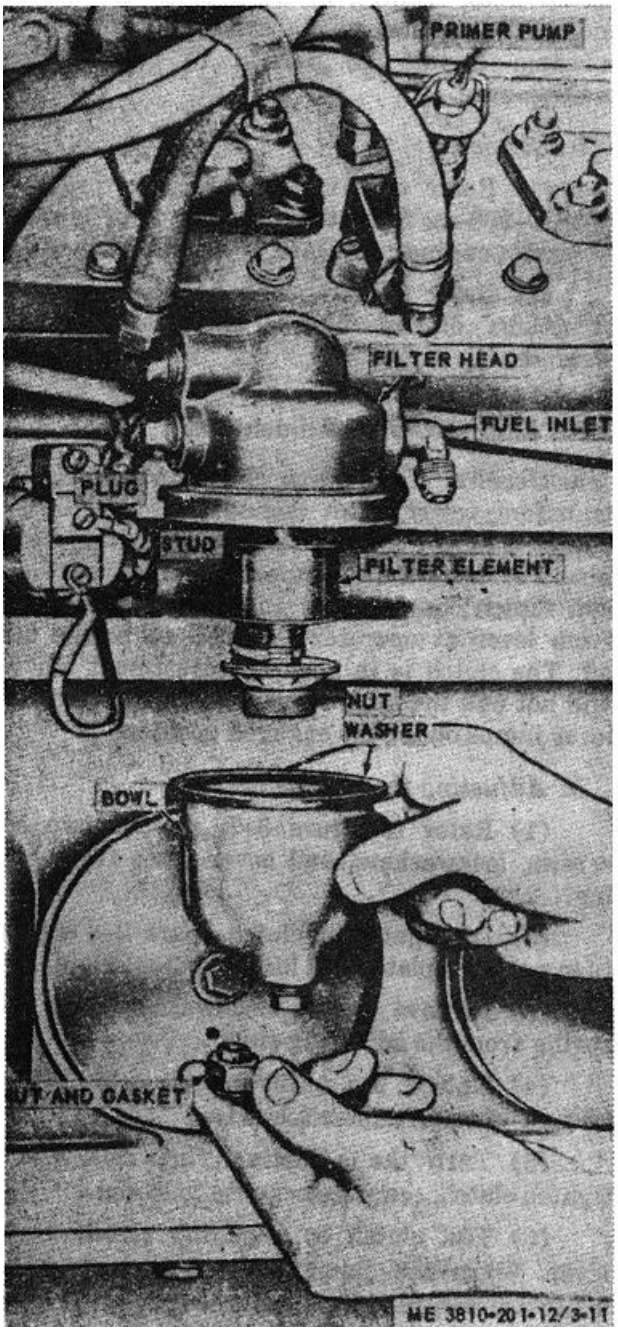

Figure 3-10. Primary fuel filter service (model 687C-18-ES).

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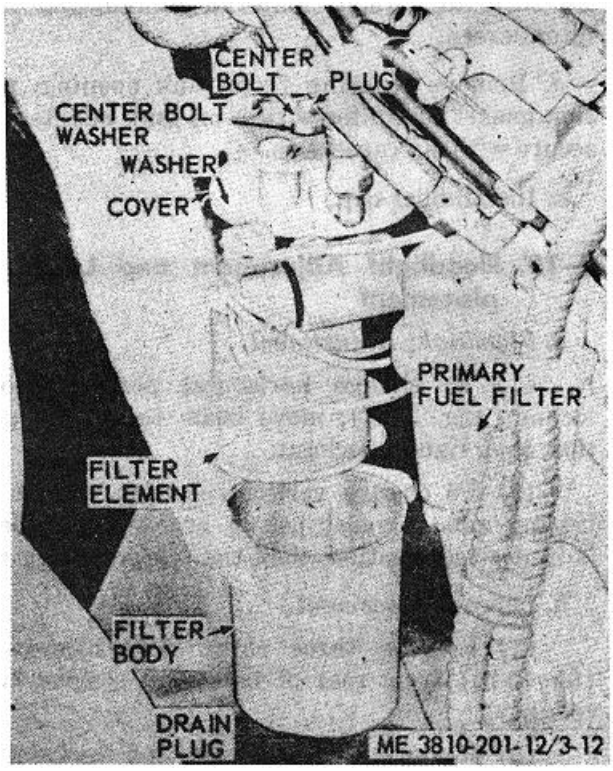


Figure 3-11. Secondary fuel filter service (model 687C-18-ES).

over filter element, and secure with gasket and nut.

(7) After fuel line is connected to inlet port prime filter with primer pump (para 3-71).

c. Secondary Fuel Pump Service (Model 687C-18-ES)

(1) Remove drain plug (fig. 3-11) and drain filter.

(2) Remove plug from center bolt; remove center bolt and center bolt washer, then remove filter body from cover.

(3) Remove disposable filter element and washer and discard.

(4) Clean all parts with an approved cleaning solvent and dry thoroughly. Be sure that all sludge and foreign matter has been removed from filter body.

(5) Install new filter element in body; install washer on cover, then install filter body in cover and secure with center bolt washer and center bolt.

Caution:
Be sure that washer between cover and body is serviceable and properly installed, or an air leak will occur that will starve fuel injection pump.

(6) Install plug in center bolt then install drain plug.

(7) Prime fuel system (para 871).

d. Fuel Filter Service (Model DSS3TA).

(1) Close valve in fuel line from tank; remove drain plug (fig. 3-12); open ventvalve, and drain fuel filter.

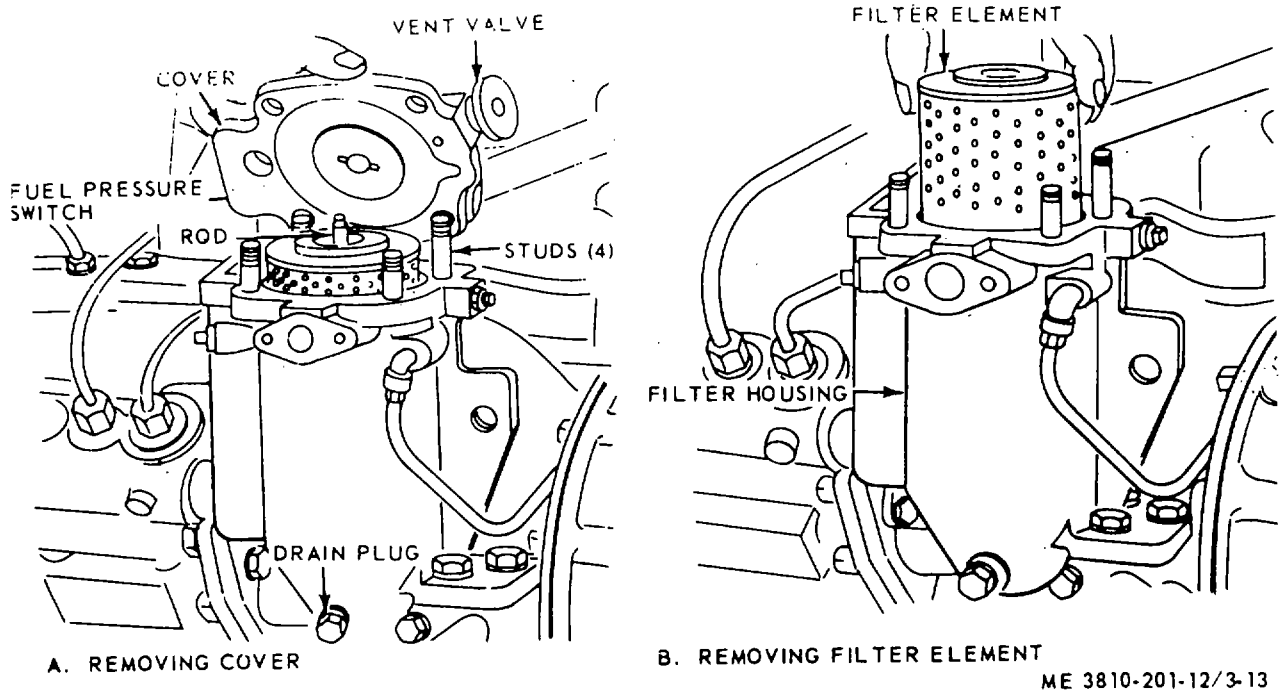


Figure 3-12. Fuel filter service an engine model D333TA.

(2) Clean thoroughly around filter cover and gasket to prevent dirt from dropping into filter when cover is removed.

(3) Remove four nuts, lockwashers, and flatwashers, then remove filter cover from housing.

(4) Remove filter element and gasket, and discard.

(5) Remove rod and spring from housing, then clean housing thoroughly by using a lint free cloth dampened in an approved cleaning solvent. Wipe dry with a clean cloth. Be sure all gummy sludge has been removed.

(6) Install rod, place spring over rod and seat it around boss in bottom of housing, then install a new filter element.

(7) Install new gasket on housing, position cover on studs, and secure with four flatwashers, lockwashers, and nuts.

(8) Install drain plug, prime fuel system (para 3-71), then close vent valve in cover.

3-14. Fuel Tank Filler Cap and Filter Service

a. Remove filler cap (fig. 3-13).

b. Remove six screws and lockwashers then remove filter and gasket from fuel tank. Cover fuel tank opening to prevent dirt entry. Open draincock in bottom of fuel tank, drain sediment, then tighten draincock.

c. Clean filter screen in an approved cleaning solvent and dry thoroughly with compressed air. Be sure all foreign material is removed from filter screen.

d. Remove covering from tank opening, position gasket and filter screen on tank adapter and secure with six capscrews.

e. *Install filler cap.*

3-15. Floodlight Adjustment and Lamp Replacement

a. *Floodlight Adjustment.*

(1) To change horizontal position loosen locknut (fig. 3-14), move beam to desired position, then tighten locknut.

(2) To change vertical position, loosen adjusting nut, move adjusting bracket until beam is in desired position, then tighten adjusting nut.

b. *Lamp Replacement.*

(1) Remove three screw and lockwasher (fig. 3-14) from rear of body and remove lamp retainer.

(2) Remove three screw and lockwasher from plate on rear of retainer, remove plate, then, remove lamp and packing from lamp retainer. Discard unserviceable lamp.

(3) Install packing in retainer, install new lamp; position plate on retainer, then secure with three lockwasher and screws.

(4) Position lamp retainer on floodlight body, so that lamp prongs engage socket in body, then secure retainer to body with three lockwasher and screws.

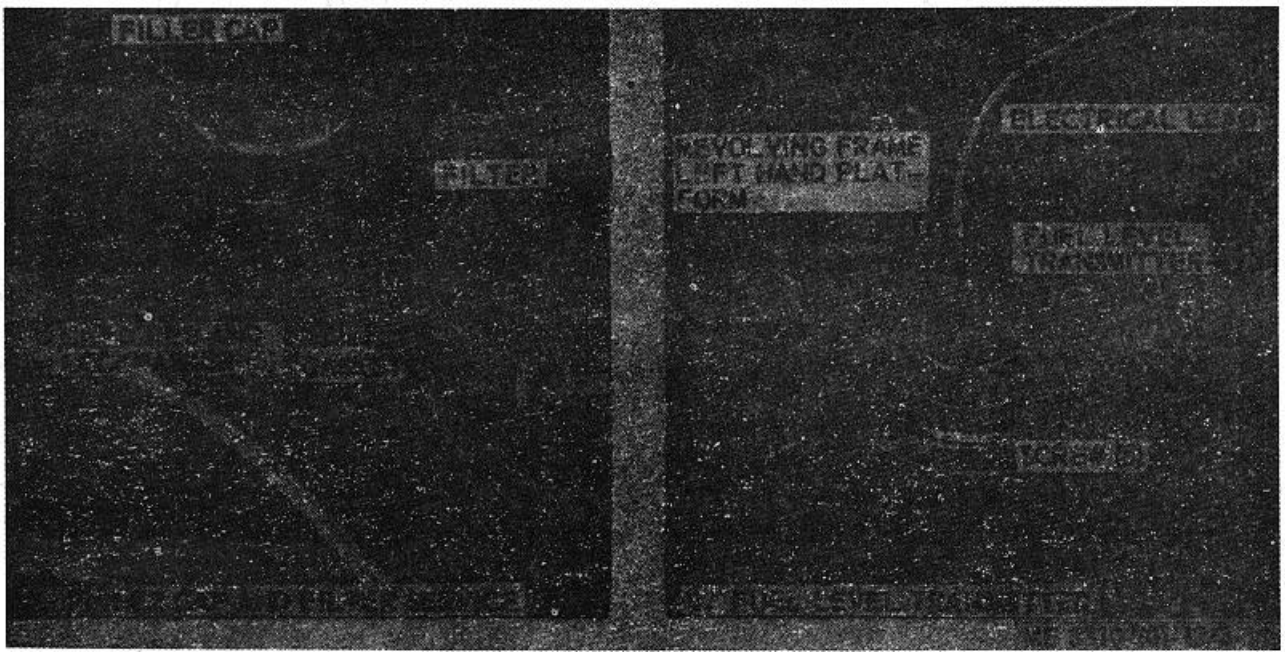


Figure 3-13. Filler cap and filter service.

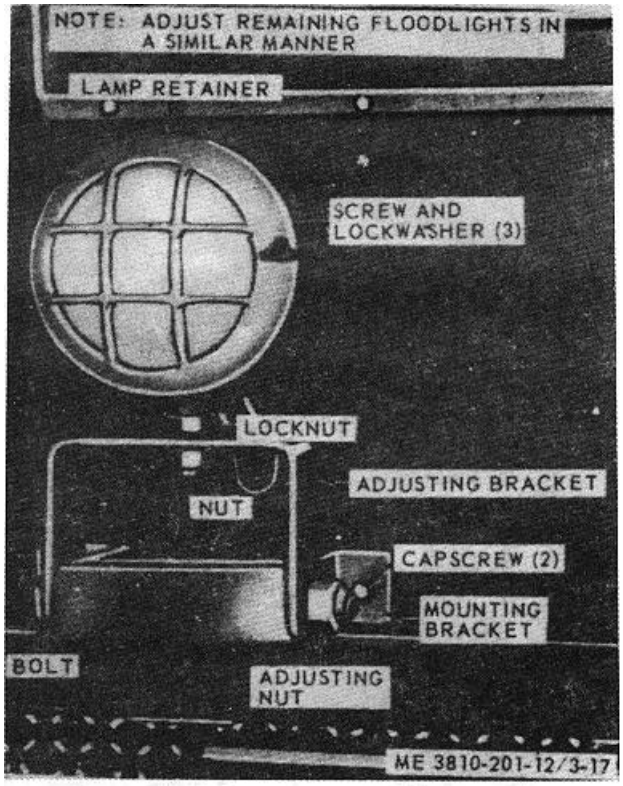


Figure 3-14. Floodlight adjustment and lamp replacement.

3-16. Battery Service

a. General. Batteries should be fully charged at all times, and acid level must be maintained at 3/8 inch above plates. Service batteries as directed in b. below.

b. Battery Service.

(1) Remove three wing nuts (fig. 3-15), remove cover then place wing nuts back on screws for safe keeping.

(2) Remove 12 filler caps; check level of electrolyte, add electrolyte or distilled water, if necessary, to bring level to 3/8 inch above plates.

(3) Clean vent holes in caps, then install all caps on batteries.

(4) Check that battery cable and ground cable connections are tight on terminals and free of corrosion.

Note.
A thin coating of grease on terminals will prevent corrosion.

(5) Clean tops of batteries to remove all spilled electrolyte or dirt.

(6) Visually inspect cables for serviceability. Replace a defective cable.

(7) Remove wingnuts from cover holddown screws, install cover on battery box, then secure with three wingnuts.

3-17. Cold Weather Starting Aids

Operator service to cold weather starting aid is limited to replenishment of cylinder at pressure primer discharger. Refer to paragraph 2-25 for operation.

3-18. Hydraulic Reservoir (Tank) Service

a. General. Operator service to hydraulic reservoir (tank) is to drain, refill, and to maintain constant level.

b. Oil Level Check. Remove two dipsticks (1, fig. 3-1) and check level. Add oil, if necessary, by

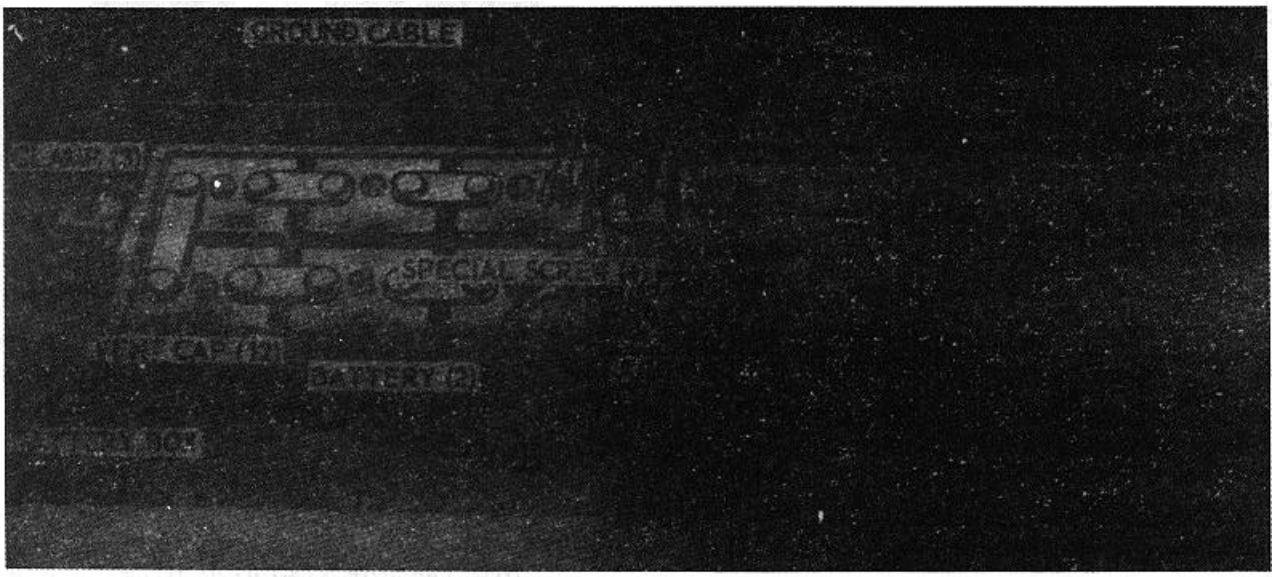


Figure 3-15. Battery service.

removing two fill plugs (2). Replace plugs after oil has been replenished.

c. Draining.

(1) Close drain plugs (3, fig. 3-1).

(2) Remove the two oil lines from adapter.

(3) Place container under drain plugs; remove fill plugs; cover opening in tank to prevent dirt entering, then open drain plugs.

(4) When oil is drained, close drain plugs, then install oil lines on adapters.

(5) Remove covering placed over fill holes, fill tank with required quantity of proper oil (LO 5-3810-206-12).

(6) Open drain plugs and allow oil to enter lines to hydraulic cylinders; add more oil in tank, if necessary; then install fill plugs.

3-19. Radiator Service

a. Maintaining Water Level. Remove radiator cap, add water until it stands two inches below filler neck, then install radiator cap.

b. Draining, Cleaning, Flushing, Neutralizing, and Filling. Refer to TB ORD 651 (Use of Antifreeze Solutions and Cleaning Compounds in Engine Cooling Systems) for instructions on cleaning, flushing, and neutralizing radiator. Drain and refill as described below.

(1) Remove radiator cap, then open draincocks on radiator and engine block.

(2) When engine and radiator is fully drained, close all draincocks.

(3) Fill system with clean water until it stands two inches below the filler neck. Install radiator cap.

3-20. Fan Drive Belt Adjustment

a. On Engine Model 687C-18-ES.

(1) Loosen four capscrews (view A, fig. 3-16) and locknut.

(2) Increase belt tension by turning setscrew clockwise. Loosen belt by turning setscrew counterclockwise.

Note.

Proper adjustment will allow belt to depress from 3/4 to one inch at a point midway between pulleys, while using a moderate pressure.

(3) When proper adjustment is attained, tighten the four capscrews and locknut.

b. On Engine Model DSSSTA.

(1) Loosen the two bracket retaining bolts which hold idler hub bracket to timing hear cover (view B, fig. 3-16).

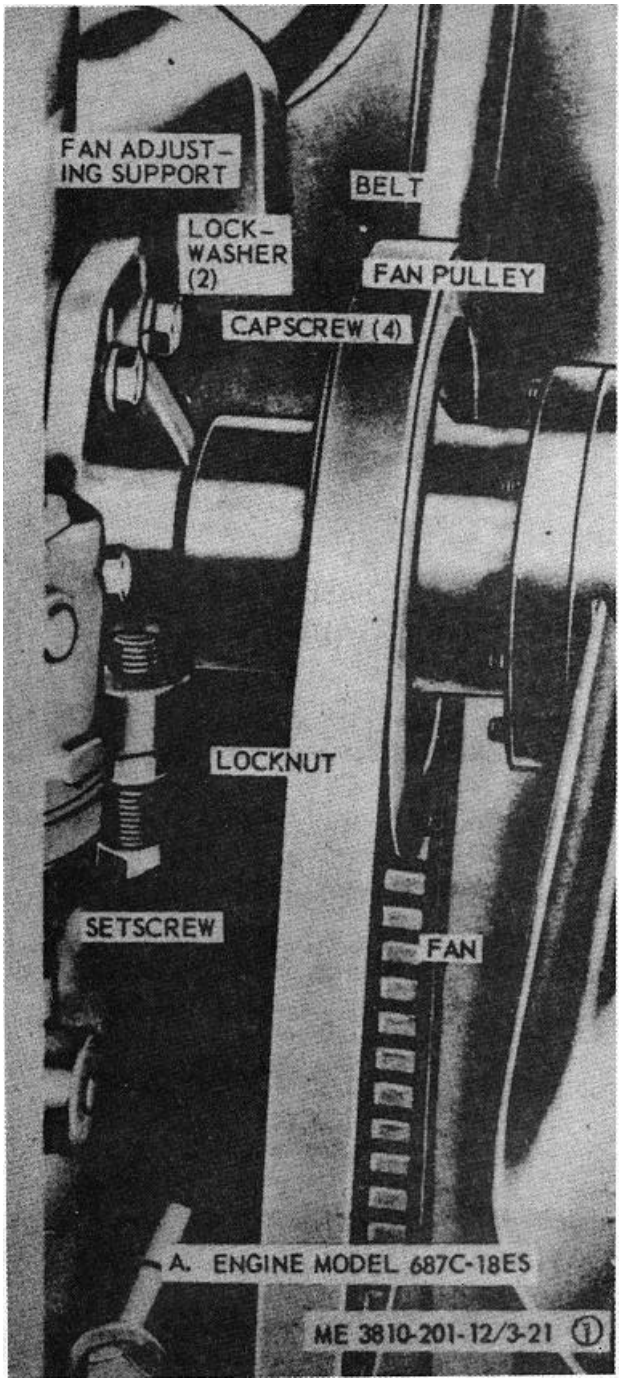


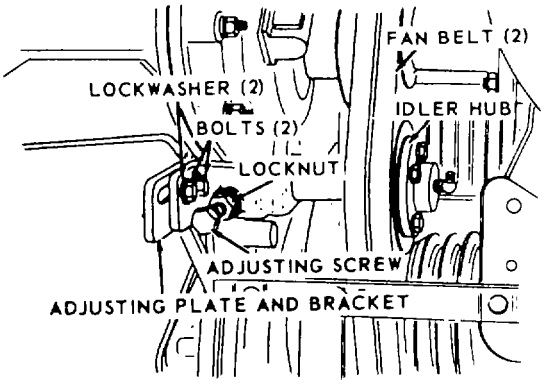
Figure 3-16. Fan drive belt adjustment (sheet 1 of 2).

(2) Loosen locknut on adjusting screw and turn adjusting screw clockwise until the two belts can be depressed approximately 1/2 inch midway between pulleys with a force of approximately 25 pounds.

(3) When adjustment is correct, tighten the two bracket retaining bolts and locknut. Recheck adjustment.

Note.

Fan drive belts must be replaced in matched sets. When belts can be depressed 3/4 inch midway between pulleys, adjustment is required.



B. ENGINE MODEL D333TA

ME 3810-201-12/3-21 (2)

Figure 3-16. Fan drive belt adjustment (sheet 2 of 2)

3-21. Generator Drive Belt Adjustment (Engine Model 687C-18-ES Only)

a. Loosen nut and capscrew (fig. 3-17) on adjusting strap.

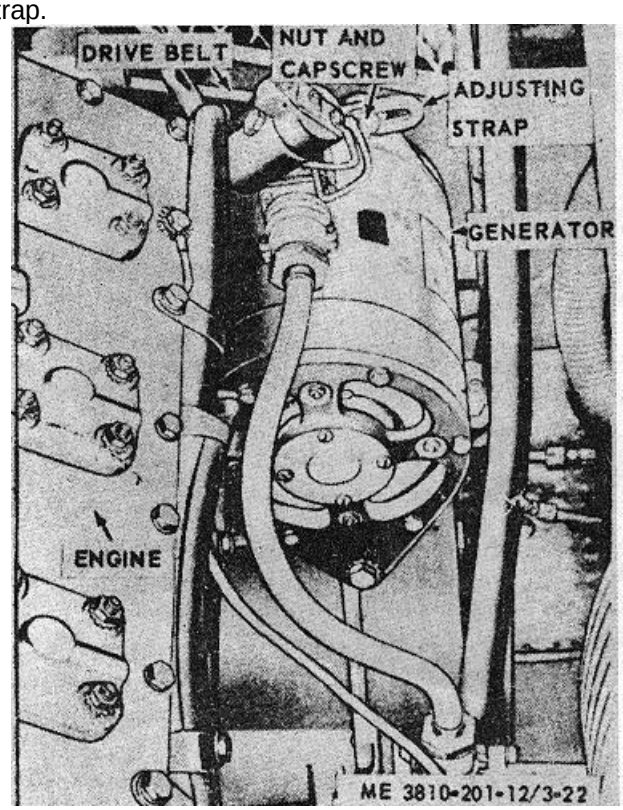


Figure 3-17. Generator drive belt adjustment.

b. Loosen two nuts at generator pivot, pull generator away from engine until belt will depress 1/2 inch at a point midway between pulleys.

c. When adjustment is correct, tighten nut and capscrew to hold generator in place. Recheck adjustment.

3-22. Alternator Drive Belt Adjustment (Engine Model D333TA Only)

a. The alternator may be driven with one or two belts. When two belts are used, they must be replaced in matched sets.

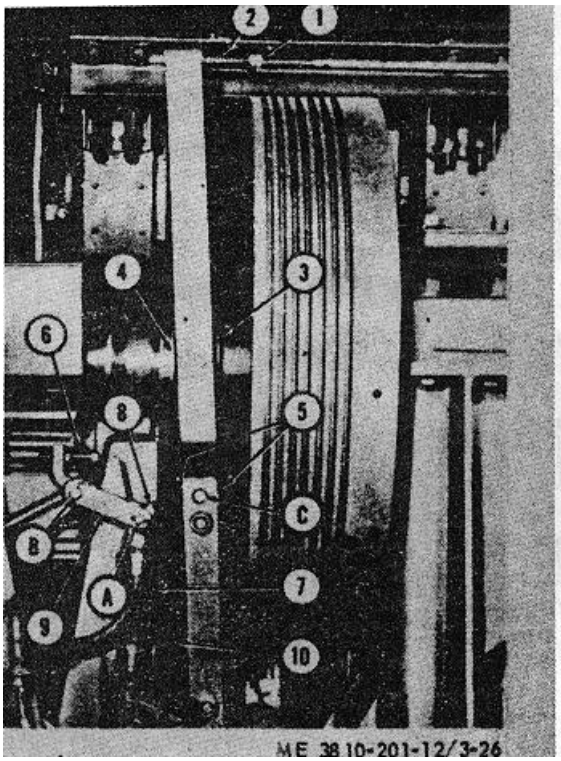
b. Adjust alternator drive belts in a manner similar to method used for generator drive belt (para 3-21).

3-23. Chain Case Fill Cap and Breather Service

Service chain case fill cap and breather as described in paragraph 3-4*h*.

3-24. Power Take-Off Breather Service

Service power take-off breather as described in paragraph 3-4*i*.



1	Locknut	6	Setscrew
2	Spring	7	Cylinder
3	Shifter Collar	8	Clevis
4	Washer	9	Link
5	Locknut	10	Spring

Figure 3-18. Swing clutch shifter mechanism.

3-25. Swing (Jackshaft) Clutch Adjustment

a. Adjustment to compensate for Lining Wear.

(1) Be sure that swing clutch lever is in neutral position, and that locknuts (fig. 3-18) hold spring (2) compressed to approximately three inches. Check on both ends of shifter rod for each swing clutch.

Note.

In released position, the shifter collar (3) must rest against the washer (4) on outer end of spider hub. Shifter collar must travel a minimum distance of 1 1/8 inches from released position to engaged position for proper clutch action. To change shifter travel, loosen one and tighten the other locknut (5) on opposite sides of the trunnion.

(2) Assure that point A is 1/4 inch below a straight line between points B and C (with clutch engaged). Be sure that setscrew (6) prevents

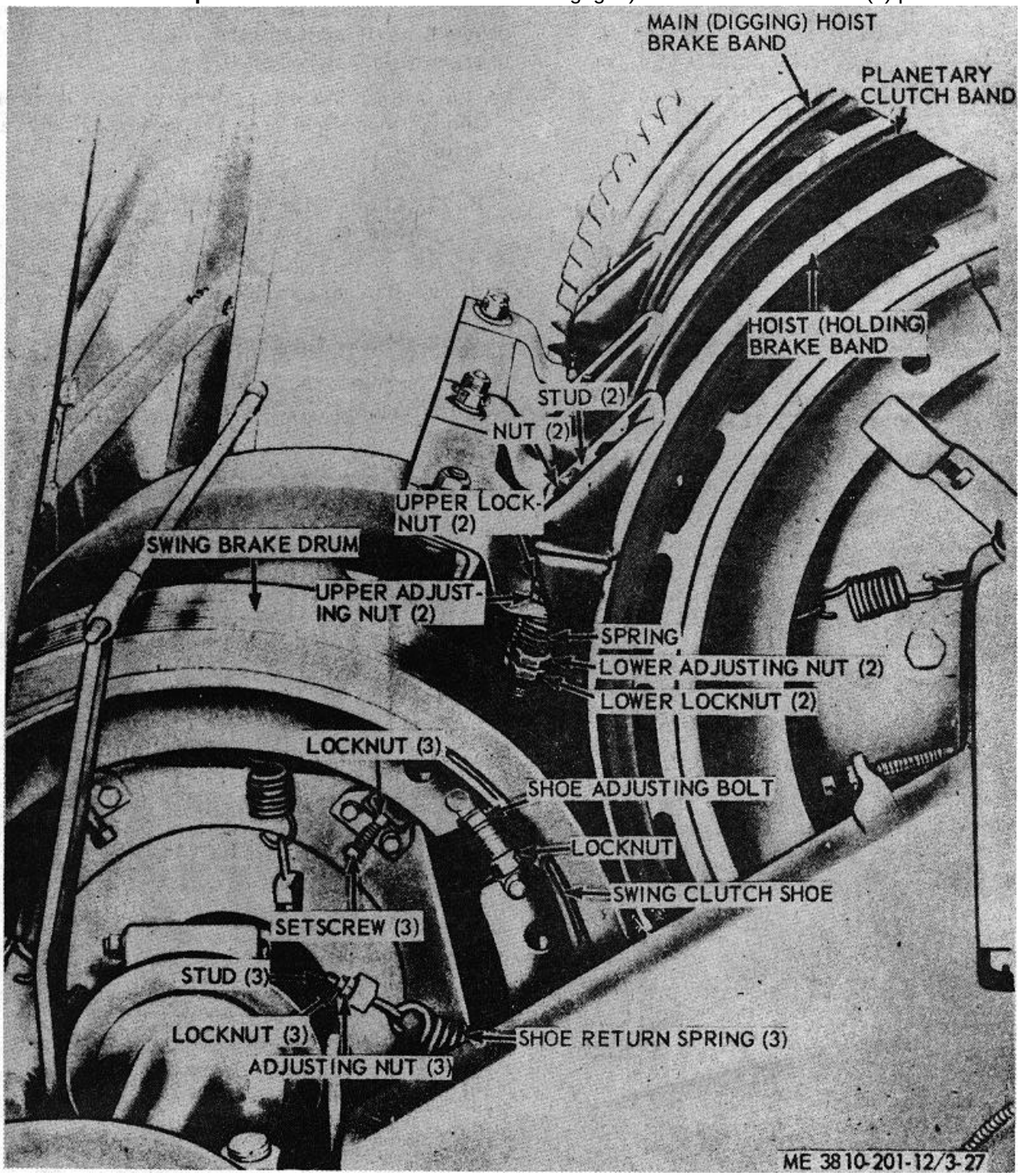


Figure 3-19. Swing clutch shoe lining wear adjustment and positioning of hoist drum clutch and brake bands.

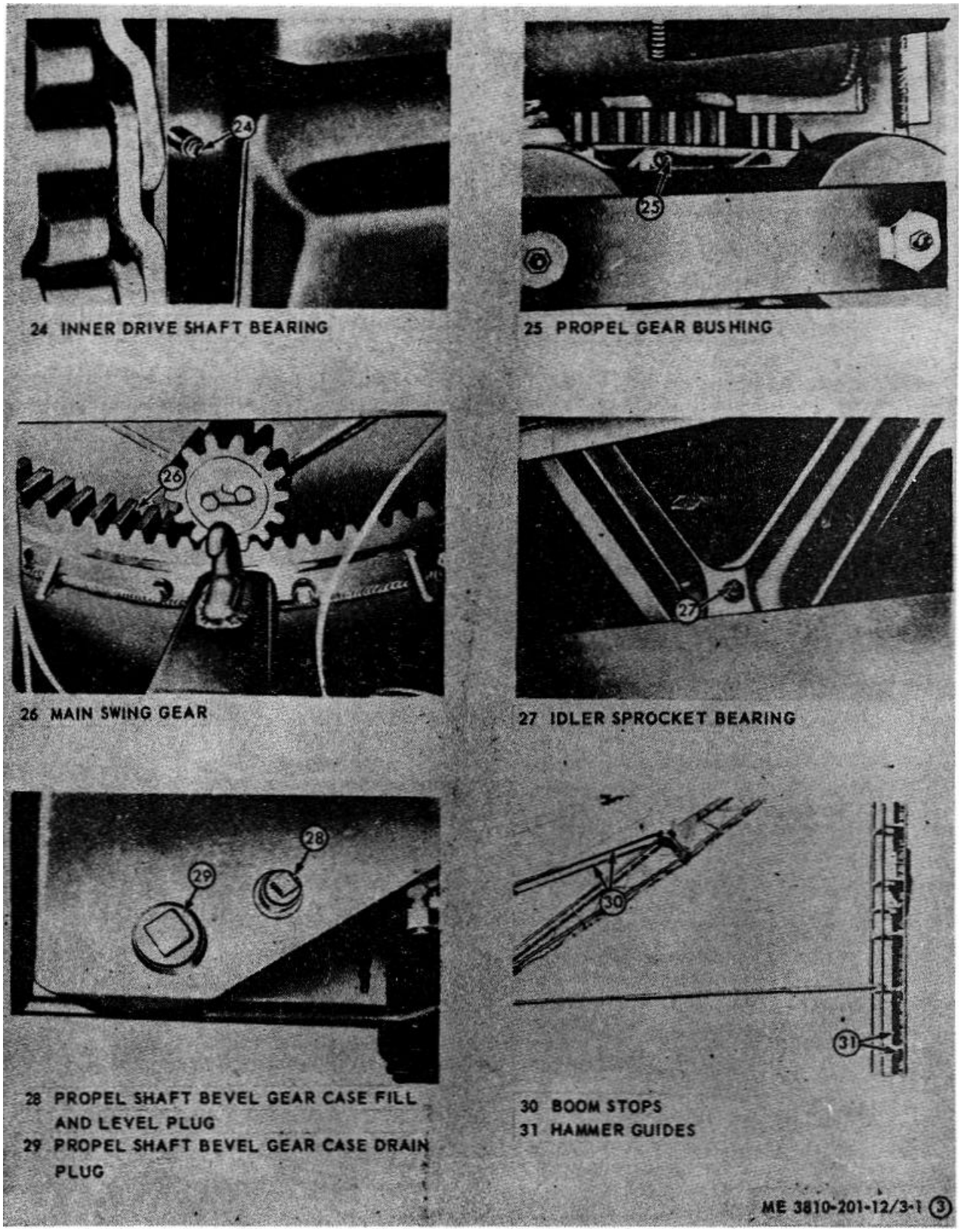


Figure 3-1. Lubricating point identification (sheet 3 of 14).

hydraulic cylinder (7) from pushing link (9) and clevis (8) into a straight line.

(3) Compensation for lining wear is accomplished by loosening locknut (fig. 3-19) and turning the adjusting bolt until the clutch lining has proper clearance from clutch drum (0.012 to 0.015 inch).

NOTE

Measure clearance with a thickness gauge blade that is long enough to reach inside edge of shoe and drum, to avoid possibility of a tilted shoe that will drag.

(4) When adjustment is correct, tighten locknut, then recheck clearance. Readjust if necessary.

b. Adjustment After Lining Replacement or Disassembly.

(1) Remove capscrew and lockplate, then rotate adjusting sleeve (same as fig. 3-10) until there is between 0.012 and 0.015 inch clearance between shoe lining and clutch drum at dead end. Be sure shoes are not tilted in drum (see note in *a* above).

(2) Continued adjustment in manner described in paragraph 3-28*c*.

3-26. Positioning Clutch and Brake Bands on Hoist Drum

a. General. Hoist drum brake and clutch bands are spring mounted to allow bands to move slightly during engagement or disengagement.

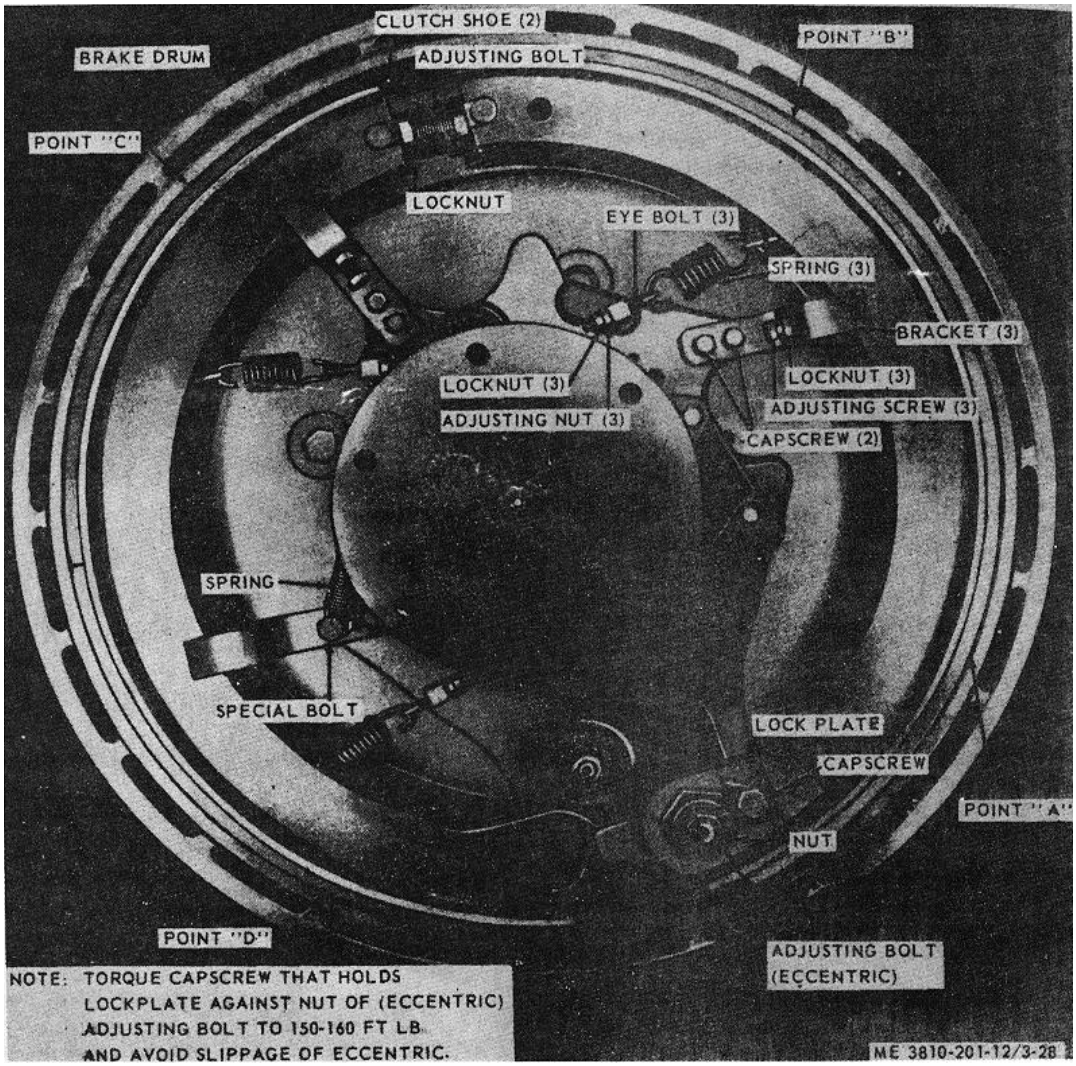


Figure 3-20. Hoist clutch shoes adjustment and removal points.

Spring tension keeps them ill the desired position. With applicable brake or clutch control lever in neutral, position band on drum as described below.

b. Installation Positioning. Install band on two studs (fig. 3-19) on mounting bracket, and secure with two lockwashers and nuts.

NOTE

See paragraph 3-123 for difference in planetary clutch band linkage arrangement between shovel and crane operation.

c. Positioning Prior to Adjustment. Position band so that it does not drag on drum by backing off the upper and lower locknuts on both studs (fig. 3-19), then tightening or loosening the lower or upper adjusting nuts until there is clearance all around the drum. After band is positioned correctly, tighten the four locknuts on the two studs.

d. Position hoist drum brake band, digging drum brake band, and planetary clutch band in similar manner, then proceed to adjust brake or clutch band (para 3-27).

3-27. Hoist Brake, Digging Brake, or Planetary Clutch Band Adjustment

a. Position planetary clutch band (para 3-26).

b. Adjust planetary clutch band (fig. 3-21) by loosening locknut and tightening adjusting bolt as far as it will go, then back-off on adjusting bolt until operation of clutch lever engages clutch with band smoothly under nominal pressure. After clutch band is properly adjusted, tighten locknut.

NOTE

A few drops of light oil on trunnions will smooth out operations at band and lever.

NOTE

See different linkage arrangement for planetary clutch band in paragraph 3-123, for shovel or crane operation.

c. Adjust digging brake and hoist brake bands in a similar manner.

CAUTION

Do not adjust bands so tight that operation of lever is hard. Tight bands cause excessive wear on linings and shorten their serviceable life.

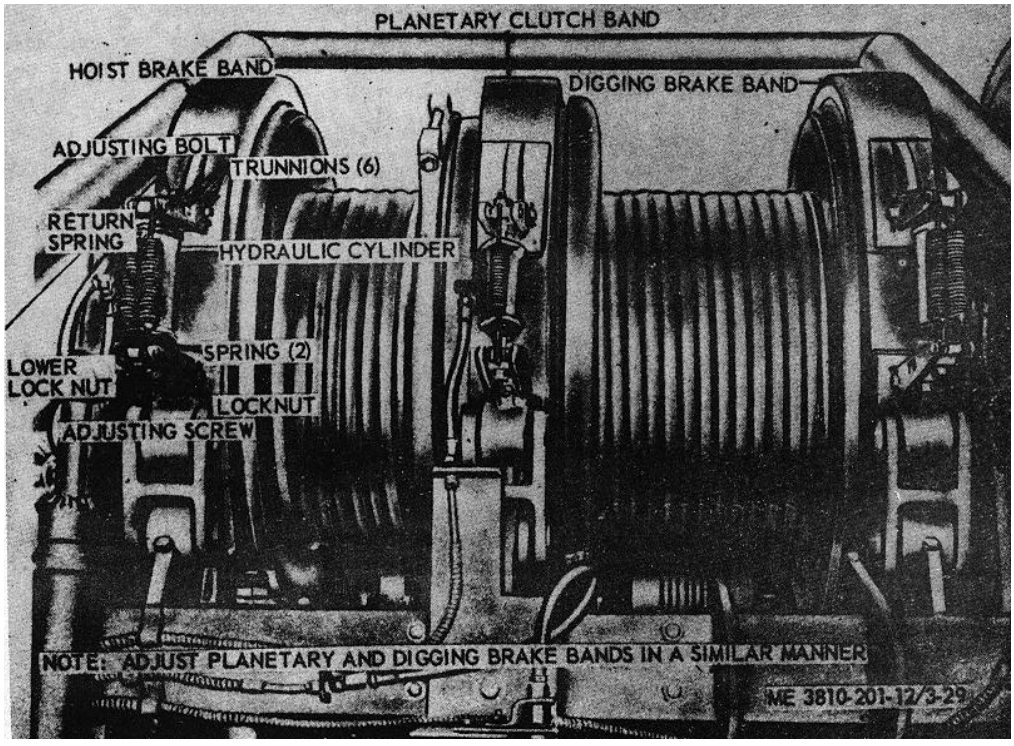


Figure 3-21. Hoist brake, digging brake, and planetary clutch band adjustment.

3-28. Hoist Clutch and Digging Clutch Adjustment

a. General.

(1) Each main clutch has an auxiliary, or booster clutch, which is the unit most frequently requiring adjustment. However, determine which one actually requires adjustment by engaging the hand lever controlling the clutch to be checked, then setting the foot brake pedal controlling the same drum.

NOTE

Setting the foot brake simulates a load on the drum. If this is not done, the clutch will not "wrap in" to the drum as it does during normal operation.

(2) Engage the engine clutch long enough for the clutch to "wrap in", then measure gap (fig. 3-22) between lug and stop on clutch spider. If there is less than ½ inch clearance between these points, the main clutch linings are worn and must be tightened. If there is more than ½ inch clearance between the above points the auxiliary clutch must be adjusted.

b. Main Hoist or Digging Clutch Lining Wear Adjustment. To compensate for lining wear on main clutch, loosen locknut on adjusting bolt (fig. 3-20) and turn adjusting bolt until clutch linings are in proper adjustment. Tighten locknut to hold the adjustment.

c. Main Clutch Shoe Adjustment.

(1) When clearance between clutch shoe lining and the clutch drumpoints A, B and C (fig. 3-20) exceeds 3/32 inch, or when new clutch

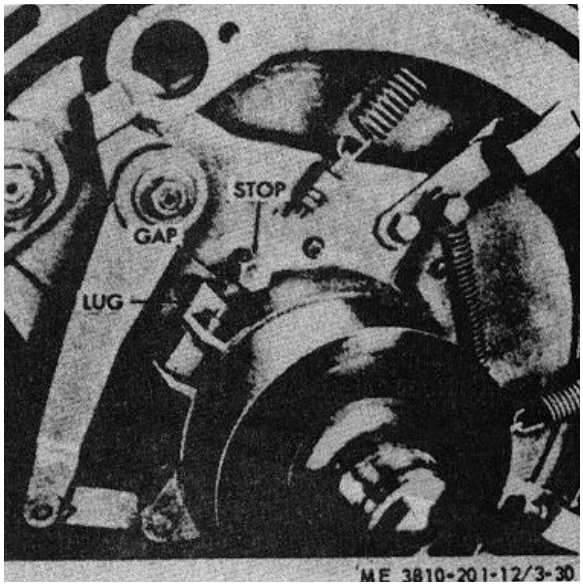


Figure 3-22. Main hoist or auxiliary clutch lining wear determination.

shoes are installed, the clutch shoes are installed, the clutch must be adjusted for proper lining clearance.

(2) To adjust clearance at point A, remove capscrew and lockplate then rotate adjusting sleeve (eccentric) until a minimum clearance of 1/32 inch is obtained at point A.

(3) Establish approximately 1/16 inch clearance at points B and C by backing off locknut (2) and turning the two adjusting screws until clearance is correct.

NOTE

Clearance at point D will always be greater than that at points A, B and C, and does not effect clutch operation.

(4) The tension of three springs (fig. 3-20) should be adjusted just tight enough to prevent clutch shoes from engaging the clutch drum when machinery is rotated at full speed. These springs should not be tighter than necessary to prevent clutch shoes from dragging.

(5) It may be necessary to bend the two brackets slightly to get a good fit of the clutch shoe within the clutch drum.

NOTE

It is good practice, before linings are worn out, to exchange the dead shoe for the live shoe. Most lining wear is concentrated on the live shoe.

CAUTION

Be sure there is enough tension on springs. Operation with clutches too loose may cause breakage of release spring.

d. Auxiliary (Booster) Clutch Adjustment.

(1) To compensate for normal clutch lining wear, loosen locknut (fig. 3-23) and turn adjusting bolt. Do not adjust nut for normal band wear adjustment.

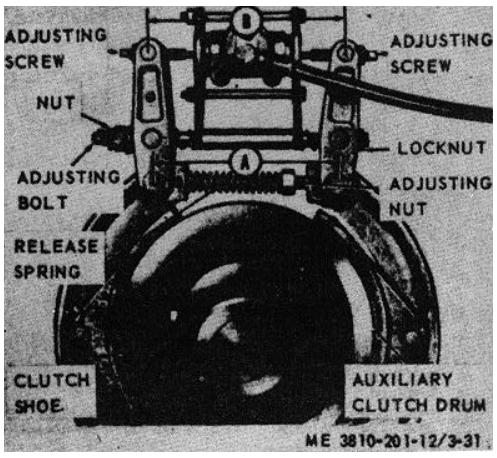


Figure 3-23. Auxiliary (booster) clutch adjustment points.

(2) If the unit has been disassembled for any reason, adjust as follows:

(*a*) Tighten nut until spring is bottomed. Backoff nut one complete turn, then install cotter pin through nut.

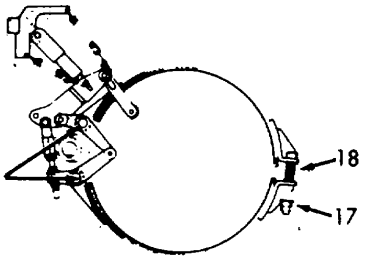
(*b*) Turn the two adjusting screws in equally until distance II is just slightly less than distance A.

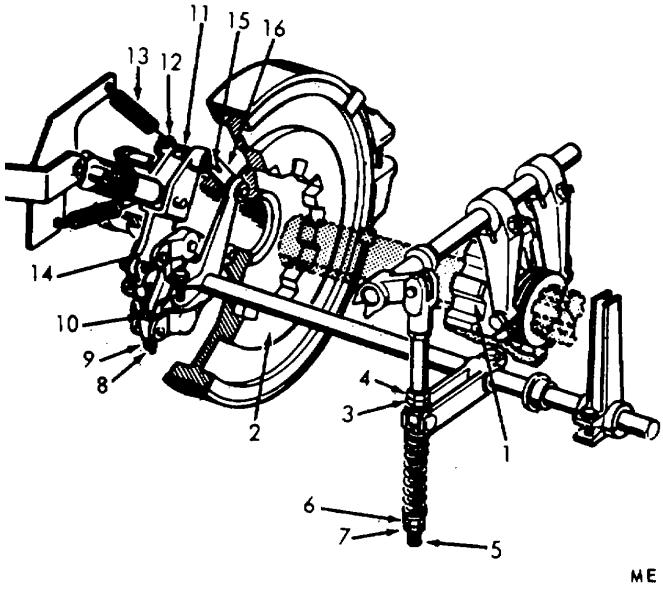
(*c*) Tighten adjusting nut until the release spring is compressed to a length of approximately 3½ inches.

3-29. Steering Linkage, Swing Brake, and Propel Brake Adjustment

a. Steering Linkage Adjustment.

(1) Raise steering engage lever (fig. 2-24) to engage steering gear.





1	Jaw clutch	10	Adjusting nut
2	Brake drum	11	Adjusting nut
3	Adjusting nut	12	Eye bolt
4	Locknut	13	Spring
5	Rod	14	Lever
6	Nut	15	Pin
7	Nut	16	Link
8	Locknut	17	Nut
9	Adjusting nut	18	Bolt

Figure 3-24. Steering linkage and propel brake adjustment.

(2) Turn steering wheel counterclockwise as far as it will go. (This disengages both jaw clutches, and sets both propel brakes in locked position).

(3) Measure distance between face of jaw clutch (1, fig. 3-24) and face of brake drum (2), which must be approximately ¾ inch. When distance is less, turn adjusting nut (3) and locknut (4) downward until distance between faces measures ¾ inch. When distance is greater, turn adjusting nut (3) and locknut (4) upward until the distance is ¾ inch between faces.

(4) Spring tension on rod (5) against lever is obtained by turning nuts (6) and (7) in an upward direction.

(5) Turn steering wheel clockwise until both jaw clutches (1) are fully engaged with recesses in brake drum (2). When clutches are fully engaged, both propel brakes will be in released position.

(6) Backoff locknut (8) and adjusting nuts (9) and (10). Turn adjusting nut (11) on eyebolt (12) until maximum tension is placed on spring (13) (the hydraulic cylinder must be completely compressed).

(7) Pull lever (14) toward hydraulic cylinder, hold it there while tightening adjusting nuts (10) and (9) up against linkage. The pin (15) in lever (14) must be snug against top of slot in link (16).

b. Propel Brake Adjustment.

(1) Turn steering wheel counterclockwise as far as it will go. Both propel brakes will be set in locked position.

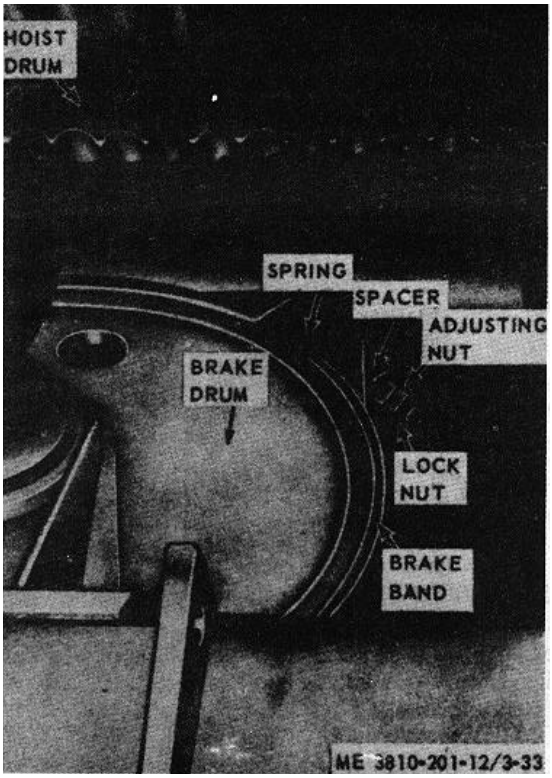


Figure 3-25. Swing brake adjustment.

(2) Tighten adjusting nut (17) on bolt (18) until propel brake bands are tight. Secure the adjustment with locknut.

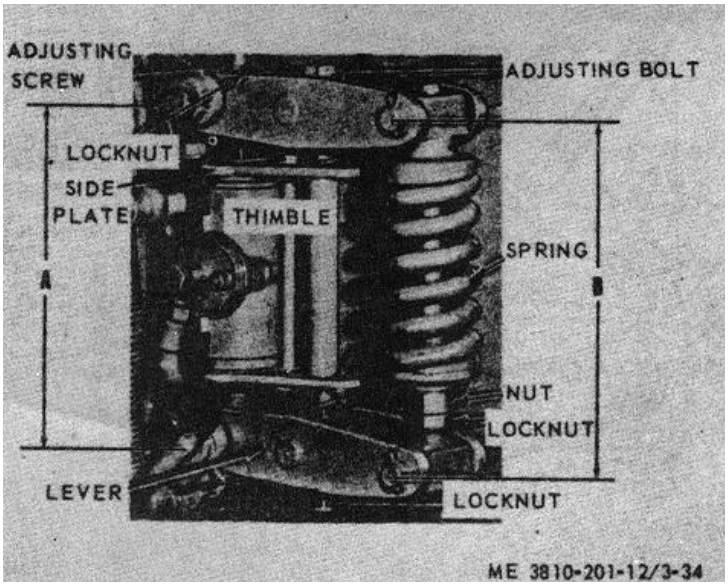


Figure 3-26. Boom hoist brake adjustment points.

c. Swing Brake Adjustment. To compensate for lining wear, back off locknut (fig. 3-25); tighten adjusting nut just enough to get the proper feel on swing brake lever (fig. 2-24), then tighten locknut (fig. 3-25).

3-30. Boom Hoist Brake Adjustment

a. Before making any adjustment on boom hoist brake, assure that pawl is engaged in hoist drum ratchet gear to prevent boom from lowering.

b. To adjust boom hoist brake, sufficient tension must be placed on spring (fig. 3-26) to hold boom in desired position. Position boom hoist lever in neutral. (With boom hoist lever in neutral brake is applied and clutch is disengaged). Turn nut clockwise until brake band is tight, then tighten locknut.

c. Always check clearance between thimble and side plate. It should be at least 1/16 inch. Adjust this clearance, when necessary, by backing off locknut then turning adjusting screw. When clearance is correct, tighten locknut.

d. With brake applied, measure distances A and B. Distance A should be from 3/8 inch to ½ inch less than distance B. Make adjustment by turning adjusting bolt then tighten locknut. Check gap between thimble and side plate after adjusting (*c* above).

NOTE

Levers should be parallel when brake is released.

NOTE

A few drops of light engine oil on all pins and trunnions, before adjustment, will allow smoother operation.

e. Engage boom hoist clutch by pulling boom hoist lever toward operator just enough to take pressure off pawl, then disengage pawl. Return boom hoist lever to neutral, slowly, to assure that brake will hold boom. Readjust if necessary. After adjustment is complete, engage boom hoist pawl, move boom hoist lever away from operator to release brake, then check levers for position described in note in *d* above.

3-31. Crowd Chain Adjustment

a. Loosen top adjusting nut (fig. 3-27) and bottom adjusting nut on the two studs.

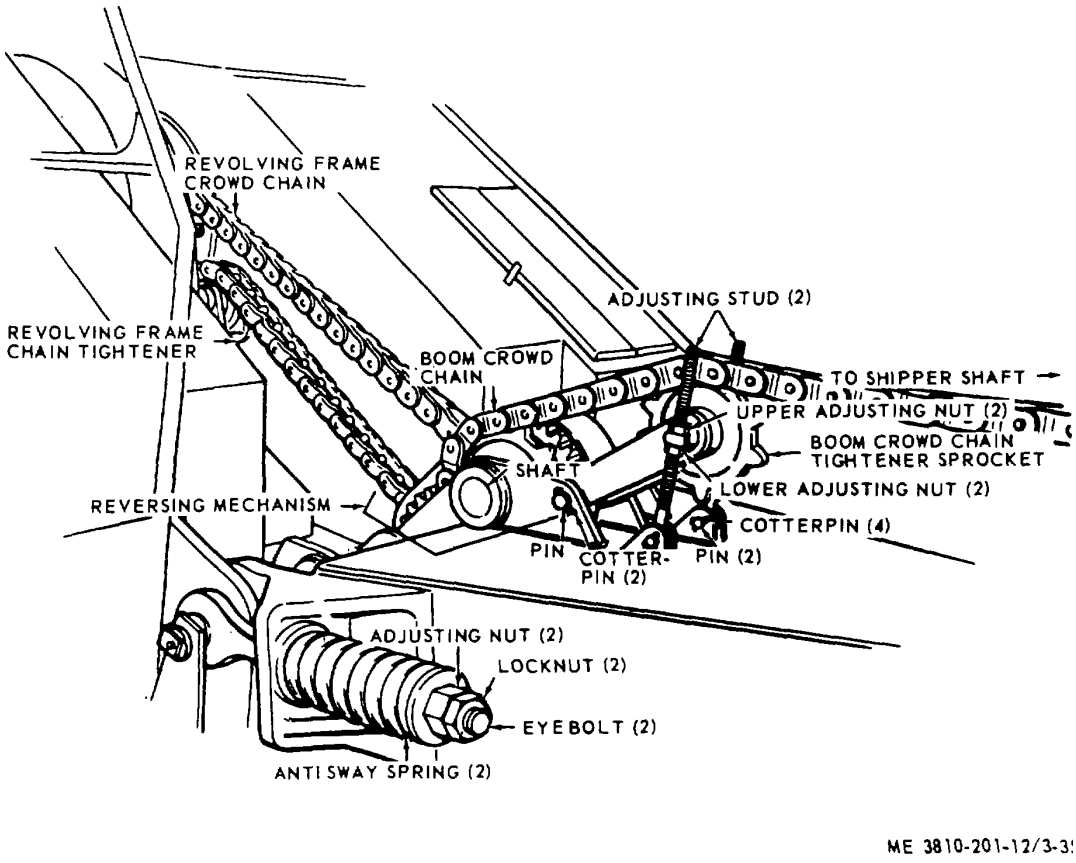


Figure 3-27. Crowd chain and anti-sway spring adjusting points.

b. Lift up on tightener sprocket to tighten, or lower to loosen boom crowd chain, then tighten adjusting nuts.

c. Proper adjustment allows from three to four inches of sag in chain between shipper shaft sprocket and chain tightener sprocket.

d. Adjust revolving frame crowd chain in a similar manner.

3-32. Anti-sway (Boom Foot) Spring Adjustment

a. Tension on anti-sway springs allows boom some freedom of movement, yet prevents excessive swaying. At installation, tighten adjusting nut (fig. 3-27) to compress spring until it is 14-5/8 inches in length.

CAUTION

Never tighten spring enough to remove clearance between coils. If spring coils are bottomed, all strain will be transferred to boom foot lugs and damage to the revolving frame will result.

b. Operator will check shovel anti-sway springs frequently. When length of spring is correct, but excessive sway occurs because of weakened springs; replace old springs with new, and adjust as directed in *a* above.

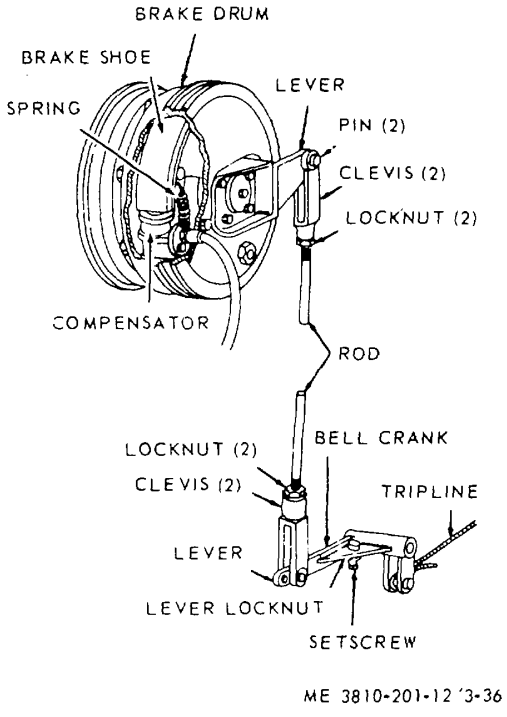


Figure 3-28. Dipper trip adjustment points.

3-33. Dipper Trip Adjustment

a. If the brake drum (fig. 3-28) does not tend to rotate when dipper trip lever (fig. 2-23) is operated, the brake shoes (fig. 3-28) are probably worn enough to require adjustment.

b. Turn the bell crank (underneath revolving frame) until the brake shoe just barely drags against brake drum; turn bell crank back until brake shoe is just clear of the drum, then loosen locknuts on rod and adjust length of rod until top and bottom levers are both from 15 to 20 degrees below a horizontal position.

c. Loosen lever locknut and adjust setscrew so that travel of rod is stopped before lever is bottomed in upper clevis and bends rod.

d. When brake shoe adjustment is correct, tighten two locknuts on rod, and locknut on setscrew, to hold the adjustment.

3-34. Trip Cable Adjustment

a. Assure that trip cable is fastened to equalizer bracket (fig. 3-29) with a cable clamp; loosen clamp at bell crank; take up all slack, then refasten cable clamp at bell crank.

b. Assure that boom trip cable is reeved correctly; from take-up drum mounted on shipper shaft; through equalizer sheave on equalizer bracket, then over idler sheave to dipper trip lever mounted on dipper sticks near dipper.

c. If there is any slack in boom trip cable; loosen cable clamp at dipper trip lever; take up slack until dipper trip lever is just downward from perpendicular to the dipper sticks, then secure cable clamp.

d. Adjust length of trip chain as required.

3-35. Hook Roller Adjustment

a. Lower boom to near the horizontal position. This will put weight on rear hook rollers while both front hook rollers are being adjusted.

b. Remove screws, lockwashers and keeper plate (fig. 3-30), then rotate eccentric shafts until both rollers are snug against bottom of roller path. A maximum of 1/16 inch clearance is allowed between hook rollers and roller path. When adjustment is correct, install keeper plate and secure with lockwashers and screws.

c. Build up cribbing equal to revolving frame height under boom, and lower boom to reset on cribbing. This will equalize weight of revolving rollers in same manner as front hook rollers above.

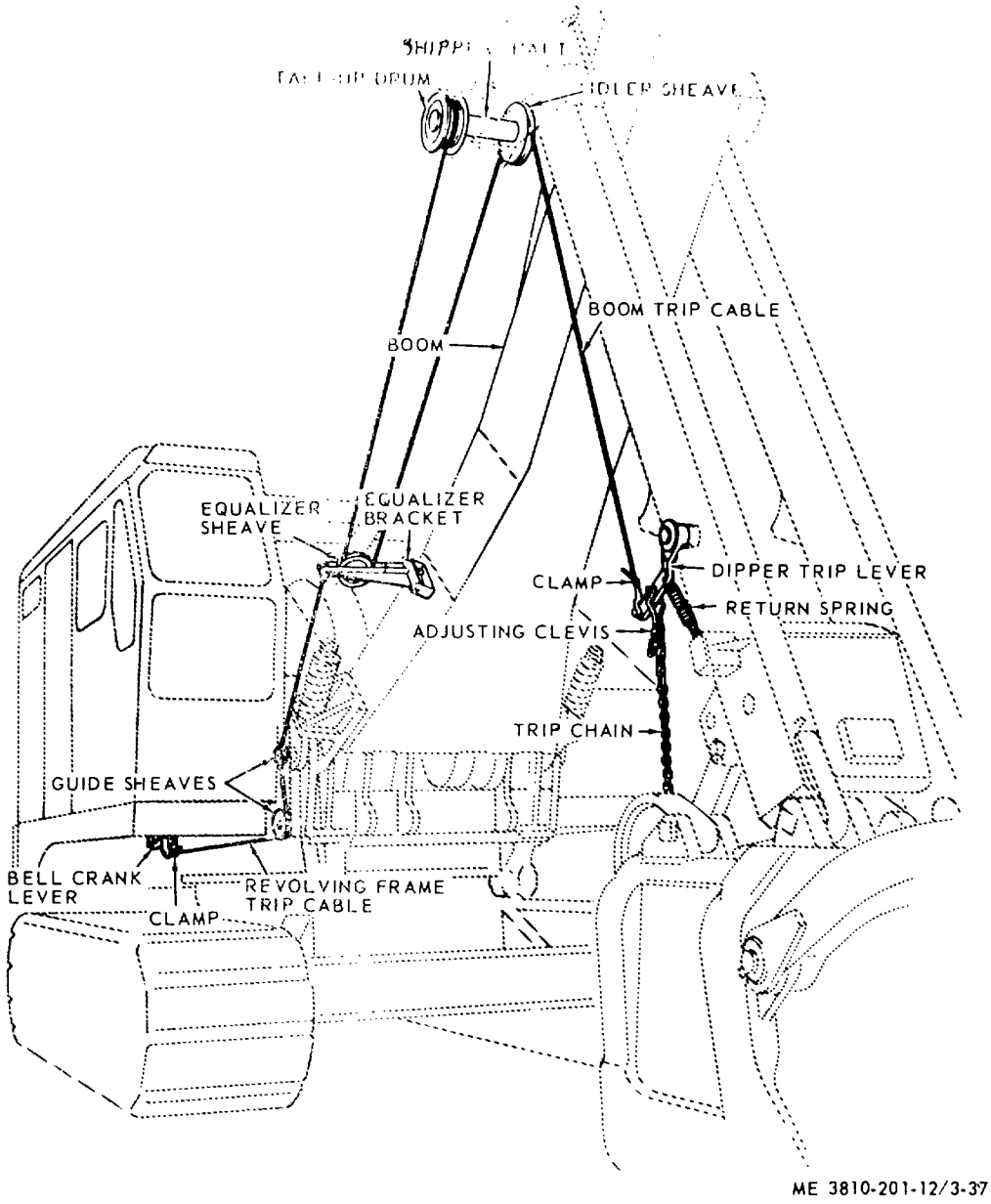


Figure 3-29. Trip cable adjustment.

NOTE

When replacing keeper plates, the lip of front hook roller keeper plate must be between flange of eccentric shaft and hook roller mounting bracket. The lip of rear hook roller keeper plate must be on outside of the eccentric shaft.

CAUTION

If boom tip had been lowered to rest on the ground because no cribbing was available, be sure and get assistance from another crane or hoisting device to lift boom tip above the horizontal before using boom hoist to position boom. Booms have been known to collapse under stress applied by boom hoist clutch when boom tip was lower than boom foot

3-36. Propel Chain Adjustment

a. General. To properly adjust the propel chain, the crane-shovel should be propelled backward for at least the length of the crawler frame.

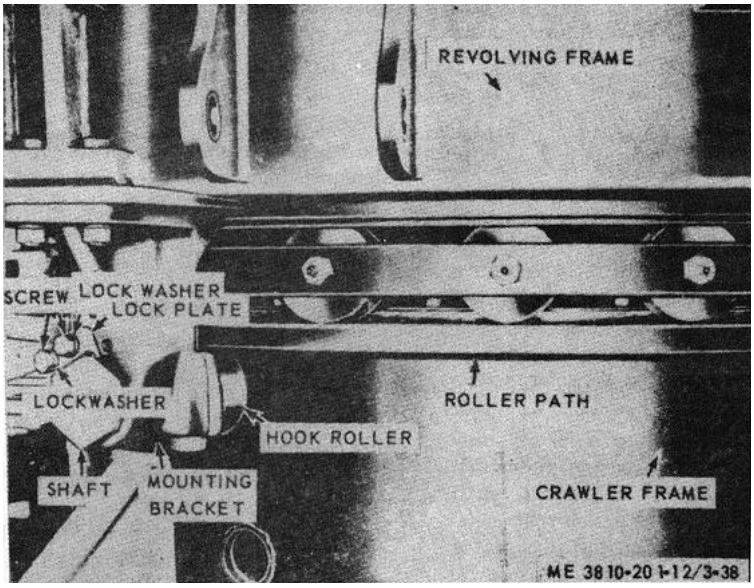


Figure 3-30. Hook roller adjustment points.

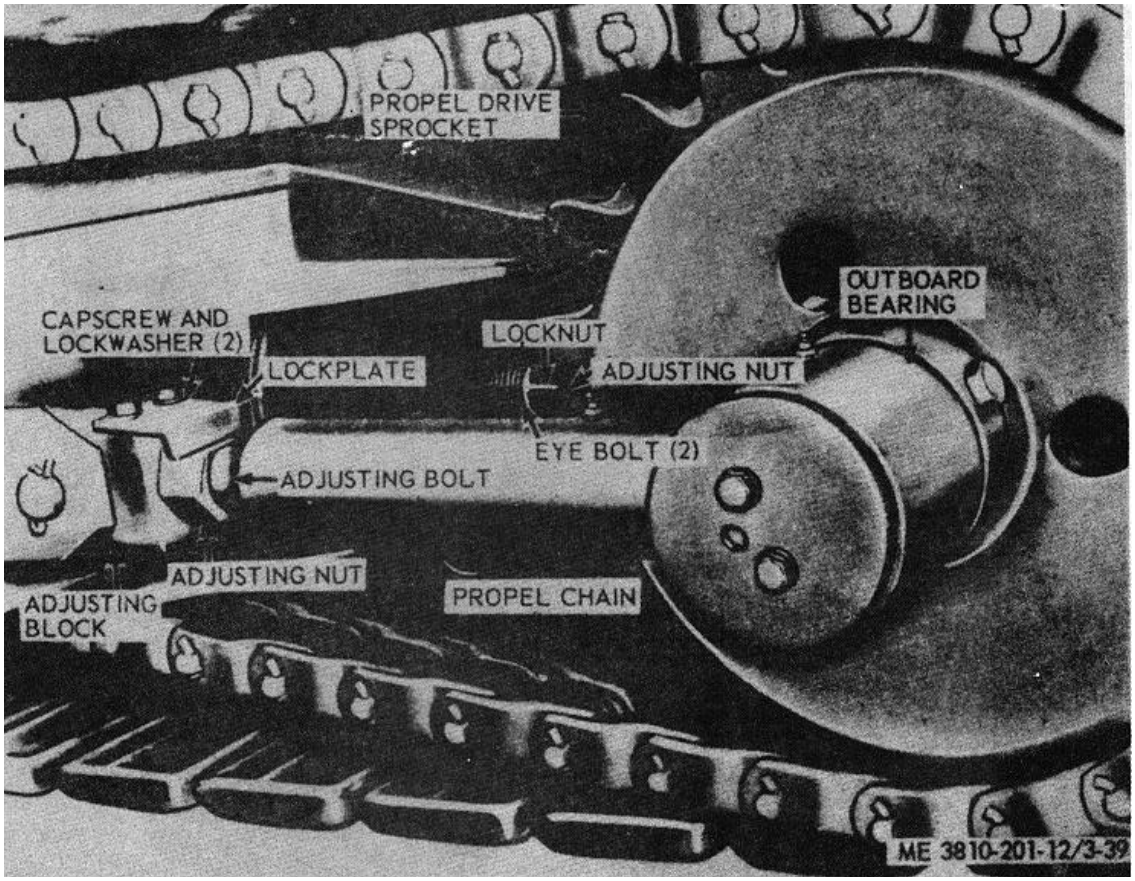


Figure 3-31. Propel chain adjustment.

at least the length of the crawler frame. This will place the slack in the chain on top. Adjust as follows.

b. Adjustment.

(1) Backoff locknuts on two eyebolts (fig. 3-31) (one on each side of sprocket) then, alternately turn adjusting nuts, first on outside then on inside, in or out until slack in propel chain can be raised approximately 1½ inches. Repeat on opposite side of frame for remaining propel chain. When adjustment is correct, tighten locknuts to secure adjustment.

NOTE

When a new propel chain is installed, it must be adjusted tight (no slack), to allows for stretch.

(2) Remove two capscrews, lockwashers, and lockplate from the adjusting block on outboard bearing of both propel sprockets, then turn adjusting nut on adjusting-bolt, in or out, until crawler drive shaft is parallel to the rear axle. When adjustment is correct, install lockplates and secure with lockwashers and capscrews.

3-37. Track Adjustment

a. General. The crane-shovel unit should be propelled in a forward direction for a distance equal to length of crawlers, in order that sigh in track will be on top. Adjust as follows.

b. Adjustment.

(1) Position a straight edge on track parallel with frame, between upper roller (fig. 3-32) and high point of track on top of drive sprocket. Measure distance between straight edge and low point of track sag. This distance should be approximately 1½ inches. If sag is more than 1 ½ inch, loosen locknut on adjusting bolt (on both sides of sprocket), then tighten adjusting nuts until sag is correct.

CAUTION

Equalize turning of adjusting nuts, so that idler shaft is parallel to front axle. The teeth on idler sprocket must be centered between side bars on crawler track. Be sure locknuts on adjusting bolts are drawn up tight to adjusting blocks to secure the adjustment.

(2) Measure compressed length of springs. Each spring should measure 31 inches. To adjust length, backoff, or tighten spring adjusting nut (fig. 3-32), until length is correct.

CAUTION

Correct tension on springs is necessary to take up shock when small stones lodge between idler sprocket and crawler shoes.

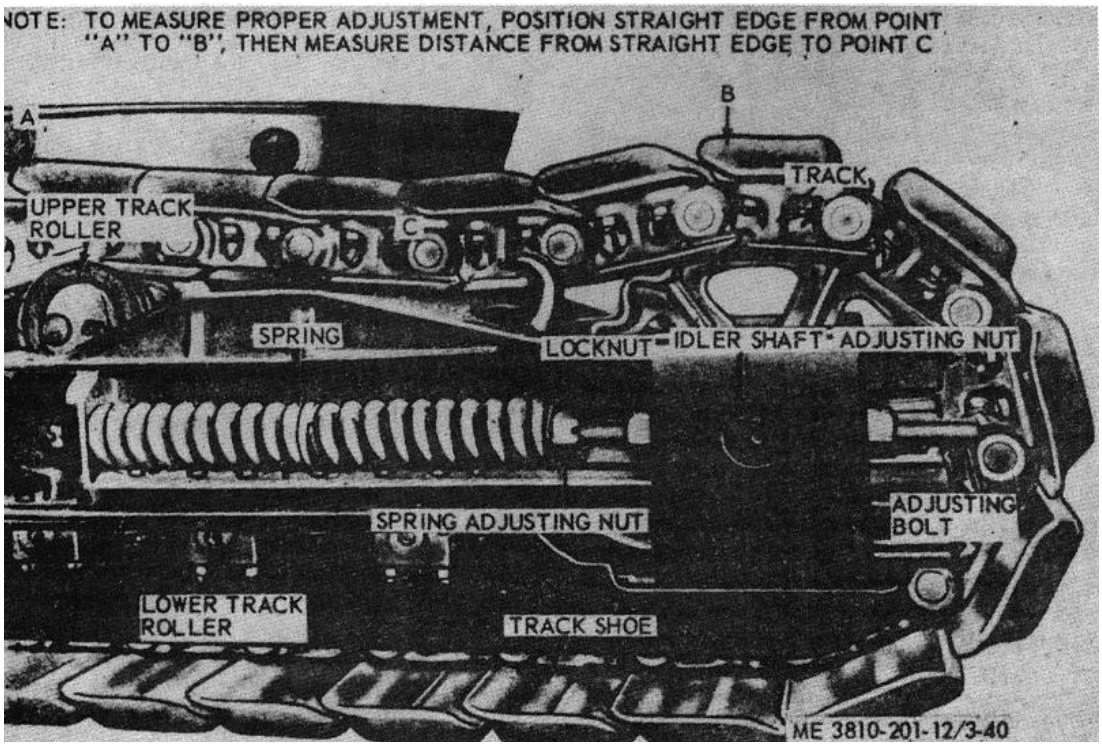


Figure 3-32. Track adjustment.

3-38. Instrument Panel and Cab Light Lamp Replacement

a. General. Illumination for performance of preventive maintenance checks and services on operating machinery within cab enclosure is furnished by lamps in holders on cab ceiling behind operators seat and on left rear side. These lamps are to be augmented by use of trouble light (para 2-27). Panel lights illuminate instruments on control stand and switches on lighting control panel.

b. Lamp Replacement.

(1) *Panel Lights*. Remove cover by turning counterclockwise; remove defective lamp by pressing in and turning counterclockwise to free prongs. Insert new lamp and install cover by reversing this procedure.

(2) *Cab Lights*. Remove lamp by pressing in and turning counterclockwise to free prongs. Insert new lamp, push in, and turn clockwise to engage prongs of lamp in socket of holder.

3-39. Cable Replacement

a. Cable Removal. To replace a defective cable, from shovel hoist drum or when changing front end attachment, proceed as follows:

(1) Remove cable clamps securing cable in dead end socket on right hand boom point sheave (fig. 2-19).

(2) Slowly wind cable on drum through right hand boom point sheave, dipper sheave, and left hand boom point sheave.

(3) Unwind cable from hoist drum, carefully coiling slack in a suitable box, or on a reel, then disconnect cable from dead end on lagging of drum.

(4) Remove remaining cables in a similar manner.

b. Cable Installation.

(1) Refer to table 1-2 and select proper type and length of cable for required operation.

(2) Place reel, or coil, of cable at left side of crane-shovel near boom foot.

(3) Pull loose end of cable from reel, or coil, and lead the end of cable to the proper drum.

(4) Position end of cable in dead end socket of drum and secure by driving cable wedge into the drum dead end socket.

(5) Wind cable length on hoist drum until completely off of reel, or out of coil, then begin reeving cable through sheaves as shown on applicable reeving diagram.

(6) Install remaining cables in a similar manner.

c. Cable Lubrication.

(1) *General*. When cables are removed from drums at time of front end attachment conversion, the cable that is serviceable should be wiped free of dirt and thoroughly lubricated with HDO engine oil (see current lubrication order LO 5-3810-206-12) as it is placed on reel, or in a coil, for storage.

(2) *Method of lubrication at removal*.

(*a*) *Paint brush application*. For penetration between strands, and safety from injury by a single broken strand of wire, use two paint brushes from opposite sides of wire. Saturate brushes freely and frequently in HDO engine oil and cover cable thoroughly on all sides as it comes off drum toward reel or coil. Use drying brushes to wipe away excess oil as -it goes on reel, or in coil.

(*b*) *Rag application*. Saturate two large rags in HDO, hold one in each hand, and oil cable plentifully as it comes off drum. Wipe away excess oil before cable winds on reel, or in coil.

WARNING

Use heavy leather gloves while holding oily rags on cable, and avoid injury by a broken strand of wire.

(3) *Lubrication at installation*. The procedure outlined above should be reversed at installation, if cable being installed appears in need of lubrication. Lubricate groove and hub of sheaves as cable are reeved also (LO 5-3810-206-12).

NOTE

Field tests have proved that cables, like any machined part, last longer when they are kept well lubricated.

Section V. TROUBLESHOOTING

3-40. General

This section provides information useful in diagnosing and correcting unsatisfactory operation or failure of the crane-shovel and its components. Malfunctions which may occur are stated, and followed by a list of probable causes of the trouble. The corrective action recommended is described opposite the probable cause.

3-41. Troubleshooting

Refer to table 3-3 for listing of possible malfunctions. Any trouble beyond scope of organizational maintenance personnel shall be reported to direct support maintenance.

Table 3-3. Troubleshooting.

Malfunction	Probable cause	Corrective action
1. Engine will not start	*a.* No fuel, or fuel shutoff valve closed	*a.* Open fuel shutoff valve, or fill tank.
	b. Low temperature.	*b.* Use cold weather starting aid (para 2-25).
	c. Loss of fuel, or air leak	*c.* Tighten loose fuel connections. Prime fuel system (fig. 2-28).
	d. Defective batteries	*d.* Replace or recharge batteries (para 3-75).
	e. Improper valve clearance.	*e.* Adjust valves (para 3-56).
2. Engine hard to start	*a.* Air in fuel, or no fuel	*a.* Tighten loose connections, prime fuel system (fig. 2-28) and service fuel tank.
	b. Low ambient temperature.	*b.* Use cold weather starting aid (para 2-25).
	c. Clogged air cleaner	*c.* Service air cleaner (para 3-11).
3. Engine starts but will not run, or stalls frequently	*a.* Low on fuel	*a.* Service fuel tank.
	b. Wrong type of fuel	*b.* Drain fuel tank and service with proper fuel.
	c. Loss of fuel	*c.* Tighten loose fuel line connections then prime system (para 3-71).
	d. Fuel filters clogged.	*d.* Service fuel filters (para 3-13).
	e. Air cleaner clogged or defective.	*e.* Service air cleaners (para 3-11) or replace defective air cleaner (para 3-65).
4. Engine starts but misfires, or vibrates excessively	*a.* Wrong fuel in tank	*a.* Drain tank and service with proper grade fuel.
	b. Fuel filters clogged.	*b.* Service fuel filters (para 3-13).
	c. Air cleaner clogged.	*c.* Service air cleaner (para 3-11).
	d. Fuel injector defective.	*d.* Replace fuel injector (para 3-64).
5. Engine lacks power	*a.* Air cleaner clogged or damaged.	*a.* Service dirty air cleaner (para 3-11) or replace defective air cleaner (para 3-65).
	b. Fuel filter, clogged or defective	*b.* Service fuel filters (para 3-13). Replace defective filter (paras 3-68 and 3-69).
	c. Defective fuel lines	*c.* Tighten loose lines or fittings. Replace a defective line (para 3-67).
6. Engine overheats	*a.* Loose fan belt	*a.* Adjust (para 3-20).
	b. Obstructions in fins of radiator	*b.* Clean fins.
	c. Collapsed hose or loose connections	*c.* Check condition of coolant hose. Tighten loose connections, or replace defective hose (para 3-98).
	d. Low on coolant	*d.* Service radiator (para 3-19).
	e. Oil low in crankcase.	*e.* Check oil level. Add when necessary (LO 5-3810-206-12).
	f. Defective thermostat	*f.* Replace (para 3-98).
7. Engine exhaust excessively smoky	*a.* Air cleaner clogged.	*a.* Service air cleaner (para 3-11).
	b. Defective fuel injector	*b.* Replace (para 364).
8. Engine clutch slips	*a.* Clutch out of adjustment	*a.* Adjust (para 3-9).
	b. Linkage out of adjustment	*b.* Adjust (para 3-101).
9. Engine clutch will not engage	*a.* Linkage out of adjustment	*a.* Adjust (para 3-101).
	b. Clutch out of adjustment	*b.* Adjust (para 3-9).
	c. Worn clutch	*c.* Report defect to general support maintenance.
10. Engine temperature fails to raise	Defective thermostat (stuck open)	Replace (para 3-98).
11. Water temperature indicator inoperative.	*a.* Loose electrical connection	*a.* Tighten all connections. Make good ground.
	b. Transmitter defective.	*b.* Replace (para 3-85).
	c. Indicator defective.	*c.* Replace (para 3-147).

Malfunction	Probable cause	Corrective action
12. Oil pressure indicator inoperative	*a.* Loose electrical connections	*a.* Tighten all connections. See that ground is good.
	b. Defective transmitter	*b.* Replace (para 3-84).
	c. Defective indicator	*c.* Replace (para 3-143).
13. Ammeter Inoperative	*a.* Battery cables loose or corroded	*a.* Remove corrosion and tighten cables (para 3-75).
	b. Dead batteries	*b.* Charge or replace (para 3-75).
	c. Ammeter defective	*c.* Replace (para 3-142).
14. Starter motor inoperative	*a.* Loose electrical connections	*a.* Remove corrosion and tighten battery cables (para 3-75) and at solenoid. Replace defective cables.
	b. Starter push switch defective	*b.* Replace (para 3-150).
	c. Batteries defective	*c.* Replace (para 3-75).
	d. Defective starter motor	*d.* Replace (para 3-81).
15. Lights are dim or do not light	*a.* Defective lamps or lights	*a.* Replace (paras 3-15 and 3-38). Replace defective light (paras 3-173 thru 3-175).
	b. Short in wiring	*b.* Replace defective leads (para 3-89).
	c. Batteries dead	*c.* Charge, or replace (para 3-75).
	d. Defective generator, alternator, or regulator	*d.* Test. Replace defective component (paras 3-77 thru 3-80).
16. Revolving frame teeters, or will not owing	*a.* Hook rollers out of adjustment or worn excessively	*a.* Adjust (para 3-35) or replace (paras 3-118 and 3-119).
	b. Swing brake lock engaged, or out of adjustment	*b.* Release, or adjust (para 3-29).
	c. Swing jaw clutch out of adjustment	*c.* Adjust shoe (para 3-25) or shifter (para 3-29).
17. Boom will not lower	*a.* Boom hoist pawl still engaged	*a.* Release pawl (paras 2-8*c* and 2-12*b*).
	b. Brake does not release	*b.* Adjust boom hoist lever and linkage (para 3-113), or clutch (para 3-0).
18. Crane-shovel does not steer properly	*a.* Steering gear not engaged	*a.* Engage (para 2-8*aa*).
	b. Steering linkage, clutch, or brake out of adjustment	*b.* Adjust (para 3-29 and/or 3-131).
19. Cables twisted	*c.* Twisted during installation	*a.* Unwind cable from drum and rewind.
	b. Too much slack	*b.* Refer to applicable front end attachment reeving diagram and reeve correctly.
20. Cables wear rapidly	*a.* Sheave(s) dragging or defective	*a.* Lubricate (LO 5-3810-206-12), or replace defective sheave bearing or shaft (refer to applicable front end attachment paragraphs).
	b. Incorrectly reeved and dragging against another cable	*b.* Refer to applicable front end attachment reeving diagram and reeve correctly.
21. Cables jump boom point sheave	*a.* Improper operation	*a.* Operator must center boom point overload (para 2-28).
	b. Improper operation	*b.* Do not allow cable overrun when dropping clamshell or dragline (pares 2-29 or 2-30).
	c. Improper reeving	*a.* Refer to applicable front end attachment reeving diagram and reeve correctly.
22. Backhoe front end attachment does not operate properly	*a.* Cable out of sheave	*a.* Install cable (para 3-39).
	b. Improperly reeved	*b.* Refer to figure 2-16 and reeve correctly.
	c. Dipper digs incorrectly	*c.* Adjust pitch brace (para 429b).
23. Clamshell bucket fails to open	*a.* Closing cable jammed in sheaves	*a.* Lower clamshell and free cable.
	b. Closing cable too short	*b.* Lower boom to a horizontal position and replace short cable with one of proper length (table 1-2 and fig. 2-9).
24. Clamshell bucket will not take proper bite	*a.* Operator holding too much tension on hoist brake	*c*. Gradually release brake (para 2-29).
	b. Improper reeving (wrong cable)	*b.* Lower boom to a horizontal position and check cables (table 1-2 and fig. 29).
25. Crane will not lift rated capacity	*a.* Hook block incorrectly reeved	*a.* Reeve hook block with maximum parts of the cable (fig. 2-7).
	b. Crane not level	*b.* Crane must be level, and as near to load as possible (boom near vertical) for

Malfunction	Probable cause	Corrective action
		maximum lift and swing. (See capacity chart in cab for boom angle or radius required for lift).
26. Dragline bucket will not dump properly	*a.* Dump sheave binding	*a.* Clean and lubricate cable (para 3-39 and sheave (LO 5-3810-206-12).
	b. Fairlead sheaves binding	*b.* Clean sheave throat. Lubricate sheaves (LO 5-3810-206-12).
	c. Bucket does not dump soon enough	*c.* Lengthen dump cable.
	d. Bucket dumps too soon	*d.* Shorten dump cable.
27. Shovel front end attachment does not operate properly	*a.* Clutches slipping	a Adjust (para 3-28).
	b. Dipper trip inoperative	*b.* Adjust (paras 3-33 and 3-34), or replace clutch shoes (para 49).
	c. Crowd chain loose	*c.* Adjust (para 3-31).
28. Propel chain excessively noisy	*a*. Chain loose or defective	*a.* Adjust (para 3-36) or replace (para 3-137).
	b. Worn sprocket too tight	*b.* Replace (para 3-136).
29. Pins and bushings in crawler track wear excessively	*a.* Crawler track too tight	*a.* Adjust (para 3-37).
	b. Crawler track too loose	*b.* Adjust (para 3-37).
30. Idler roller wear excessive	*a.* Crawler track out of adjustment	*a.* Adjust (para 3-37).
	b. Idler roller, or drive shaft, not parallel to horizontal propel shaft	*b.* Adjust (para 3-37).
31. Trackshoes wear excessively	*a.* Too much sag in track	*a.* Adjust (para 3-37).
	b. Defective track	*b.* Replace (para 3-134).

Section VI. FIELD EXPEDIENT REPAIRS

3-42. General

Organizational maintenance troubles may occur while the crane-shovel is operating in the field where supplies and repair parts are not available and corrective action cannot be performed. When this condition exists, the following expedient repairs may be used in emergencies, upon the decision of the unit commander. Equipment so repaired must be removed from operation as soon as possible and properly repaired before being placed in service again.

3-43. Starter Motor Fails to Turn Engine

Trouble	*Expedient remedy*
Dead batteries	Use jumper cables from other batteries or another piece of equipment to supply current for starting engine.

3-44. Engine Overheats

Trouble	*Expedient remedy*
Defective thermostat	Remove thermostats (para 3-98) and operate without until one is received.

3-45. Engine Starved for Fuel

Trouble	*Expedient remedy*
Clogged filter element	Remove filter element (para 3-13) and operate without until one is received.
Defective fuel filter	Remove fuel filter (paras 3-68 or 3-69), connect by-pass line, and operate without until one is received.

3-46. Low Engine Oil Pressure

Trouble	*Expedient remedy*
Clogged filter element	Remove oil filter element (para 3-4*f*) and operate without until one is received

3-47. Engine Oil Strainer Faulty

Trouble	*Expedient remedy*
Clogged or defective filter element	Remove filter element (para 3-4*g*) reassemble oil strainer and use without until one is received.

Section VII. RADIO INTERFERENCE SUPPRESSION

3-48. General Methods Used to Attain Proper Suppression

Essentially, suppression is attained by providing a low resistance path to ground for the stray currents. The methods used include shielding the ignition and high-frequency wires, grounding the frame with bonding straps, and using capacitors and resistors.

3-49. Interference Suppression Components

a. Primary Suppression Components. The primary suppression components are those whose primary function is to suppress radio interference. These components are described and located in figure 3-33.

b. Secondary Suppression Components. The secondary suppression have radio interference suppression functions which are incidental or secondary to their primary function.

3-50. Replacement of Suppression Components

a. General. Replacement of suppression components requires positive metal-to-metal contact with washers and ground straps. Replace as follows:

b. Generator Ground Strap.

(1) Remove capscrew (fig. 3-33) and IET washer that secures ground strap to engine.

(2) Remove capscrew and IET washer that secures ground strap to generator, and remove ground strap.

(3) Place new ground strap in position and secure to engine with IET washer and capscrew.

(4) Connect ground strap to generator and secure with IET washer and capscrew.

c. Voltage Regulator.

(1) Remove four nuts and screws (fig. 3-33) that secure regulator and two mounts, and remove regulator.

(2) Place new regulator in position with two mounts and secure with four screws and nuts.

3-51. Testing of Radio Interference Suppression Components

Test any capacitors for leaks and shorts on a capacitor tester; replace defective capacitors. If test equipment is not available and interference is indicated, isolate the cause of interference by the trial and error method of replacing each capacitor in turn until the cause of interference is located and eliminated.

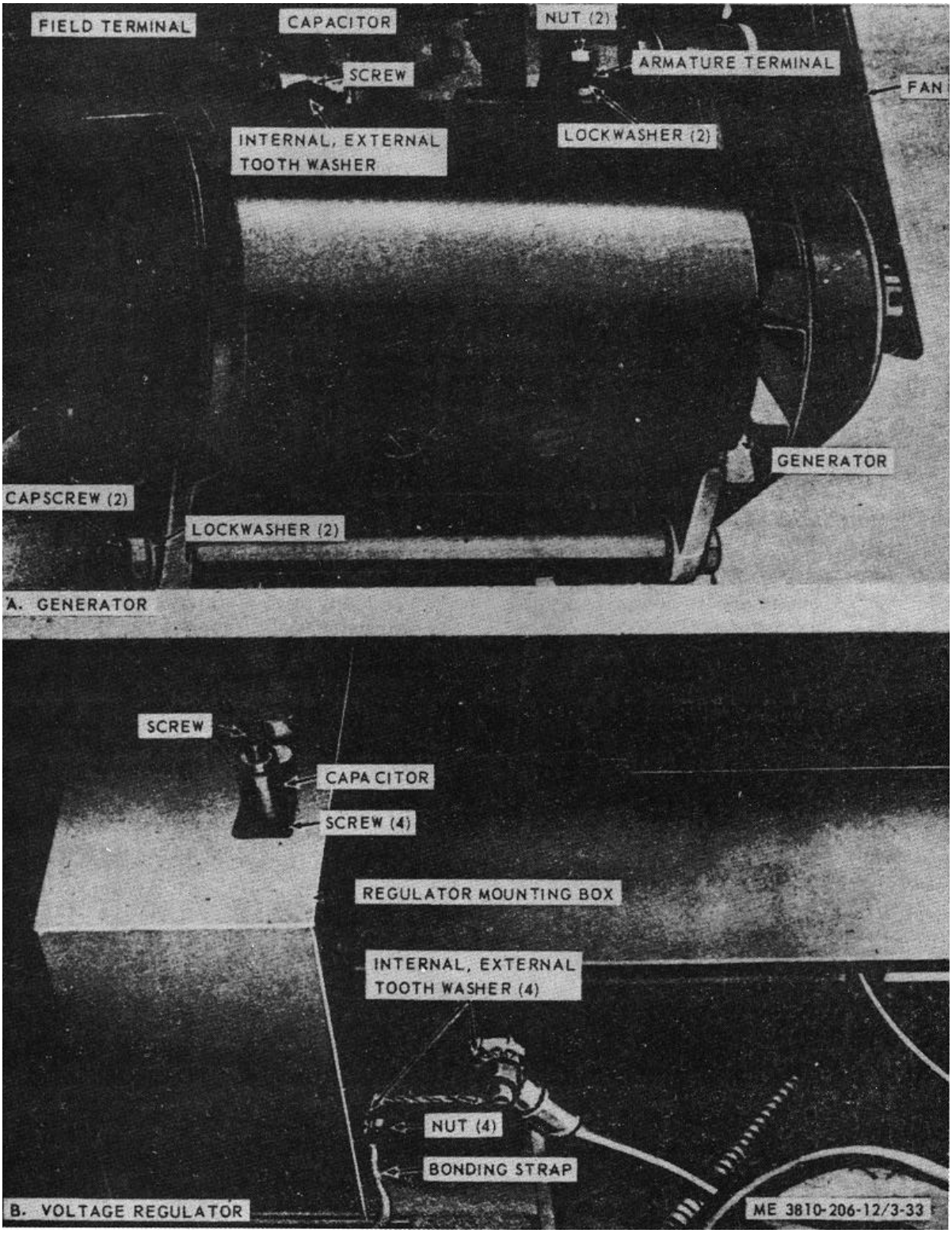


Figure 3-33. Radio interference suppression components.

Section VIII. ORGANIZATIONAL MAINTENANCE PROCEDURES

3-52. General

The instructions in this section, and all subsequent paragraphs and sections, are published for the information and guidance of organizational maintenance personnel in maintaining the crane-shovel.

3-53. Inspection and Test

All inspection and test requirements outlined in maintenance allocation chart for organizational level are covered in the paragraphs describing other maintenance procedures within the system.

Section IX. ENGINE CYLINDER HEAD AND VALVE MECHANISM

3-54. General

a. Model 687C-18-ES Engine. On this two cycle diesel engine the cylinder head forms the top of the combustion chamber and contains passages for the intake of air and the expulsion of gases. The exhaust valve mechanism is attached to the head. The rocker arm, which directly operates the exhaust valve, operates on a short shaft mounted in two supports on the cylinder head. Valve lash adjustment is accomplished with the adjustable ball-ended screw in the rocker arm.

b. Model DSSSTA Engine. On this four cycle diesel engine the valves and valve mechanism admit inlet air and release exhaust gases at precisely timed intervals during engine operation. The inlet valve is open during intake stroke of piston to permit air to enter cylinder. After the power stroke, the exhaust valve is opened to permit piston to force burned gases from the cylinder as it moves upward in the exhaust stroke.

c. Differences. There are other changes in configuration between the two engines, in addition to quantity of valves and stroke cycles, which will be covered in the applicable maintenance paragraphs.

3-55. Valve Cover and Gasket

a. Removal and Installation, Model 687C-18-ES Engine.

(1) Turn three locking hand-wheels securing cover counterclockwise until they are loose, then remove valve cover from cylinder head.

(2) Remove valve cover gasket from cylinder head (or cover) and discard.

(3) Install new valve cover gasket on cylinder head; position valve cover on gasket, then secure by turning the three locking hand-wheels clockwise until they are tight.

(4) Start engine (para 2-10), run until engine reaches operating temperature, checking for oil leaks at gasket. Stop engine (para 2-11); correct any leaks, then add engine oil to crankcase, if necessary (LO 5-3810-206-12).

b. Removal and Installation, Model DSSSTA Engine.

(1) Remove the six bolts, flatwashers, and seals that secure valve cover to cylinder head; remove valve cover, and inspect gasket.

(2) Replace a defective gasket seal, then carefully install valve cover. Be sure gasket fits recess in valve cover, then install six seals in top of valve cover; position flatwashers on bolts, install bolts through seals, and tighten to between 12 and 18 foot pounds torque.

(3) Start engine (para 2-10) and run until engine reaches operating temperature, checking for oil leaks at gasket and seals. Stop engine (Para 2-11), correct any leaks, then add engine oil to crankcase if necessary (LO 5-3810-206 12).

3-56. Valve (Rocker Arm) Adjustment

a. General. The valve adjustment may be accomplished with engine hot or cold. But when adjusted cold, final adjustment must be made while hot. These instructions will cover valve adjustment on a hot engine (water temperature between 160° F and 180° F).

b. Model 687C-18-ES Engine Valve Adjustment.

(1) Remove valve cover (para 3-55).

(2) Start engine (para 2-10) and run until operating temperature is reached (between 160° and 180° F).

(3) When engine is at operating temperature, stop engine (para 2-11), with cylinder No. 1 at top dead center (valve seated closed). Use wrench (fig. 3-44) to loosen locknut holding valve adjusting screw.

(4) Use screw driver and turn adjusting screw until a clearance of 0.012 inch (hot) to 0.014 inch (cold) is obtained with thickness gauge.

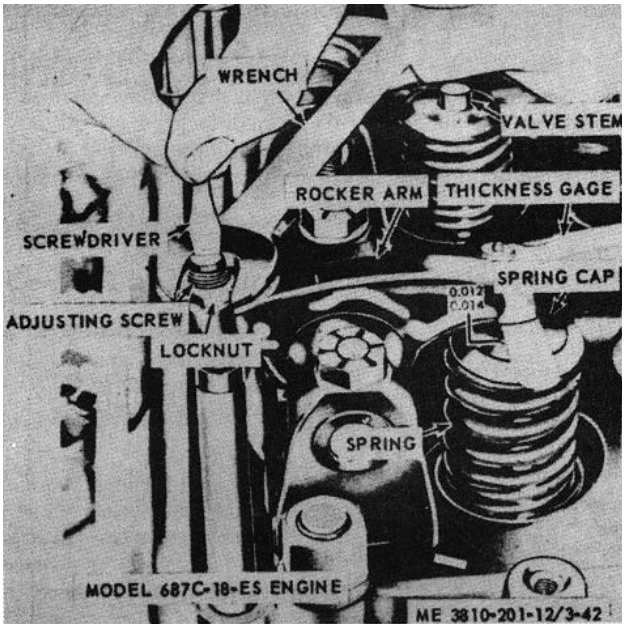


Figure 3-34. Valve (rocker arm) adjustment, model 687C-18-ES engine.

NOTE

When engine temperature is at 130° F or below it is considered to be a cold engine.

(5) When clearance is correct, hold adjusting screw with screwdriver and tighten the locknut.

(6) Recheck clearance. Readjust if necessary.

(7) Repeat steps (3) through (6) above for remaining cylinders. Cylinders fire in 1-6-2-4-3-5 order.

(8) Install valve cover (para 3-55).

c. Model DSSSTA Engine Valve Adjustment.

(1) Remove valve cover (para 56).

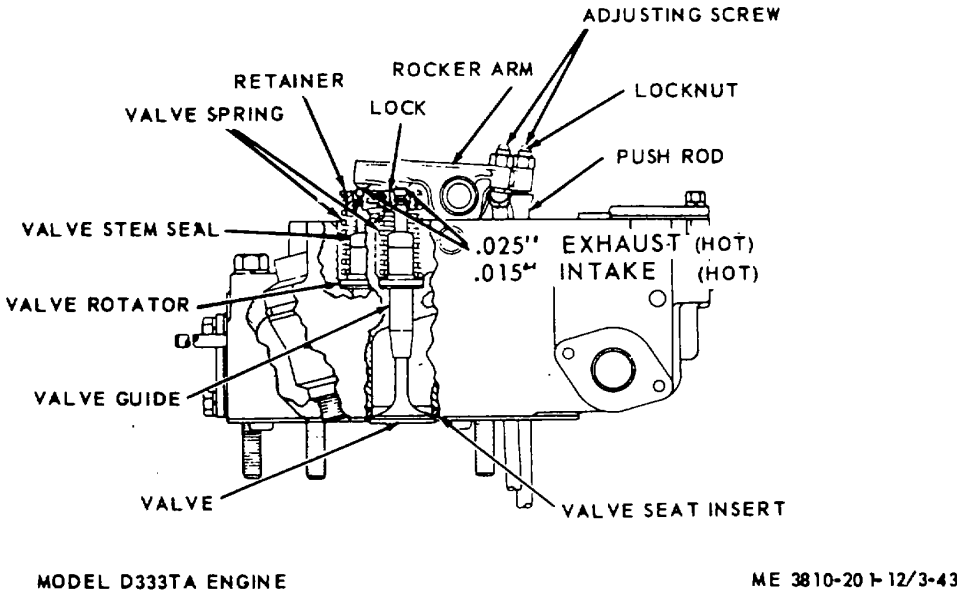


Figure 3-35. Valve (rocker am) adjustment, Model D333TA engine.

(2) Start engine (para 2-10) and run until operating temperature is reached (between 160° and 180° F).

(3) When engine is at operating temperature, stop engine (para 2-11) with cylinder No. 1 at top dead center on compression stroke (both valves seated closed). Refer to figure 335, and use a wrench to loosen locknuts holding valve adjusting screws.

(4) Use screwdriver and adjust exhaust valve with a clearance of 0.025 inch (hot) 0.028 inch (cold) is obtained with thickness gauge (fig. 3-34).

NOTE

When engine temperature is at 130° F, or below, it is considered to be a cold engine.

(5) When clearance is correct, hold adjusting screw with screwdriver and tighten the locknut.

(6) Recheck clearance. Readjust if necessary.

(7) Repeat steps (3) through (6) for intake valves, except use 0.015 inch (hot) 0.017 inch (cold).

(8) Repeat above procedure for remaining cylinders. Cylinders fire in 1-5-3-6-2-4 order.

(9) Install valve cover (para 3-55).

Section X. ENGINE LUBRICATING SYSTEM

3-57. General

a. Description. A pressurized lubricating system, filtered and strained, with full flow by-pass features is pumped from crankcase oil pan through strainer and filter to passages designed to distribute oil where it is most required. Differences are described under paragraph devoted to each engine.

b. Engine Model 687C-18-ES. A gear type oil pump is mounted in bottom of oil pan at rear of engine. This pump forces oil to front of engine through a supply line and cored passage to oil strainer; through strainer to manifold on each side of engine, where it is distributed to all moving parts by means of holes drilled at strategic points. Exhaust valve rocker arms are lubricated through an external line which supplies oil to end rocker arm shaft. The remaining rocker arms are lubricated by means of short jumper connections. The blowers are also lubricated through external lines. Drain plugs for draining system are located on bottom of oil pan, and side of oil strainer housing.

c. Engine Model D333TA. A two section oil pump contains a scavenge pump and a pressure pump. Oil that does not return to pan is collected by a scavenge tube and then returned to oil pan. Oil is pumped from oil pan to oil cooler, then to oil filters, except on starting, when it is bypassed through an external line to the filters, cutting out the cooler for cold oil. When engine is first started, unfiltered oil is passed by the turbocharger lubrication valve to turbocharger components by an external line. As the oil temperature increases, the oil cooler by pass valve closes, forcing oil through cooler to filter bases. As oil pressure is built up through filters, the turbocharger lubrication valve closes off flow of unfiltered oil and provides filtered oil to turbo charger components. The oil filter bypass valve opens when filters become restricted and allows oil to bypass filters and flow directly to outlet passage. Unless filters become restricted, or oil viscosity is extremely high, only filtered oil is furnished to the engine bearings. The bypass valves assure a supply of lubricating oil any time filter, cooler, or both may become clogged.

3-58. Engine Oil Filters

a. For Engine Model 687C-18-ES.

(1) *Removal and installation*.

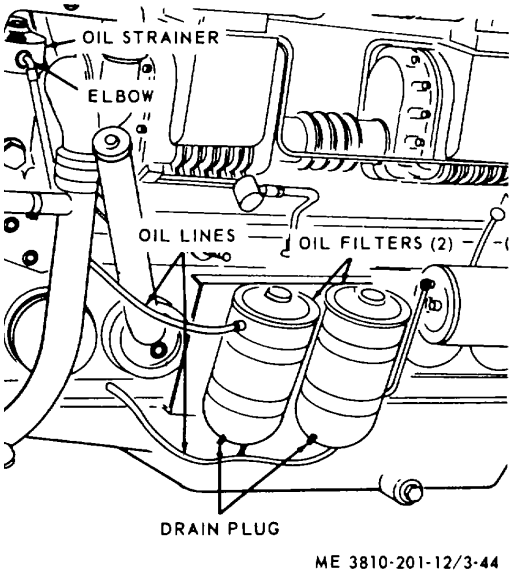
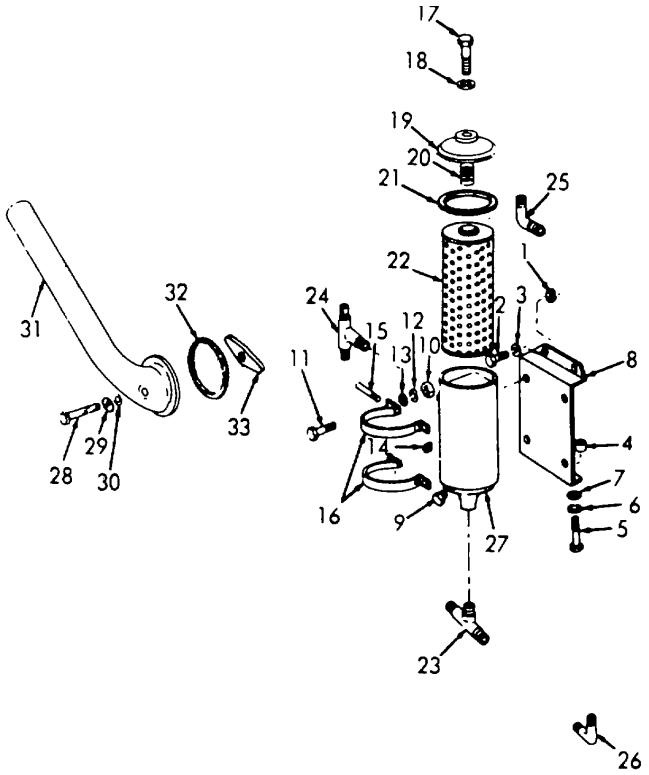


Figure 3-36. Engine oil filters (for engine 687C-18-ES), removal and installation.



1	Nut (4)	18	Plug
2	Capscrew (4)	19	Cover
3	Lockwasher (4)	20	Spring
4	Nut (4)	21	Packing
5	Bolt (4)	22	Filter element
6	Lockwasher (4)	23	Tee
7	Flatwasher (4)	24	Tee
8	Bracket (2)	25	Elbow
9	Drain plug	26	Elbow
10	Nut (4)	27	Filter
11	Bolt (4)	28	Bolt
12	Lockwasher (4)	29	Lockwasher
13	Flatwasher (4)	30	Flatwasher
14	Nut (2)	81	Filler, pipe
15	Bolt (2)	32	Packing
16	Straps (2)	33	Bracket
17	Capscrew		

Figure 3-37. Engine oil filters (model 687C-18-ES) disassembly, and reassembly, and oil filler pipe removal and installation.

(*a*) Refer to figure 3-36, disconnect oil line from elbow at strainer, then remove oil line from filter.

(*b*) Remove drain plug, drain filter, then remove remaining oil lines and fittings. Plug line ends or ports to prevent contamination of oil supply.

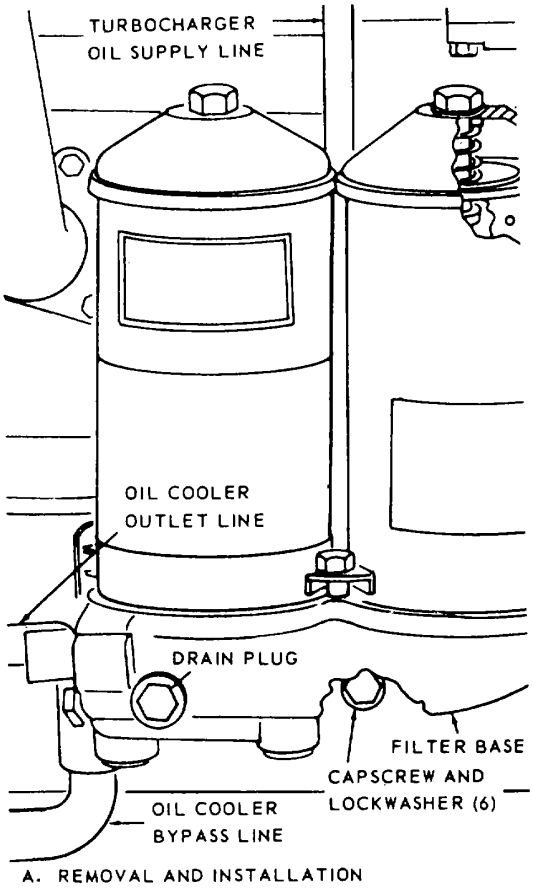
(*c*) Remove items 1 through 7, figure 3-37, then remove filter and mounting bracket (8) from engine as an assembly.

(*d*) Remove remaining filter in a similar manner.

(2) *Disassembly and reassembly*. Refer to figure 3-37 and disassemble the oil filter in numerical (9 thru 27) order. Reassemble in reverse order.

(3) *Cleaning, inspection, and repair.*

(*a*) Clean all parts in an approved cleaning solvent, except filter element and gaskets which are discarded, then dry thoroughly.



1	Screw	17	Gasket (2)
2	Clip	18	Spring pin (2)
3	Plate	19	Stud (2)
4	Spring	20	Adapter
5	Gasket	21	Retainer
6	Cover	22	Spring
7	Seal	23	Valve
8	Washer	24	Plug (2)
9	Filter element	25	Spring (2)
10	Capscrew	26	Valve (2)
11	Lockwasher	27	Plug
12	Clamp	28	Plug
13	Capscrew (2)	29	Packing
14	Lockwasher (2)	30	Packing
15	Clamps (2)	31	Filter Base
16	Case (2)		

Figure 3-38. Oil filters, removal, disassembly, reassembly and installation for engine Model D333TA (sheet 1 of 2).

(*b*) Visibly inspect all parts for signs or damage or defect.

(*c*) Repair by replacing damaged or defective part, all gaskets, and filter element.

b. For Engine Model DSSSTA.

(1) *Removal and installation*. Remove drain plug (view A, fig. 3-38) and drain oil filters, disconnect oil lines, remove six capscrews and lockwashers then remove oil filter base from engine.

Install in reverse order.

(2) *Disassembly and reassembly*. Refer to view B of figure 3-38 and disassemble the oil filters in numerical sequence. Reassemble in reverse order.

(3) *Cleaning, inspection and repair*.

(*a*) Clean all parts except filter element, which is discarded, in an approved cleaning solution and dry thoroughly.

(*b*) Visibly inspect all parts for deformation, stripped threads, or excessive wear. Inspect the three bypass valves and the seating surfaces within filter base for wear or damage. Inspect springs for loss of tension or deformation. Inspect packing, seals and gaskets for signs of damage or deterioration.

(*c*) Repair by replacing damaged or defective parts.

3-59. Engine Oil Strainer (for Engine Model 687C-18-ES)

a. Removal and Installation. Refer to figure 3-39, perform step 1 and remove oil strainer from engine. Install in reverse order.

b. Disassembly and Reassembly. Refer to figure 3-39, perform step 2 and disassemble oil strainer. Reassemble in reverse order.

c. Cleaning, Inspection, and Repair.

(1) Clean all parts in an approved cleaning solvent and dry thoroughly, using low pressure compressed air to blow filter element dry. Be sure all gummy sludge has been removed from filter element.

(2) Visually inspect all parts for bends, breaks, or distortion, and mounting hardware for stripped threads or other defects.

(3) Repair by replacing all gaskets, then replace any other part that is excessively worn, damaged or defective.

3-60. Engine Oil Level Gauge (Dipstick)

a. On Engine Model 687C-18-ES.

(1) *Removal*.

(*a*) Refer to figure 3-1 (6), reference number 53, and remove dipstick from tube.

NOTE

THE RETAINER (21) IS A PRESS FIT, BUT IS EASILY REMOVED BY USING A 3/8-16 (NC) BOLT OF SUITABLE LENGTH AND A SPACER.

NOTE

AT REASSEMBLY, COAT PREFORMED PACKING OR SEALS WITH LIQUID SOAP TO EASE INSTALLATION.

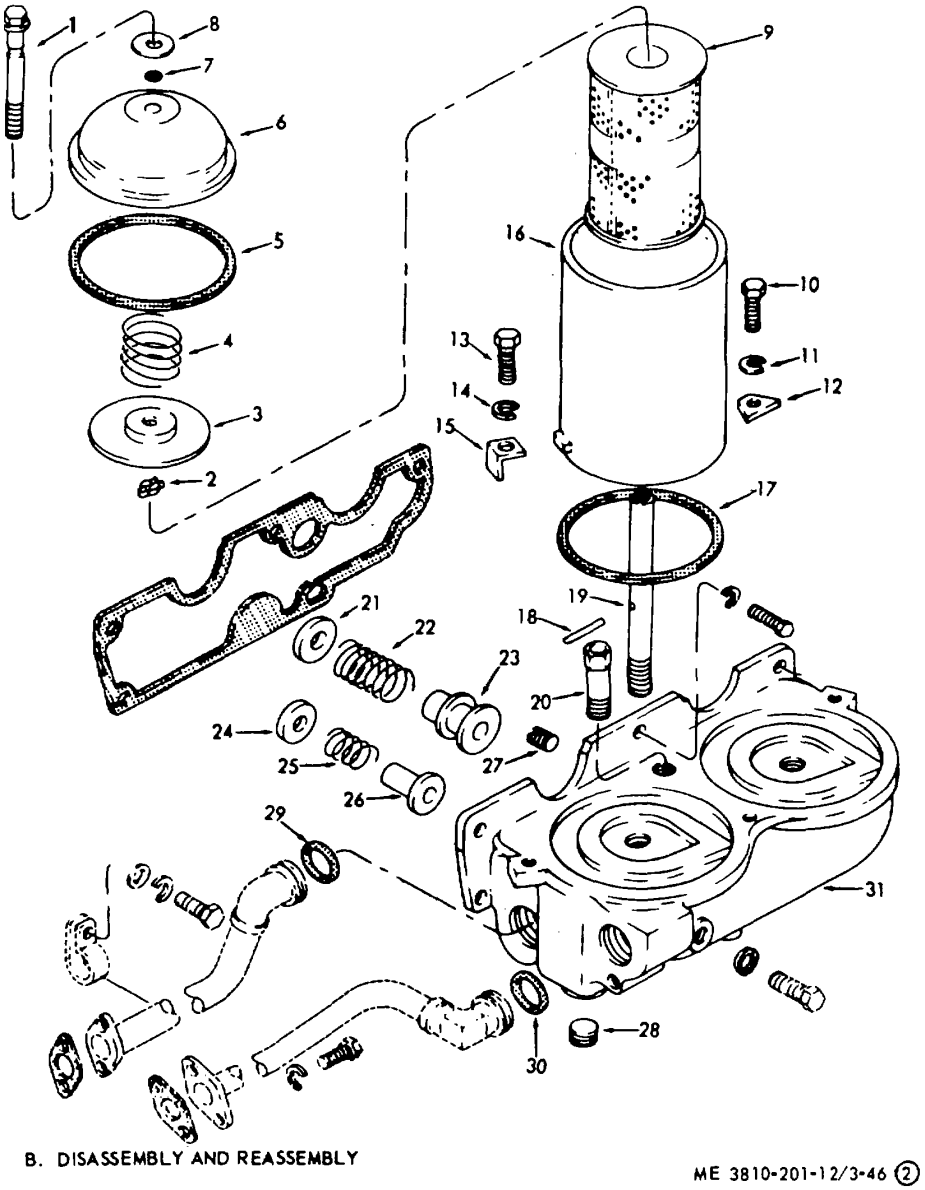


Figure 3-38. Oil filters, removal, disassembly, reassembly, and installation for engine Model D333TA (sheet 2 of 2).

(*b*) Remove tube from bushing by turning in a counterclockwise direction.

(*c*) Remove bushing from block.

(2) *Installation*. Install by reversing procedure used in (1) above.

b. On Engine Model DSSSTA.

(1) *Removal*.

(*a*) Refer to figure 3-40 and remove dipstick from tube.

(*b*) Remove two capscrews and lockwasher, then remove the tube from oil pan.

STEP 1

DISCONNECT OIL LINE (NOT SHOWN) FROM ADAPTER, REMOVE ITEM 1 AND 2 AND DRAIN STRAINER. REMOVE ITEMS 3, 4, AND 5, THEN REMOVE STRAINER AND GASKETS 6 AND 7 FROM ENGINE.

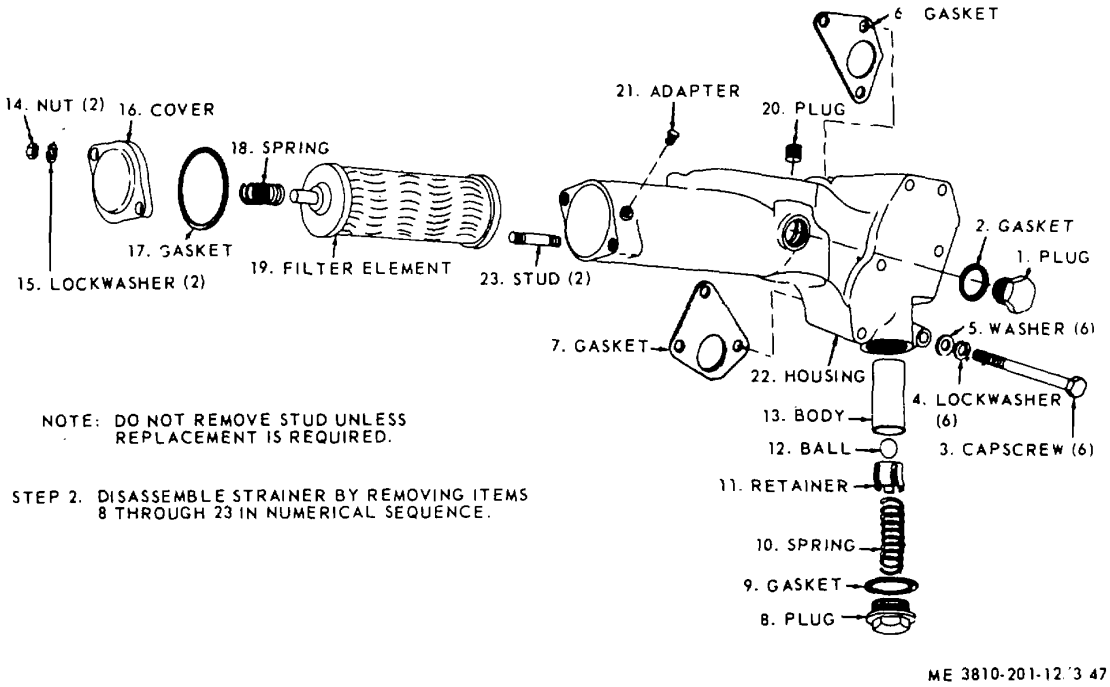


Figure 3-39. Engine oil strainer (for engine Model 387C-18-ES), removal, disassembly, reassembly and installation.

(2) *Installation*. Install by reversing procedure in (1) above.

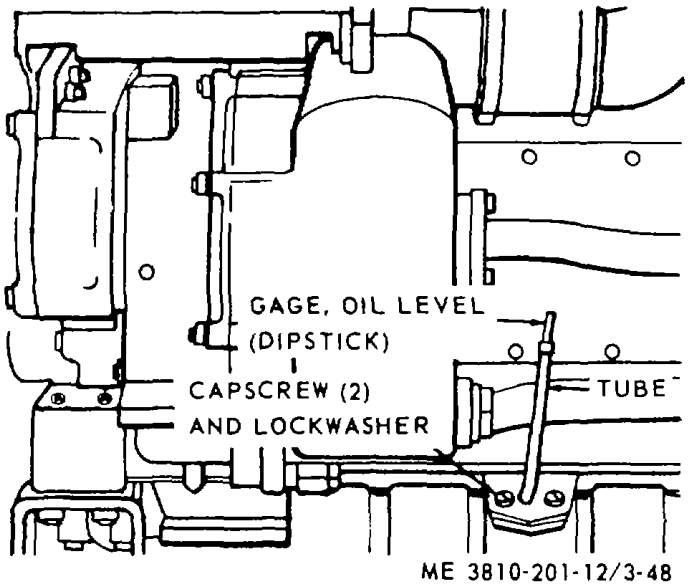


Figure 3-40. Engine oil level gauge (Dipstick).

3-61. External Oil and Ventilation Lines

a. On Engine Model 687C-18-ES.

(1) *Removal*.

(*a*) Loosen coupling nut (fig. 3-41) and remove air box drain tube from clamp.

(*b*) Remove crankcase ventilation line by removing items 4 through 12 in sequence.

(*c*) Remove remaining external oil lines in a similar manner.

(2) *Installation*. Install external oil and ventilation lines by reversing procedure in steps (*a*) (*b*) and (*c*) above.

b. On Engine Model D333TA. Remove and install external oil and ventilation lines from engine model D333TA in a manner similar to that described in a above.

3-62. Crankcase Breather and Oil Filler Pipe

(1) *Removal*. Refer to figure 3-37 and remove oil filler pipe by removing items 23 through 27 in numerical sequence.

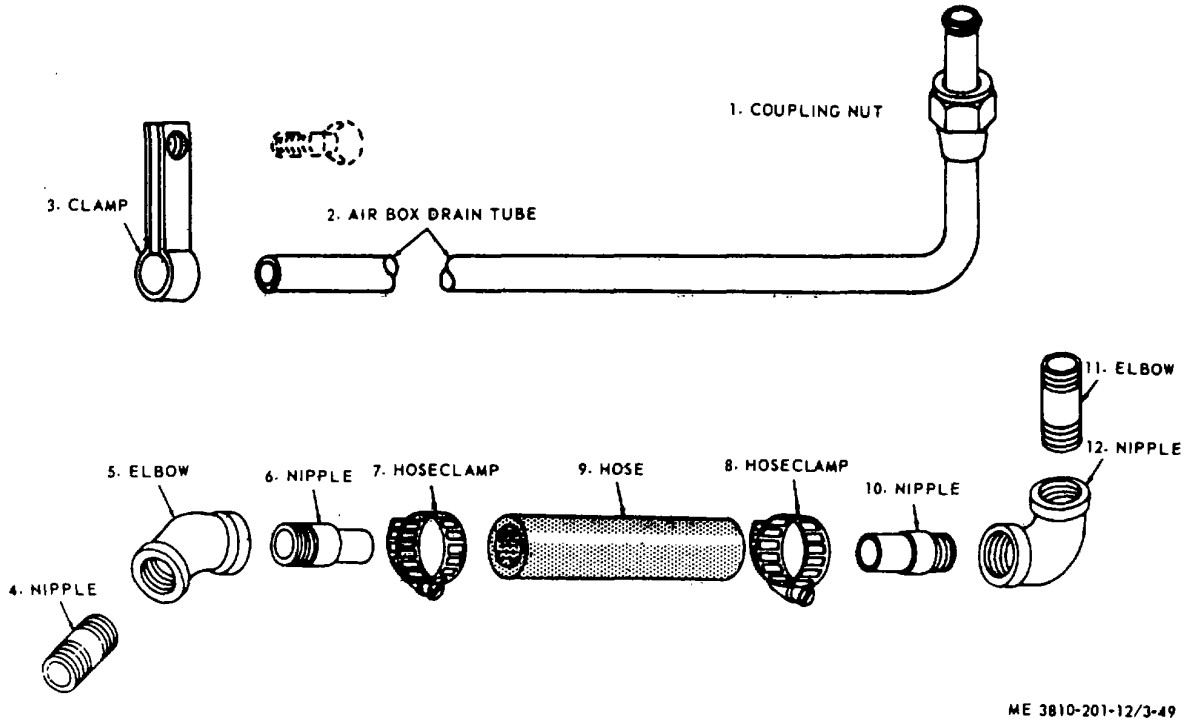


Figure 3-41. External oil and ventilation lines, removal and installation.

(2) *Installation*. Install oil filler pipe by reversing procedure in (1) above.

b. Crankcase Breather and Oil Filter (on Model D333TA).

(1) Removal Refer to figure 3-42 and remove crankcase breather and oil filler from left hand side of engine.

(2) *Disassembly and reassembly*. Refer to figure 3-42 and disassemble crankcase breather and oil filler. Reassemble in reverse order.

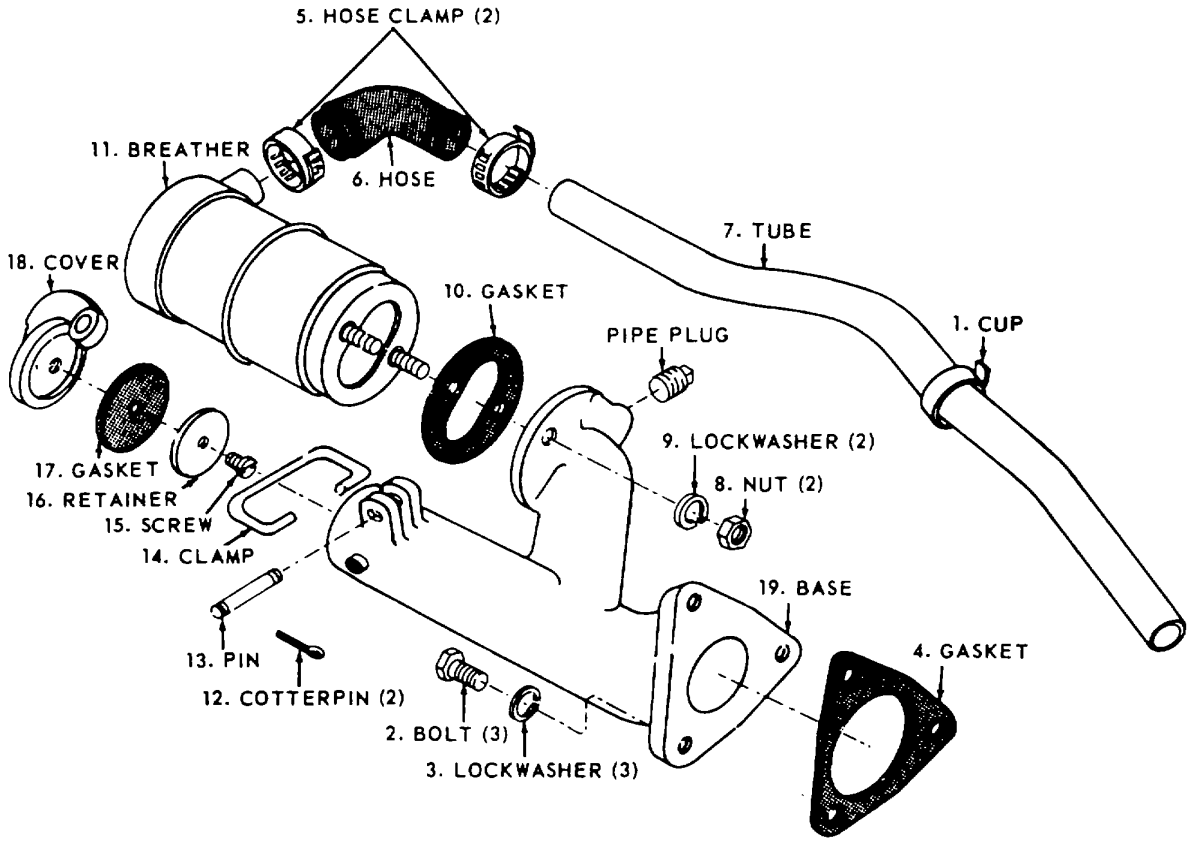
(3) *Installation*. Reverse procedure in (1) above for installation.

c. Cleaning, Inspection, and Repair.

(1) Clean all parts in an approved cleaning solvent and dry thoroughly.

(2) Visually inspect for deformation or defect, including deterioration of hose or gaskets.

(3) Repair by replacing damaged or defective parts.



STEP 1

REMOVE CLIP FROM TUBE, BOLT (3) AND LOCKWASHER (3), THEN REMOVE BASF AND GASKET FROM LEFT SIDE OF ENGINE.

STEP 2

DISASSEMBLE BY REMOVING ITEMS 5 THROUGH 18 IN NUMERICAL SEQUENCE FROM BASE 19.

NOTE

REASSEMBLE AND INSTALL BY REVERSING ABOVE PROCEDURE.

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Figure 3-42. Crankcase breather and oil filler (engine model D333TA), removal, disassembly, reassembly and installation.

Section XI. FUEL SYSTEM

3-63. General

a. Fuel System for Engine Model 687C-18-ES. The fuel supply system for this engine consists of a fuel tank, shutoff valve, primary filter, priming pump, secondary filter, and a transfer pump that is built into the fuel injection pump, It also includes a return flow line from injectors to pump, and return lines through shutoff valve to fuel tank. The injection pump forces a metered amount of fuel through lines to injectors, and into engine cylinders at high pressure. An overspeed governor driven by tachometer drive, activates shutdown lever on fuel injection pump

through a micro-switch controlled circuit, when rpm exceeds 1935 ± 15 rpm.

b. Fuel System Flushing Procedure for Engine Model 687C-18-ES.

(1) Disconnect fuel line at pump inlet and place end of line in a suitable container.

(2) Pump the hand primer (para 2-8 *ap*) several times to flush the lines and filters.

(3) Reconnect fuel line to pip inlet. Be sure the fuel line connector screws, are set at proper torque of 420 inch-pounds.

NOTE

New fuel line connector washers should be installed every time the fuel line connector screws are loosened.

(4) Disconnect injector fuel lines at the injectors.

(5) Crank the engine with starter for thirty seconds.

(6) Reconnect injector fuel lines

NOTE

A characteristic of the Roosa-Master fuel injection pump is that if engine misfiring occurs and it is traced to a certain cylinder in which no combustion is taking place, the cause may be a nozzle valve sticking open in the cylinder which immediately precedes that cylinder in the firing order. During injection to the cylinder which has the nozzle valve sticking in the open position, the fuel rushes into that cylinder with no restriction, causing a scavenging effect in the pump distributor rotor and a void which cannot be reached to a sufficient degree to provide opening pressure of fuel to the following nozzle valve. Hence, no combustion can take place.

c. Fuel System for Engine Model D333TA. The fuel is drawn from supply tank by a gear type transfer pump that forces fuel through a drilled

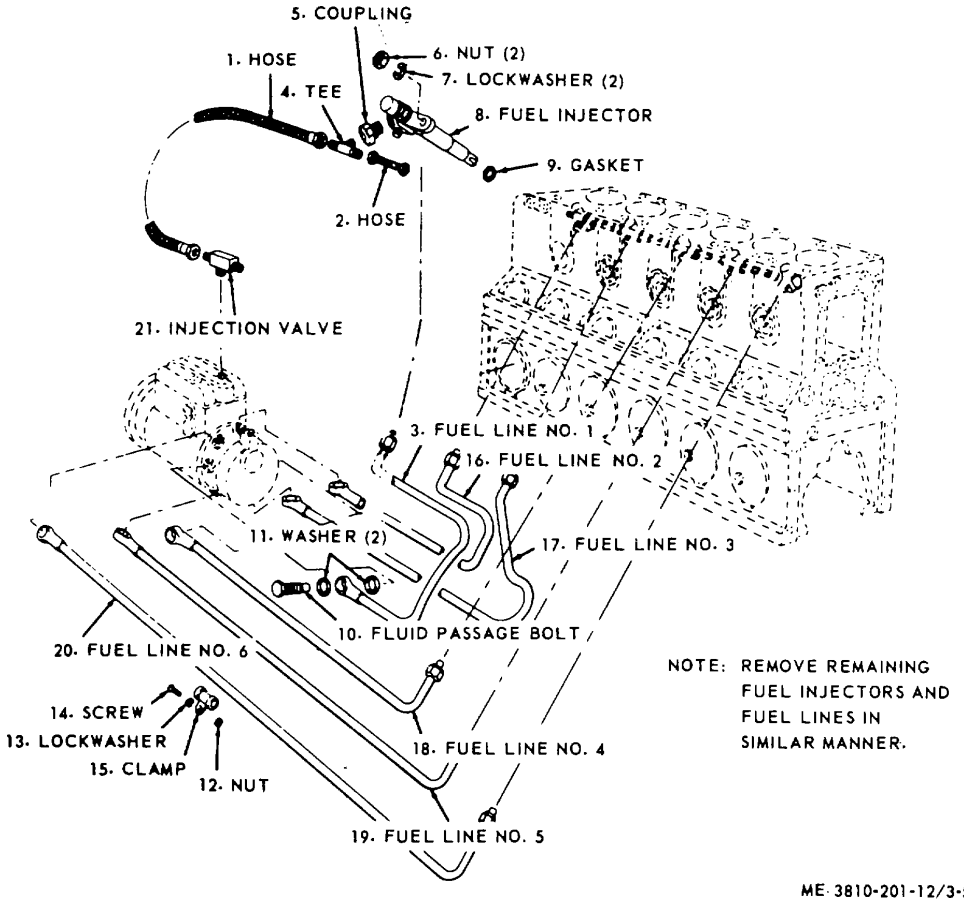


Figure 3-43. Fuel injector and fuel line removal and installation (engine model 687C-18-ES).

passage in filter housing to the outside of filter element. A spring loaded bypass valve on front of filter housing maintains a maximum pressure of approximately 15 psi on the fuel in filter housing; as indicated on fuel pressure gauge mounted on housing. This fuel transfer pump supplies more fuel than is required by engine, or to maintain 15 psi pressure. Excess fuel is bypassed around valve and returned to fuel tank. Filtered fuel flows up center of filter housing into a passage through cover then down rear of housing to fuel manifold, which distributes fuel to the injection pumps. A cam activated injection pump for each cylinder, forces fuel through an injection line to proper fuel injector where a definite quantity of fuel is forced into pre-combustion chamber at the proper time.

d. Fuel System Flushing Procedure for Engine Model D333TA.

(1) Operate vent valve at front of filter cover.

(2) Operate primer pump (para 2-8 *ap*) several times, until a solid stream of fuel flows out of the drain tube, indicating that all air has been flushed from the system.

(3) Close the vent valve.

NOTE

The fuel system may also be flushed by using transfer pump to force fuel out of drain tube. Open vent valve and operate starter for approximately thirty seconds, or until a solid stream of fuel flows out of drain tube, whichever requires the shorter time, then close vent valve.

3-64 Fuel Injector and Fuel Line

a. General. Fuel injector or fuel line that is loose, damaged, or defective will effect diesel engine operation. When it is suspected that a fuel injector is defective, the defective injector can be isolated by the following process of elimination:

(1) Loosen fuel line coupling nut at fuel injector while engine is idling, and observe engine performance.

(2) If idling speed slows down, the injector is working.

(3) If there is no noticeable difference in engine speed, that injector is defective. Repeat on remaining five injectors. Replace a defective injector or damaged fuel line.

b. Removal and Installation.

(1) On engine model 687C-18-ES.

(*a*) Refer to figure 3-43 and remove items in numerical sequence.

(*b*) Install by reversing procedure above.

(2) On engine Model DSSSTA.

(*a*) Refer to figure 344 and remove glow plug to prevent damage.

(*b*) Remove remaining items in numerical sequence.

(*c*) Install by reversing procedure above.

3-65. Air Cleaners

a. Used by Engine Model 687C-18-ES.

(1) *Removal and installation*. Refer to figure 3-45, remove items 1 through 5 in numerical sequence, and remove air cleaner from engine.

Install in reverse order.

(2) *Disassembly and Reassembly*. Refer to figure 3-45, remove items 6 through 21 in numerical sequence and disassemble air cleaner.

Reassemble in reverse order.

(3) *Mounting Bracket Removal and Installation*. Refer to figure 3-45, remove items 23 through 33 in numerical sequence and remove mounting bracket from engine. Install in reverse order.

(4) *Cleaning, inspection and repair*.

(*a*) Clean all parts with an approved cleaning solvent and dry thoroughly.

(*b*) Visually inspect for dents, breaks, cracks, stripped threads on mounting hardware, or deterioration of packing.

(*c*) Repair by replacing defective packing, hardware, or damaged air cleaner.

(5) *Service*. Service air cleaner as described in paragraph 3-4.

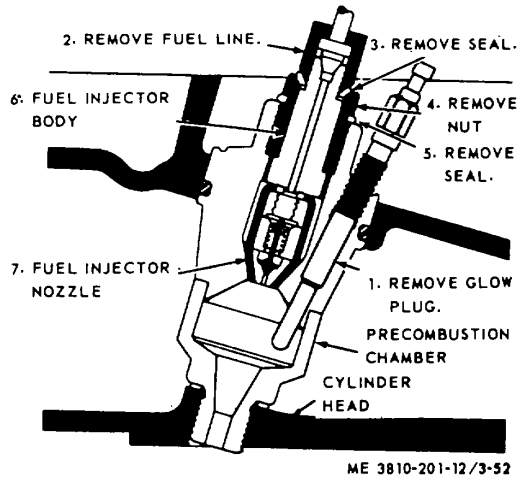
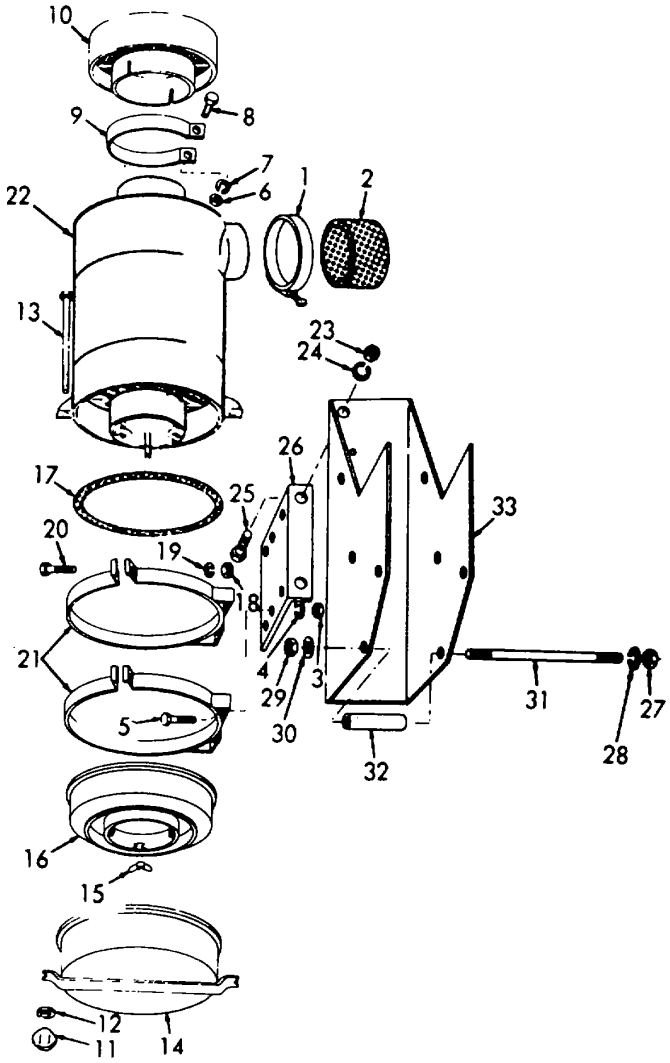


Figure 3-44. Fuel injector, fuel line and glow plug, removal and installation.



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1	Hose damp (2)	18	Nut (2)
2	Hose	19	Lockwasher (2)
3	Nut (4)	20	Capscrew (2)
4	Lockwasher (4)	21	Bands
5	Capscrew (4)	22	Body
6	Nut	23	Nut (2)
7	Lockwasher	24	Lockwasher (2)
8	Capscrew	25	Capscrew
9	Clamp	26	Bracket
10	Cover	27	Nut
11	Wing nut (2)	28	Lockwasher
12	Lockwashers (2)	29	Nut
13	Thumbscrew (2)	30	Lockwasher
14	Oil cup	31	Stud
15	Wingnut (3)	32	Spacer
16	Tray	33	Bracket
17	Packing (2)		

Figure 3-45. Air cleaner and mounting bracket, removal, disassembly and installation (on Crane model 855BG with engine 687C-18-ES).

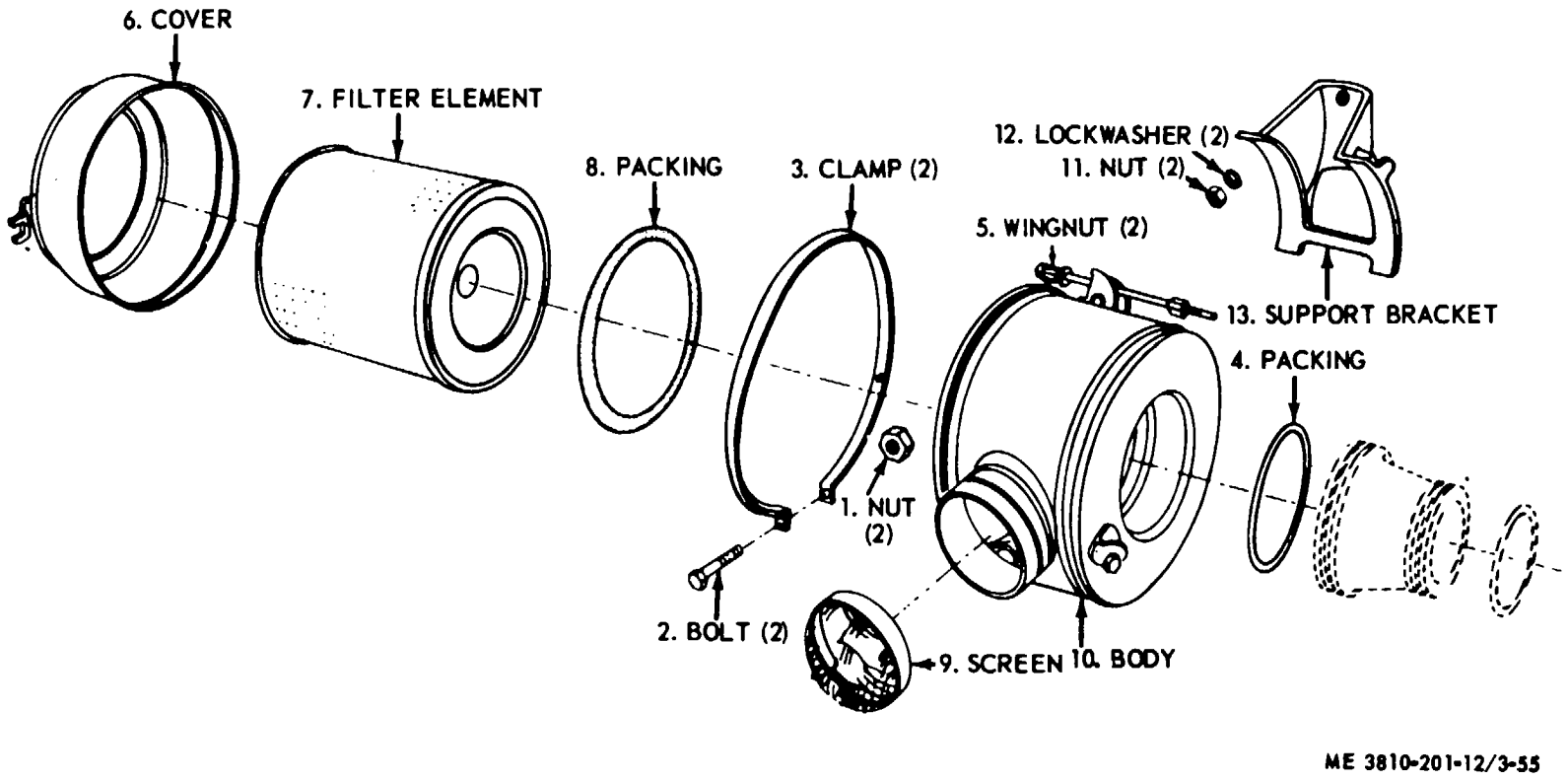


Figure 3-46. Air cleaner, dry type, removal, disassembly, reassembly, and installation (for engine model D333TA).

b. Used by Engine Model D333TA.

(1) *Removal and installation*. Refer to figure 3-46, remove items 1 through 3 in numerical sequence, then remove air cleaner from support bracket and turbocharger coupling. Install in reverse order.

(2) *Disassembly and reassembly*. Refer to figure 346, disassemble air cleaner by removing items 4 through 10 in numerical sequence. Reassemble in reverse order.

(3) *Support bracket removal and installation*. Refer to figure 3-46, remove items 11 and 12, then remove support bracket from engine. Install in reverse order.

(4) *Cleaning, inspection, and repair*.

(*a*) Clean all parts with an approved cleaning solvent and dry thoroughly. Dry filter element with, low pressure compressed air.

(*b*) Visually inspect all parts for damage, defect, or deterioration.

(*c*) Repair by replacing damaged or defective parts.

(5) *Service*. Service dry type air cleaner as directed in paragraph 3-11.

3-66. Air Manifold (Blower to Blower) Engine Model 687C-18-ES

a. Removal.

(1) Remove two hose clamps (fig. 3-47) from hose.

(2) Remove eight capscrew, lockwasher, and flatwasher, then remove blower-to-blower air manifold and gaskets from blower adapters.

b. Cleaning, inspection, and repair.

(1) Clean all parts with an approved cleaning solvent and dry thoroughly.

(2) Visually inspect all parts for bends, cracks, other damage or defects.

(3) Repair by straightening bends, welding cracks, or replacing damaged gaskets, defective manifold or mounting hardware.

c. Installation. Install by reversing procedure described in *a* above.

3-67. Fuel Tanks, Lines, and Fittings

a. Removal and Installation. Refer to figure 3-48 and remove fuel tank, lines, and fittings. Install in reverse order.

b. Cleaning and inspection.

(1) Clean all parts with an approved cleaning solvent and dry thoroughly.

(2) Visually inspect all parts for cracks, breaks, or other damage. Inspect hardware for stripped threads or other defect. Inspect fuel strainers for breaks, tears of screen, or other damage. Inspect fuel tank for leaks. Replace defective components or mounting hardware.

(3) Repair cracks and breaks by welding. Repair a leaking tank as follows:

(*a*) Remove fuel tank (*a* above).

(*b*) Fill tank with water to avoid concentration of fumes.

(*c*) Weld leaking area.

(*d*) Drain water from tank, blow dry as possible with compressed air, then pour about ½ gallon of fuel oil into-tank and slosh it around

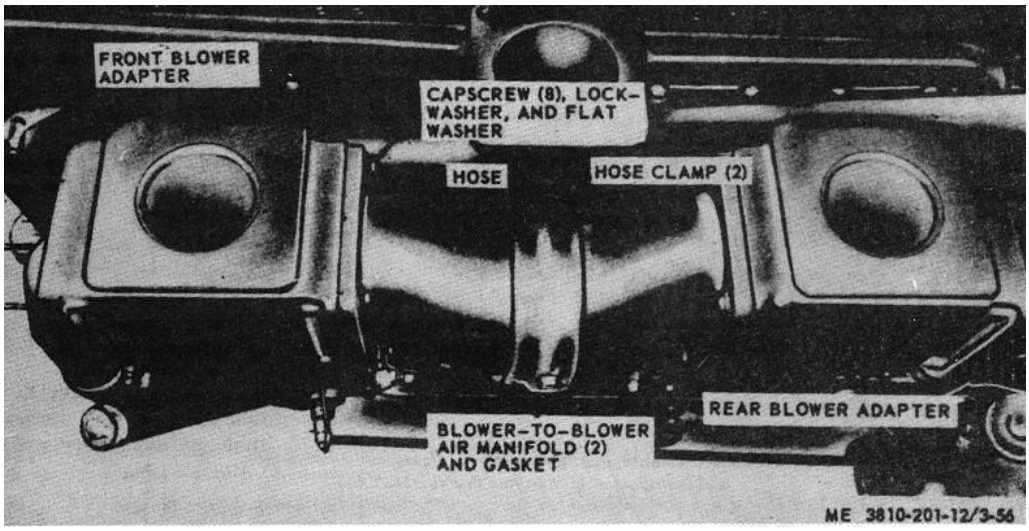
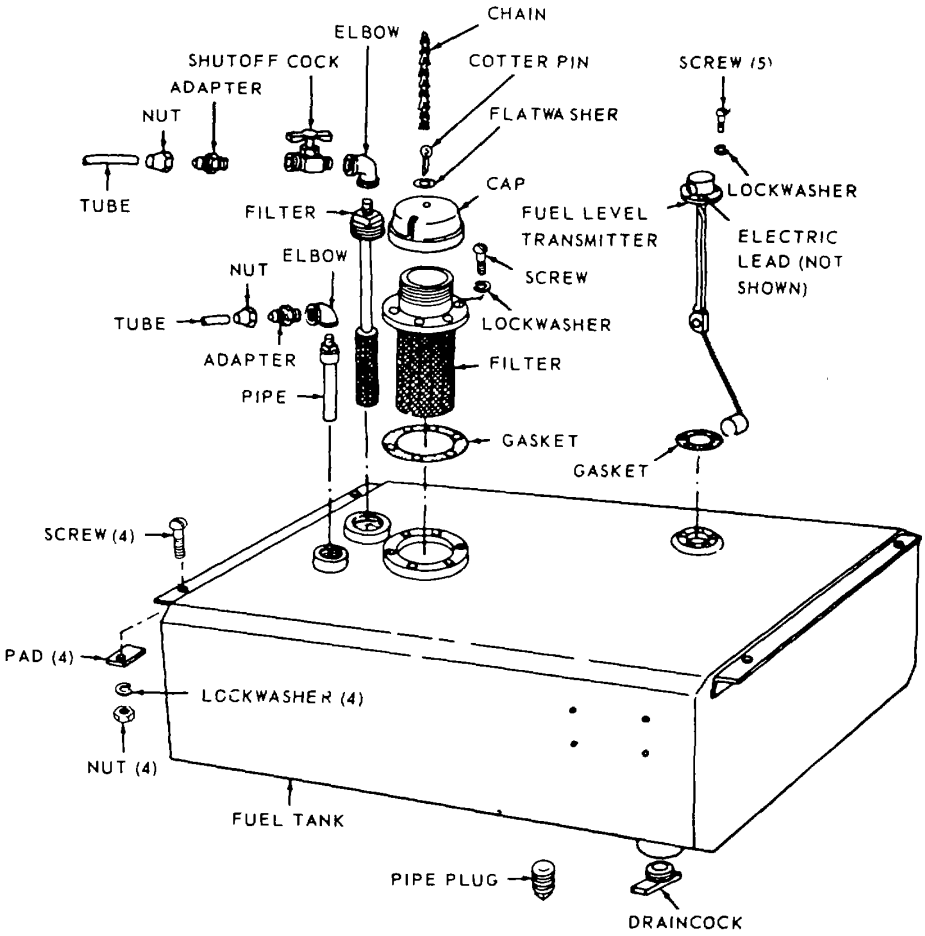


Figure 3-47. Air manifold and blower adapters, installed view.

STEP 1

REMOVE CAP, OPEN DRAINCOCK AND DRAIN FUEL FROM TANK, THEN LOOSEN NUT AND REMOVE TUBE FROM ADAPTERS (2) AND PLUG OR COVER END OF TUBES AND ADAPTERS. DISCONNECT ELECTRICAL LEAD (NOT SHOWN) FROM FUEL LEVEL TRANSMITTER.



STEP 2

REMOVE NUT (4), LOCKWASHER (4), PAD (4), AND SCREW (4) THEN REMOVE FUEL TANK FROM REVOLVING FRAME.

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Figure 3-48. Fuel tank, lines, and fittings, removal and installation.

to pick up remaining moisture. Let tank set in normal position for about 10 minutes, then remove drain plug and drain tank. Install drain plug.

(*e*) Install fuel tank by reversing procedure used to remove in (*a*) above.

3-68. Primary Fuel Filter (Engine Model 687C-18-ES Only)

a. Removal and Installation. Refer to figure 3-49, remove items 1 through 3, then remove filter from engine. Install in reverse order.

b. Disassembly and Reassembly. Refer to figure 3-49 and disassemble filter by removing items 4 through 13 in numerical sequence from item 14. Reassemble in reverse order.

c. Cleaning, Inspection, and Repair.

(1) Clean all parts in an approved cleaning solvent and dry thoroughly.

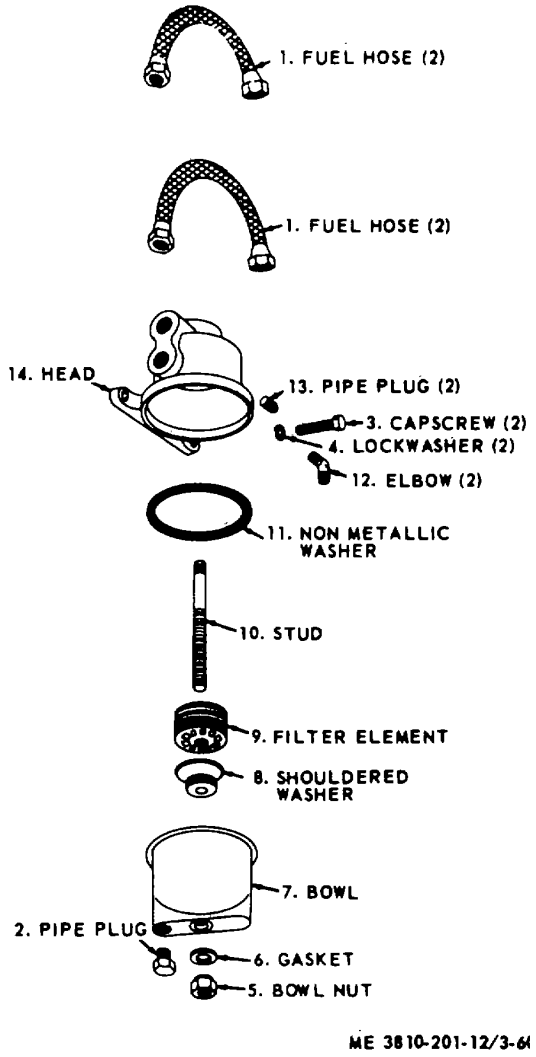


Figure 3-49. Primary fuel filter (on engine model 687C-18-ES only) removal, disassembly, reassembly and installation.

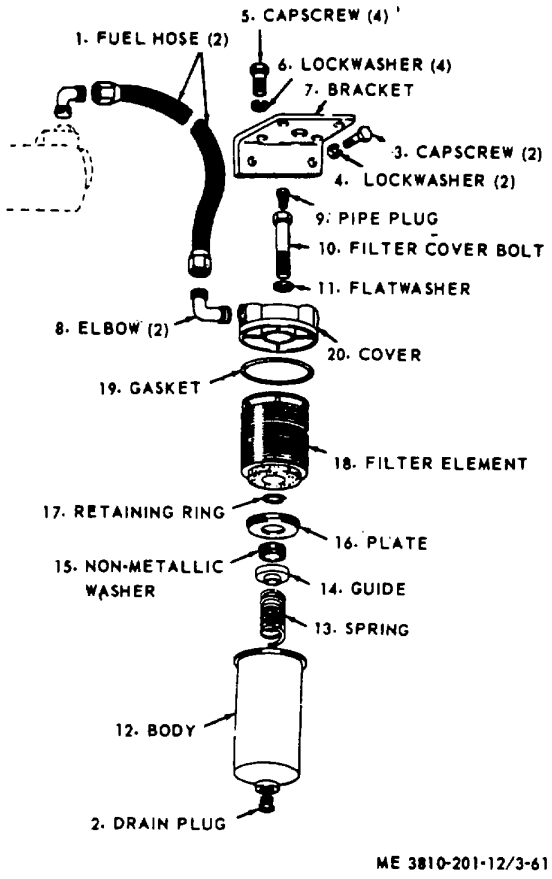


Figure 3-50. Fuel filter (secondary), removal, disassembly, reassembly and installation (engine model 687C-18-ES).

(2) Visually inspect all parts for damage or defect.

(3) Repair by replacing defective parts. Replace all gaskets at reassembly.

3-69. Fuel Filter (Secondary, on Engine Model 687C1 ES)

a. Secondary Fuel Filter on Engine Model 687C-18-ES.

(1) *Removal and installation*.

(*a*) Refer to figure 3-50, remove items 1 and 2, and drain filter.

(*b*) Remove items 3 and 4 and remove filter and bracket from engine.

(2) *Disassembly and reassembly*. Refer to figure 3-50 and disassemble fuel filter by removing items 5 through 19 in numerical sequence from item 20. Reassemble in reverse order.

(3) *Cleaning, inspection, and repair*.

(*a*) Clean all parts in an approved cleaning solvent and dry thoroughly.

(*b*) Visually inspect all parts for dents, cracks, stripped threads, or other damage.

(*c*) Repair by replacing defective components or mounting hardware.

(4) *Service*. Service fuel filter as directed in paragraph 3-18.

b. Fuel Filter on Engine Model DSSSTA.

(1) *Removal and installation*. Refer to figure 3-1, perform steps 1 and 2, and remove fuel filter. Install in reverse order.

(2) *Disassembly and reassembly*. Refer to figure 3-51, perform step 3, and disassemble fuel filter. Reassemble in reverse order.

(3) *Cleaning, inspection, and repair*.

(*a*) Clean all parts except pressure gauge

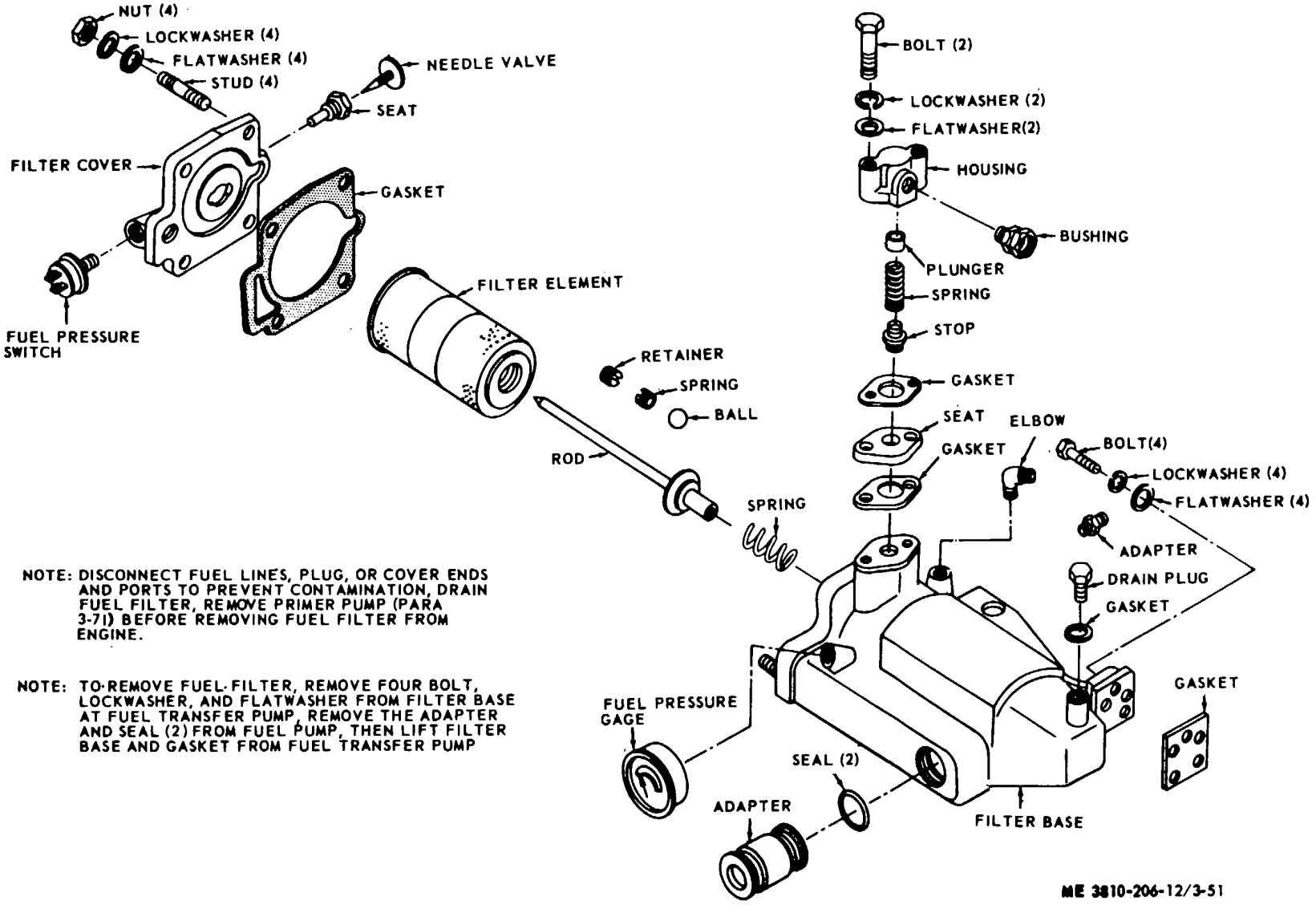


Figure 3-51. Fuel filter (for engine model D333TA), removal, disassembly, reassembly, and installation.

and switch, and filter element which is discarded, in an approved cleaning solvent and dry thoroughly. Wipe gauge and switch clean with a rag dampened in cleaning solution, then wipe dry.

(*b*) Visually inspect all parts for excessive wear, cracks, dents, or stripped threads. Test continuity of low fuel pressure switch. Test fuel pressure gauge with controlled air pressure.

(*c*) Repair by replacing damaged, defective, or worn parts. Install new filter element at reassembly.

(4) *Service*. Service fuel filter as directed in paragraph 3-13.

3-70. Governor Throttle Control Linkage

a. Removal and Installation. Refer to figure 3-52 and remove governor throttle control linkage in numerical sequence. Install in reverse order.

b. Cling, Inspection, and Repair.

(1) Clean all parts except flexible control cable in an approved cleaning solvent and dry thoroughly. Wipe housing and rod ends of control cable clean with rag dampened in cleaning solvent, then wipe dry.

(2) Visually inspect mounting hardware for stripped threads or other defects. Move flexible control through housing to check freedom and ease of movement. Inspect housing for dents or other deformation.

(3) Repair by replacing defective items. When housing of control cable is deformed and binds control, replace the flexible control.

c. Adjustment. The flexible control is adjustable at either the engine, or throttle lever end. When throttle lever is not correctly positioned on quadrant, at idle or high speed, adjust as follows:

(1) Remove cotterpin and pin from rod end clevis (fig. 3-63), back off locknut, then turn clevis on rod end clockwise to shorten, or counterclockwise to lengthen control cable.

(2) Reinstall cable rod end on shaft and try throttle lever position.

(3) Repeat steps (1) and (2) until adjustment is correct, then tighten locknut.

3-71. Primer Pump, Lines, and Fittings

a. For Engine Model 687C-18-ES.

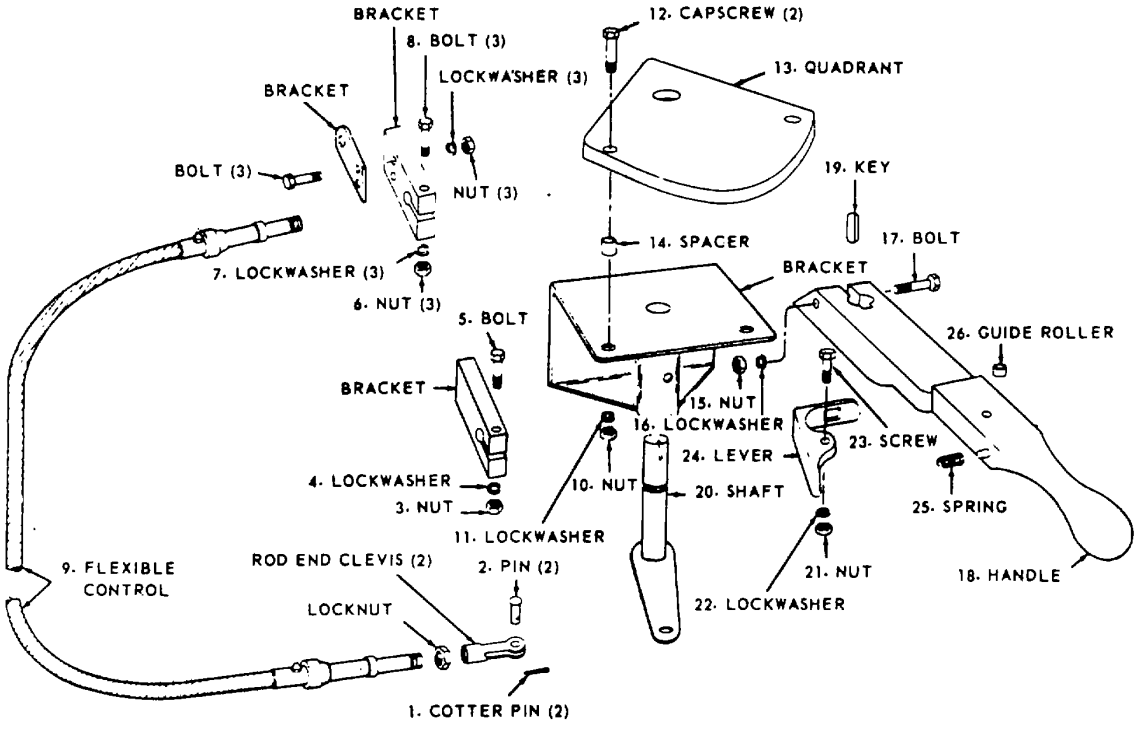


Figure 3-52. Governor throttle control linkage, removal and installation.

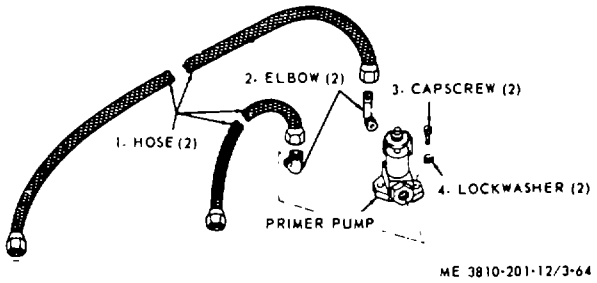


Figure 3-53. Primer pump (for engine model 687C-18-ES) removal and installation.

(1) *Removal and installation*. Refer to figure 3-53 and remove primer pump in numerical sequence. Install in reverse order.

(2) *Cleaning, inspection, and repair.*

(*a*) Clean all parts in an approved cleaning solvent and dry thoroughly.

(*b*) Visually inspect for bent or clogged fuel lines, burs, or stripped threads.

(*c*) Repair by removing burs, replacing

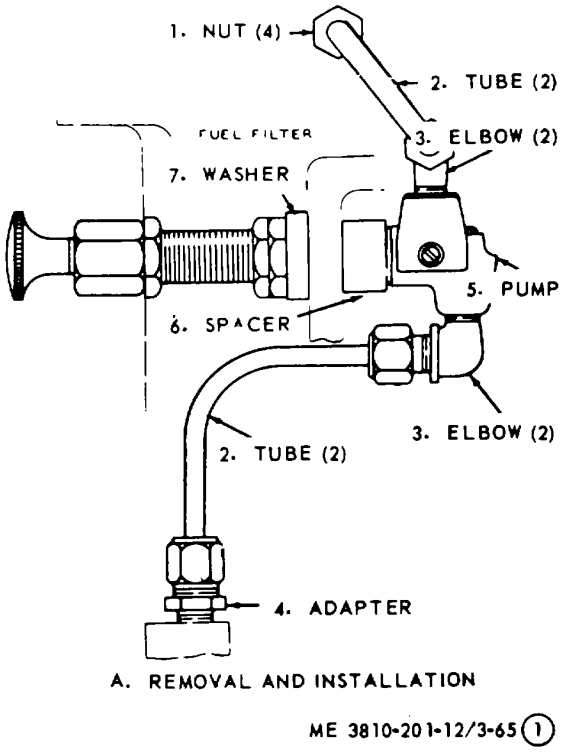


Figure 3-54. Primer pump (for engine model D333TA) removal, disassembly, reassembly and installation (sheet 1 of 2).

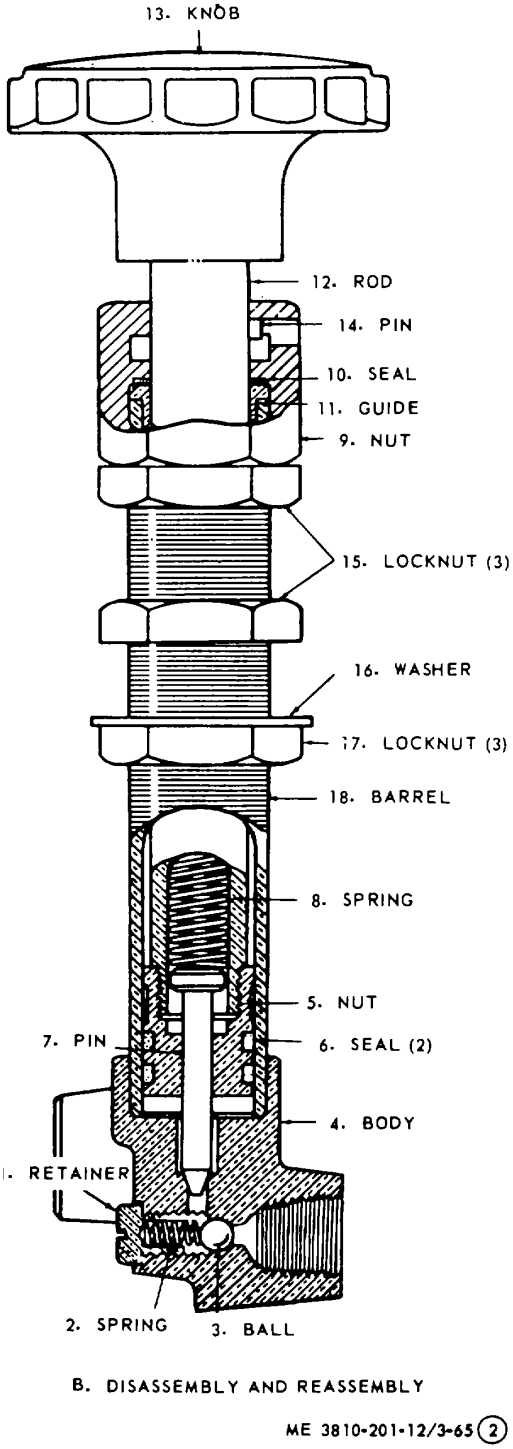


Figure 3-54. Primer pump (for engine model D333TA) removal, disassembly, reassembly and installation (sheet 2 of 2).

damaged or defective hardware or replacing a defective primer pump.

b. For Engine Model D333TA.

(1) *Removal and Installation*. Refer to view A of figure 3-54 and remove items in numerical sequence. Install in reverse order.

(2) *Disassembly and Reassembly*. Refer to view B of figure 3-54 and disassemble the primer pump in numerical sequence. Reassemble in reverse order.

(3) *Cleaning, Inspection and Repair*.

(*a)* Clean all parts in an approved cleaning solvent and dry thoroughly.

(*b)* Visually inspect for burred threads, weak springs, damaged seals, and bent or clogged fuel lines (tubes).

(*c)* Repair by replacing defective items.

3-72. Engine Shutoff Control

a. Removal and Installation. Refer to figure 3-55, remove items in numerical sequence, and remove engine shutoff control. Install in reverse order.

b. Cleaning, Inspection, and Repair.

(1) Clean all parts in an approved cleaning solvent and dry thoroughly.

(2) Visually inspect all hardware for burred or stripped threads, test that flexible control pulls through housing easily (does not bind), and that knob is serviceable.

(3) Repair by replacing defective hardware of flexible control.

3-73. Blower Adapters (For Engine Model 687C-18-ES)

a. Removal and Installation. Refer to figure 3-56 and remove blower adapters. Install in re verse order.

b. Cleaning, Inspection, and Repair.

(1) Clean all parts in an approved cleaning solvent and dry thoroughly.

(2) Visually inspect all parts for dents, cracks, excessive wear, or other defect Inspect gaskets and hose for deterioration or other defect.

Inspect mounting hardware for burs, stripped threads, or other defect.

(3) Repair by replacing defective component or mounting hardware.

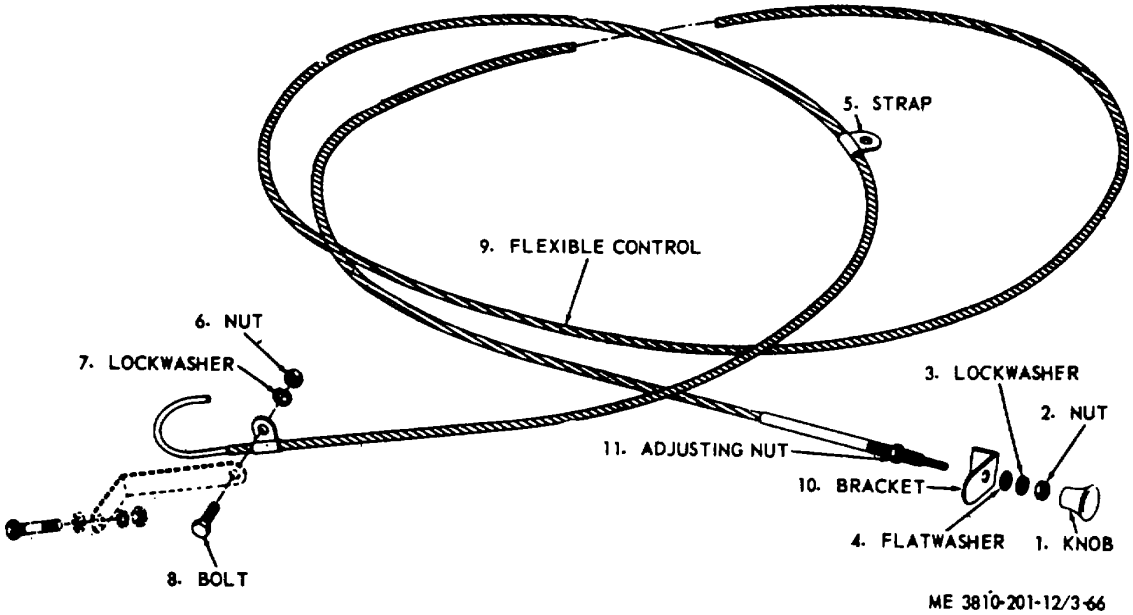


Figure 3-22. Engine shutoff control, removal and installation.

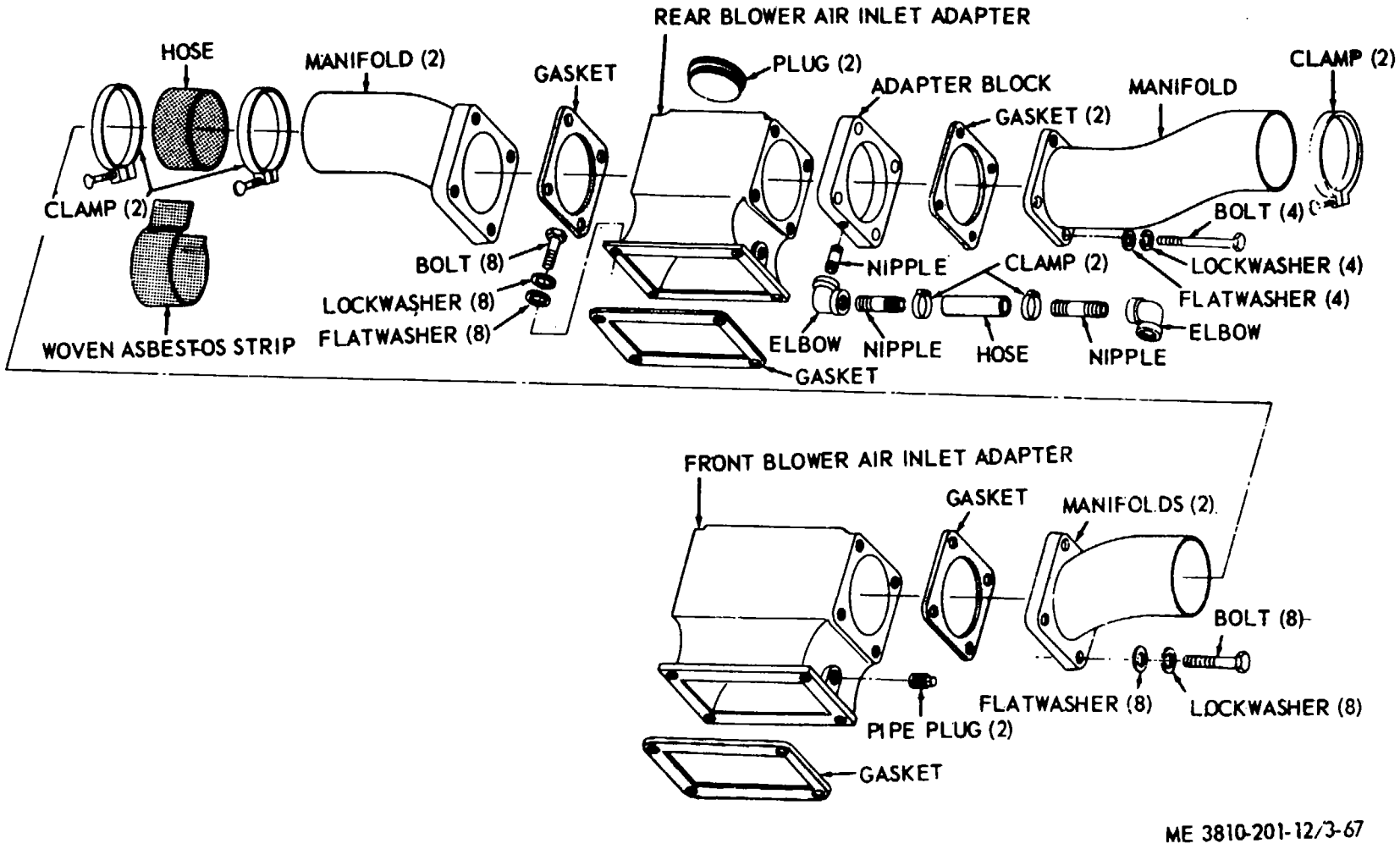


Figure 3-56. Blower Adapters, removal and installation (Engine Model 687C-18-ES).

3-74. General

a. For Crane Units with Engine Model 687C-18-ES. This 24 volt electrical system consists of two 12 volt batteries connected in series, a belt driven battery-charging generator, starter, starter solenoid relay, panel lights, generator voltage regulator, trouble light, oil pressure transmitter, water temperature transmitter, low oil pressure switch, water high temperature switch, and ammeter. An over speed governor driven through tachometer drive, actuates the shutdown lever on injection pump through a micro-switch controlled circuit when engine overspeeds the predetermined limit. The cranes are also equipped with a horn and floodlight. See wiring schematic diagram (view A of fig. 1-9).

b. For Crane Units with Engine Model D333TA. This unit is equipped with battery-charging alternator and alternator voltage regulator instead of generator and generator voltage regulator. It is not equipped with the micro-switch overspeed governor shutdown circuit, but has a low fuel pressure switch mounted on clean side of fuel filter that is normally open to prevent electrical current from flowing back to the alternator when engine is stopped, and cause damage to rectifiers in alternator or transistors in regulator. See wiring schematic diagram (view B of fig. 1-9).

c. Organizational Maintenance Procedures. This section will outline and illustrate organizational maintenance procedures authorized by the Maintenance Allocation Chart (app. C).

3-75. Batteries

a. Removal and Installation.

(1) Refer to figure 3-57, perform steps 1 and 2, and remove batteries.

(2) Install in reverse order.

b. Cleaning, Inspection, and Repair.

(1) Clean batteries with an approved cleaning solution and dry thoroughly. Remove all corrosion from battery cables and terminal posts.

(2) Visually inspect battery cases and vent caps for cracks, or terminals for looseness. Use a hydrometer and test electrolyte for specific gravity. Charge, or replace a battery reading less than 1.250 on hydrometer.

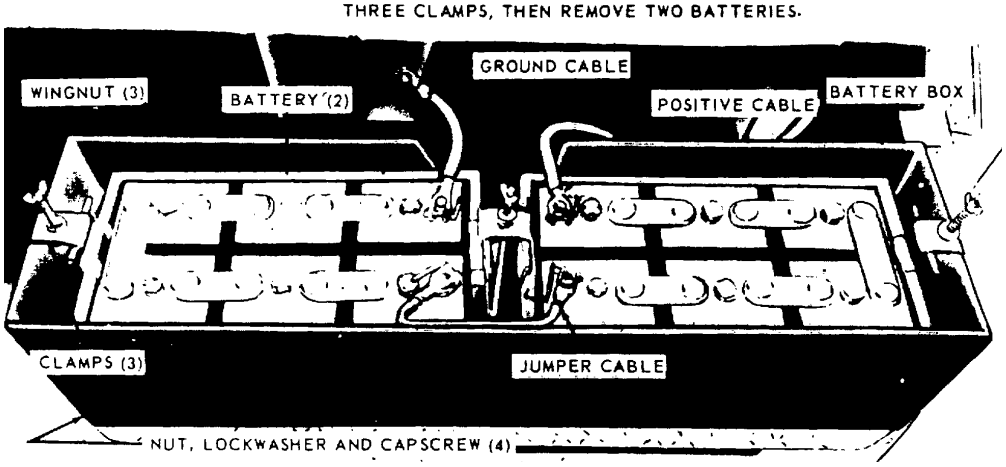
(3) Repair by replacing defective cables or battery.

STEP 1

REMOVE THREE WING NUTS, REMOVE COVER (NOT SHOWN). THEN REMOVE GROUND CABLE.

STEP 2

REMOVE JUMPER CABLE, POSITIVE CABLE, THREE CLAMPS, THEN REMOVE TWO BATTERIES.



STEP 3

REMOVE FOUR CAPSCREW, LOCKWASHER AND NUT FROM END BRACKET, THEN REMOVE BATTERY BOX FROM CAB FLOOR.

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Figure 3-57. Battery and Battery Box, removal and installation.

3-76. Battery Box

a. Removal.

(1) Remove batteries (para 3-75).

(2) Refer to figure 3-57, perform step 3, and remove battery box.

b. Installation. Refer to figure 3-57, perform step 3 in reverse order, and install battery box.

3-77. Generator and Belt (For Engine Model 687C-18-ES)

a. On Equipment Test of Generator.

(1) *Field current test*. Refer to figure 3-58, remove shielded cable, and inspection band from generator.

(*a*) Use automotive generator and voltage regulator test set as illustrated in view A of figure 3-59 and test field current output.

(*b*) Adjust variable resistance until voltmeter reads 24 volts.

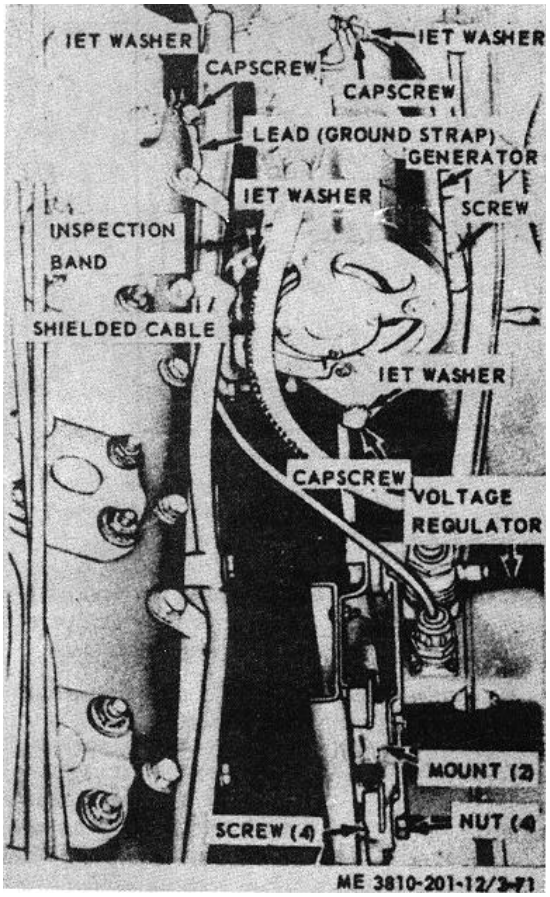

Figure 3-58. Generator and voltage regulator test points.

NOTE

Batteries must be fully charged for this test.

(*c*) *Read ammeter*. Correct reading should be from 1.00 to 1.05 ampere.

(*d*) When readings do not meet requirements of (*b*) and (*c*) above, generator is defective and must be replaced.

(2) *Motoring test*. Connect test set as illustrated in view B of figure 3-59.

(*a*) Adjust variable resistor to maximum resistance.

(*b*) Close battery switch then gradually reduce resistance until armature begins to rotate. It should rotate freely.

(*c*) When armature falls to rotate freely, generator is defective and must be replaced.

(*d*) Remove test set, install inspection band, and replace shielded cable.

b. Removal and Installation.

(1) Tag and remove all electrical leads.

(2) Remove capscrew from adjusting bracket, move generator toward engine block and remove belt from pulley.

(3) Remove two capscrews, washers and nuts from generator mounting bracket, then lift generator from bracket.

(4) Install in reverse order.

c. Cleaning, Inspection and Repair.

(1) Clean exterior of generator housing with a rag dampened in an approved cleaning solvent then dry thoroughly. Blow dust from armature brush area with low pressure compressed air.

(2) Inspect mounting hardware for worn or stripped threads, inspect belt for excessive wear, frayed, or deteriorating condition. Visually inspect housing, end bells, or pulley for breaks or cracks. Inspect brushes for wear beyond 50 percent of original length.

(3) Repair by replacing defective mounting hardware, belt, or worn brushes. Replace a defective generator.

d. Brush Replacement. Worn brushes will be replaced in a manner similar to that described for starter motor brushes (para. 3-81).

e. Belt Removal, Installation and Adjustment.

(1) *Removal and Installation*. Remove belt as described in *b* (2) above. Install in reverse order.

(2) *Adjustment*. Adjust generator belt as shown on figure 3-17.

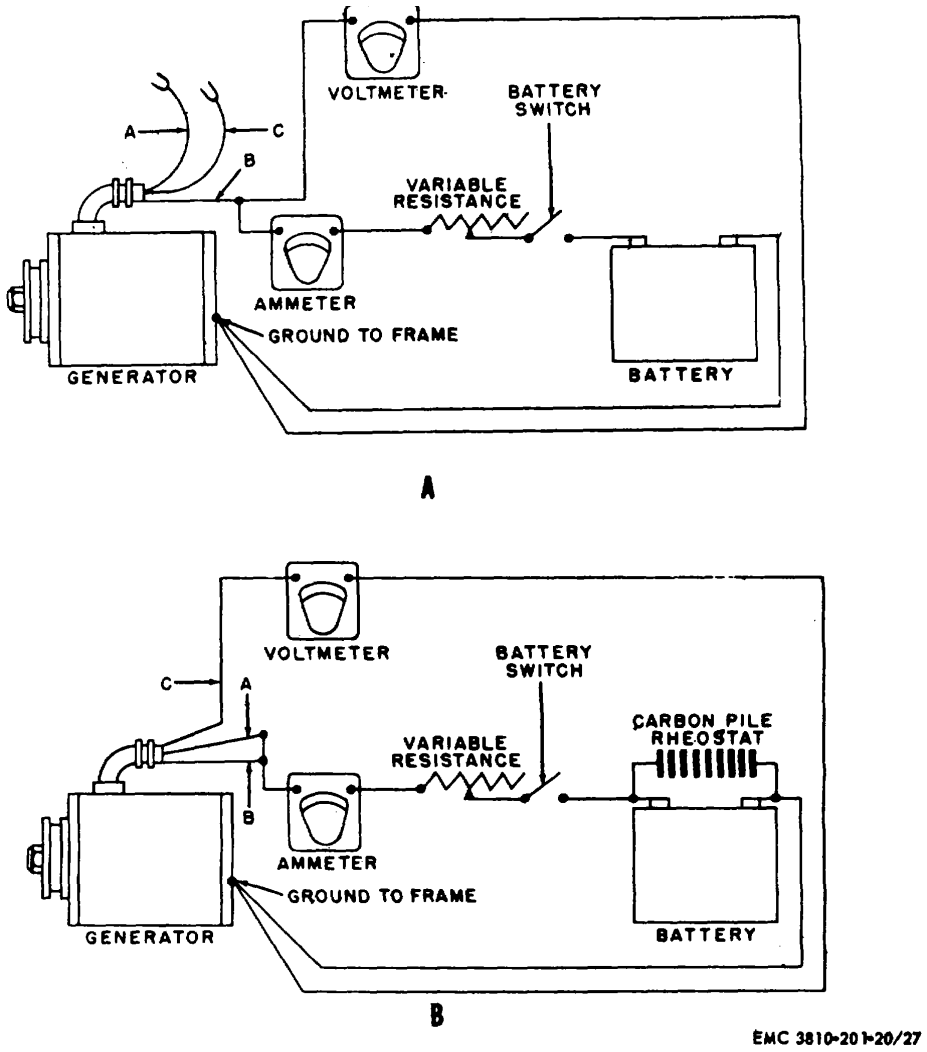

Figure 3-59. Generator test connections.

3-78. Alternator and Belt (For Engines Model D333TA)

a. General. The self-rectifying charging alternator is designed to give long and satisfactory service with a minimum amount of maintenance, but the following precautions must be observed.

CAUTION

Do not attempt to polarize the alternator. If an accidental connection were made between the battery terminal and either of the terminals "F1" or "F2" on the alternator the transistors in voltage regulator will be damaged.

CAUTION

Do not make, or break, any alternator connections while alternator is operating. This would damage the voltage regulator.

CAUTION

Never operate alternator without battery being connected in circuit.

CAUTION

When charging batteries from an external source of power, be sure battery is disconnected from circuit before beginning charging operation, to prevent damage to alternator rectifying diodes

CAUTION

Before using booster cables to start the engine, be sure of the lead polarity and connect the batteries correctly. Incorrect connection, even for an instant, will destroy alternator's rectifying diodes.

Caution

Do not operate the alternator simultaneously with a DC generator on a common battery circuit.

b. On Equipment Test.

(1) Disconnect battery cables and tie back to prevent accidental flash current.

(2) Tag accurately for position, then remove all electrical leads from alternator.

(3) Use automotive generator and voltage regulator test set and hook up as illustrated in figure 3-60.

(4) Operate the alternator at approximately 2,500 RPM.

Caution:

Do not allow voltage to exceed the recommended voltage setting of the regulator.

(5) Adjust the load rheostat to obtain 28 volts. When the correct voltage is obtained, the ammeter should read 61 amperes.

(6) If the correct output is not obtained, replace the alternator.

(7) If the correct output is obtained and the batteries are not charging correctly, check remainder of the charging circuit (view B of fig.1-9).

(8) Remove test set harness, reconnect all electrical leads, then remove tags.

(9) Install battery cables.

c. Removal and Installation.

(1) Remove battery cables 'and tie back to prevent flash currents.

(2) Tag correctly for position, then remove all electrical leads from alternator.

(3) Remove alternator in manner similar to that described for generator (para 3-77).

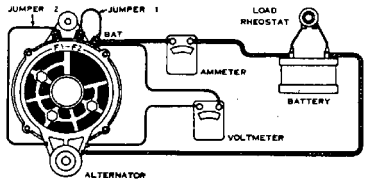

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Figure 3-60. Alternator test connections .

d. Cleaning, Inspection and Repair.

(1) Clean exterior of alternator with a rag dampened in an approved cleaning solvent then dry thoroughly. Blow all dust from brush area with low pressure compressed air.

(2) Visually inspect all mounting hardware for wear or stripped threads. Inspect alternator for cracks or breaks in pulley, housing, or end bells. Inspect belt for wear, frayed condition, or deterioration.

(3) Repair by replacing defective hardware, belt, or alternator.

e. Belt Removal, Installation, and Adjustment.

(1) Removal and installation. Remove alternator belt in manner similar to that described for generator (para 3-77). Install in reverse order.

(2) Adjustment. Adjust generator belt as shown on figure 3-17.

3-79. Generator Regulator (For Engine Model 687C-18-ES)

a. On Equipment Test.

(1) Remove electrical leads from voltage regulator (fig. 3-58).

(2) Test voltage regulator in conjunction with generator (para. 3-77) by using connections illustrated in view B, figure 3-61. Polarize generator by momentarily touching jumper wire as shown in view A.

(3) Start generator and gradually increase speed until cutout relay points close. Closing voltage should be 26 volts.

(4) With generator operating at 4,000 RPM, reading on voltmeter should be 28.2 volts, and ammeter should read 40 amperes.

(5) If requirements of (3) and (4) above are not met, regulator is defective, and must be replaced.

Note.

Do not remove voltage regulator except when replacement is required

b. Removal and Installation. Refer to figure 3-62 and remove items. 1 through 4 in numerical sequence to remove voltage regulator. Items 5 through 8 removes shock mount. Install in reverse order.

3-80. Alternator Voltage Regulator (For Engine Model D333TA)

a. General. The alternator voltage regulator senses charge condition of batteries as well as electrical system power demand, and controls alternator output accordingly. As battery charge increases, charging rate decreases, until batteries

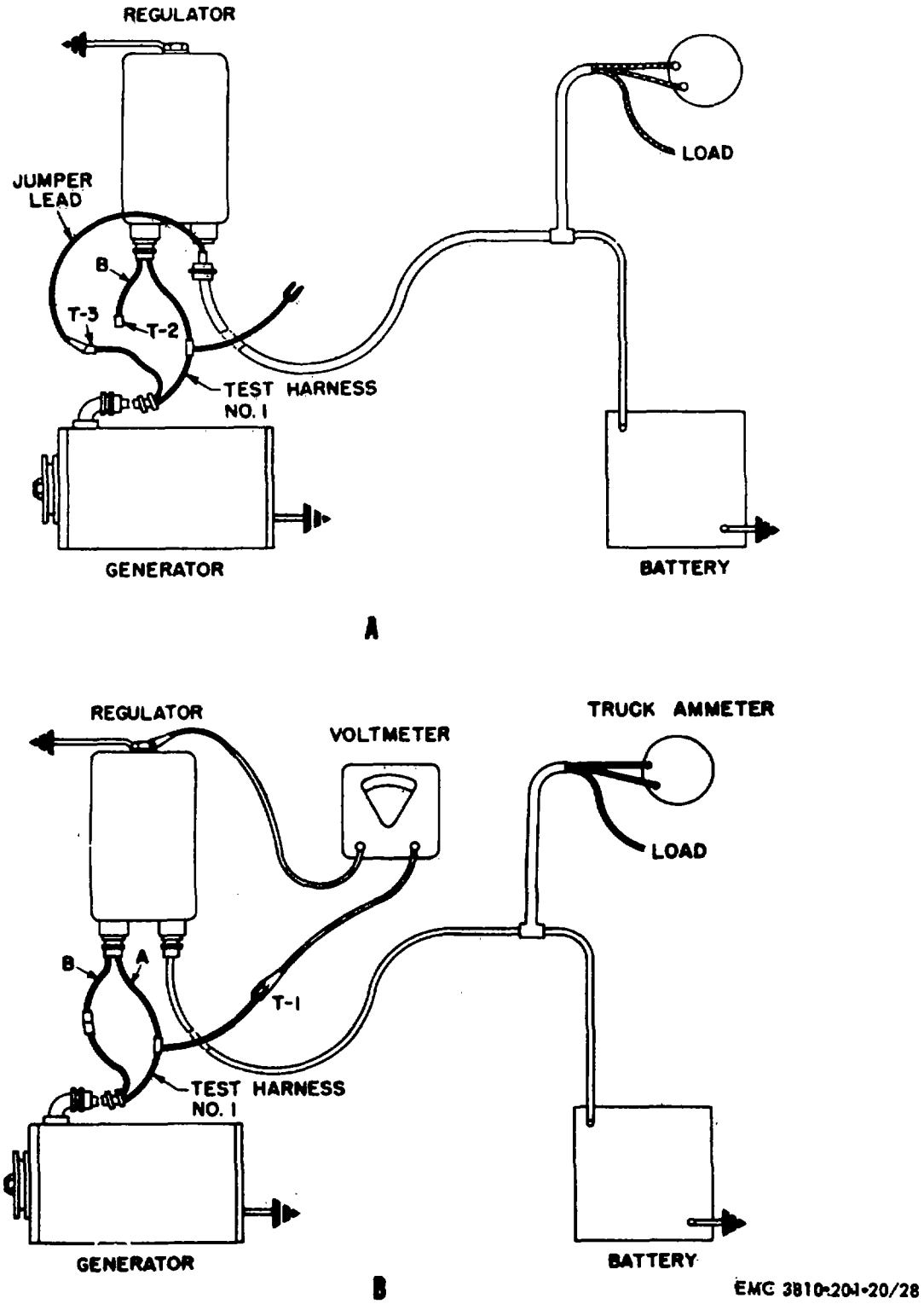


Figure 3-61. Generator voltage regulator test connection.

are fully charged and ammeter will indicate a rate only perceptibly above zero. Since this regulator is factory adjusted for average operating conditions, it may require adjustment for the particular ambient temperature in which the engine is operating.

b. Test and Adjustment.

(1) Use voltmeter set on 0 to 60 vdc scale, refer to view B of figure 1-9 and connect positive (red) lead of voltmeter to alternator terminal "FI", connect negative lead (black) to ground, then start engine.

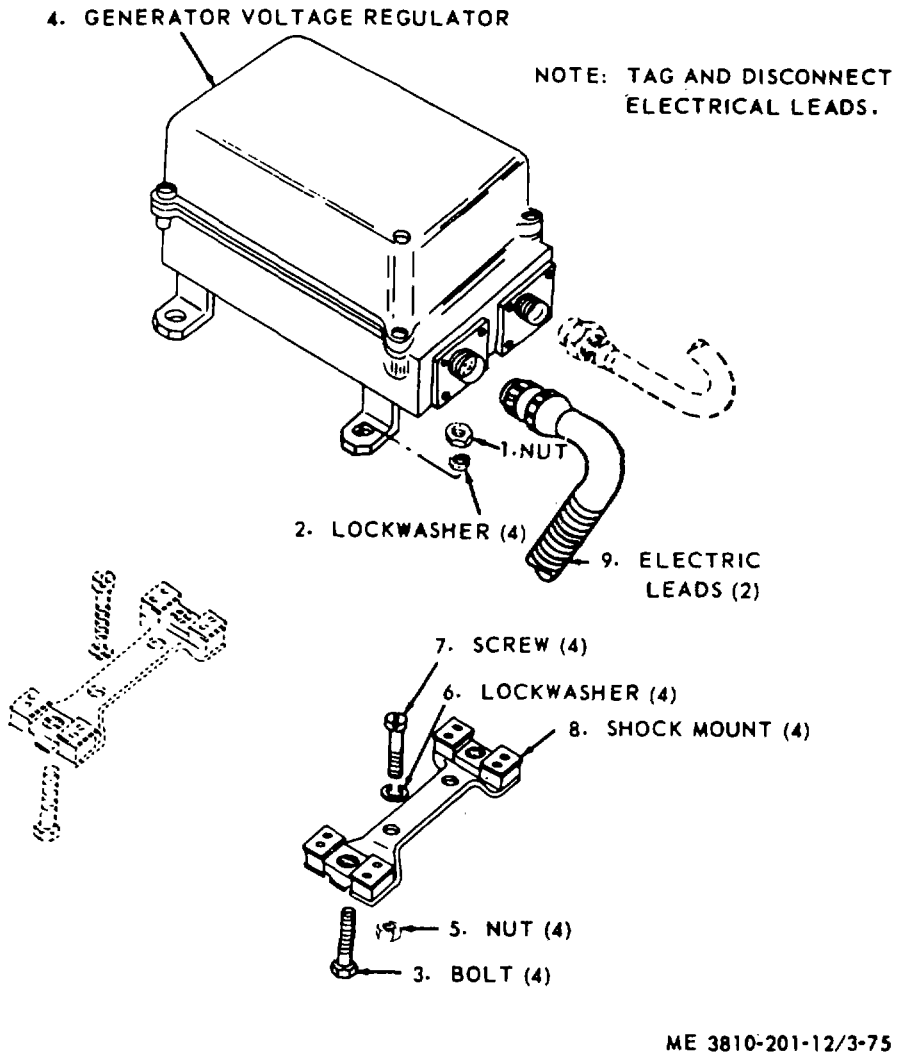


Figure 3-62. Generator voltage regulator and shook mount, removal and installation

(2) Operate alternator at approximately 2,500 RPM and read voltmeter. It should read between 27.5 and 28.5 volts.

(3) If reading is not within limits pre ,scribed in (2) above, remove plug (fig. 3-63) from voltage regulator and use screwdriver to adjust screw within regulator counterclockwise to reduce voltage, clockwise to increase voltage, until reading on voltmeter is correct.

(4) When regulator will not adjust to prescribed reading, regulator is defective and must be replaced.

(5) Stop engine and remove voltmeter.

Note

Do not remove regulator except we replacement is required.

c. Removal and Installation

(1) Disconnect battery cables and tie back to prevent flash currents.

(2) Disconnect electrical connector (fig. 3-63) from voltage regulator.

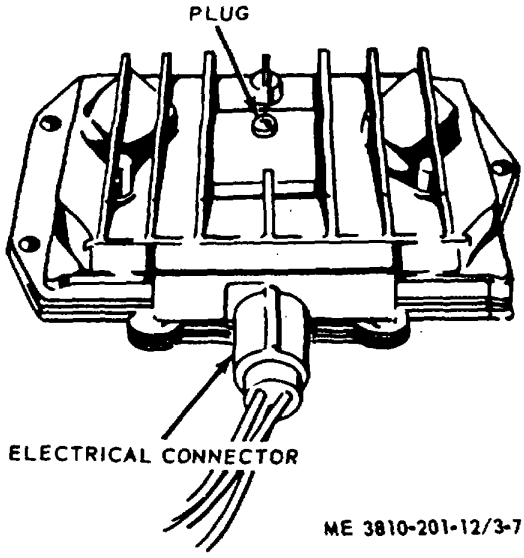


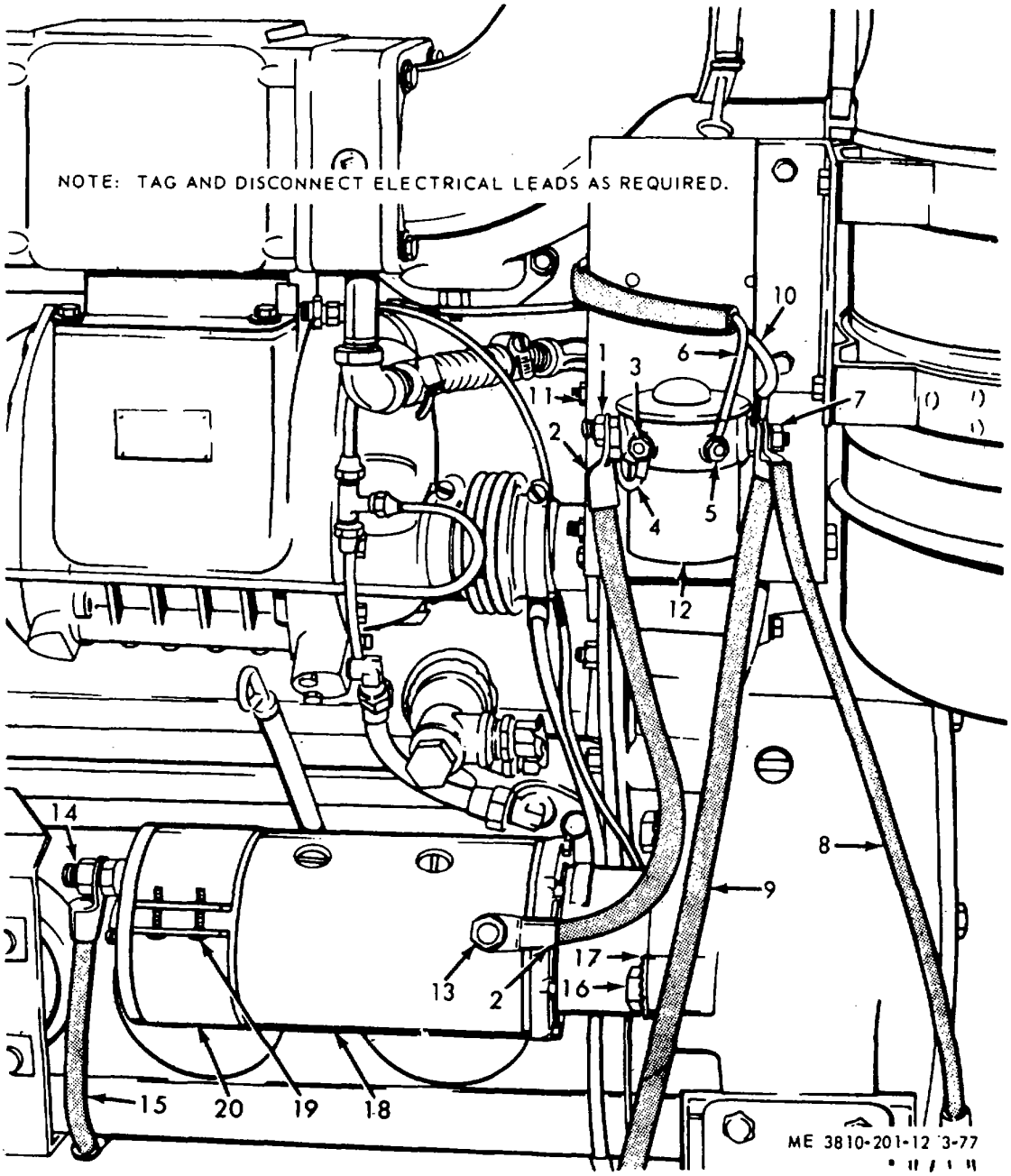
Figure 3-63. Alternator voltage regulator, adjustment , removal and installation.

(3) Remove three nuts, washers, and capscrews, then remove voltage regulator from mounting bracket.

(4) Install in reverse order.

3-81. Starter Motor

a Removal and Installation. Refer to figure 3-64, remove items (2) and (13) through (18)



1	Nut	11	Bolt, washer and nut (2)
2	Electrical lead	12	Relay solenoid
3	Nut	13	Nut
4	Electrical lead	14	Nut
5	Nut	15	Electrical lead
6	Electrical lead	16	Nut (3)
7	Nut	17	Lockwasher (8)
8	Electrical lead	18	Starter motor
9	Electrical lead	19	Screw and nut (2)
10	Electrical lead	20	Inspection band

Figure 3-64. Starter motor relay solenoid and inspection band removal and installation.

in numerical sequence, and starter motor is removed. Install in reverse order.

b. Cleaning and Inspection.

(1) Clean all parts with a rag dampened in an approved cleaning solution and dry thoroughly. Blow dust from brush area with low pressure compressed air.

(2) Visually inspect mounting hardware for wear or stripped threads. Replace defective hardware or starter motor. Repair by replacing defective brush set (c below).

c. Starter Motor Brush Replacement.

(1) Remove starter motor (a above).

(2) Refer to fig. 3-64 and remove items (19) and (20).

Note

Remove and replace one brush at a time, until set of eight is replaced.

(3) Refer to figure 3-65, remove screw and lockwasher from brushholder.

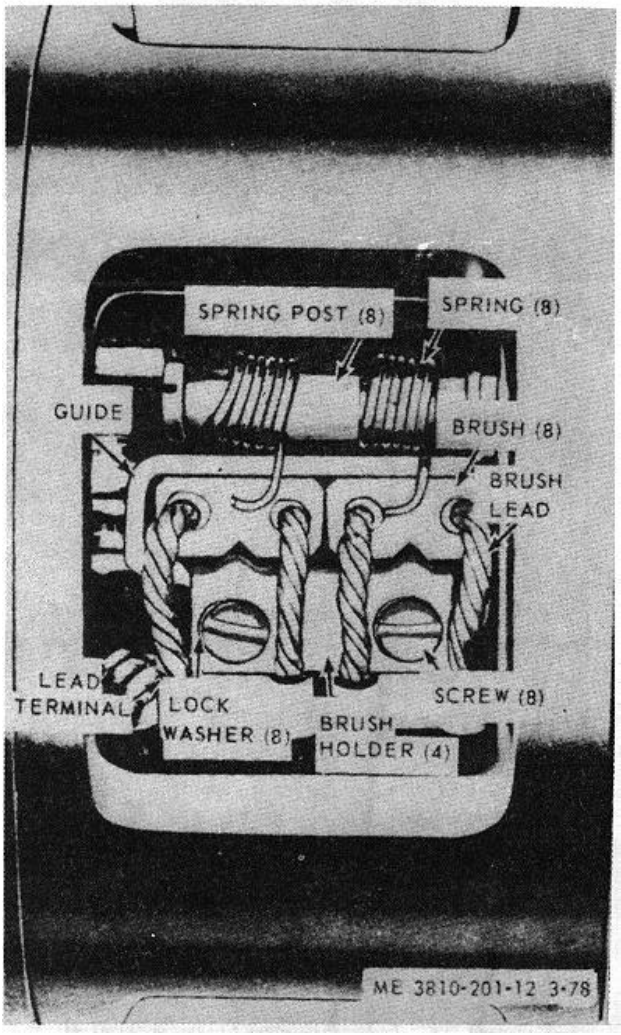


Figure 3-65. Starter motor brush replacement.

(4) Remove brush from guide by pulling outward on brush lead.

(5) Install new brush by first lifting outward on brush spring.

(6) Insert brush into guide, push it down into contact with commutator, and let spring down on top of brush.

(7) Seat brush so it has perfect surface contact with commutator.

Note

Brushes can be seated perfectly by drawing a piece of 00 grade sandpaper between commutator and brush and against brushholder. Sand only as much as is necessary to obtain a perfect brush fit. Blow the sand and carbon dust out of starter motor with low pressure compressed air.

(8) Pull brush outward 1/4 inch and then allow spring to push it back down into guide. Repeat this step as often as necessary to assure brush is free in guide and will not bind.

(9) Connect brush cable terminal to brushholder with screw and lockwasher.

(10) Install remaining brushes by repeating steps (3) through (9) for each brush.

(11) Position inspection band on starter and secure with two screws and nuts (fig. 3-64).

(12) Refer to figure 3-64 and install starter by reversing numerical sequence (18) through (13), then (2).

3-82. Relay Solenoid (Starter)

a. Removal and Installation.

(1) From engine model 687C-18-ES. Refer to figure 3-64, remove items (1) through (12) in numerical sequence, to remove relay solenoid. Install in reverse order.

(2) From engine model D333TA. Remove or install in a manner similar to that' described in (1) above.

b. Cleaning, Inspection and Repair.

(1) Clean relay solenoid with a rag dampened in an approved cleaning solvent and dry thoroughly.

(2) Visually inspect mounting hardware for excessive wear or stripped threads, electrical leads for loose terminals, bare wire, or frayed insulation, and test relay for proper operation by placing source-of 24 vdc power across terminals and listen for solenoid movement.

(3) Repair by replacing defective hardware, electrical lead, or defective relay solenoid.

3-83. Receptacle (Slave) Electrical Connector

a. Removal and Installation.

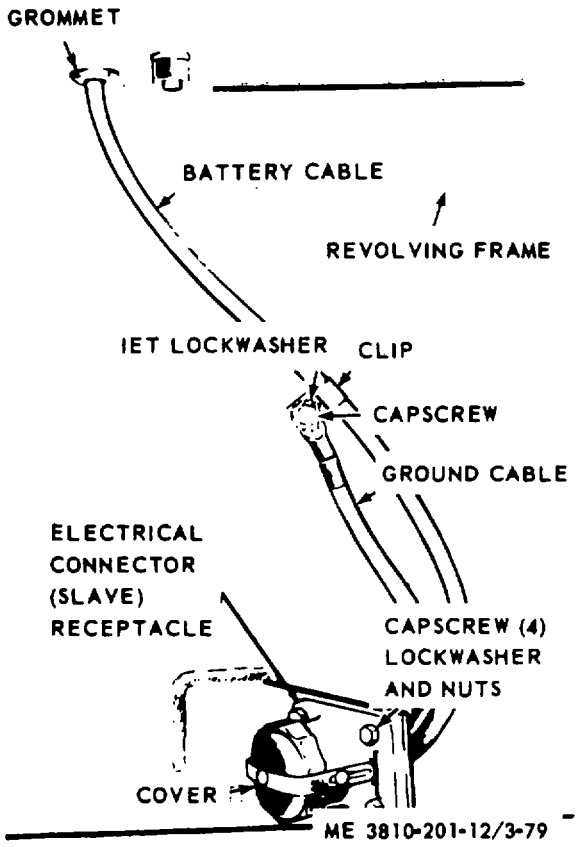


Figure 3-66. Receptacle (slave) electrical connector, removal and installation

(1) Remove capscrew, lockwasher, and ground cable (fig. 3-66).

(2) Remove nut (7, fig. 3-64) and electrical lead (8) then remove clip and grommet (fig.3-66).

(3) Remove capscrews (4), lockwashers, nuts, and receptacle (slave) electrical connector.

(4) Install by reversing steps (3) through (1) above.

b. Cleaning, Inspection and Repair.

(1) Clean all parts with an approved cleaning solvent and dry thoroughly.

(2) Visually inspect hardware for excessive wear or stripped threads, electrical leads for loose terminals, bare wire, or frayed insulation, and receptacle for proper mating with plug electrical connector.

(3) Repair by replacing defective hardware, electrical leads, or receptacles.

384. Lubricating Oil Pressure Transmitter

a. Removal and Installation.

(1) Refer to figure 3-67 and remove lubricating oil pressure transmitter from engine model 687C-18ES. Install in reverse order.

(2) Remove lubricating oil pressure transmitter from engine model D333TA in a manner similar to that given in (1) above.

b. Cleaning, Inspection, and Repair.

(1) Clean all parts with an approved cleaning solvent-and dry thoroughly.

(2) Visually inspect electrical connector for defective connections or frayed lead, inspect transmitter for defective threads, cracked housing, or other defect.

(3) Repair by repairing electrical lead (para 3-89) or replacing defective lead or transmitter.

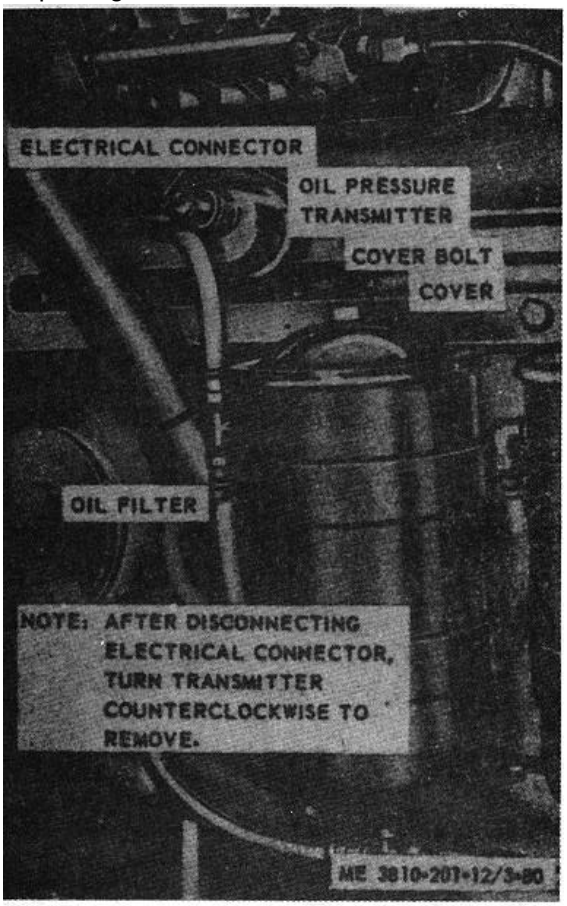


Figure 3-67. Lubricating oil pressure transmitter, removal and installation

3-85. Water Temperature Transmitter

a. Removal and Installation.

(1) Refer to figure 3-68 disconnect electrical connector, and remove water temperature transmitter from engine model 687C-18ES. Install in reverse order.

(2) Remove transmitter from engine model D333TA in a similar manner to that given in (1) above.

b. Cleaning, Inspection and Repair.

(1) Clean all parts in an approved cleaning solvent and dry thoroughly.

(2) Visually inspect electrical connector for defective connections or frayed lead, inspect transmitter for defective threads, cracked housing, or other defect.

(3) Repair by repairing electrical lead (para 3-89), replacing lead, or transmitter.

3-86. Water High Temperature Switch

a. Removal and Installation.

(1) Refer to figure 3-68, tag and disconnect three electrical leads, then remove water high temperature switch from engine model 687C-18-ES. Install in reverse order.

(2) Remove water high temperature switch

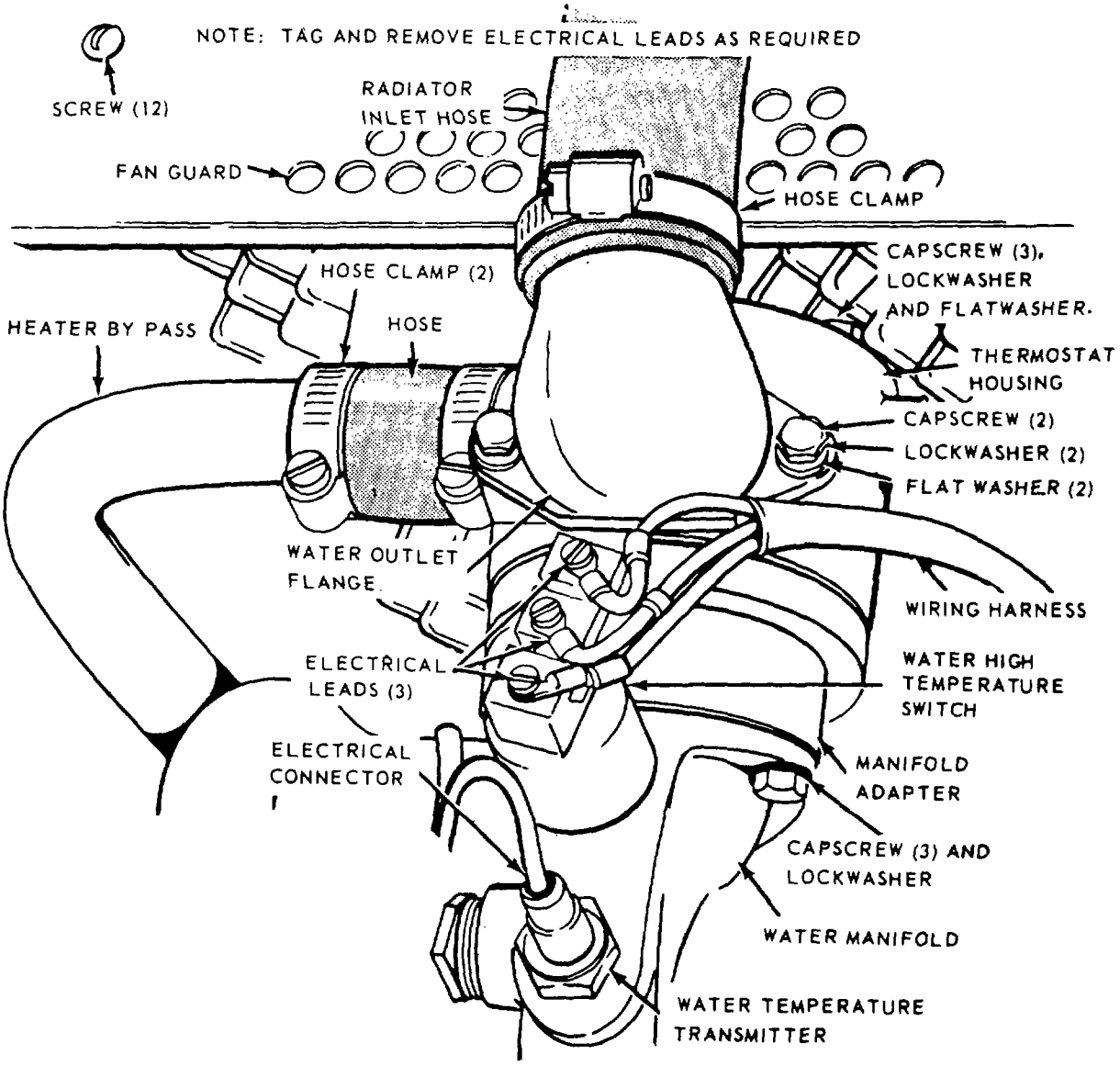


Figure 3-68. Water temperature transmitter, and water high temperature switch, removal and installation.

from engine model D333TA in a manner similar to that given in (1) above.

b. Cleaning, Inspection and Repair.

(1) Clean all parts in an approved cleaning solvent and dry thoroughly.

(2) Visually inspect electrical leads for loose connections or frayed insulation, inspect switch for cracked or dented housing.

(3) Repair by replacing defective lead or Switch.

3-87. Low Oil Pressure Switch

a. Removal and Installation.

(1) Refer to figure 3-69, tag and disconnect three electrical leads, then remove low oil pressure switch from engine model 687C18ES. Install in reverse order.

(2) Remove low oil pressure switch from engines model DB83TA in a manner similar to that given in (1) above.

b. Cleaning, Inspection and Repair.

(1) Clean all parts in an approved cleaning solvent and dry thoroughly.

(2) Visually inspect electrical leads for loose connections or frayed insulation, inspect switch for cracked or dented housing.

(3) Repair by replacing defective lead or switch

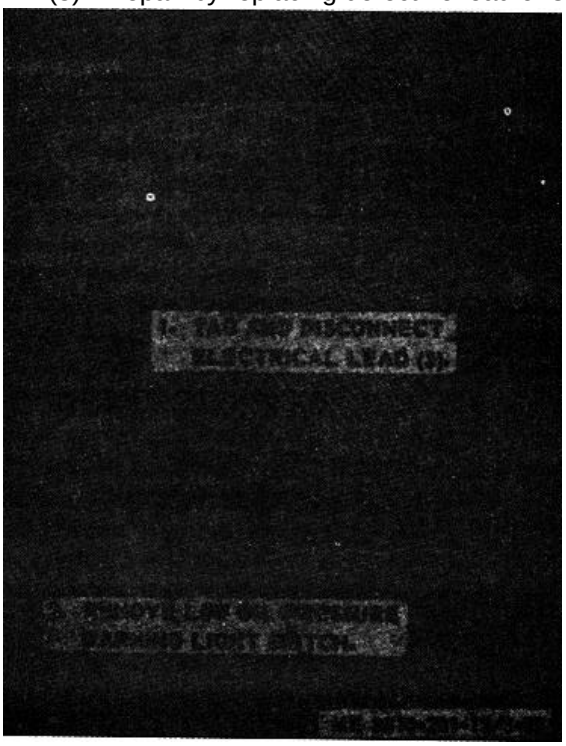


Figure 3-69. Low oil pressure switch removal and installation.

3-38. Overspeed Governor (On Engine Model 687C-18-ES)

a. Removal and Installation.

(1) Disconnect and remove tachometer drive cable (fig. 3-70), then tag and disconnect two electrical leads,

(2) Remove four capescrew, lockwasher, and flatwashers securing overspeed governor to engine front cover, then remove governor.

(3) Install in reverie order.

b. Cling and Inspection

(1) Clean all metal parts with an approved cleaning. solvent and dry thoroughly. Wipe microswitch with a rag dampened in solvent.

(2) Visually inspect mounting hardware and other threaded surfaces for burs or stripped threads. Replace defective parts.

c. Test for Speed Adjustment.

(1) Start engine (par 2-10).

(2) Run at full throttle. If tachometer indicates more than 1,985 ± 15 RPM without shutting down engine, overspeed governor requires adjustment.

(3) If engine shuts down before tachometer indicates 1,920 RPM, overspeed governor requires adjustment

d. Adjustment.

(1) If engine shuts down before tachometer indicates 1,920 RPM, increase between head of the adjustment screw (fig. 3-70) and microswitch arm by turning adjusting screw counterclockwise then moving adjusting nut toward throttle lever. Repeat adjustment, by trial and error, until engine shuts down at 1,985 ± 15 RPM.

(2) If adjustment does not shutdown when tachometer indicates more than 1,950 RPM, decrease distance between head of dusting screw and microswitch arm by backing off adjusting nut, turn adjusting screw clockwise, then move adjusting nut toward throttle lever. Repeat adjustment by trial and error until engine shuts down at 1,985 ± 15 RPKL

(3) Throttle spring tendon is adjusted in a similar manner by adjustment screw on back side of overspeed governor. Tighten adjusting screw against bracket to increase tension screw from bracket to decree tension.

3-89. Wiring

a. general Crane electrical system consists of wiring of varied types including harness single including harness, single

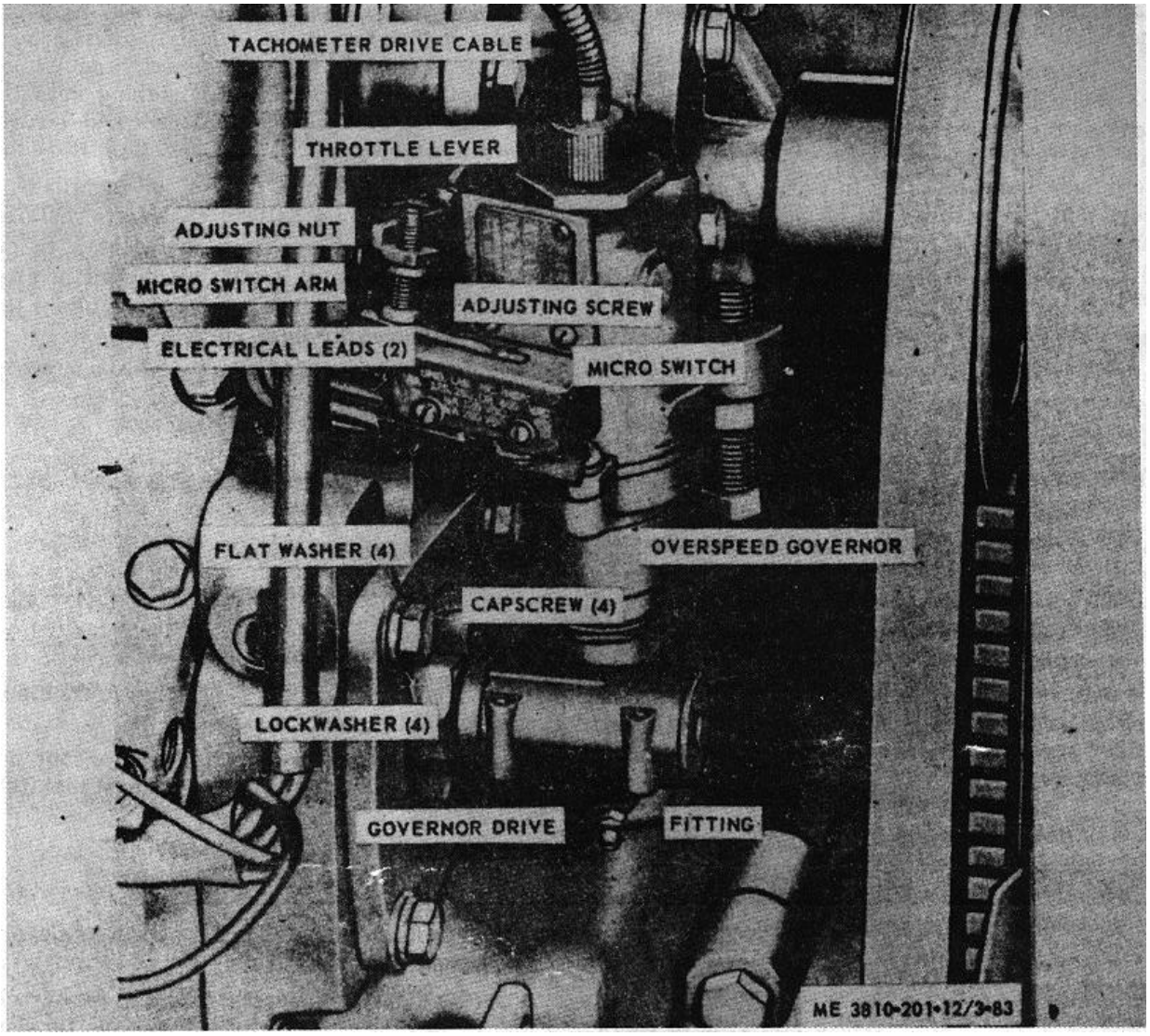


Figure 3-70. Overspeed governor, removal, installation, and speed adjustment (engine model 687C-18-ES).

wires, and conduit protected circuits between junction boxes.

Caution

Keep all wiring free of grease, oil, and accumulations of dust and dirt. Grease and oil will cause rapid deterioration of insulation, and excessive dust accumulations will speed grounding at cracked insulation of electrical leads

b. Testing. Individual electrical leads may be tested for continuity by use of a multimeter or low voltage test lamp. Leads within a harness may be tested similarly by tagging and disconnecting one end of a harness, moving loose end closer to fixed end for ease in reaching terminals by problems of multimeter or test lamp.

c. Inspection. Visually inspect insulation or looms for cracks or fraying. Closely examine lead or harness at all points where passage is over rough or sharp edges, or through holes without grommet protection. Examine lead terminals for security to lead or terminal post of junction box and accessory. Carefully trace leads by referring to applicable portion of wiring diagram (fig.1-9, view A and B). Repair or replace defective leads or harness.

d. Replacement.

(1) Individual leads will be replaced by disconnecting at both terminal points, and installing a new lead of .exactly the same size wire. Be sure that end terminals are secure on lead and terminal post, and that markers are removed from old

lead and installed on new lead in a similar manner.

(2) Individual leads within a harness may be replaced by cutting a length of wire lead as long. as the defective lead, taping it to outside of harness at frequent intervals, installing end terminals and connecting to proper terminals. Be sure that protruding ends of old lead are cut off as close to harness as practical, and that markers are removed from old lead and installed on both ends of the substitute lead.

(3) When there are two or more defective leads within a harness, the harness should be replaced. Tag terminals, identifying lead color or marker number, and disconnect and remove harness. Install new harness, making sure that all leads are correctly positioned and securely fastened to terminals.

Caution

Never remove, or install, leads to alternator while battery cables are installed. Disconnect and tie battery cables back to pre vent flash current Rectifying diodes in alternator, or transistors in voltage regulator are easily damaged by flash current.

Section XIII. EXHAUST SYSTEM

3-90. General

a. Engine Model 687C-18-ES. This exhaust system provides a positive method of expelling exhaust gases from cylinders to atmosphere through twin mufflers and pipes. Each muffler handles the exhaust of three cylinders.

b. Engine Model D333TA. This exhaust system uses gases to power the turbocharger. The exhaust manifold directs gases to turbocharger, and thence to atmosphere through an unruffled exhaust pipe.

3-91. Exhaust Pipe and Cap

a. Engine Model 687C-18-ES. Refer to figure 3-71 and remove cap, and unscrew exhaust pipe from coupling. Install in reverse order.

b. Engine Model D333TA. Refer to figure 3-72 perform steps 1 and 2 and remove cap, hood, and exhaust pipe. Perform step 3 and remove elbow and plugs. Install in reverse order.

3-92. Muffler (Engine Model 687C-18-ES only)

Refer to figure 3-72, unscrew coupling and muffler to remove. Install in reverse order.

3-93 Exhaust Manifold (Engine Model 687C-18-ES)

a. Removal and Installation

(1) Remove exhaust pipe and cap (para 3-19).

(2) Remove muffler (para 3-92).

(3) Refer to figure 3-71, remove four nuts, capscrews, flange and gaskets.

(4) Remove four nuts and clamp, four nuts and washers, then remove two exhaust manifolds and gaskets.

(5) Install in reverse order.

b. Cleaning, Inspection, and Repair.

(1) Clean all parts in an approved cleaning solution and dry thoroughly.

(2) Visually inspect manifold for cracks, breaks, or other defect. Inspect gaskets for damage or defect. Inspect mounting hardware for bur, stripped threads or other defect.

(3) Repair by welding cracks or breaks, and replacing defective mounting hardware. Replace an excessively damaged manifold.

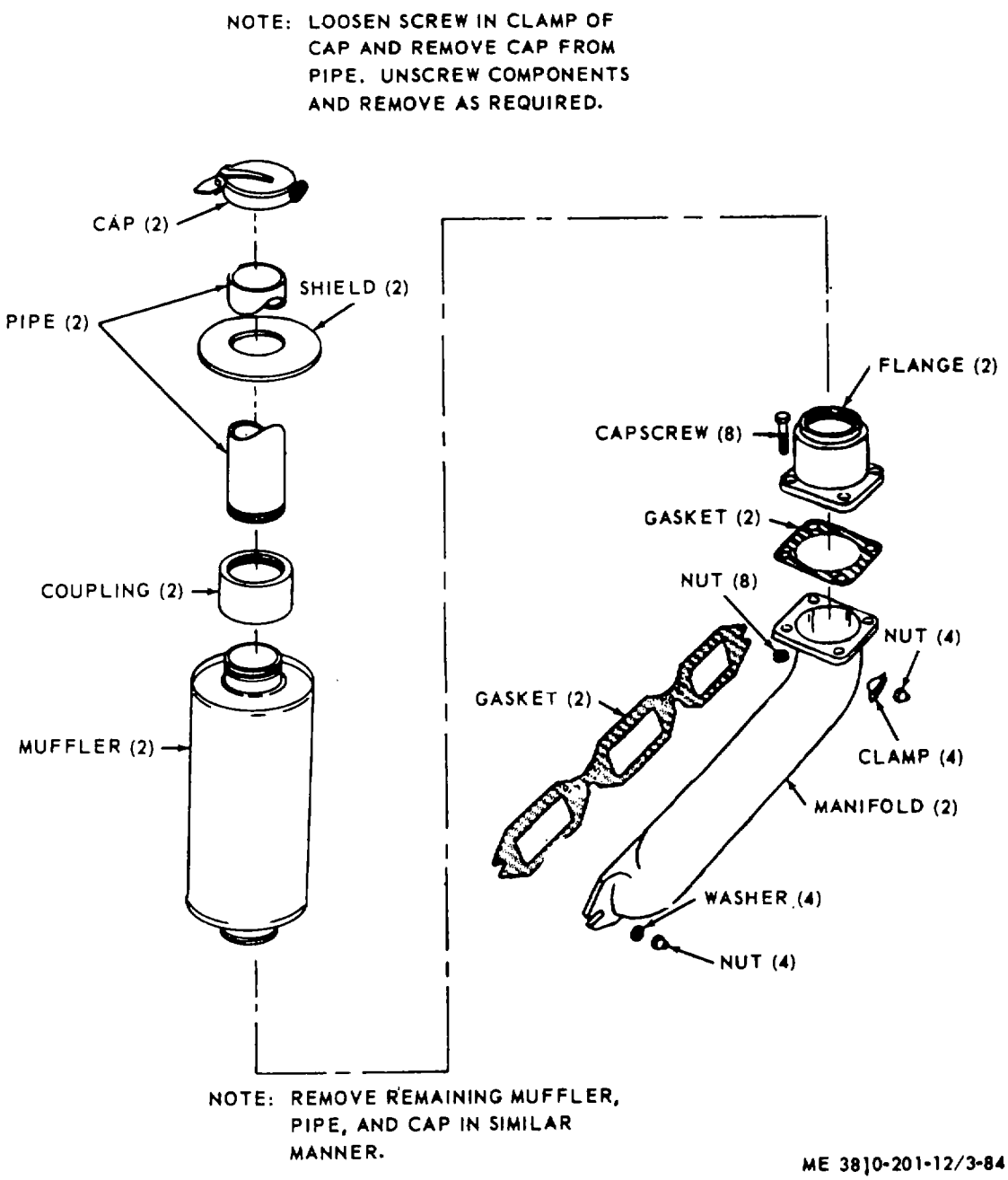


Figure 3-71. Exhaust pipe, muffler, and cap, removal and installation (engine model 687C-18-ES).

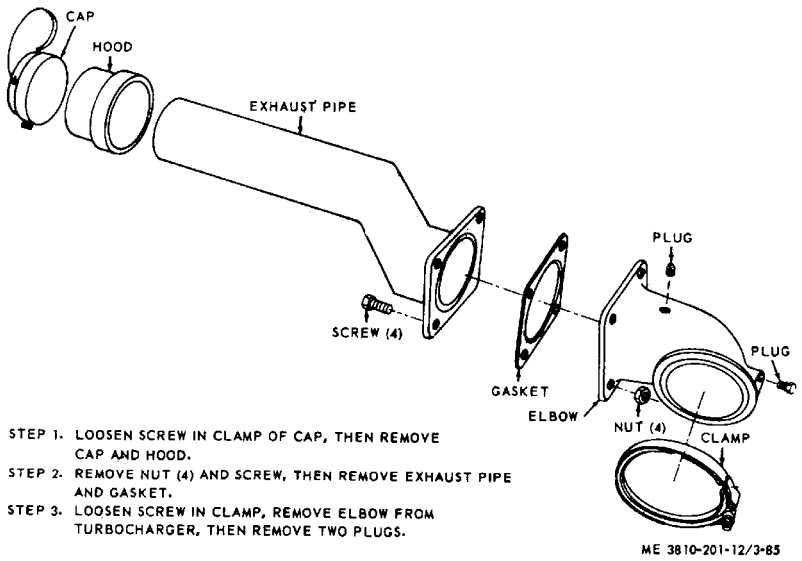


Figure 3-72. Exhaust pipe, hood, cap and elbow, removal and installation (engine model D333TA).

Section XIV. COOLING SYSTEM

3-94. General

The sealed-type liquid cooling system consists of: radiator, fan, fan drive belt, thermostat, water temperature transmitter (para 3-85), water high temperature switch (para 3-86), water temperature indicator (para 3-147) water high temperature warning indicator light (para 3-148), by pass line, and hoses and fittings connecting radiator to engine and water pump. Coolant is drawn from bottom of radiator by the water pump, circulated through engine, and returned to radiator through upper connections, ,or through the bypass line for recirculation through system. When engine is operating, air is drawn through radiator core by the fan to cool and maintain correct operating temperature of the engine. The six blade fan is driven by a single belt.

3-95. Radiator, Shroud, and Fan Guard

a. Remove and Installation (Engine Model 687C-18-ES).

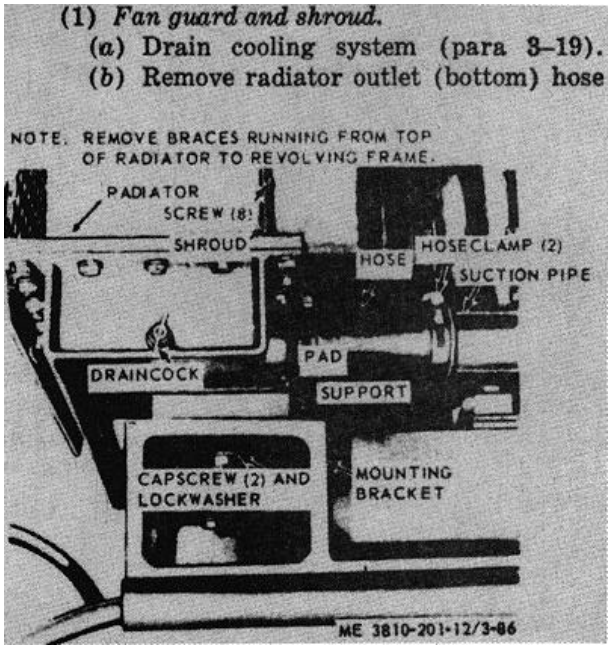


Figure 3-73. Radiator removal points.

(fig. 3-73) by loosening hose clamps at radiator and suction side of water pump.

(c) Remove radiator inlet (top) hose (fig. 3-74) in a similar manner.

(*d*) Remove two capscrews, lockwashers, and flatwashers, then remove pipe flange from thermostat housing (fig. 3-68).

(*e)* Remove 12 screws (fig. 3-74) that secures fan guard to shroud, then remove fan guard.

(*f*) Remove eight screws (fig. 3-73) during shroud to radiator, then remove shroud.

(*g*) Install in reverse order.

(2) Radiator.

Note

Provide lifting device that will reach through cab side door and couple close to radiator.

(*a*) Remove fan guard and shroud ((1) above).

(*b*) Refer to figure 3-73, remove two cap screws and lockwashers, lift radiator off of pad and out of side door.

(*c*) Remove pad and support from mounting bracket.

(*d*) Install in reverse order.

b. Removal and Installation (Engine Model D33STA).

(1) Fan guard and shroud.

(*a)* Refer to figure 3-75 and remove fan guard.

(*b*) Shroud is welded to this radiator and is not ordinarily removable at organizational maintenance.

(2) Radiator.

Note

Provide lifting device that will reach through cab side door and couple close to radiator.

(*a)* Drain cooling system (para 3-19).

(*b*) Remove fan guard ((1) above).

(*c*) Refer to figure 3-76 and remove radiator.

(*d*) Install in reverse order.

3-96. Fan

a. Fan and Support Bracket (Engine Model 687C-1 8-ES).

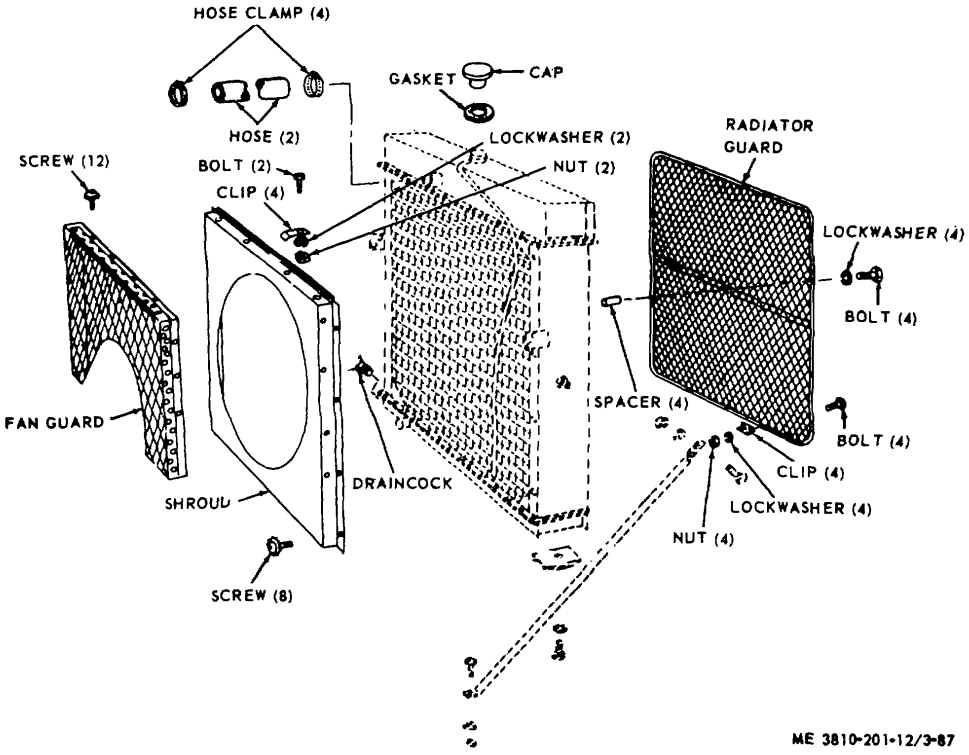


Figure 3-74. Fan guard and shroud (engine model 687C-18-ES), removal and installation

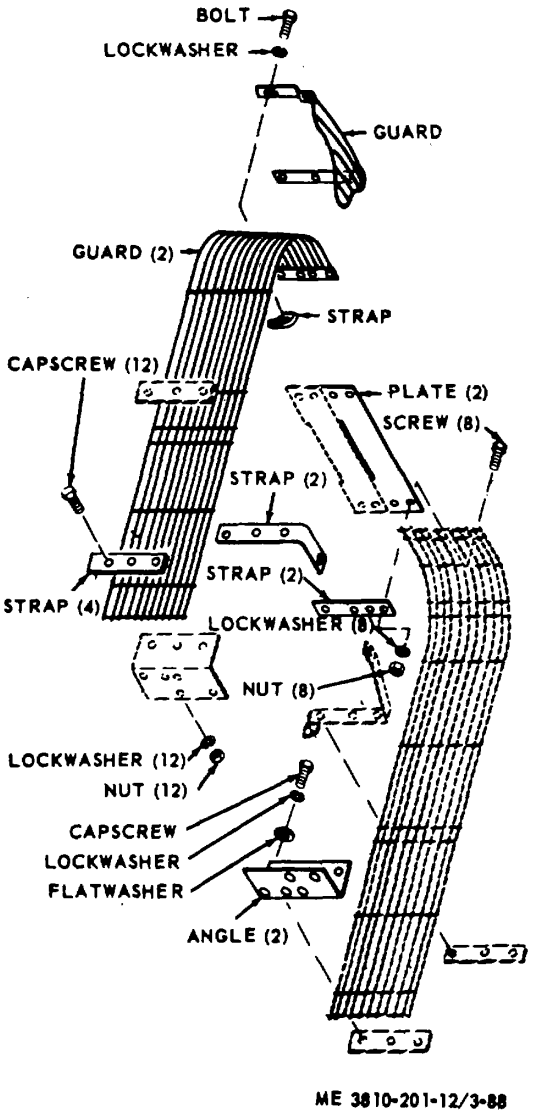


Figure 3-75. Fan guard (engine model D33TA) removal and installation.

(1) Removal and installation

(*a*) Remove fan belt (para 3-97).

(*b*) Refer to figure 3-77 and remove fan and support bracket

(*c*) Install in reverse order.

(2) Cleaning, inspection and repair.

(*a*) Clean all parts in an approved cleaning solvent and dry thoroughly.

(*b*) Visually inspect all parts for cracks, breaks, damaged threads, or other defect.

(*c*) Repair by replacing defective parts or mounting hardware.

b. Fan (Engine Model DE33TA).

(1) Removal and Installation

(*a*) Refer to figure 3-78 and remove fan.

(*b*) Install in reverse order.

(2) Cleaning, Inspection and Repair.

(*a*) Clean all parts in an approved cleaning solvent and dry thoroughly.

(*b*) Visually inspect fan blades for bends, cracks, or other damage. Inspect mounting hardware for burs or stripped threads.

(*c*) Repair by straightening bends, welding cracks, or replacing defective hardware.

c. Fan Idler Pulley (Engine Model D333TA).

(1) *Removal and installation*. Refer to view A of figure 3-79 and remove fan idler pulley. Install in reverse order.

(2) Disassembly and reassembly. Refer to view D of figure 3-79 and reassemble fan hub. Reassemble in reverse order.

(3) Cleaning, inspection, and repair.

(*a*) Clean all parts in an approved cleaning solvent and dry thoroughly.

(b) Visually inspect all parts for damage or defect. Inspect seal for deterioration, bearings for wear or scoring, and mounting hardware for burs or stripped threads.

(*c*) Repair by replacing damaged, defective, or worn parts.

3-97. Fan Belt

a. Removal and Installation

(1) *From engine model 687-18-ES*. Refer to figure 3-16, loosen adjustment screw, then remove belt from pulleys. Install in reverse order.

(2) *From engine model D333TA*. Refer to view A of figure 3-79, loosen adjustment screw, then remove belts from pulleys. Install in reverse order.

Note

When twin belts are used, replace belts in matched pairs when one is defective

b. Cleaning and Installation.

(1) Clean belts with a rag dampened in an approved cleaning solution and dry thoroughly.

(2) Visually inspect belt for fraying, tearing, or other deterioration. Replace defective belt(s). See note in a(2) above 398. Thermostat Housing, Thermostat, and Coolant Lines

a. On Engine Model 687C-18-ES.

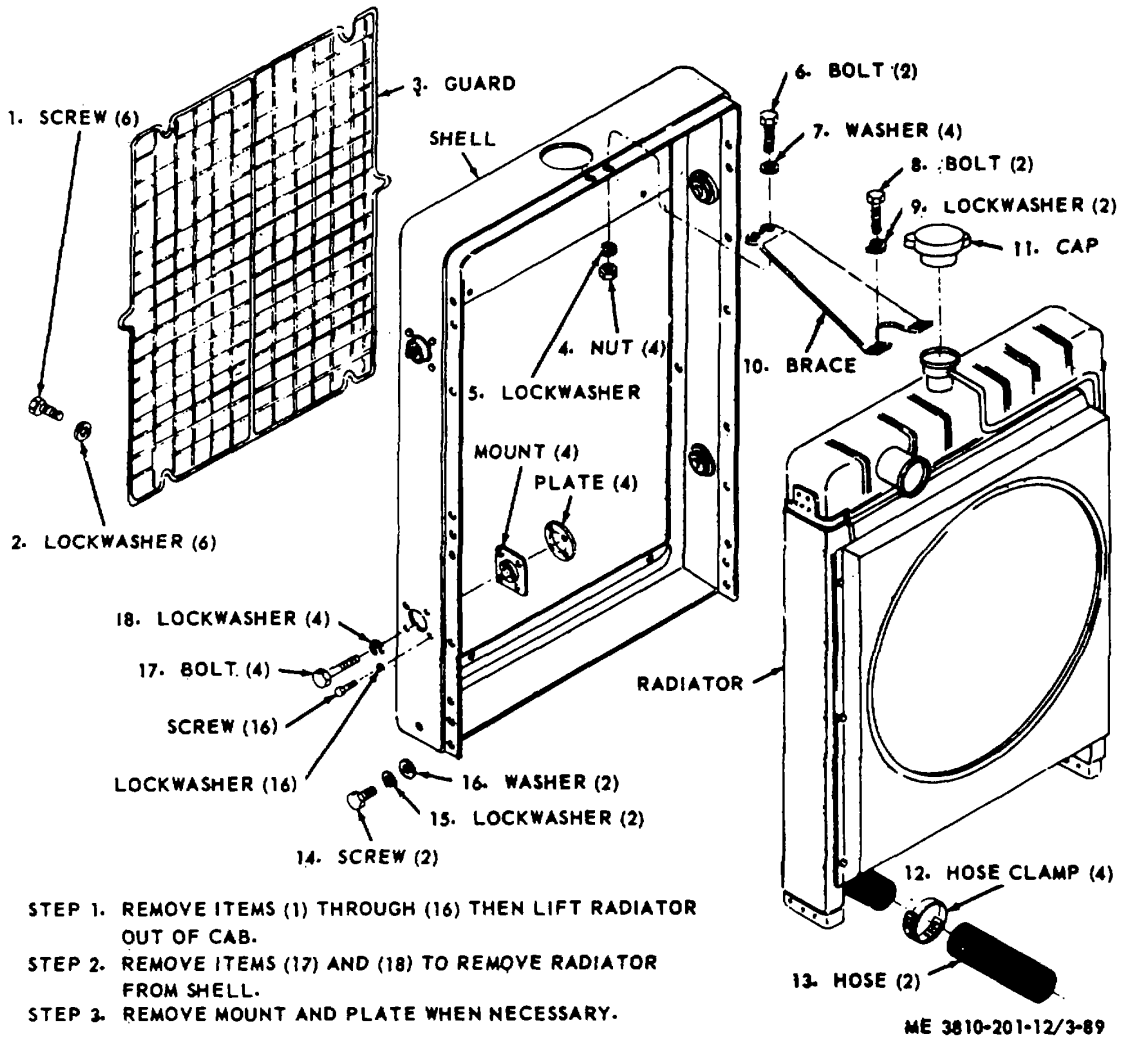


Figure 3-76. Radiator, removal and installation

(1) Thermostat housing removal and installation ,

(*a*) Drain coolant system below manifold level (para 3-19).

(*b*) Refer to figure 3-68, remove pipe flange, disconnect bypass line, then remove thermostat housing and gasket from manifold.

(*c*) Install in reverse order.

(2) Thermostat housing disassembly and reassembly. Refer to figure 3-40 and disassemble the thermostat housing. Reassemble in reverse order.

(3) Cleaning, inspection, and repair.

(a) Clean all parts in an approved cleaning solvent and dry thoroughly.

(*b*) Visually inspect all metal parts for excessive wear, burs, or scoring of surface. Inspect gaskets and seals for tears,' deterioration, or other damage or defects

(*c*) Repair by replacing defective or excessively worn parts. Replace a defective seal or gasket.

(4) Thermostat removal an installation.

(*a*) Remove thermostat housing (1) above).

(*b*) Disassemble thermostat housing ((2) above).

(*c*) Remove thermostat for test below.

(*d*) Install in reverse order.

(5) Testing the thermostat

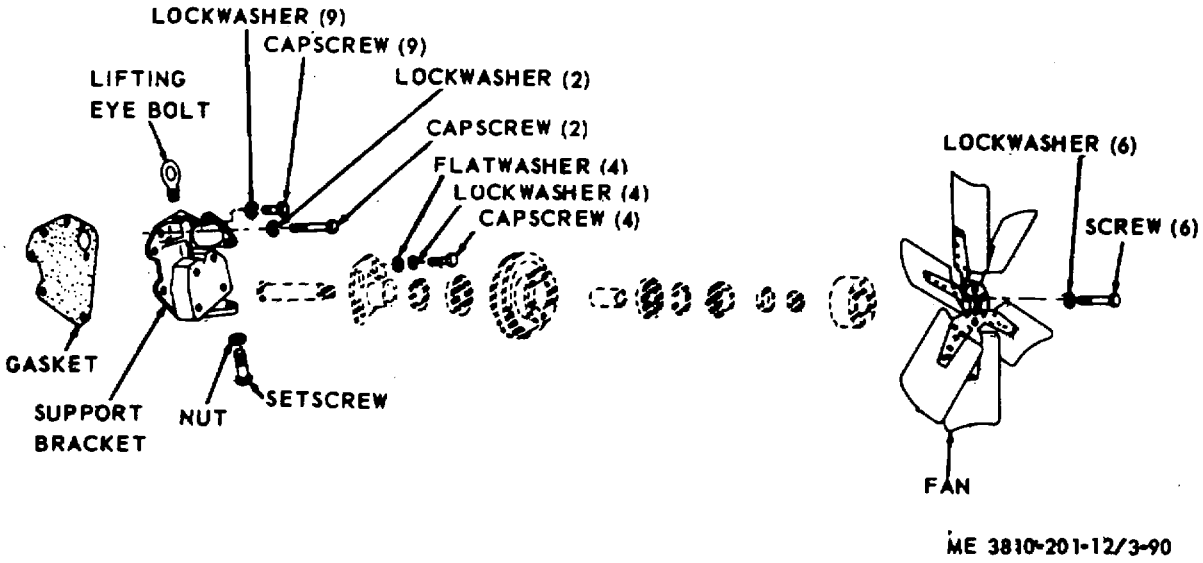


Figure 3-77. Fan and support bracket (engine model 687C-18-ES), removal and installation

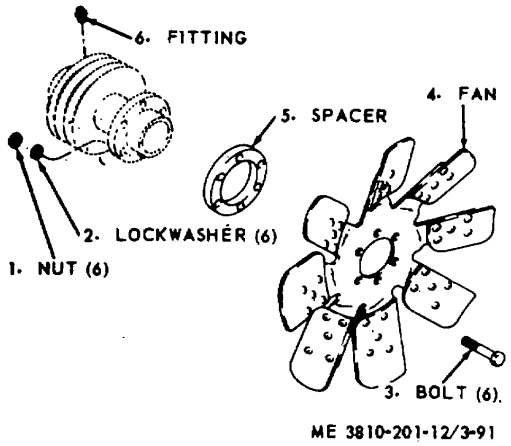


Figure 3-78. Fan (engine model DJ33TA), removal or installation

(*a*) Insert thermostat and a suitable thermometer in a container 'of water.

(*b*) Heat water until thermostat is open, noting temperature when thermostat 'begins to open, and when it is fully open. Thermostat should begin to open at 165° F, and be fully open at 180° F.

(*c*) When thermostat does not meet requirements of (*b*) above, it is defective and must be replaced.

(6) Coolant Lines removal and installation.

(*a*) Drain coolant system (para 3-19).

(*b*) Loosen two hose clamp (fig. 3-68) and remove hose from bypass line.

(*c*) Disconnect bypass line from water pump connection in similar manner.

(d) Remove remaining coolant lines in a similar manner.

(*e*) Install in reverse order.

b. On Engine Model D333TA. The thermostat housing, thermostat, and coolant lines are removed from and installed on engine model D33STA in a manner similar to that described above.

3-99. Water Manifold (Model 687C-18-ES)

a Removal and Installation.

(1) Remove the exhaust manifold from crankcase (para 3-93).

(2) Remove high water temperature switch (para 3-86).

(3) Remove the water temperature transmitter (para 3-85).

(4) Remove thermostat housing (para 3-98).

(5) Remove 12 capscrews, washers, and lockwashers, that secure water manifold to crankcase.

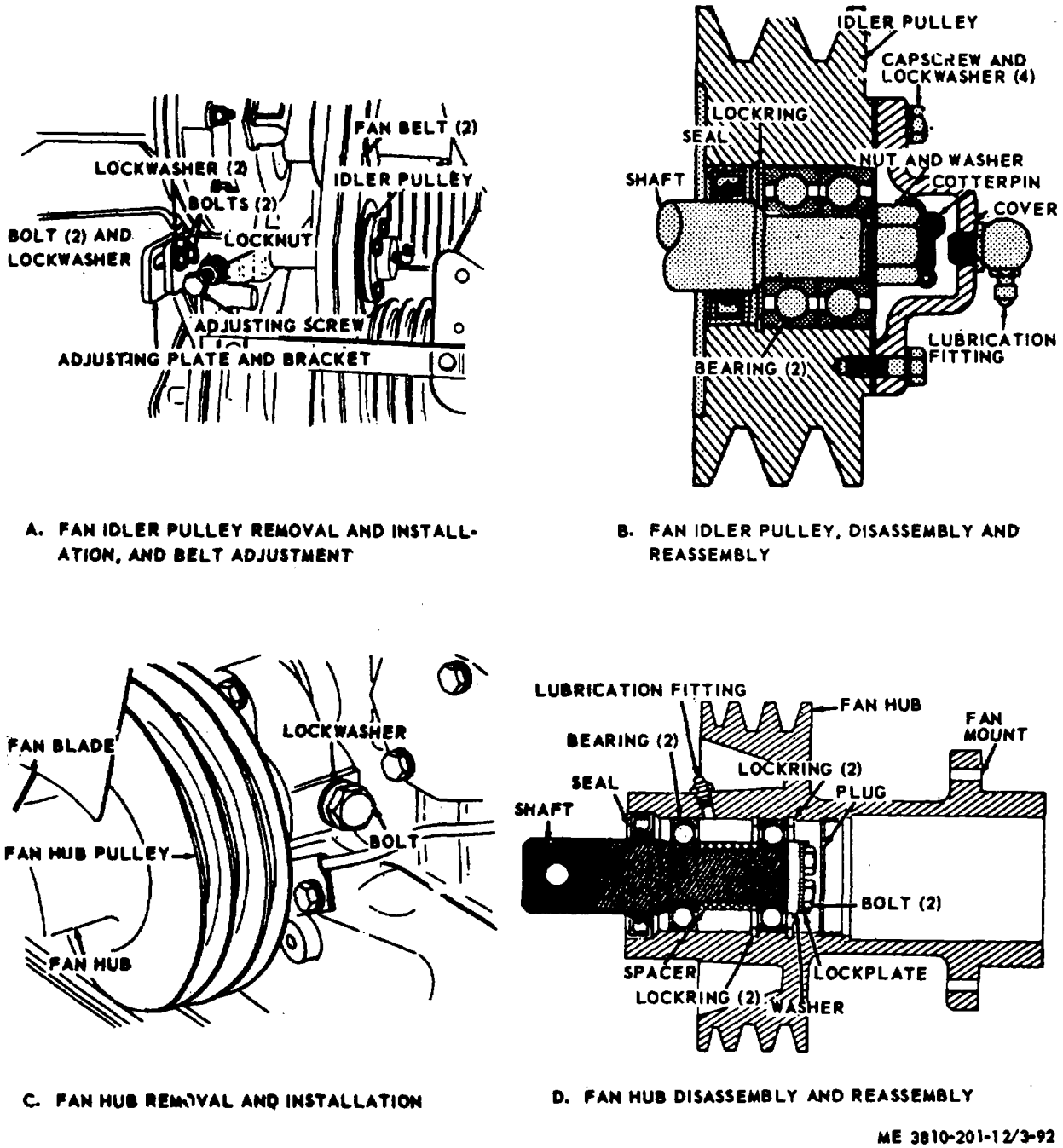
(6) Remove water manifold and six gaskets from engine.

(7) Install in reverse order.

b. Cleaning, Inspection, and Repair.

(1) Scrape or brush all carbon, corrosion, or rust off parts, clean with an approved cleaning solvent and dry thoroughly.

(2) Visually inspect water manifold for cracks, breaks, or warping.



A. FAN IDLER PULLEY REMOVAL AND INSTALLATION, AND BELT ADJUSTMENT

B. FAN IDLER PULLEY, DISASSEMBLY AND REASSEMBLY

C. FAN HUB REMOVAL AND INSTALLATION

D. FAN HUB DISASSEMBLY AND REASSEMBLY

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Figure 3-79.Fan Idler pulley fan hub and fan belt removal disassembly reassembly installation and adjustment.

(3) Visually inspect 11 threaded surtax for burs or defective W4W AS.

(4) Replace a defective manifold, all gaskets, and defective mounting hardware.

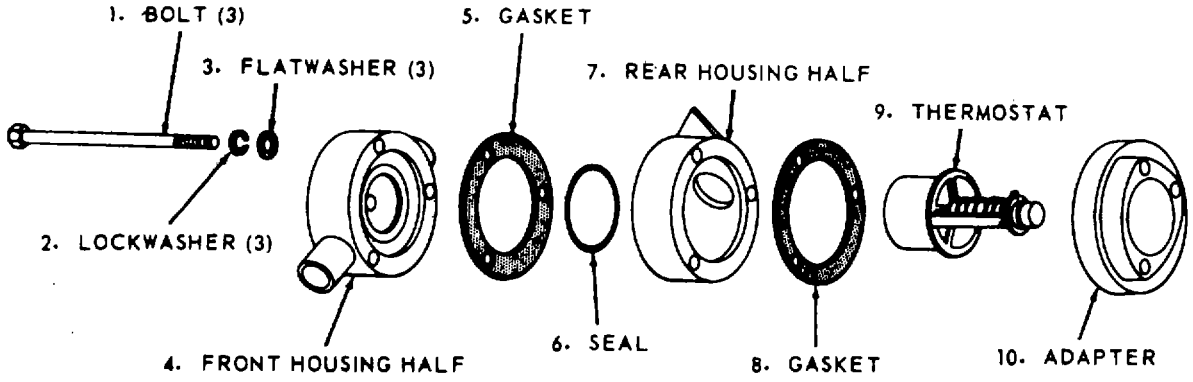

Figure 3-80. Thermostat housing, disassembly and reassembly.

Section XV. ENGINE CLUTCH

3-100. General

The clutch, when engaged, transfers power from engine to power takeoff output shaft, which actuates the operating mechanism. A drive chain connects the engine drive sprocket, working off the output shaft, to the main drive sprocket. The clutch is controlled, through adjustable linkage, from the operators cab. An auxiliary control lever is located on the power takeoff housing. The engine clutch requires adjustment if it will not pull the load, heats, or the operating lever jumps out of engagement

3-101. Clutch Lever and Linkage

a. Removal and Installation. Refer to figure 3-81 and remove clutch lever and linkage. Install in reverse order.

b. Cleaning, Inspection, and Repair.

(1) Clean all parts in an approved cleaning solvent and dry thoroughly.

(2) Visually inspect all parts for excessive wear, burs, stripped threads, ,or other damage or defect.

(3) Repair by replacing a damaged or defective part, or defective mounting hardware

c. Adjustment.

(1) Refer to paragraph 3-9 for instructions on engine clutch adjustment

(2) Adjust lever and linkage by removing pins from clevises, and turning each clevis clock

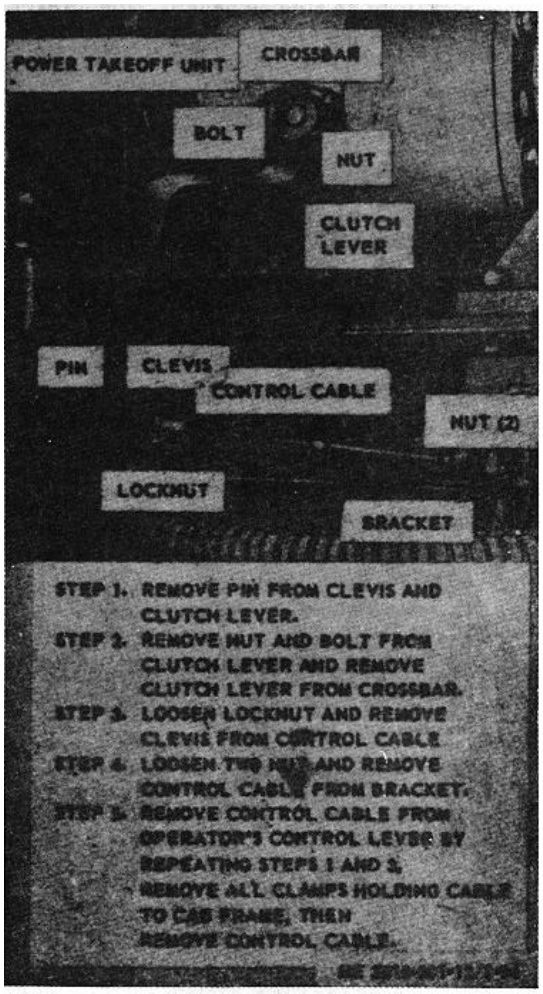

Figure 3-81. Clutch lever and linkage, removal and installation.

wise to shorten, counterclockwise to lengthen, until operators control lever is properly positioned on quadrant when clutch is in the engaged or disengaged position.

3-102. Auxiliary Clutch Lever

a. Removal and installation. Refer to figure 3-82, remove capscrew and lockwasher from lever, then remove lever from crossbar. Install in reverse order.

b. Cleaning, Inspection, and Repair.

(1) Clean lever and mounting hardware in an approved cleaning solvent and dry thoroughly.

(2) Visually inspect lever for bend, crack, or excessive wear. Inspect hardware for burs, or stripped threads.

(3) Repair by replacing worn or defective parts.

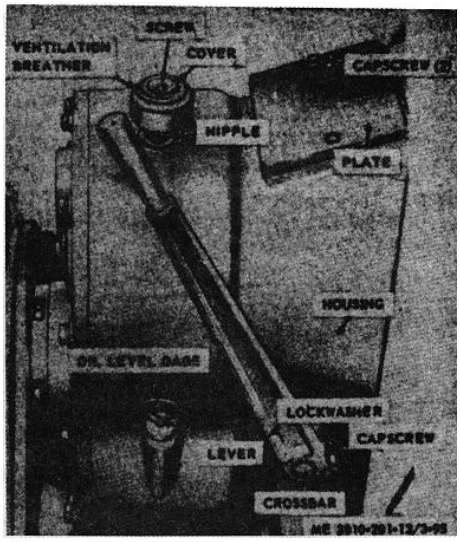

Figure 3-82. Auxiliary clutch lever and ventilation breather, removal points.

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Section XVI. POWER TRANSFER

3-103. General

The main drive chain case is located at right rear side of crane shovel unit inside the cab. The case completely surrounds the input and main shaft sprockets, and the transfer chain. The transfer chain is a multiple strand roller chain which connects input and main shaft sprockets.

3-104. Ventilation Breather (Filter)

a. Removal and Installation

(1) Refer to figure 3-82, remove screw, and cover, from ventilation breather (filter).

(2) Remove ventilation breather (filter) from nipple by turning counterclockwise. Remove a damaged nipple.

(3) Install in reverse order.

b. Cleaning, Inspection and Repair.

(1) Clean all parts in an approved cleaning solvent and dry thoroughly. Use low pressure compressed air to dry breather (filter).

(2) Visually inspect screw for burs or stripped threads. Inspect breather for excess clogging of filter portion.

(3) Repair by replacing a defective breather or screw.

3-105. Transfer Chain Case Cover

a. Removal and Installation.

(1) Refer to figure 3-43 and remove transfer chain case cover.

(2) Remove gasket from cover, or case.

(3) Install in reverse order.

b. Cleaning, Inspection, and Repair.

(1) Clean all parts in an approved cleaning solvent and dry thoroughly.

(2) Visually inspect case for dents or cracks. Inspect mounting hardware for burs or stripped threads. Inspect gasket for deterioration.

(3) Repair by straightening dents or welding cracks. Replace a defective cover damaged gasket, or mounting hardware.

3-106. Transfer Chain

a. Removal and Installation.

(1) Remove transfer chain case cover (para 3-105).

(2) Remove two cotterpins (fig. 3-84) and master link from chain, then remove transfer chain from input and main shaft sprockets.

NOTE

REMOVE DRAIN PLUG AND DRAIN OIL BEFORE REMOVING CHAIN CASE COVER. AT INSTALLATION, REFER TO CURRENT LUBRICATION ORDER AND REFILL THROUGH FILL PIPE UNTIL OIL RUNS OUT OF LEVEL PLUG HOLE.

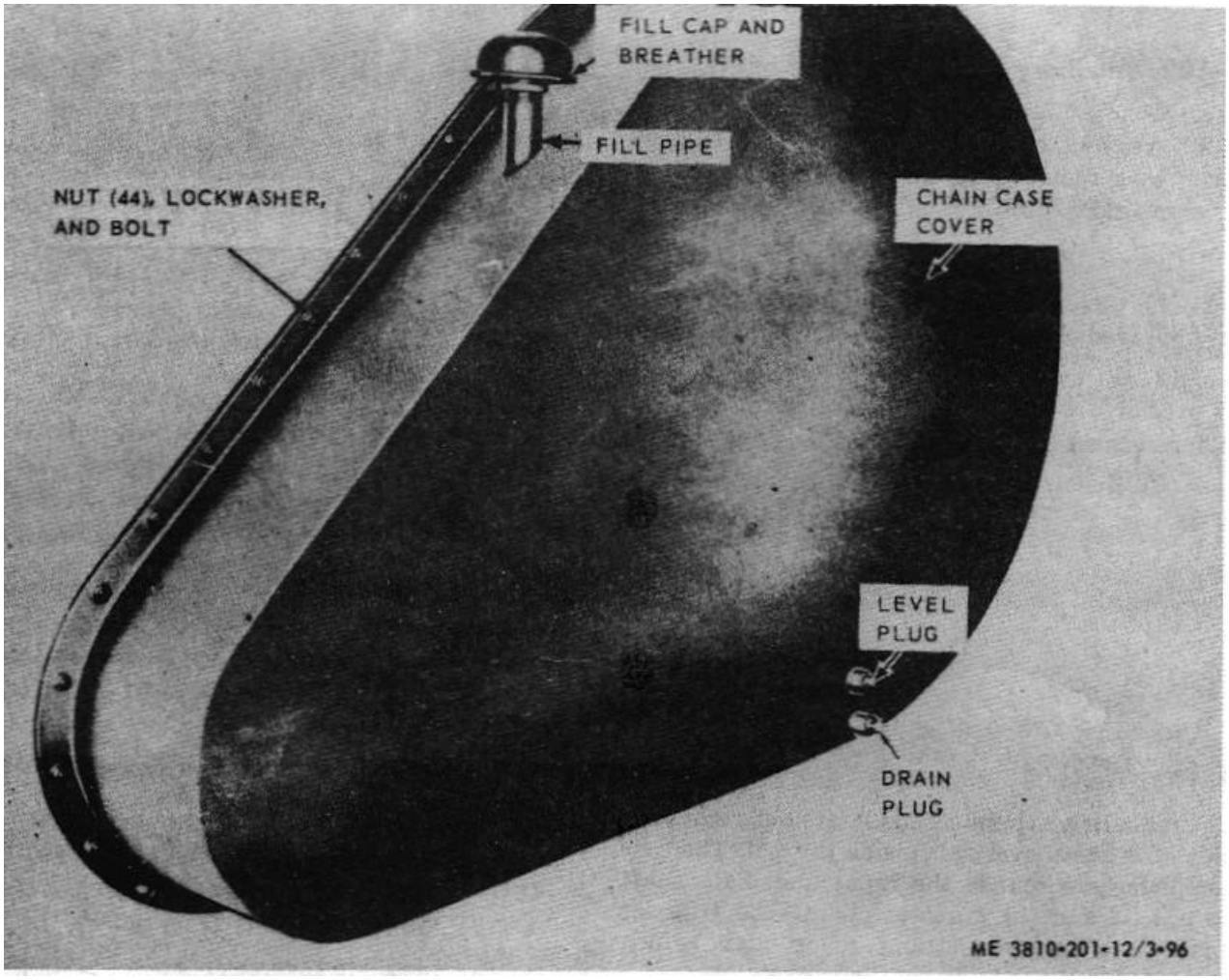


Figure 3-83. Transfer chain case cover, removal and installation.

(3) Install in reverse order.

b. Cleaning, Inspection, and Repair.

(1) Clean chain in an approved cleaning solvent and dry thoroughly.

(2) Visually inspect chain for damaged links, pins, or cotterpins.

(3) Repair by replacing damaged links, pins, or removed cotterpins.

3-107. Input Shaft Chain Sprocket a. Removal and Installation.

(1) Remove transfer chain case cover (para 3-105).

(2) Remove transfer chain (para 3-106).

(3) Remove lockwire from two screws in input shaft (fig. 3-84).

(4) Remove two screws and plate, then remove input shaft sprocket from input shaft.

(5) Install in reverse order.

b. Cleaning, Inspection, and Repair.

(1) Clean all parts in an approved cleaning solvent and dry thoroughly.

(2) Visually inspect mounting hardware for burs or stripped threads. Inspect sprocket for cracked or broken teeth.

(3) Repair by replacing a damaged sprocket, or defective hardware.

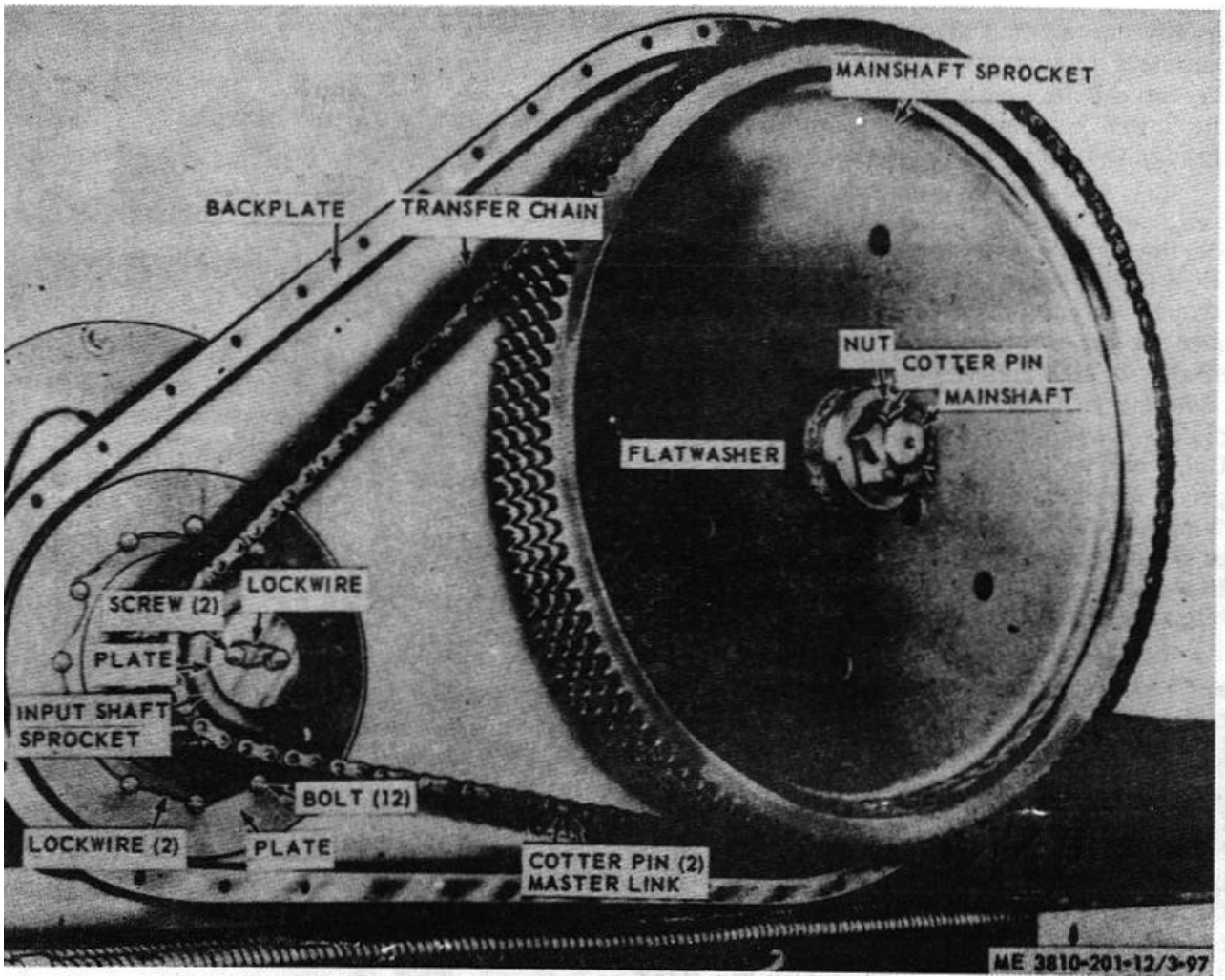


Figure 3-84. Transfer chain, removal and installation

3-108. Main Shaft Sprocket

a. Removal and Installation.

(1) Remove transfer chain case cover (para 3-105).

(2) Remove transfer 'chain (para 3-106).

(3) Remove cotterpin, nut, and flatwashers from mainshaft, then remove mainshaft sprocket.

(4) Install in reverse order.

b. Cleaning, Inspection and Repair. Clean, inspect, and repair in manner similar to that described in paragraph 3-107, above.

Section XVII. HYDRAULIC SYSTEM

3-109. General

a. Description. Each hydraulic control lever or foot pedal is connected to a master cylinder (compensator). Each master cylinder is connected by a hydraulic line to an hydraulic cylinder. The hydraulic cylinder is connected to brake, clutch, or other mechanism by mechanical linkage. When the lever or foot pedal is moved, there is a corresponding movement of the piston in master cylinder, which transmits fluid to hydraulic cylinders, thus actuating brake or clutch. When pressure is released from pedal or lever, springs cause pistons in hydraulic cylinders to return to normal position.

b. Bleeding the Hydraulic System. When air is - present in the hydraulic system, controls become "spongy" and do not hold brake or clutch firmly as they should. To remove air from system proceed as follows: (1) Fill hydraulic tank with clean hydraulic fluid (para 3-18 and LO 5-3810-206-12). Check level in tank frequently during bleeding operation, to prevent air from entering supply line.

(2) Be sure shutoff cock (drain cock) in supply line at bottom of tank is open to assure gravity flow of fluid to cylinders, then bleed compensator (cylinders) in lever stand by opening bleeder cap in each compensator, starting with the lower compenstor, and working upward through the top row.

(3) After bleeding lever stand compenstor begin bleeding clutch and brake cylinders, starting with the lowest one than working upward toward cylinders mounted at highest point Attach one end of bleeder hose to bleeder hose then let opposite hose end rest in jar partially filled with hydraulic fluid. Always keep this end of hose under fluid to prevent air from entering bleeder hose and reentering the hydraulic system Open bleeder screw, apply pressure to appropriate lever or pedal and watch hose end in jar. When bubbles no longer form in fluid, close bleeder screw and remove bleeder hose from screw. Repeat above procedure for each cylinder in system

(4) Move each control lever or pedal slowly and note clutch or brake action. If any of the controls still feel spongy, repeat bleeding operation.

(5) Fill both hydraulic tanks (para 3-18 -and LO 5-3810-206-12) with clean fluid. Check level frequently while bleeding cylinders, then bleed air from the propel brake cylinders in car body. Reach through holes in turret just above the tread. The bleed screw for these cylinders is toward inside of car body. Reach around the cylinder, install bleeder hose, then open screw. Tighten bleeder screw as soon as bubbles no longer appear in bleeder jar. Repeat procedure on remaining propel clutch hydraulic cylinder.

3-110. Hydraulic Tank (Reservoir)

a. Removal and Installation.

(1) Close shutoff cocks in two supply lines beneath tank, tag and disconnect supply lines, then plug lines to prevent contamination of hydraulic system.

(2) Open tank by removing breather or filler plugs, position suitable container to receive fluid, then open shutoff cocks and drain hydraulic fluid from tank.

(3) Refer to figure 3-85 and remove hydraulic tank.

b. Cleaning, Inspection and Repair.

(1) Clean all parts in an approved cleaning solvent and dry thoroughly.

(2) Visually inspect all parts for dents, cracks, or excessive wear.

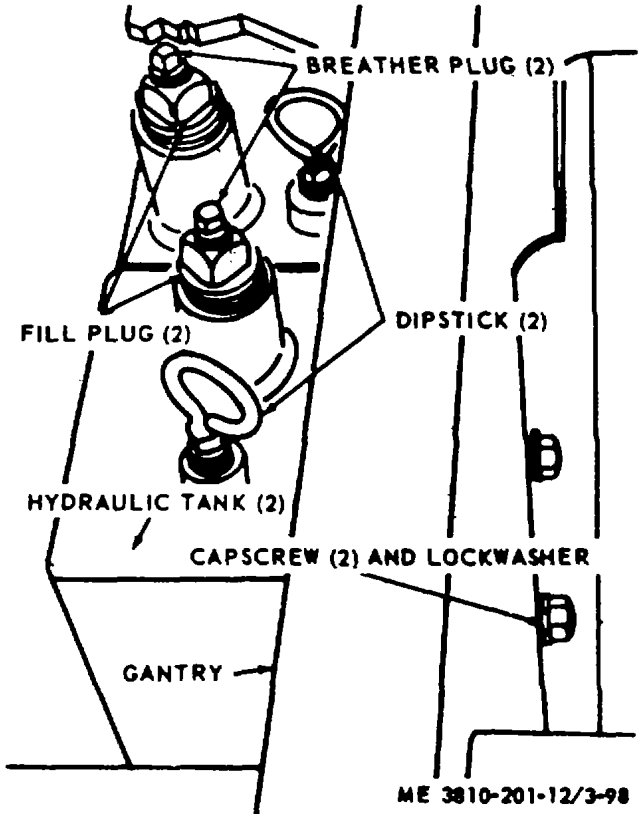


Figure 3-85. Hydraulic tank removal and installation.

(3) Repair by welding cracks, straightening dents, or replacing defective hardware or hydraulic tank.

3-111. Hydraulic Hose, Lines Tubes and Fittings.

a. Removal and Installation. Refer to figure 3-86 and remove appropriate hydraulic hose line tube or fitting. Install in reverse order.

b. Cleaning, Inspect and Raw.

(1) Clean all parts in an approved cleaning solvent and dry thoroughly.

(2) Visually inspect all for leaking connection, dents, or cracks. Inspect hardware and fittings for signs of excessive wear or damaged condition.

(3) Repair by -replacing defective components.

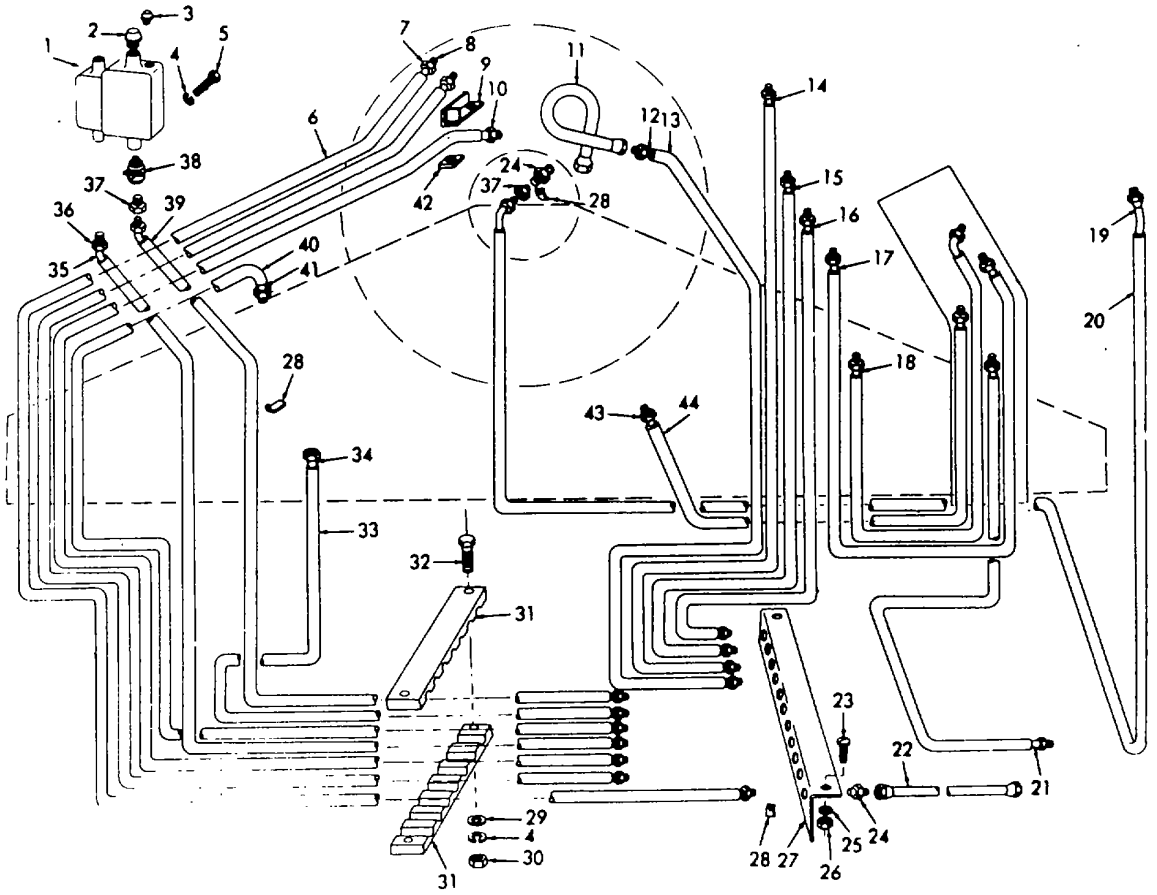
3-112. Compensators (Cylinders)

a. Removal and Installation. Refer to sheet 1 of figure 3-87, and remove applicable compensator. Install in reverse order.

b. Clean , Inspection and Repair

(1) Clean all parts with an approved cleaning solvent and dry thorough.

NOTE: WHEN A LINE IS REMOVED, MARK ITS FITTINGS AND POSITION ON THE REVOLVING FRAME. PLUG OR COVER ENDS OR PORTS TO PREVENT CONTAMINATION OF HYDRAULIC SYSTEM.



1	Hydraulic tank	12	Tubing	23	Screw (2)	84	Tubing
2	Fill plug	13	Conduit	24	Adapter (22)	35	Tubing
3	Fluid level plug	14	Tubing	25	Lockwasher (2)	36	Nut connector (80)
4	Lockwasher (2)	15	Tubing	26	Nut (2)	87	Adapter (2)
o	Capscrew (2)	16	Tubing	27	Bracket	88	Shutoff cock
6	Conduit	17	Tubing	28	Spring clip (22)	39	Conduit
7	Tubing	18	Tubing	29	Flatwasher (2)	40	Conduit
8	Tubing nut	19	Tubing	30	Nut	41	Tubing
9	Bracket	20	Conduit	31	Clamp	42	Clamp
10	Tubing	21	Tubing	32	Capscrew	43	Tubing
11	Home	22	Hose (10)	33	Conduit	44	Conduit

Figure 3-86. Hydraulic hose, lines, tubes, and fittings, removal and installation.

(2) Visually inspect compensator for external damage or excessive wear, burs, or stripped threads on mounting hardware, or deterioration of boot on push rod.

(3) Repair by replacing damaged hardware, defective boot or compensator.

3-113. Levers and Linkage (Lever Stand)

a. General. Normal servicing of this equipment win not require complete removal or disassembly of the lever stand and its components, therefore, these instructions will cover individual component removal.

b. Lever and Linkage Removal and Installation

(1) Remove upper and lower cover plates from lever stand.

(2) Remove boom hoist hydraulic control handle (fig. 2-23) from boom hoist lever, and applicable (raise and lower) compensator

NOTE: TAG, DISCONNECT, AND PLUG ALL HYDRAULIC LINES REMOVED, THEN PLUG OR COVER PORTS OF COMPENSATORS TO PREVENT CONTAMINATION OF HYDRAULIC SYSTEM.

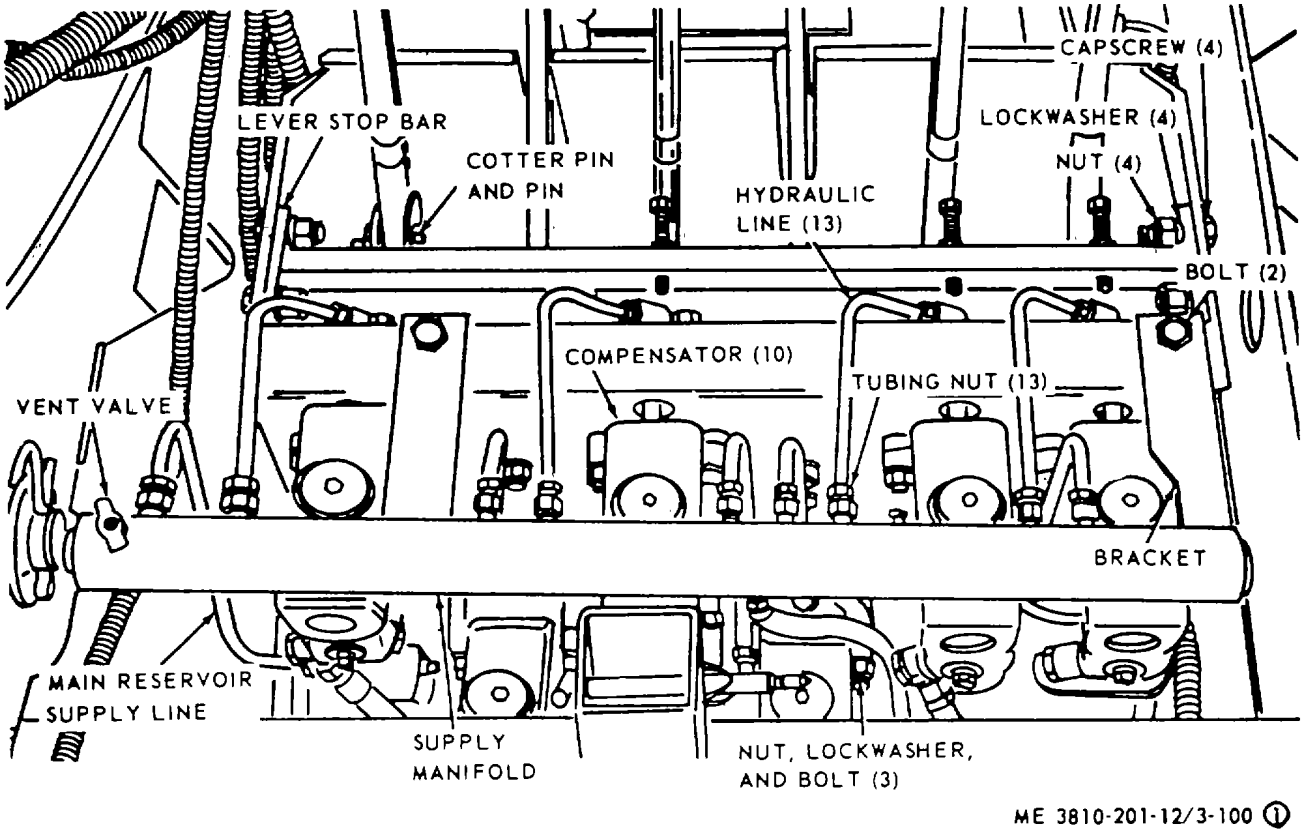


Figure 3-87. Lever stand, showing compensator, lever, pedal and linkage removal and adjustment points (sheet 1 of 2).

(cylinder) from lever stand (para 3-112).

(3) Refer to sheet 2 of figure 3-87 and remove boom hoist lever and linkage from lever stand.

(4) Install in reverse order.

c. Cleaning, Inspection and Repair.

(1) Clean all parts in an approved cleaning solvent and dry thoroughly.

(2) Visually inspect all parts for breaks, cracks, deformation, or excessive wear. Inspect mounting hardware for burs, or stripped threads.

(3) Repair by replacing defective parts or mounting hardware.

d. Adjustment.

(1) Make adjustment to mechanical linkage by lengthening or shortening adjusting setscrews in lever bar (sheet 2 of fig. 3-87) or clevis at rod end.

(2) Adjust the adjusting screws at both compensator push rods until lever remains in neutral when push rods are snug against piston.

(3) Minor adjustment of foot pedals are made by connecting links to pedals in either the front or rear holes in lower portion of pedal. Pus rod adjustment at pedal compensator are made in a manner similar to that described in (2) above.

3-114. Swing and Propel Shiner Lever and Linkage

a. Removal and Installation

(1) Refer to figure 3-88 and remove swing and propel shifter lever and linkage.

(2) Install in reverse order.

b. Cleaning, Inspection, and Repair.

(1) Clean all parts in an approved cleaning solvent and dry thoroughly.

(2) Visually inspect all parts for excessive wear, bends, breaks, or other defect. Inspect mounting hardware for burs or stripped threads.

(3) Repair by replacing damaged parts or defective hardware.

c. Adjustment. Adjust the linkage for positive

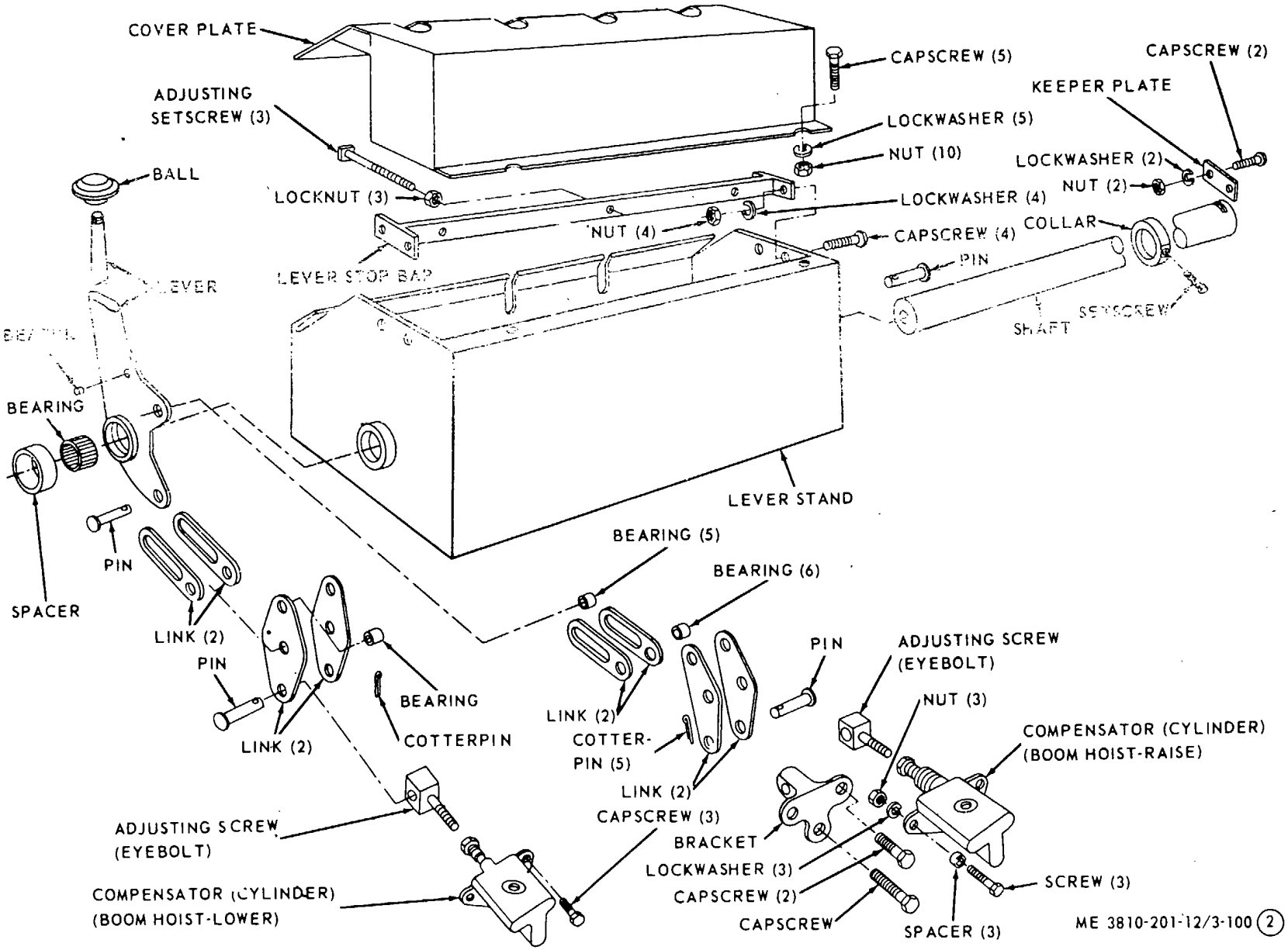


Figure 3-87. Lever stand showing compensator, lever, pedal, and linkage removal and adjustment points (sheet 2 of 2).

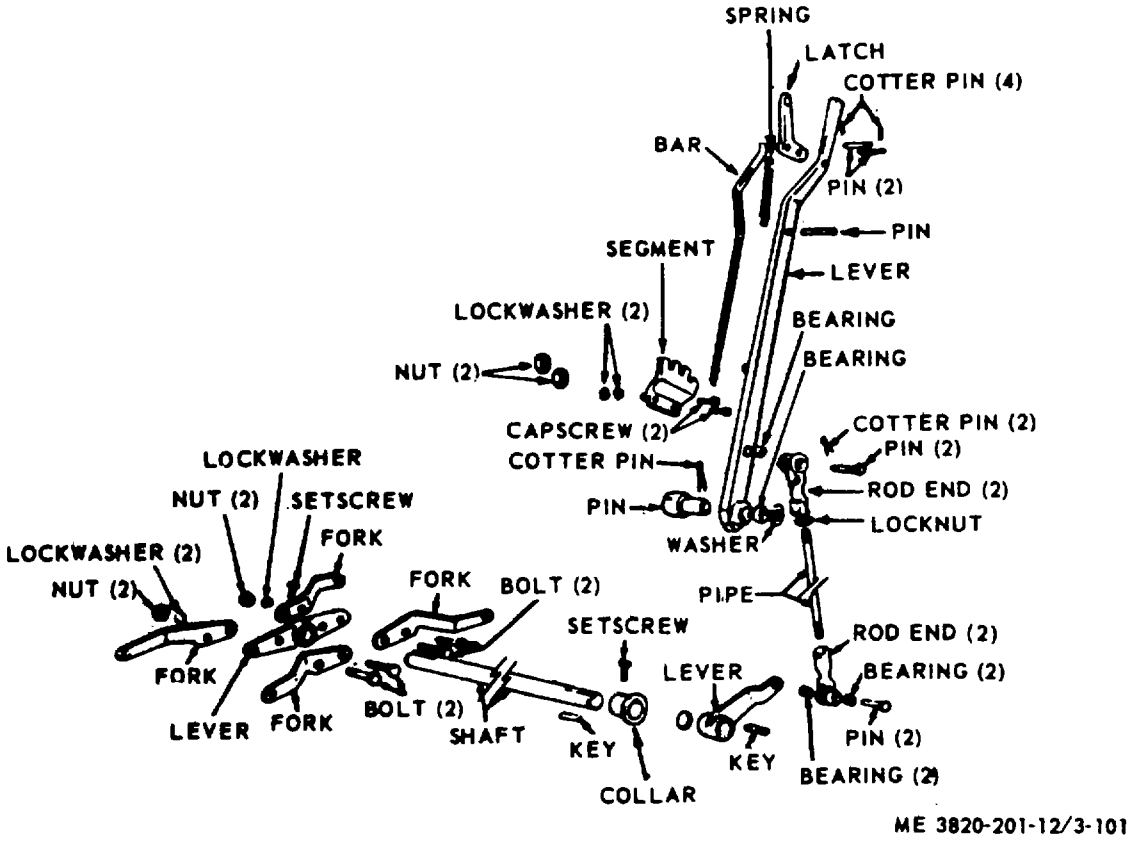


Figure 3-88. Swing and propel shifter lever and linkage, removal and installation.

engagement at of the swing or propel jaw clutches by adjusting the overall length of pipe and two rod ends as follows:

(1) Remove cotterpin and pin that connects rod end clevis to lever.

(2) Loosen locknut at rod end, then turn pipe clockwise to shorten, counterclockwise to lengthen.

(3) When length is satisfactory, tighten locknut up to rod end and connect rod end to lever by installing pin and securing

3-115. Swing Broke Hydraulic Control and Linkage Adjustment

a. Swing Brake Hydraulic Control, Removal and Installation.

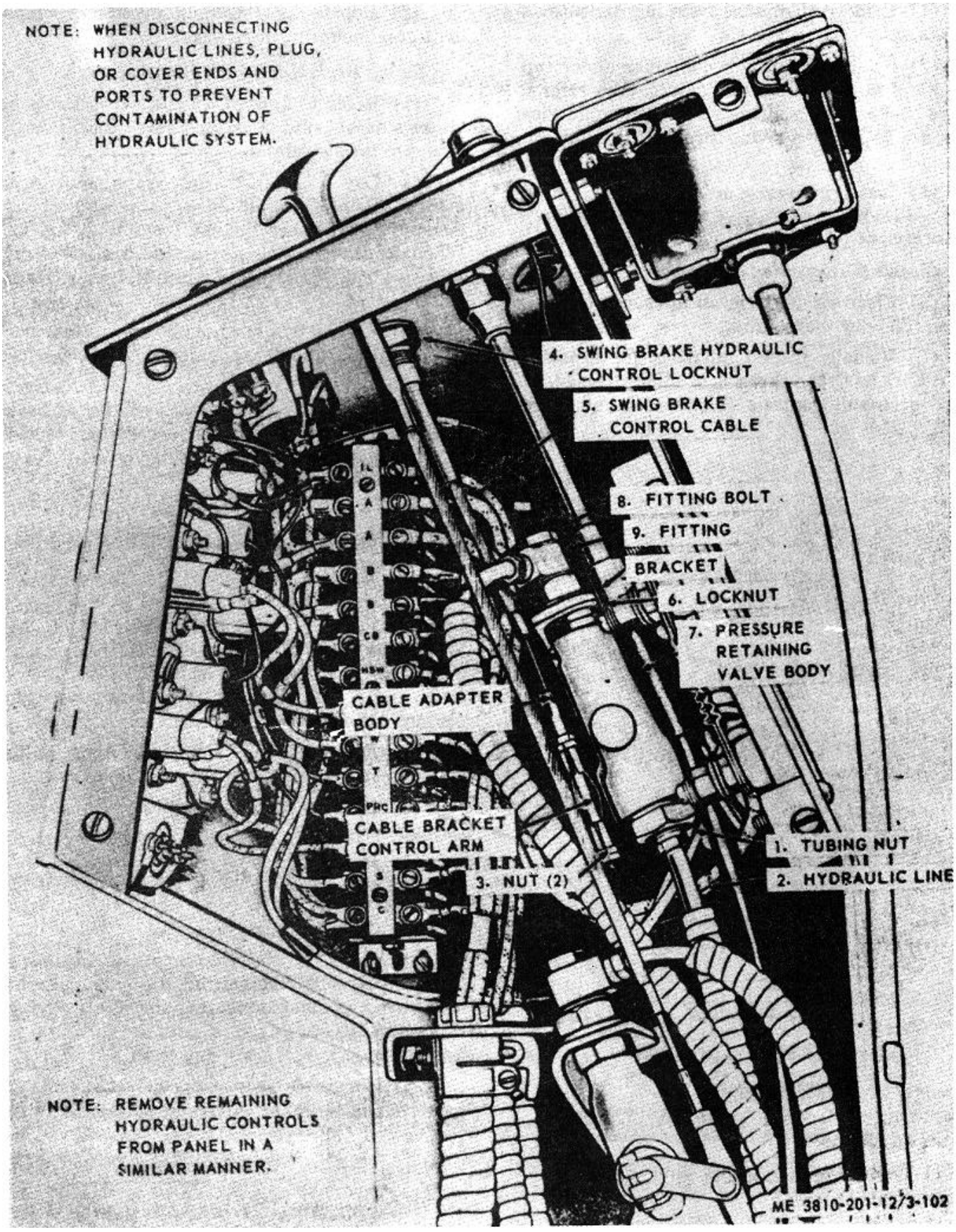


Figure 3-89. Swing and propel shifter lever and linkages removal and installation.

(1) Remove side panel from instrument control stand.

(2) Position a suitable container under control stand to receive hydraulic fluid, then refer to figure 3-89 and remove items in numerical sequence to remove wing brake hydraulic control.

(3) Install in reverse order.

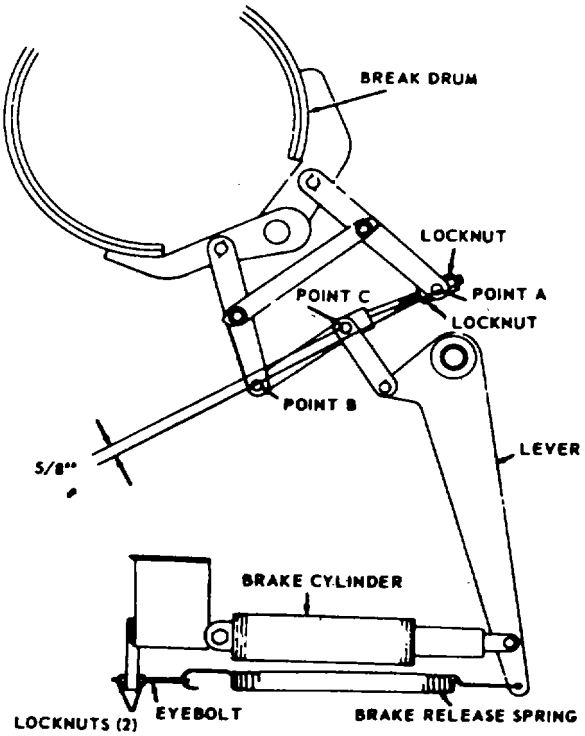
Note

Remove .remaining hydraulic controls in a similar manner.

b. Cleaning, Inspection and Repair.

(1) Clean all parts in an approved cleaning solvent and dry thoroughly.

(2) Visually inspect all parts for excessive wear, burs, stripped threads, or other damage. Inspect push-pull controls for freedom of movement.



NOTE: HARD OPERATION WILL RESULT IF THERE IS TOO MUCH TENSION ON BRAKE RELEASE SPRING.

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Figure 3-90. Swing brake linkage adjustment.

(3) Repair by replacing defective components for mounting hardware.

c. Swing Brake Linkage Adjustment.

(1) Refer to figure 3-90, adjust locknuts on either side of point A so that lever touches edge of slot in the side stand.

(2) Lay a straight edge from point A to point B. Point C should be 5/8 inch nearer brake drum. This will keep linkage from "toggling in". When toggling in does occur, the brake will not release when pressure on hydraulic cylinder is released.

(3) Adjust two locknuts so that alignment of points A,B, and C are maintained as described in (1) and (2) above.

(4) Adjust two locknuts on eyebolt at brake release spring until there is just enough tension on spring to release brake when hydraulic pressure is released.

3-116. Hydraulic Clutch and Brake Cylinders and Linkage

a. Removal and Installation.

(1) Position container to receive fluid, then disconnect hydraulic line at clutch cylinders (fig. 3-91), or brake cylinder (fig. 3-92), and plug or cover end of line and port of cylinder to prevent contamination of hydraulic system.

(2) Refer to figure 3-91 and remove clutch cylinder or figure 892 to remove brake cylinder.

(3) Remove remaining cylinders in a similar manner.

(4) Install in reverse order.

b. Clean, Inspection, and Repair.

(1) Clean all parts in an approved cleaning solvent and dry thoroughly.

(2) Visually inspect linkage and mounting hardware for distortion, wear, burs, or stripped threads. Inspect hydraulic cylinder for signs of leakage or deterioration of end cups.

(3) Repair by replacing defective linkage parts, mounting hardware, and a leaking or defective hydraulic cylinder.

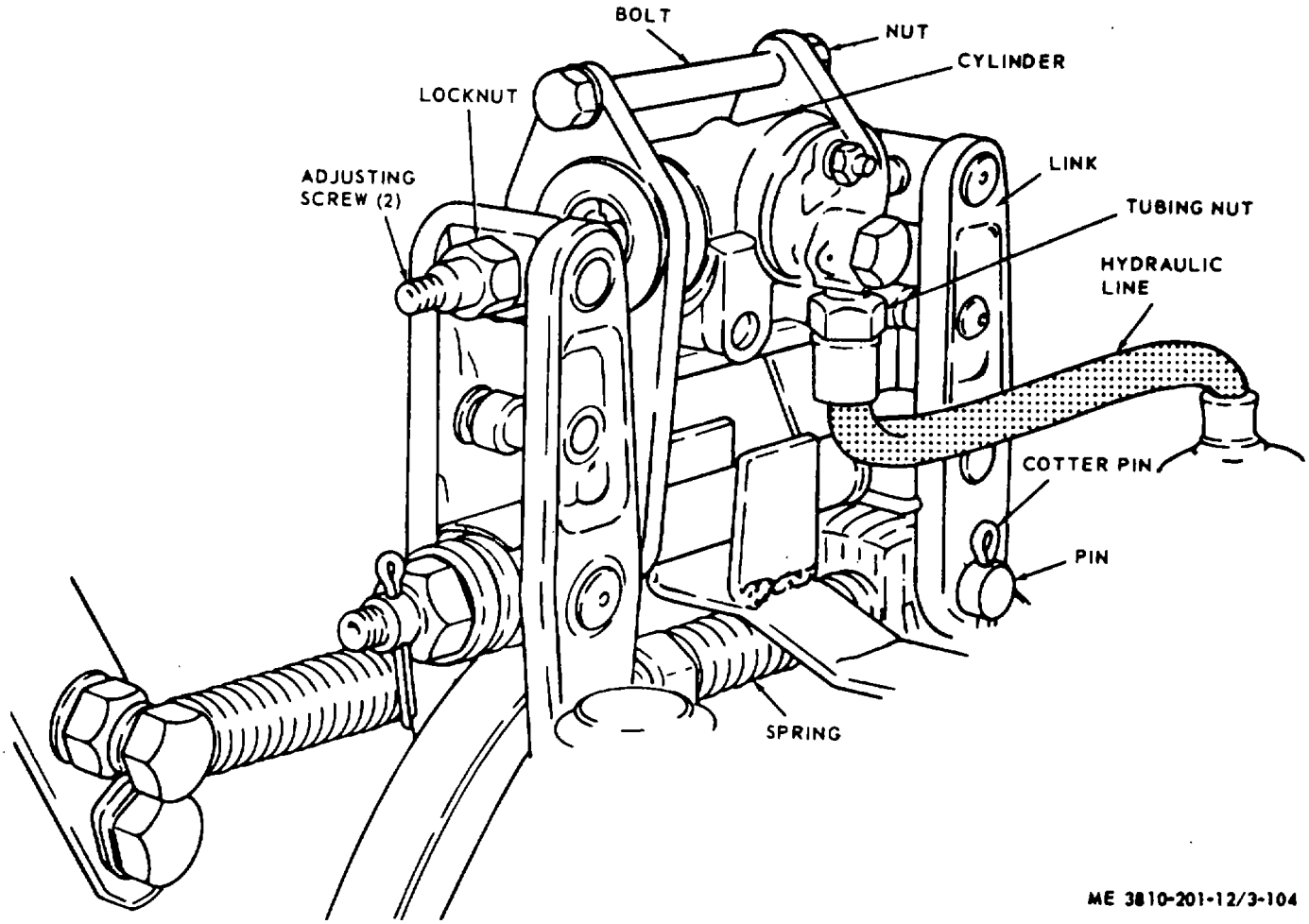


Figure 3-91. Hydraulic clutch cylinder, removal and installation.

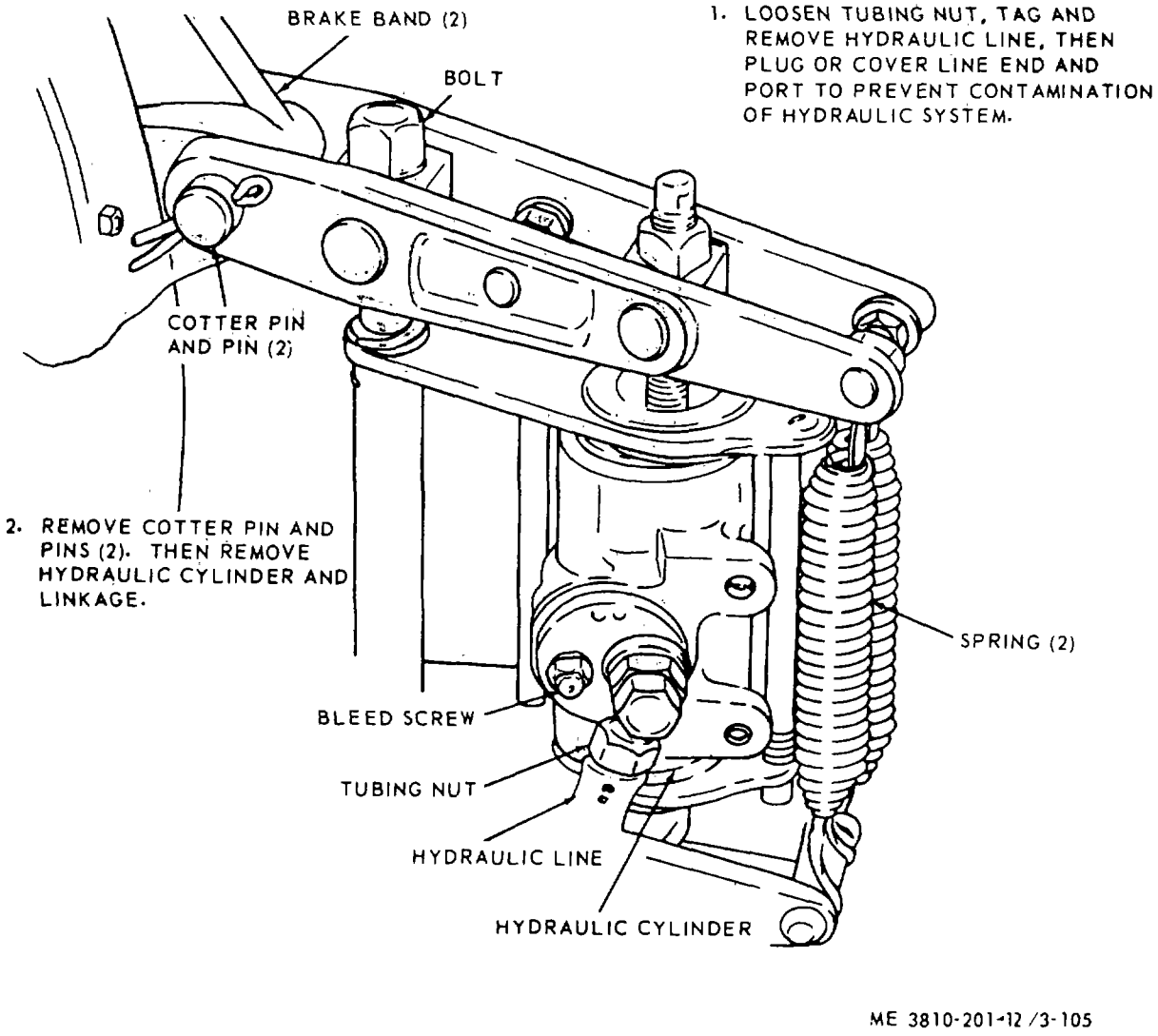


Figure 3-92. Boom hoist hydraulic brake cylinder, removal and installation.

Section XVIII. ROTATING BASE (REVOLVING FRAME)

3-117. General

The rotating base (revolving frame) of the crane-shovel unit is the mounting base for all operating components including front end attachments, engine, hoisting mechanism, and cab. The revolving frame derives swing power through a vertical swing shaft and revolves on rollers traveling in the roller circle. Front and rear hook rollers are provided to reduce strain on center gudgeon, while 8,250 pounds of counterweight slugs in box plus the counterweight extension, provides stability during swinging operation. Keep the hook rollers in proper adjustment at all times (para 3-35).

Warning: **Never travel crane-shovel basic unit (less front end attachment) over rough terrain with counterweight extension installed. The unit could tip over backward, causing damage to the unit, and possible injury to the operator.**

3-118. Front Hook Rollers

a. Removal and Installation.

(1) Lower boom to approximate horizontal position.

(2) Remove two capscrews, lockwashers, and keeper plate from bracket (fig. 3-93).

(3) Drive hook roller shaft backward slightly to make lockring accessible, remove lockring, then pull hook roller shaft forward out of mounting bracket and remove hook roller.

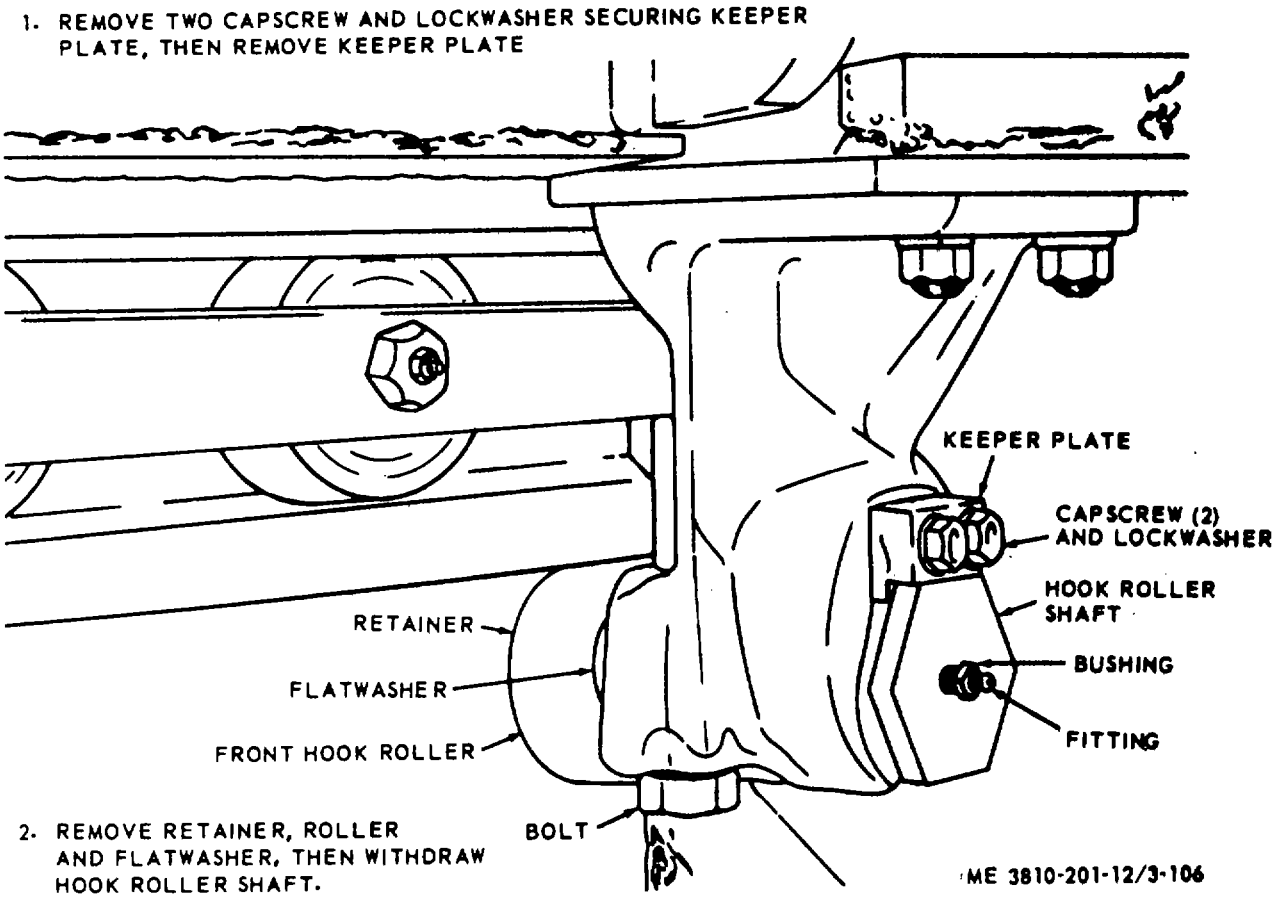


Figure 3-93. Front hook rollers, removal and installation.

(4) Remove remaining hook roller in a similar manner.

(5) Install in reverse order.

b. Cleaning, Inspection, and Repair.

(1) Clean all parts in an approved cleaning solvent and dry thoroughly.

(2) Visually inspect mounting hardware for burs or stripped threads, inspect eccentric shaft (pins) or rollers for signs of excessive wear, grooves, chips, or cracks.

(3) Repair by replacing damaged, defective or worn parts.

c. Adjustment. Adjust hook rollers as directed in paragraph 3-35.

3-119. Rear Hook Rollers

a. Removal and Installation.

(1) Lower boom until point is slightly below the horizontal with weight of boom resting on cribbing similar to that shown in figure 2-6.

(2) Support the swivel arm (fig. 3-94) with cribbing or a jack, remove two capscrews, lockwashers, and keeper plate, use wedges on cribbing, or the jack to take arm weight off eccentric pin, then remove eccentric pin.

(3) Remove four capscrews, lockwashers, and two keeper plates, push roller pins inward slightly to make retainer accessible, remove retainer, then pull roller pips outward and remove rollers and pins. Remove lubrication fittings and bushings from the two roller pin.

(4) Remove remaining rear hook roller in a similar manner.

(5) Install in reverse order.

b. Cleaning, Inspection, and Repair.

(1) Clean all part in an approved cleaning solvent and dry thoroughly.

(2) Visually inspect pins for grooves, cracks, chips or other damage. Inspect mounting hardware for burs or stripped to.

(3) Repair by replacing damaged, defective, or worn parts.

c. Adjustment. Adjust rear hook rollers an directed in paragraph 3-35.

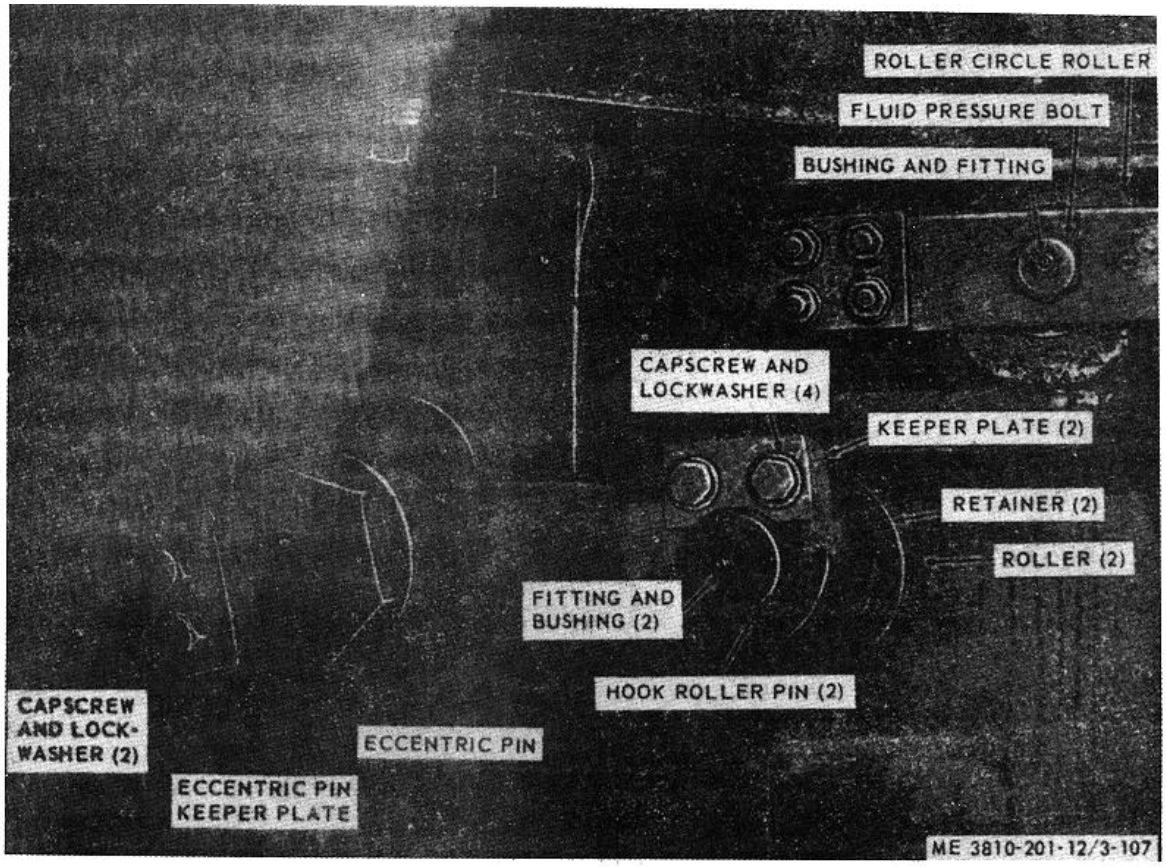


Figure 3-94. Rear hook rollers, removal and installation.

3-120. Roller Circle Rollers

a. Removal and Installation.

> ***Note.*** **To remove a damaged roller, always move revolving frame left or right until damaged roller is on high side of frame, opposite the opening in frame. This will take most of the frame weight off damaged roller and make it easier to withdraw the fluid pressure bolt from roller segment shaft.**

(1) Remove nut and lockwasher from fluid pressure bolt (fig. 3-94), then withdraw bolt from segment roller shaft, and remove roller from roller circle frame.

(2) Remove lubrication fitting and bushing from fluid pressure bolt.

(3) Remove shaft from segment roller.

(4) Install in reverse order.

(5) Remove or install remaining rollers in a similar manner.

b. Cleaning, Inspection, and Repair.

(1) Clean all parts in an approved cleaning solvent and dry thoroughly.

(2) Visually inspect mounting hardware for burs, stripped threads or excessive As car. Inspect roller for chipping, cracks, breaks, or flat spots (wear).

(3) Repair by replacing defective hardware or roller.

3-121. Jackshaft Clutch Shoes

a. Removal and Installation.

(1) Relieve tension on three shoe return springs (fig. 3-95), by loosening nuts on studs, then remove springs from stud and clutch shoe.

(2) Loosen locknut and adjusting bolt until the adjusting assembly can be removed from between the clutch shoes.

(3) Loosen three locknuts on three setscrews and back setscrews out of brackets enough to free shoes.

(4) Remove capscrew, lockwasher, and sleeve from eccentric, then lift both clutch shoes out of drum.

b. Cleaning, Inspection and Repair.

(1) Clean all metal parts except clutch shoe in an approved cleaning solvent and dry thoroughly. Blow dust off clutch shoe lining and

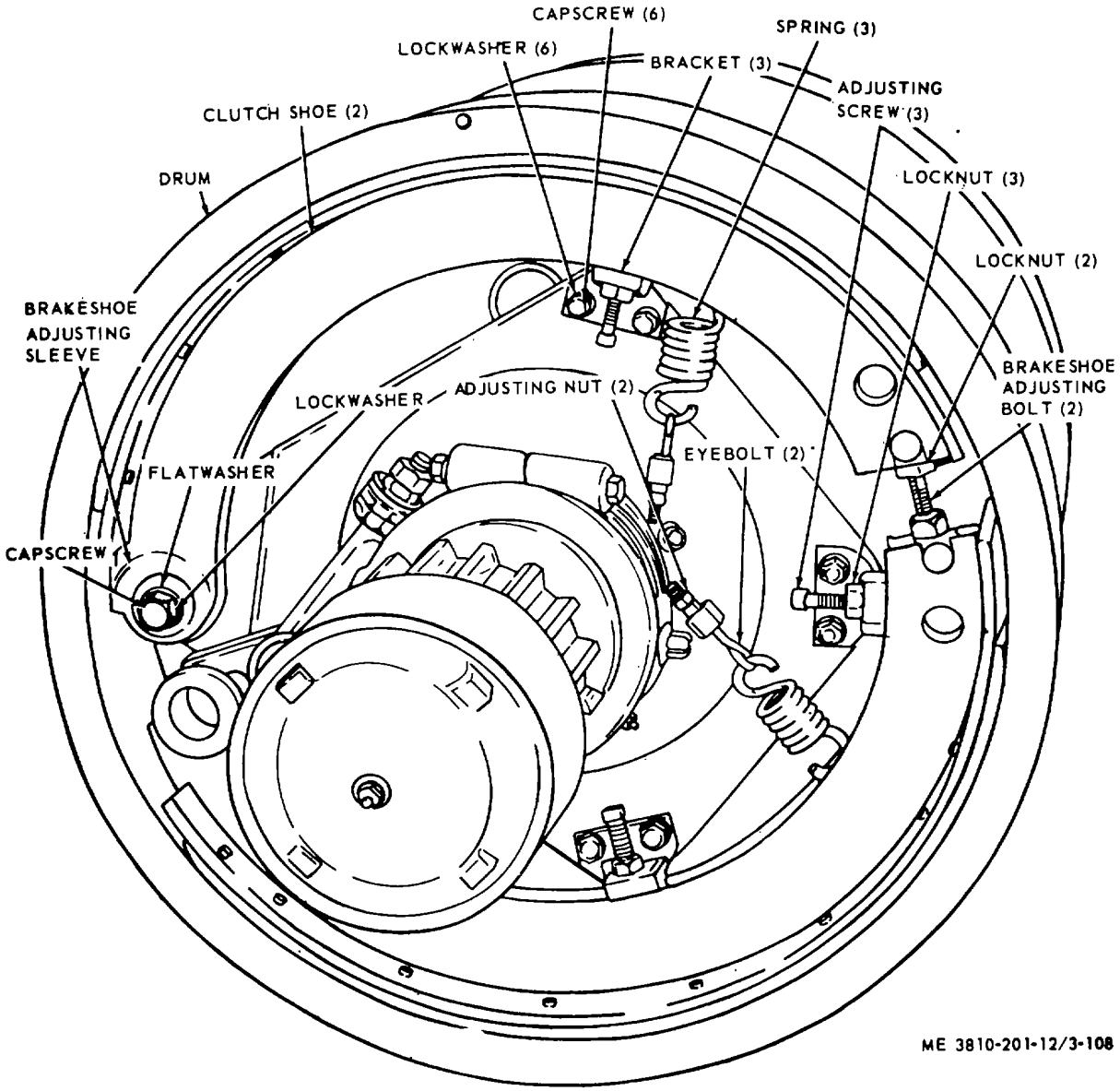


Figure 3-95. Jackshaft clutch shoes, removal and installation.

shoe with low pressure compressed air, or wipe with dry clean cloth.

(2) Visually inspect clutch shoe lining for wear, mounting hardware for burs or stripped threads, and test the strength of springs.

(3) Repair by replacing weak or damaged springs or defective mounting hardware. Replace, clutch shoe when lining is worn to within 50 percent of original thickness.

Note. Clutch shoes may be itched, placing the "dead" shoe in "live" position, since dead shoe receives very little wear.

c. Adjustment. Refer to paragraph 3-25 and adjust swing (jackshaft) clutch shoes.

3-122. Main Hoist Shaft Clutch Shoes

a. Removal and Installation.

(1) Remove auxiliary clutch hydraulic brake cylinder (para 3-116).

(2) Refer to figure 3-96 and remove main hoist shaft clutch shoes.

(3) Remove remaining clutch shoes in a similar manner.

(4) Install in reverse order.

b. Cleaning, Inspection, and Repair. Clean, inspect and repair clutch shoes in manner described in 3-121b above.

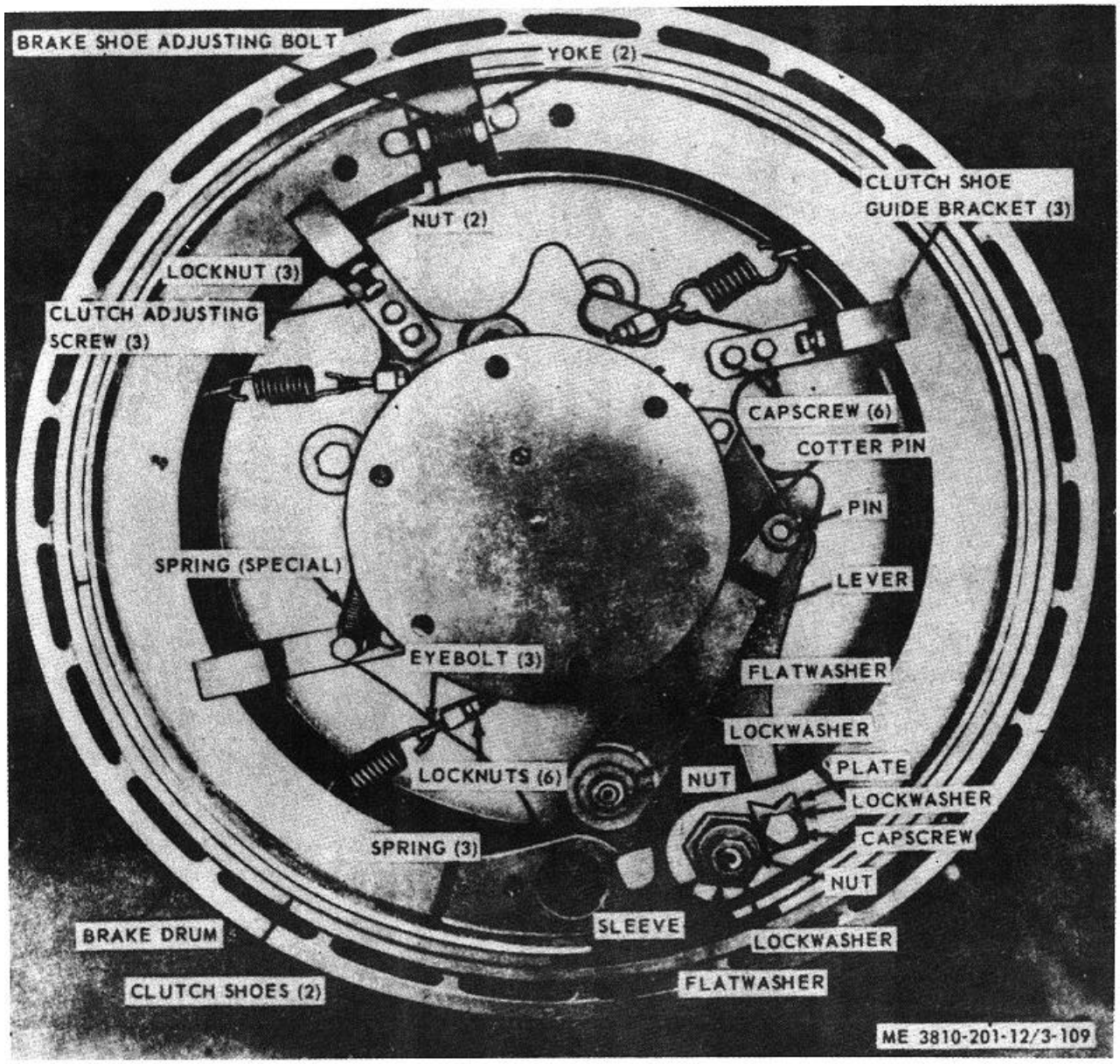


Figure 3-96. Main hoist clutch shoes, removal and installation.

c. Adjustment. Refer to paragraph 3-28 for adjustment procedures.

3-123. Planetary Clutch Band and Broke Bands (Main Shaft)

a. General. For shovel operation, the planetary clutch band must be positioned with dead end above the hydraulic cylinder. This is accomplished by use of a longer link and bracket (fig. 3-97), which is removed and installed in a manner similar to that described in *b*, below.

b. Removal and Installation.

(1) Remove hydraulic clutch cylinder (par;.3-116).

(2) Refer to figure 3-97 and remove band from support bracket.

(3) Remove the remaining bands in a similar manner.

(4) Install in reverse order.

c. Cleaning, Inspection, and Repair.

(1) Clean all metal parts in an approved cleaning solvent and dry thoroughly. Clean clutch or brake band by wiping with a clean rag, or use of compressed air.

(2) Visually inspect clutch or brake band for cracks, breaks, worn, or damaged condition Inspect springs for deformation, strength, or other defect. Inspect mounting hardware for burs, wear, stripped thread, or elongated holes.

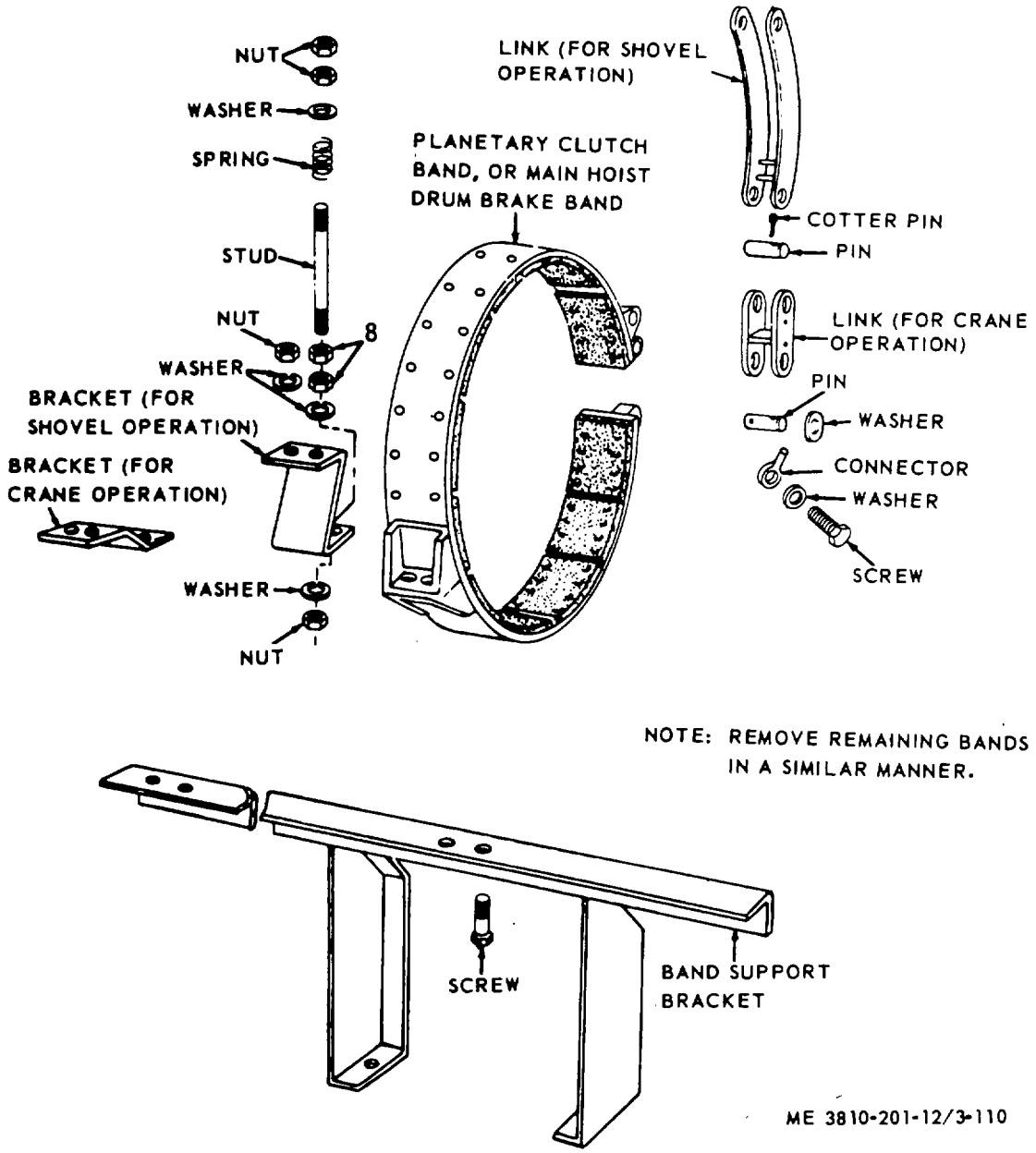


Figure 3-97. Planetary clutch band and brake band, removal and installation.

(3) Repair by replacing defective mounting hardware, defective springs, and clutch or brake bands when lining is worn to within 1/16 inch of rivet heads.

3-124. Drum Legging and Sleeve Nut (Shear Washer)

a. Removal and Installation.

(1) Remove cable from drum (para 3-39).

(2) Remove the four capscrews (fig. 3-98) and washers from lagging.

(3) Refer to figure 3-99 and remove sleeve nut (shear washer) by use of special tool (table 3-1).

(4) Secure lifting device to lagging halves,

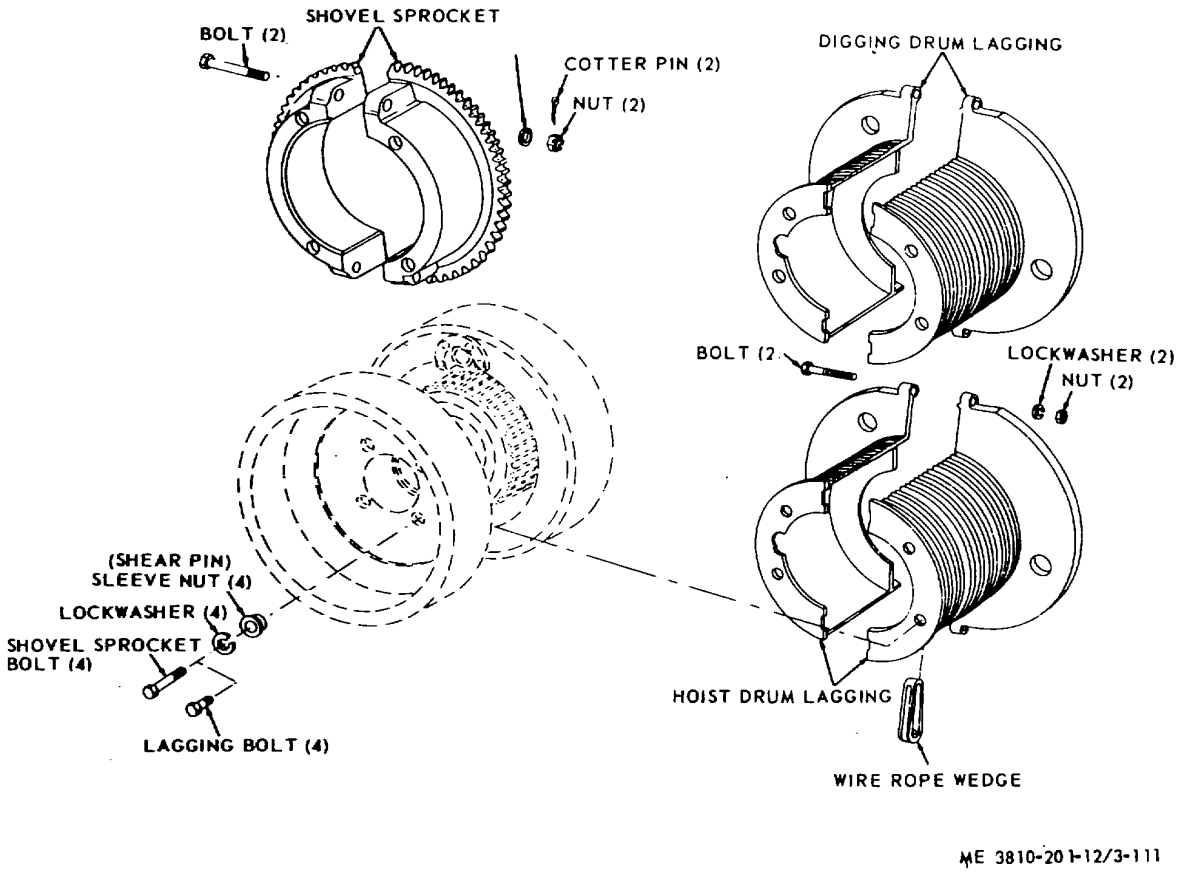


Figure 3-98. Drum Lagging, removal and installation.

remove the two nuts, washers and bolts that hold halves together, then lift lagging off drum.

(5) Remove remaining lagging in a similar manner.

(6) Install in reverse order.

b. Cleaning, Inspection, and Repair.

(1) Clean all parts in an approved cleaning solvent and dry thoroughly.

(2) Visually inspect mounting hardware for worn, burred, or stripped thread condition. Inspection lagging for wear, cracks, or other damage.

(3) Repair by replacing defective mounting hardware, and replacement of damaged or defective lagging.

Note. When lagging is removed for conversion to another front end attachment, the removed lagging must be prepared for storage.

c. Lubrication. Refer to figure 3-100, lubrication fitting arrangement.

3-125. Shovel Sprocket and Planetary Pinion Gear

a. General. The shovel front end attachment requires installation of planetary pinion gear and shovel sprocket, which must be removed when converting to any other front end attachment.

b. Removal and Installation.

(1) Remove revolving frame crowd and retract chain (para 4-3).

(2) Refer to view A of figure 3-101 and remove shovel sprocket.

(3) Refer to view B of figure 3-101 and remove planetary pinion gear.

Note. Lubrication arrangement (view A, fig. 3-101) for sprocket installation must be modified to that shown in figure 3-100 when other front end attachments are installed.

(4) Install in reverse order.

c. Cleaning, Inspection and Repair.

(1) Clean all parts in an approved cleaning solvent and dry thoroughly.

(2) Visually inspect mounting hardware for burrs, stripped threads or other damage. Inspect sprocket or pinion for cracks, breaks, excessive wear, or other damage.

(3) Repair by replacing damaged or defective

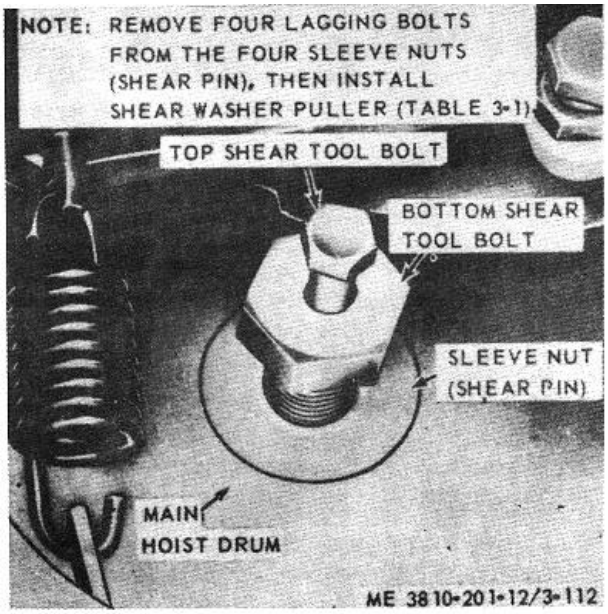


Figure 3-99. Sleeve nut, removal and installation.

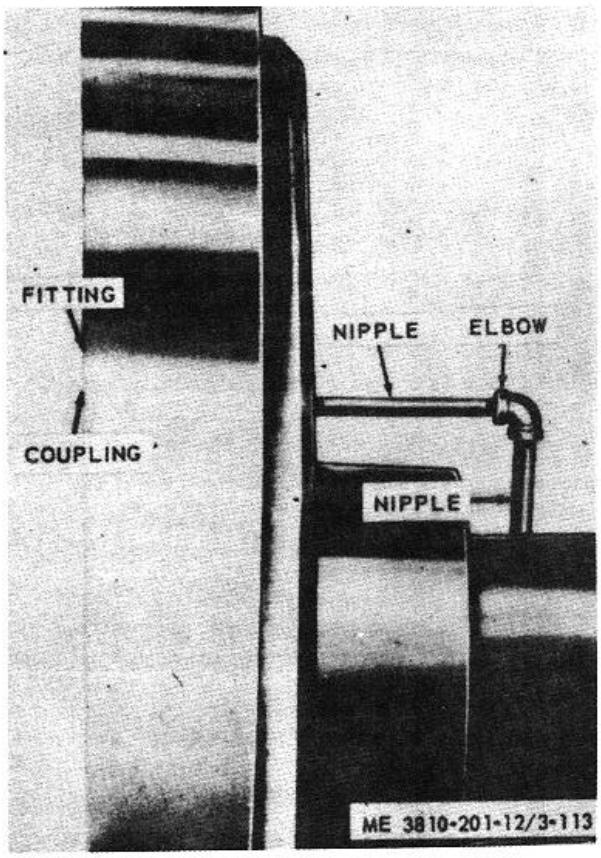


Figure 3-100. Lubricating fitting arrangement for lagging.

mounting, hardware, sprocket, or planetary pinion gear.

3-126. Gear and Dirt Guards or Shields

a. Swing Brake Dirt Guard Removal and Installation. Refer to figure 3-102 and remove swing brake dirt guard. Install in reverse order.

b. Dragline Dirt Guards, Removal and Installation. Refer to figure 3-103 and remove dragline dirt guard. Install in reverse order.

c. Hoist Gear Guard, Removal and Installation. Refer to figure 3-104 and remove hoist gear guard. Install in reverse order.

d. Vertical Propel Shaft Guard, Removal and Installation. Refer to figure 3-105 and remove vertical propel shaft guard. Install in reverse order.

e. Planetary Gear Guard, Removal and Installation. Refer to figure 3-105 and remove planetary gear guard. Install in reverse order.

f. Horizontal Gear Train Cover, Removal and Installation. Refer to figure 3-105 and remove horizontal gear train cover. Install in reverse order.

g. Intermediate Hoist and Jackshaft Cover, Removal and Installation. Refer to figure 3-106 and remove intermediate hoist and jackshaft cover. Install in reverse order.

h. Cleaning, Inspection, and Repair.

(1) Clean all parts in an approved cleaning solvent and dry thoroughly.

(2) Visually inspect guards and covers for cracks, breaks, or dents. Inspect mounting hardware for burs, stripped threads or other damage.

(3) Repair by welding cracks or breaks, straightening dents, or replacing defective hardware, guards, or covers.

3-127. Vertical Intermediate Shaft Adjustment

a. Remove cotterpin (fig. 3-107) and lockpin from bearing retainer.

b. Turn bearing retainer clockwise until all backlash is removed between the bevel pinions and the bevel gear.

c. Back off bearing retainer three holes, then secure retainer with lockpin and cotterpin.

3-128. Swing Brake Band

a. Removal and Installation. Refer to figure 3-108 and remove swing brake band. Install in reverse order.

b. Cleaning, Inspection, and Repair.

(1) Clean all metal parts in an approved cleaning solvent and dry thoroughly. Wipe brake lining with a clean cloth, or blow clean with compressed air.

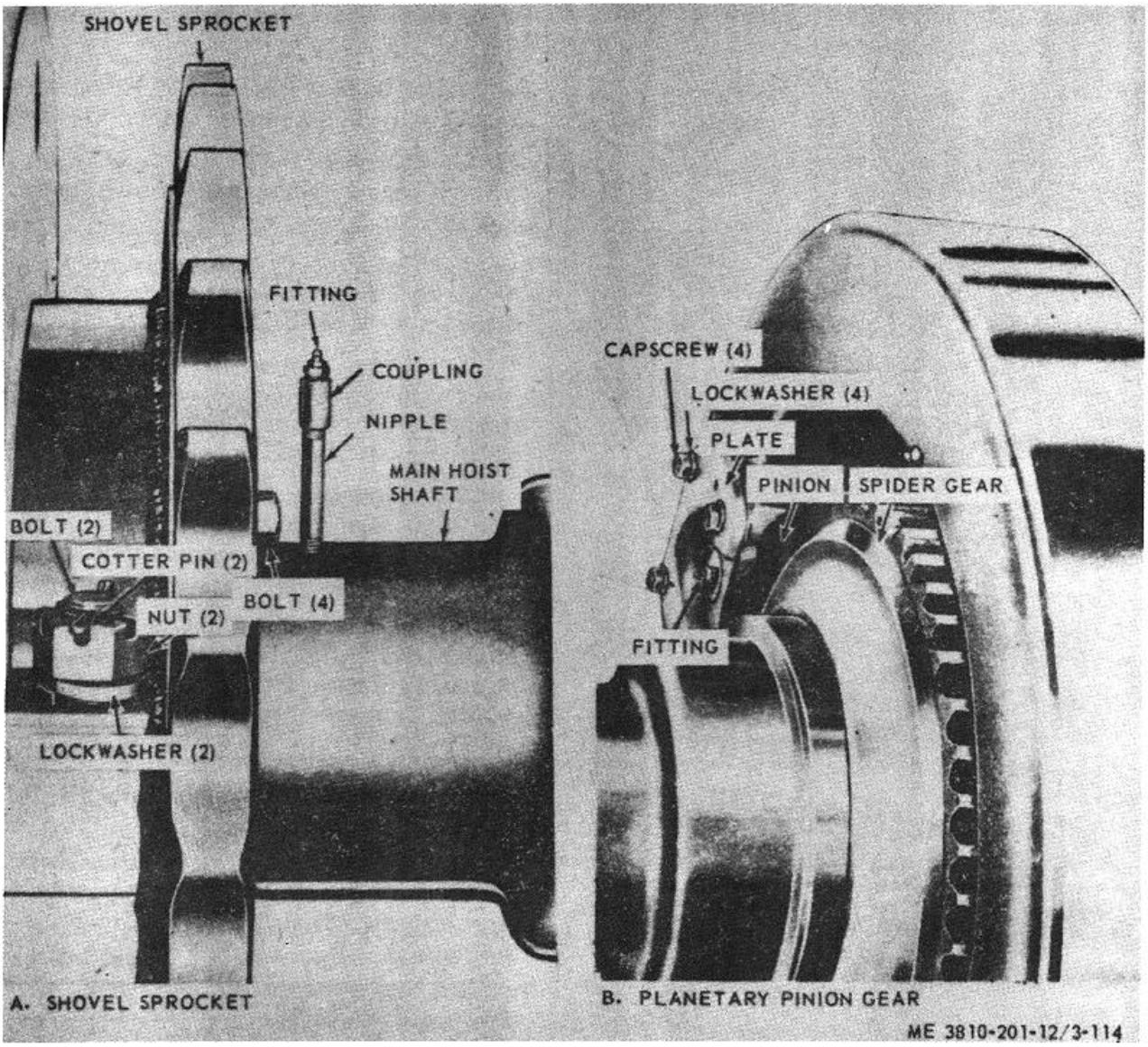


Figure 3-101. Shovel sprocket and planetary pinion gear, removal and installation.

(2) Visually inspect all parts for damage, defect, or excessive wear.

(3) Repair by replacing damaged, or defective parts. Replace brake band when lining is worn to within 1/16 inch of rivet heads.

c. Adjustment. Adjust swing brake linkage as shown on figure 3-90. Adjust swing brake (para 3-29).

3-129. Boom Hoist Planetary Broke, Hoist Brake, and Boom Hoist Holding Pawl

a. Planetary or Hoist Brake Band Removal and Installation.

(1) Loosen two tubing nuts (fig. 3-109) and remove hydraulic line.

(2) Remove two cotterpins and pins from hydraulic cylinder linkage then remove cylinder (para 3-116).

(3) Remove two cotterpins and pins securing brake band to link (fig. 3-109) then remove brake band.

(4) Remove remaining cylinder and band in a similar manner.

(5) Install in reverse order.

b. Boom Hoist Holding Pawl, Removal and Installation.

(1) Refer to figure 3-110 and remove boom hoist holding pawl.

(2) Install in reverse order.

c. Cleaning, Inspection, and Repair.

(1) Clean all metal parts in an approved

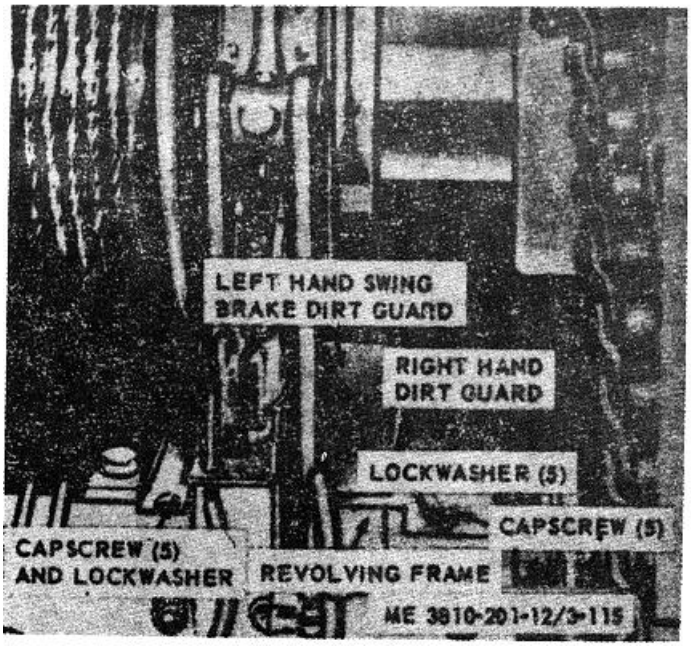


Figure 3-102. Swing brake dirt guard, removal and installation.

cleaning solvent and dry thoroughly. Clean brake end lining with a cloth, or blow dry with compressed air.

(2) Visually inspect all parts for damage or defects, and brake lining for excessive wear.

(3) Repair by replacing brake band when lining is worn to within 1/16 inch of rivet heads, and replacing all damaged or defective mounting hardware or parts as required.

3-130. Propel Broke Band and Linkage

a. Removal and Installation. Refer to figure 3-111 and remove propel brake band and linkage. Install in reverse order.

b. Cleaning, Inspection, and Repair. Clean, adjust, and repair in manner similar to that described in paragraph 3-123.

c. Adjustment. Refer to paragraph 3-29 for adjustment instructions.

3-131. Propel and Steering Mechanism Adjustment

a. Steering Wheel Adjustment. Refer to paragraph 3-132 and adjust the steering wheel.

b. Steering Linkage and Propel Brake Adjustment. Refer to paragraph 3-29 and adjust steering linkage and propel brakes.

3-132. Steering Wheel Adjustment

Refer to figure 3-112 and adjust the steering wheel.

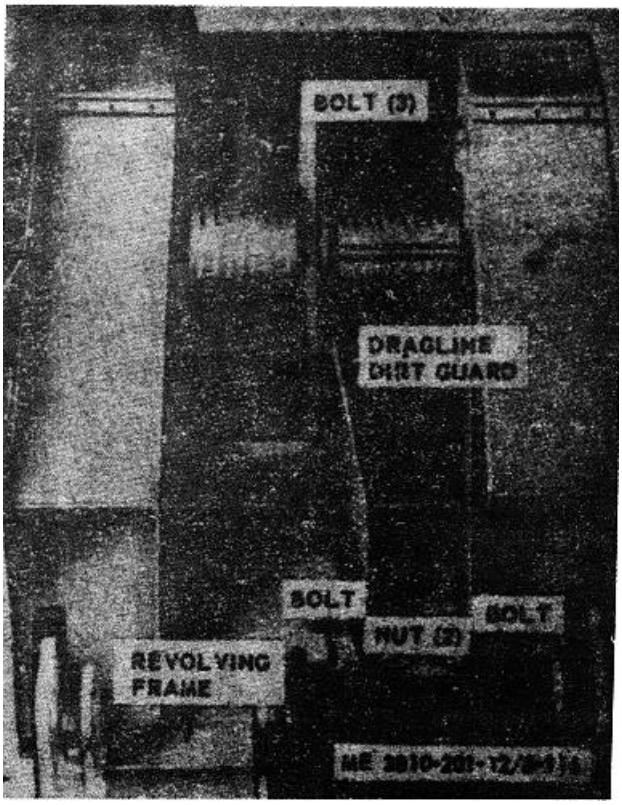


Figure 3-10. Dragline dirt guard removal and installation.

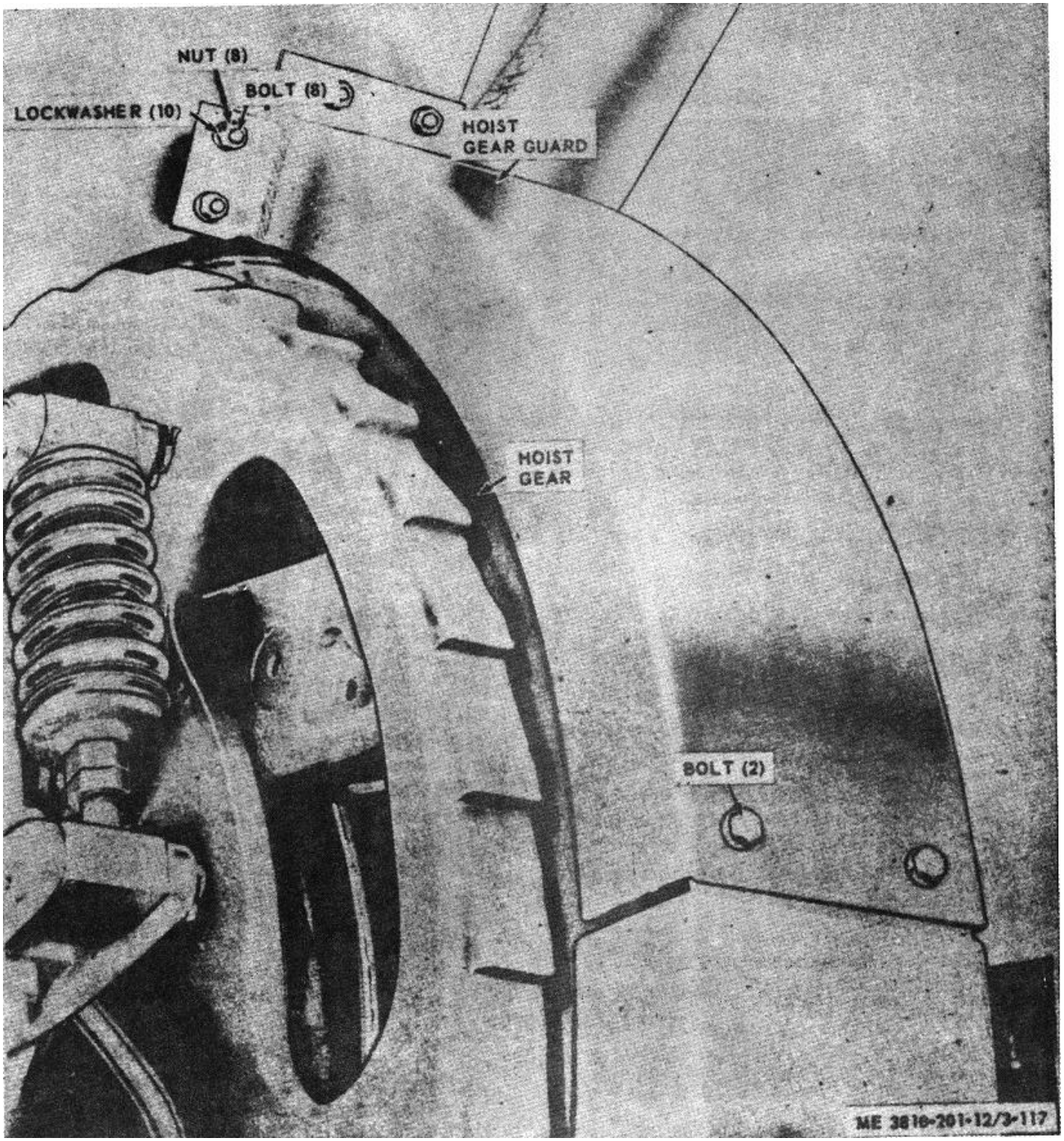


Figure 3-104. Hoist gear guard, removal and installation.

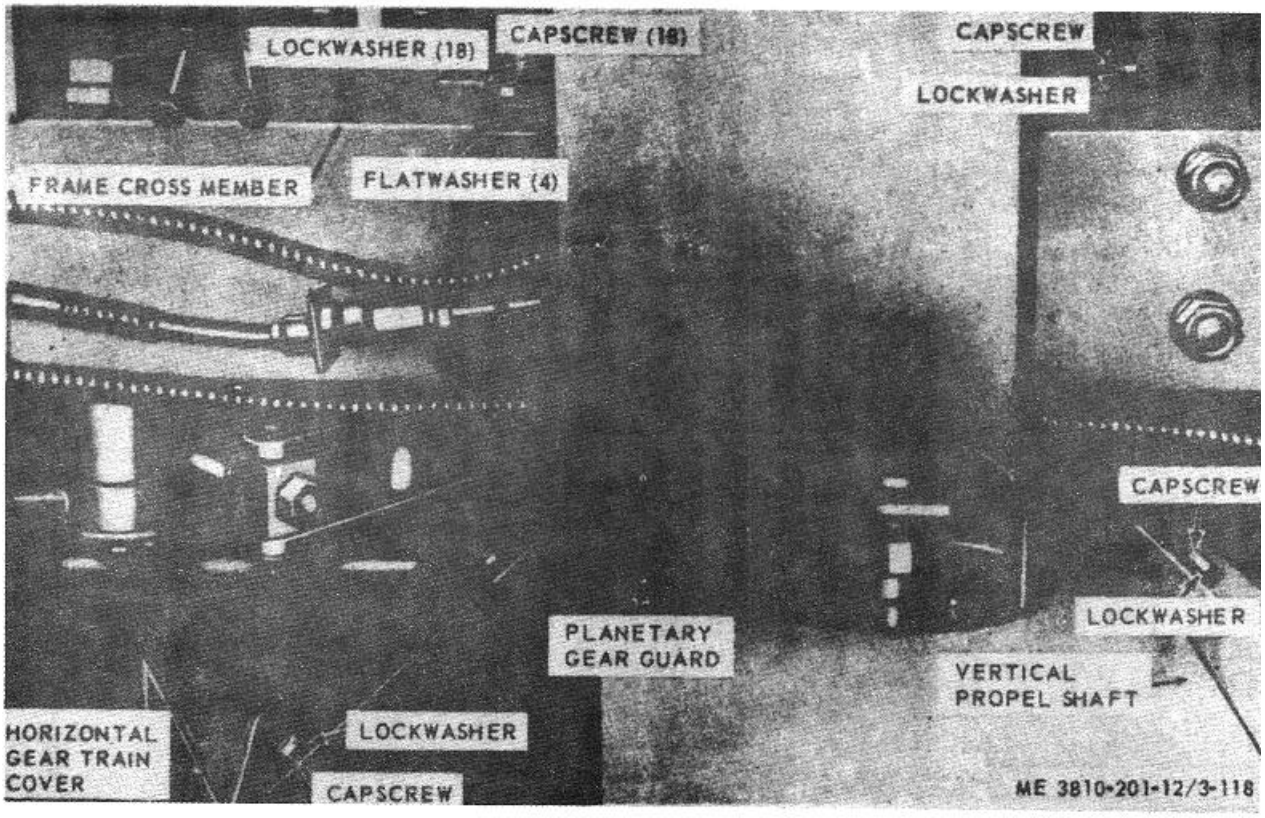


Figure 3-105. Vertical propel shaft guard, planetary gear guard, and horizontal gear train cover, removal and installation.

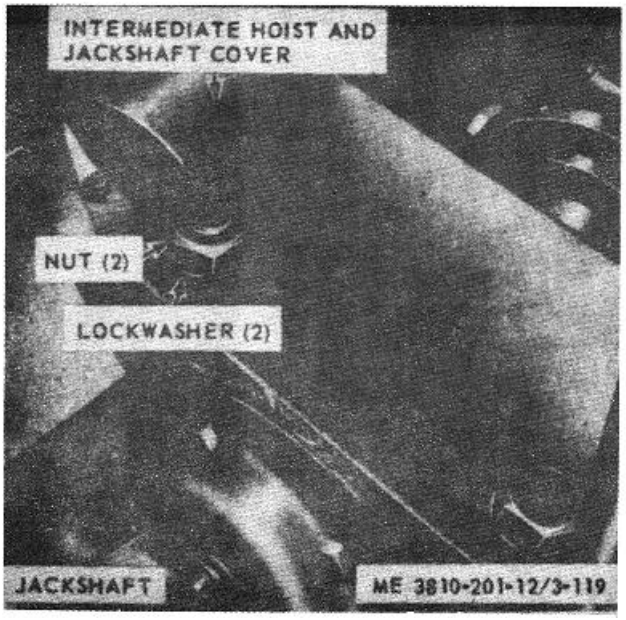


Figure 3-106. Intermediate hoist and jackshaft cover, removal and installation.

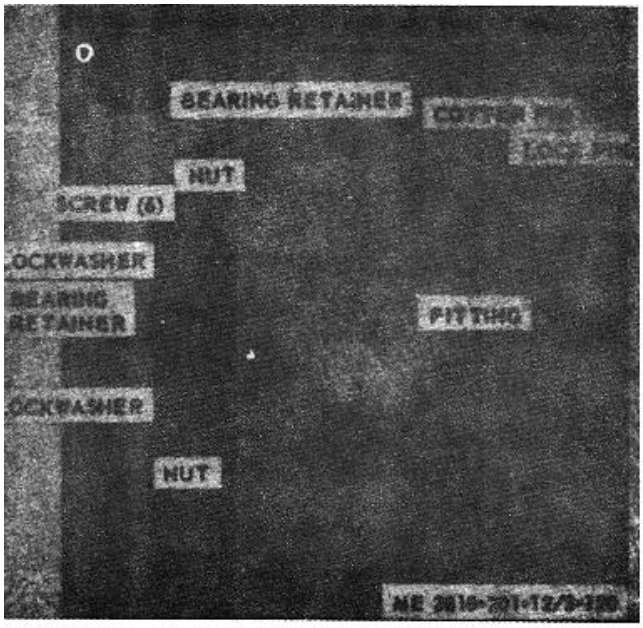


Figure 3-107. Vertical Intermediate shaft adjustment.

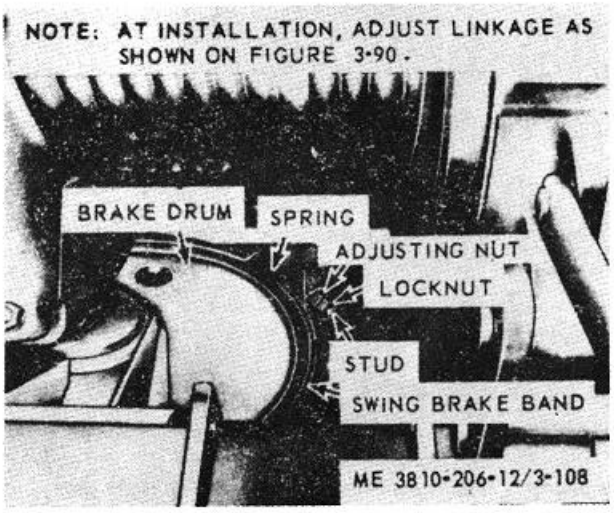


Figure 3-108. Swing brake band, removal and installation

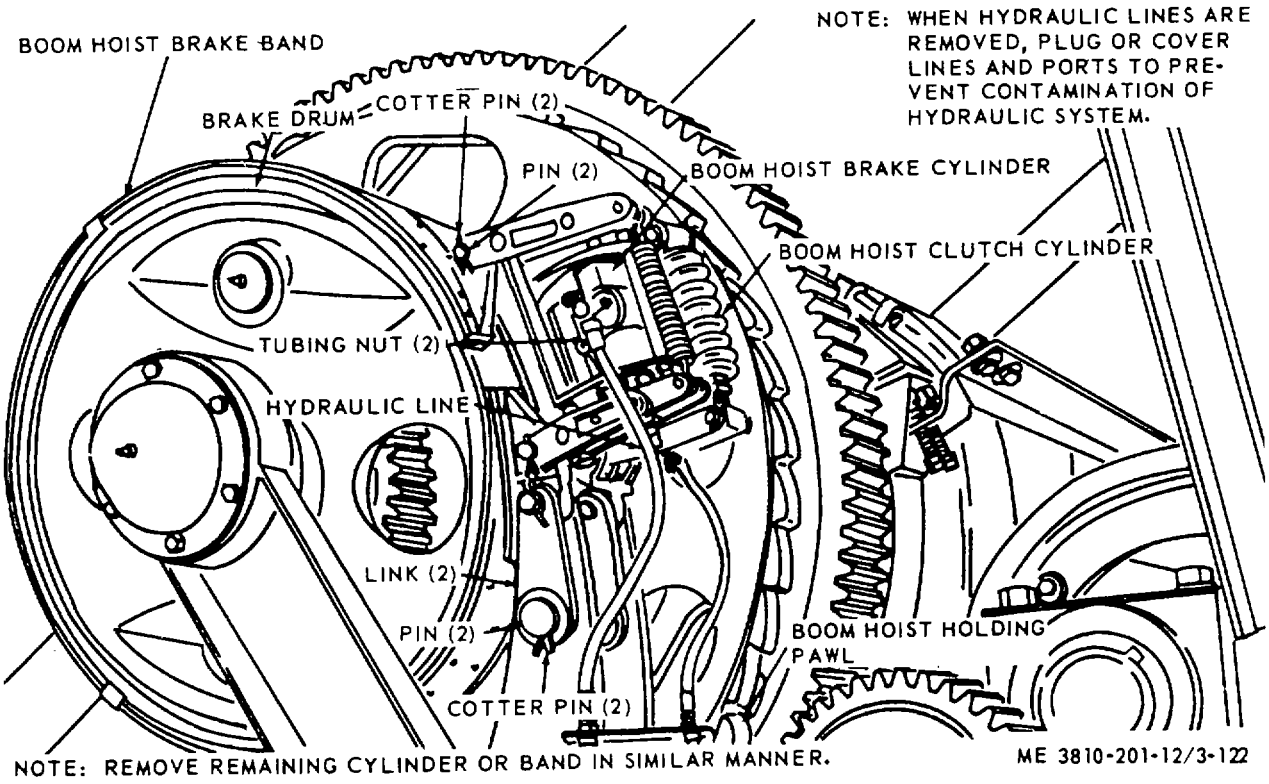


Figure 3-109. Boom Planetary or hoist brake band, removal and installation.

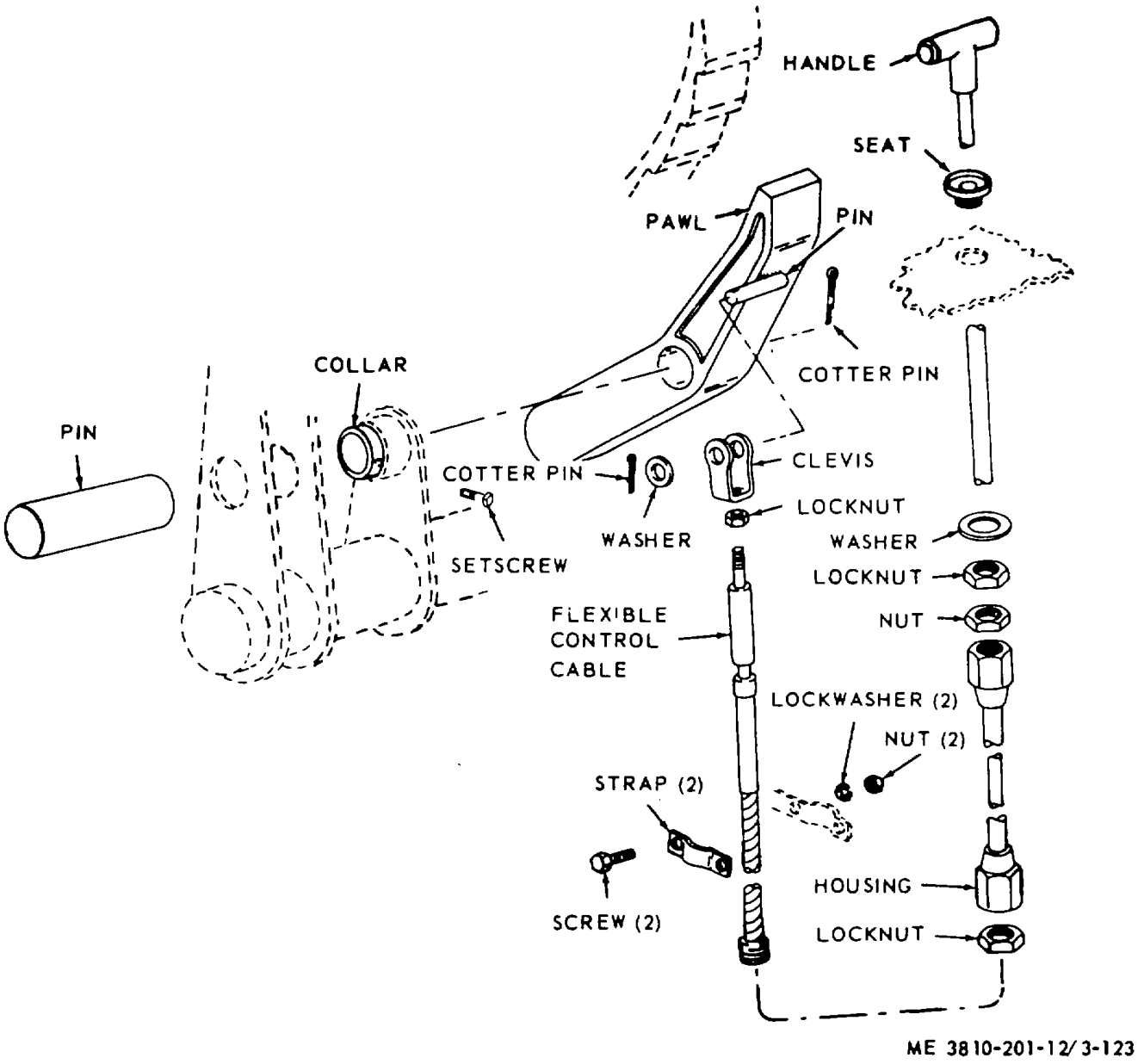


Figure 3-110. Boom hoist holding pawl, removal and installation.

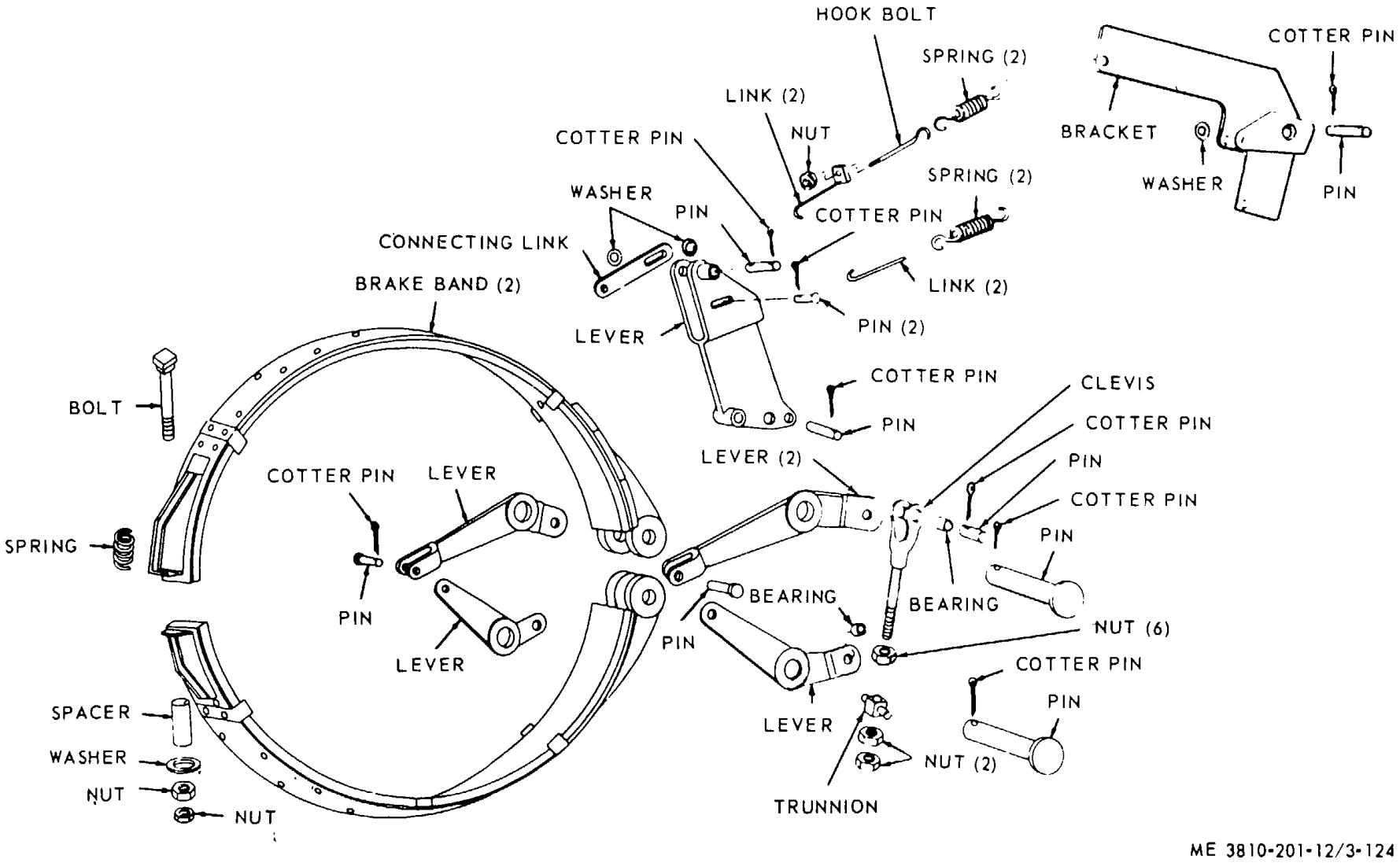


Figure 3-111. Propel brake band and linkage, removal and installation.

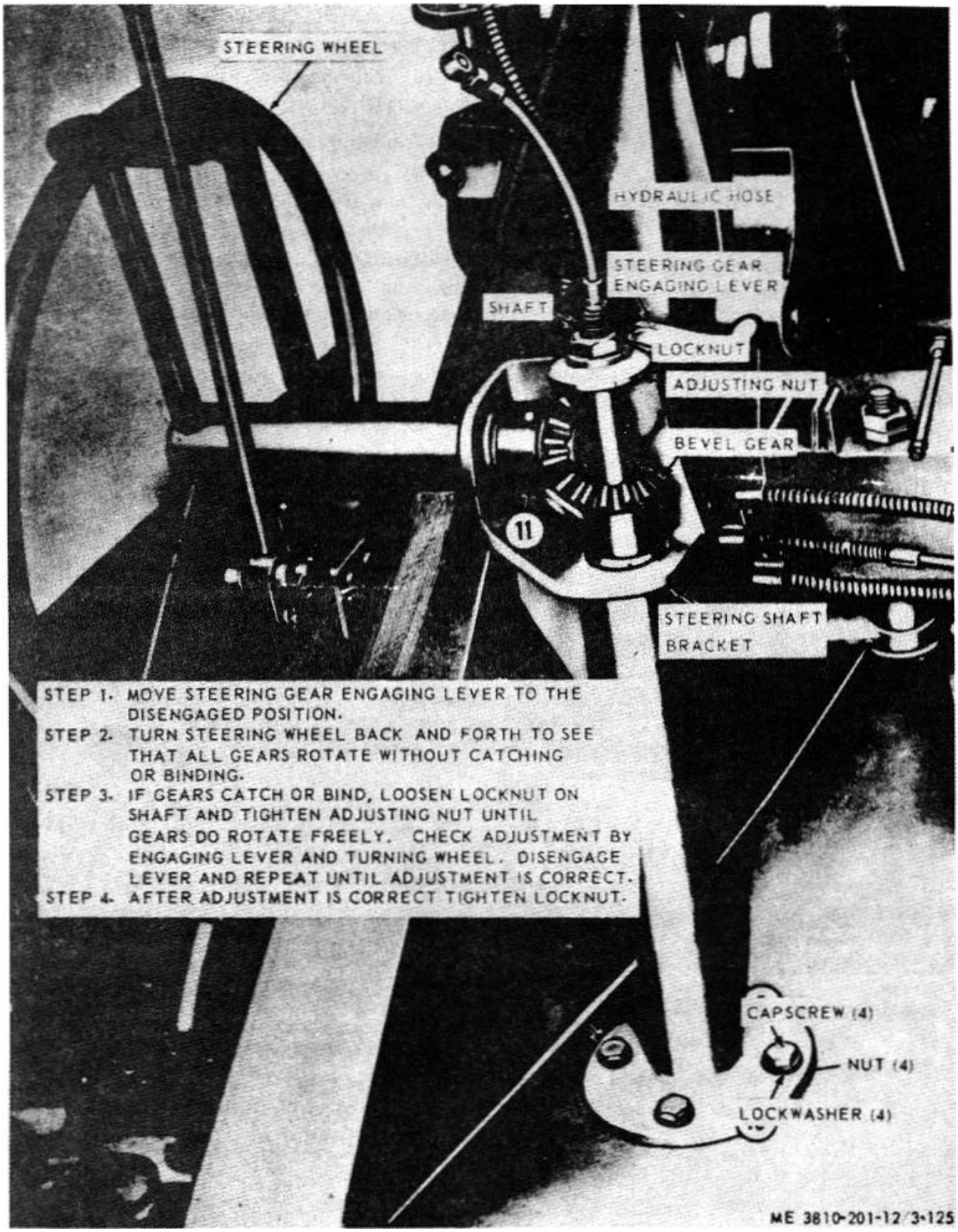


Figure 3-112. Steering wheel adjustment.

Section XIX. TRACKS

3-133. General

This section describes maintenance procedures for the portion of the crawler assembly authorized at organization by the maintenance allocation chart. The track consists of track shoes pinned together around drive sprockets, upper support and bottom idler rollers, to form a continuous tread for traveling of the crane-shovel basic unit. Two drive chains run from sprockets on propel shaft to sprockets on track drive shaft to operate individual tracks.

3-134. Track (Tread), Links, and Pins

a. Removal.

(1) Travel crane-shovel unit to firm ground that is as level as possible, and stop with one of the master pins (fig. 3-113) at one end of crawler frame.

(2) Drive out master pin, then remove spacer and master bushing from link.

(3) Travel crane-shovel unit slowly away from removed master pin until the track is flat on the ground.

(4) Position suitable jack under crawler frame on the side where track is being removed and raise crawler frame until track is free of lower track roller and sprocket.

(5) Pull the track assembly from under the crane-shovel unit.

b. Cleaning, Inspection and Repair.

(1) Clean all parts in an approved cleaning solvent and dry thoroughly.

(2) Visually inspect side bars, shoulder bolts, bushings, nuts, links, link pins, master link pins, and shoes for cracks, breaks, excessive wear, or other damage.

(3) Repair side bars by welding cracks or breaks and replace other components that are damaged or defective.

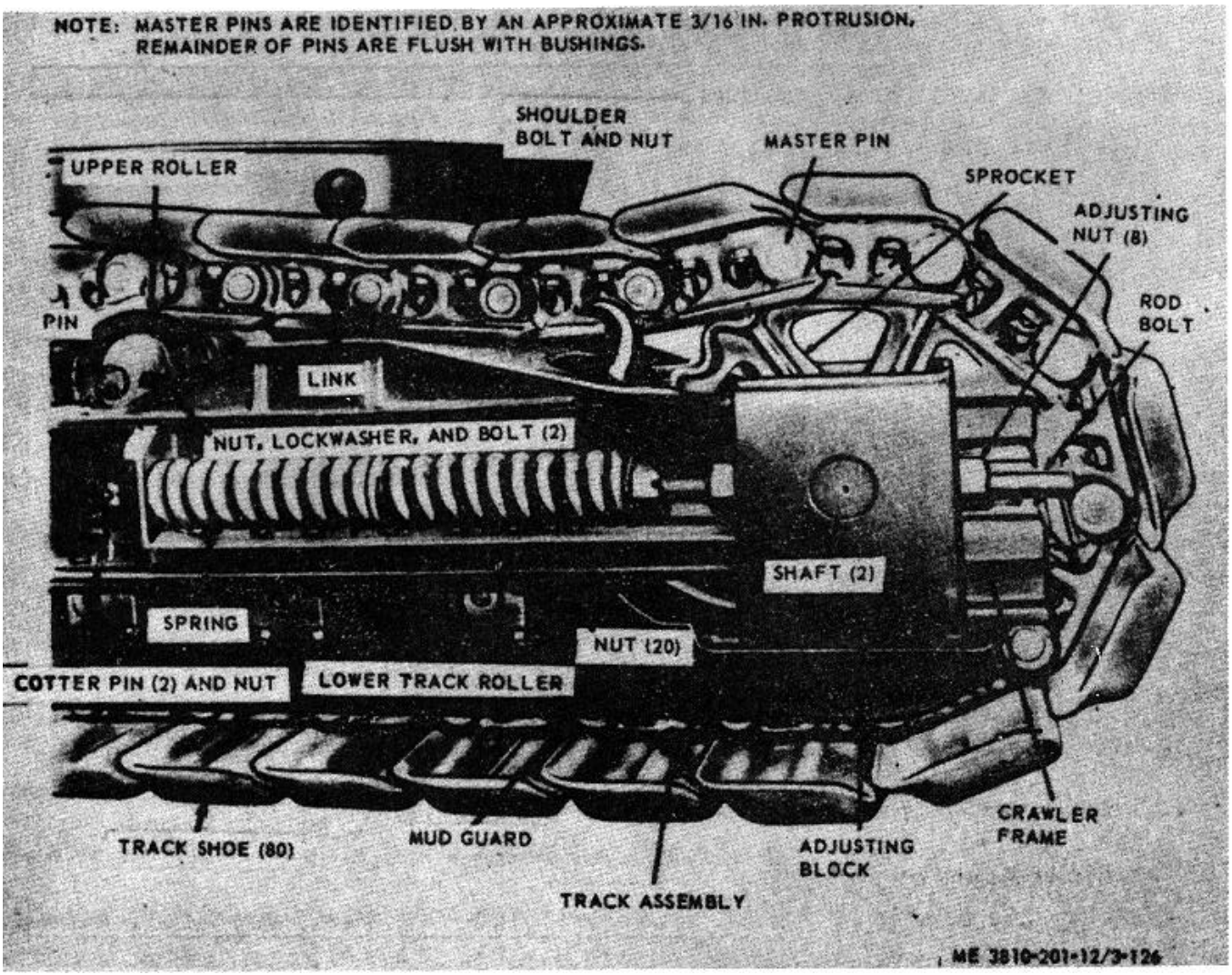


Figure 3-113. Track, removal and installation.

c. Installation.

(1) Pull the assembled track under lower track rollers and drive sprocket. Leave enough track protruding beyond drive sprocket in such a way that end of track can be lifted up around sprocket.

Note.

Be sure roller flanges are directly above track.

(2) Lower jack and crawler frame until lower track rollers rest properly on track.

(3) Pull ends of track up and around sprocket, and over upper track roller until ends meet, install bushing in link, install spacers, then install master pin.

(4) Remove jack from crawler frame.

d. Adjustment. Refer to paragraph 3-37 and adjust track.

3-135. Upper Track Support Rollers

a. Removal and Installation.

(1) Provide slack for removal of upper support rollers by loosening the adjusting nuts (fig. 13) on rod bolt.

(2) Remove two nuts, lockwashers, and bolts from roller pin.

(3) Raise track assembly with a long pry bar, insert blocking between track and crawler frame to provide clearance for removal of roller.

(4) Drive out pin and remove roller.

(5) Remove remaining rollers in a similar manner.

(6) Install in reverse order.

(7) Adjust track (para 3-37).

b. Cleaning, Inspection and Repair.

(1) Clean all parts with an approved cleaning solvent and dry thoroughly.

(2) Visually inspect rollers and pins for wear or breakage. Inspect mounting hardware for burs, stripped threads, or other damage. Inspect roller mounting brackets for cracks, or breaks.

(3) Repair by replacing defective mounting hardware, worn roller pins, or welding cracks or breaks in mounting brackets. Replace damaged rollers. Damaged or defective rollers will be forward(-d to direct support maintenance for repair.

3-136. Track Idler Adjusting Springs

a. Removal and Installation.

(1) Remove cotterpin and nut (fig. 3-113) from end of rod bolt. Remove cotterpin from nut at end of spring, and move nut toward adjusting block until tension on springs is relieved.

(2) Remove adjusting nut at end of rod bolt and back off the one on other side of adjusting block until rod bolt will come out of bracket at end of springs.

(3) Remove rod bolt from bracket, pull rod bolt out of adjusting block, then remove and separate the two springs.

Note.

At installation, position adjusting nut and spring control nut on rod bolt at their approximate positions when rod bolt was removed above.

(4) Install in reverse order.

b. Cleaning, Inspection and Repair.

(1) Clean all parts in an approved cleaning solvent and dry thoroughly.

(2) Visually inspect mounting hardware for burs, or stripped threads. Inspect springs for loss of tension (no space between coils) or breaks.

(3) Repair by replacing damaged mounting hardware, or a weak or broken spring.

3-137. Drive Chain

a. Removal and Installation.

(1) Remove lockpin (fig. 3-114) from pin in drive chain, and drive pin from chain link.

(2) If necessary to give slack, remove two capscrews and lockwashers from lockplate on adjustment block, remove lockplate, then turn adjusting bolt until chain has enough slack to allow pins easy removal.

(3) Loosen adjusting nuts on two eyebolts one on inside the other on outside of frame.

(4) Remove drive chain.

(5) Remove remaining drive chain in similar manner.

(6) Install in reverse order.

b. Cleaning, Inspection and Repair.

(1) Clean all parts in an approved cleaning solvent and dry thoroughly.

(2) Visually inspect each link of chain for bent link, worn link rollers, bent pin, or excessive]y worn chain.

(3) Repair by replacing worn or bent links, pins, or rollers. Replace the complete chain when wear appears to be equal, but excessive throughout its entire length.

c. Adjustment. After installation, refer to paragraph 3-36 for adjustment instructions.

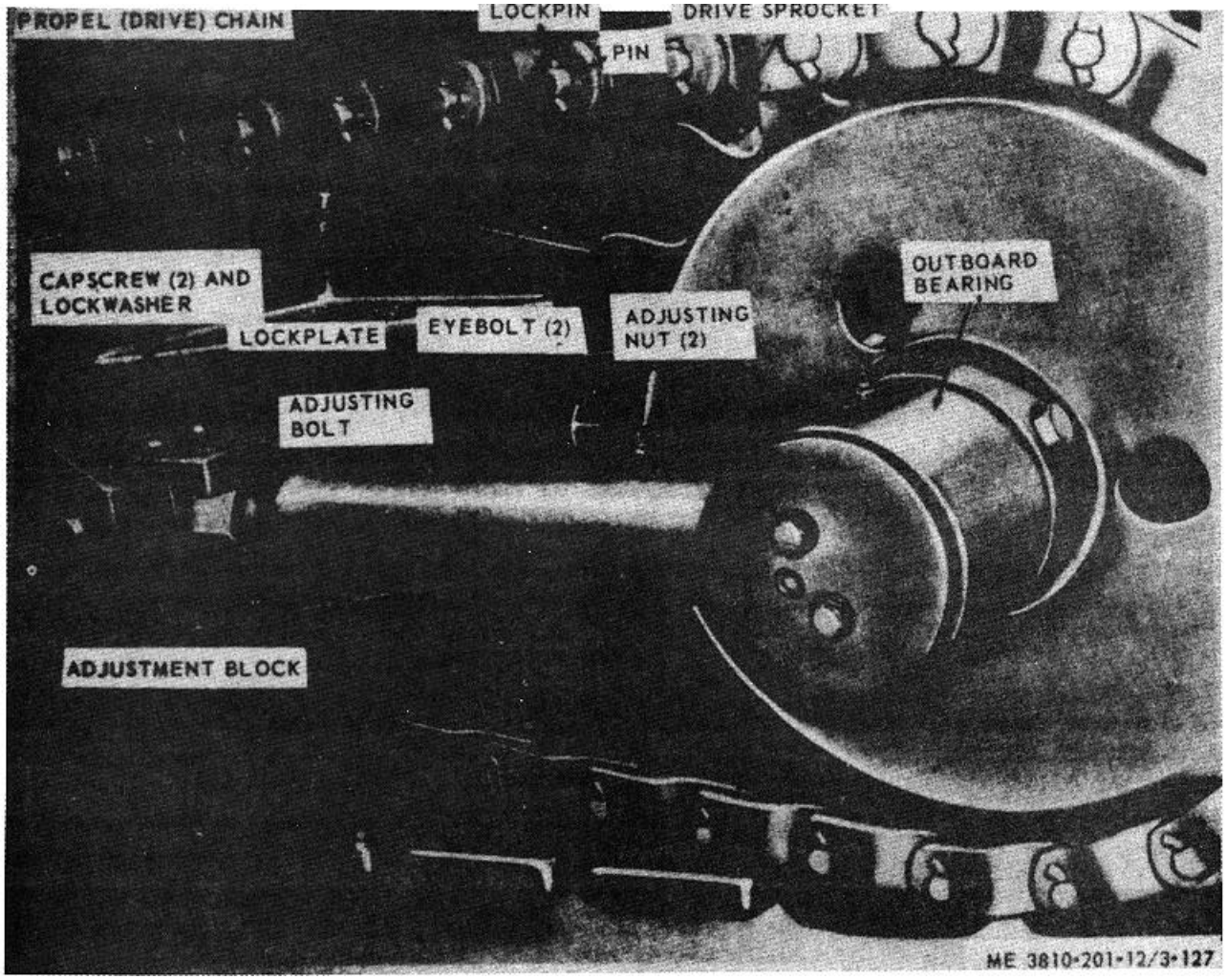


Figure 5-114. Drive (propel) chain, removal and installation

3-138. Mud Guard

a. Removal and Installation.

(1) Remove track (para 3-134).

(2) Remove 20 nuts (fig. 3-113) then remove mud guard.

(3) Remove remaining mud guard in similar manner.

(4) Install in reverse order.

b. Cleaning, Inspection and Repair.

(1) Clean all parts with an approved cleaning solvent and dry thoroughly.

(2) Visually inspect mud guard for bends, cracks, or other damage.

(3) Repair by straightening bends, welding cracks, and replacement of defective mounting hardware. Replace a mud guard damaged **be**yond repair.

Section XX. INSTRUMENTS AND CONTROLS

3-139. General

This section describes organizational maintenance for the instruments and controls, which consists of ammeter, tachometer-hourmeter, oil pressure indicator, water temperature indicator, starter push switch, horn push switch, run-shut- down switch, governor control, manual shutdown control, and (warning) indicator lights.

3-140. Tachometer-Time Totalizing Meter

a. Removal and Installation.

(1) Refer to figure 3-115. and loosen cable housing nut.

(2) Remove two nuts and lockwashers securing tachometer to control panel, then lift tachometer indicator from control panel.

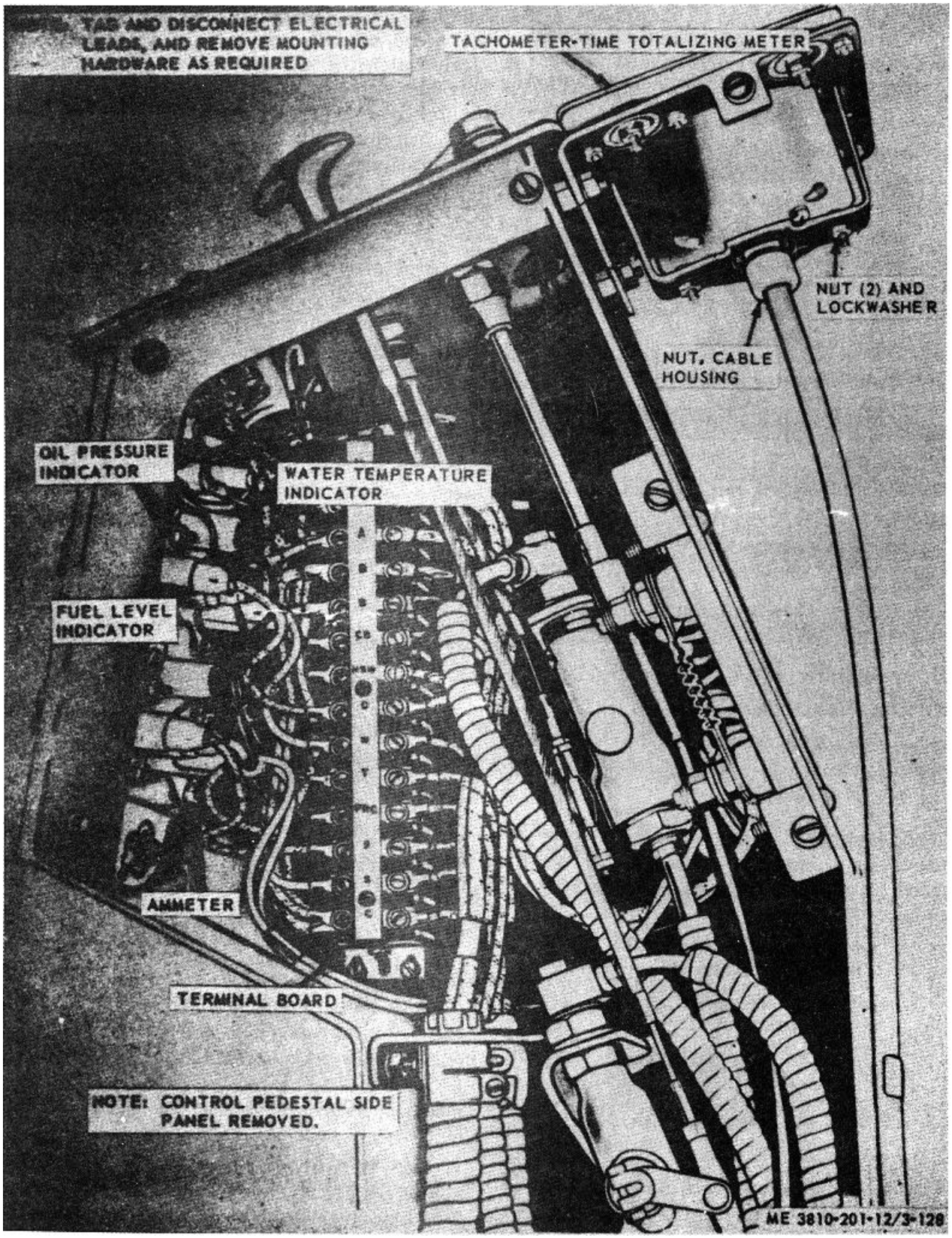


Figure 3-115. Tachometer-time totalizing meter, oil pressure indicator, fuel lever indicator, and ammeter, removal and installation.

(3) Install in reverse order.

b. Cleaning, and Inspection.

(1) Clean tachometer with a soft cloth dampened in an approved cleaning solvent, then dry thoroughly.

(2) Visually inspect tachometer for broken glass and free movement of drive shaft. Replace a defective tachometer.

3-141. Overspeed Governor Microswitch (For Engine Model 687C-1 DES)

a. Removal and Installation.

(1) Refer to figure 3-70, tag and disconnect two electrical leads, remove two screws securing switch to overspeed governor, then remove microswitch.

(2) Install in reverse order.

b. Cleaning, Inspection and Test.

(1) Clean microswitch with a soft cloth dampened in an approved cleaning solvent and dry thoroughly.

(2) Visually inspect for corroded terminals and damaged or weak arm contact.

(3) Use a multimeter and test between normally open and normally closed contacts for continuity. If continuity is shown, switch is defective. Replace a damaged or defective microswitch.

3-142. Ammeter

a. Removal and Installation.

(1) Refer to figure 3-115 and remove the ammeter.

(2) Install in reverse order.

b. Cleaning, Inspection and Test.

(1) Clean ammeter with a soft cloth dampened in an approved cleaning solvent and dry thoroughly.

(2) Visually inspect ammeter for corroded terminals, cracked glass, and other damage or defect.

(3) Use a multimeter and check across terminals for continuity. Replace a damaged or defective ammeter.

3-143. Oil Pressure Indicator

a. Removal and Installation.

(1) Refer to figure 3-115 and remove the oil pressure indicator.

(2) Install in reverse order.

b. Cleaning and Inspection.

(1) Clean oil pressure indicator with a soft cloth dampened in an approved cleaning solvent, and dry thoroughly.

(2) Visually inspect indicator for broken glass or other damage. Inspect transmitter leads for good terminal connections at indicator. If transmitter checks out (para 3-84) but indicator does not operate, return to direct support for calibration.

(3) Replace a defective oil pressure indicator, or damaged mounting hardware.

3-144. Indicator (Warning) Light, Low Oil Pressure

a. Removal and Installation.

(1) Refer to figure 3-116 and remove the low oil pressure indicator (warning) light.

(2) Install in reverse order.

b. Cleaning, Inspection and Repair.

(1) Clean all metal parts with an approved cleaning solvent and dry thoroughly.

(2) Visually inspect light for damage or defect. Check that lamp is not burned out. Inspect red lens for cracks or breaks.

(3) Repair by replacing a burned out lamp. Replace a light that is defective, or when lens is broken.

3-145. Fuel Level Indicator

a. Removal and Installation.

(1) Refer to figure 8115 and remove fuel level indicator.

(2) Install in reverse order.

b. Cleaning, Inspection and Repair.

(1) Clean indicator with clean cloth dampened in an approved cleaning solvent and dry thoroughly.

(2) Visually inspect indicator for dents, broken glass, or other damage. Inspect mounting hardware for burs, stripped threads, or other defect. Inspect electrical leads for fraying insulation, broken wire, or loose terminals. Check indicator. for operation in conjunction with transmitter (para 3-146).

(3) Repair by replacing defective indicator, mounting hardware, or electrical lead.

3-146. Transmitter Fuel Level

a. Removal and Installation. Refer to figure 3-48 and remove fuel level transmitter. Install in reverse order.

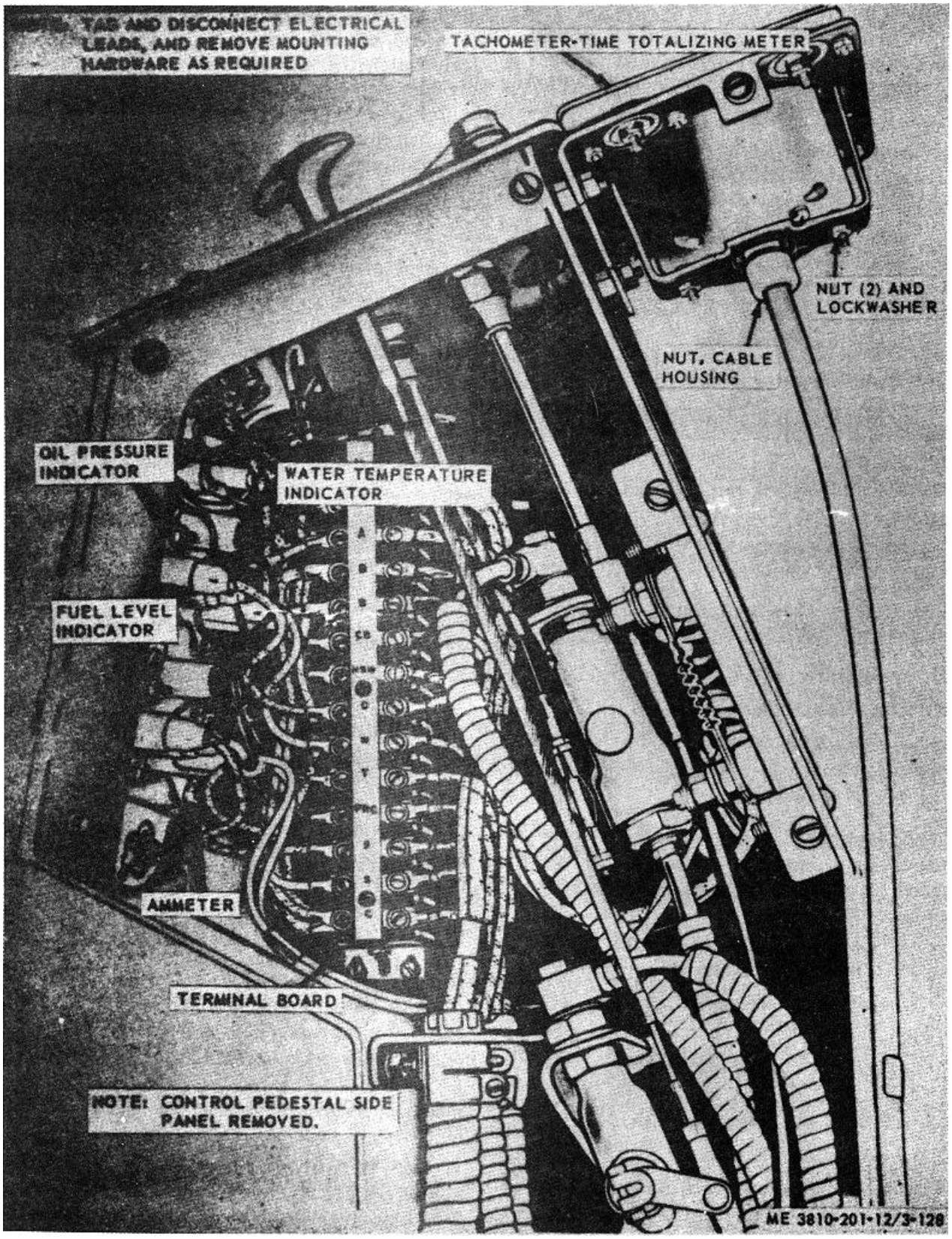


Figure 3-116. Indicator light and switch, removal and installation.

b. Cleaning, Inspection and Repair.

(1) Clean transmitter in an approved cleaning solvent and dry thoroughly.

(2) Use a multimeter set on l,)w ohm scale across terminals then move float through arc to full position. During float travel multimeter should indicate increasing ohms. When increasing ohms are indicated, install electrical lead then check position of pointer on indicator with position of float relative to distance traveled.

(3) Repair by replacing a defective transmitter or mounting hardware.

3-147. Water Temperature Indicator

a. Removal and Installation.

(1) Refer to figure 3-115 and remove the water temperature indicator.

(2) Install in reverse order.

b. Cleaning, Inspection and Repair.

(1) Clean indicator with a soft cloth dampened in an approved cleaning solvent and dry thoroughly.

(2) Visually inspect indicator for dents, broken glass, or other defect. Inspect mounting hardware for burs, stripped threads, or other damage.

(3) Repair by replacing mounting hardware or water temperature indicator.

3-148. Indicator (Warning) Lights, Water High Temperature

a. Removal and Installation. Refer to figure 3-116 and remove indicator (warning) light water high temperature. Install in reverse order.

b. Cleaning, Inspection and Repair. Clean, inspect, and repair indicator light in manner described in paragraph 3-144.

3-149. Run-Shutdown Switch

a. Removal and Installation.

(1) Refer to figure 3-116 and remove run shutdown toggle switch.

(2) Install in reverse order.

b. Cleaning, Inspection and Repair.

(1) Clean switch in an approved cleaning solvent and dry thoroughly with compressed air.

(2) Visually inspect switch for damage or defect. Use multimeter and test for continuity between terminals when switch is ON. When switch is OFF, no continuity should be indicated.

(3) Repair by replacing a defective switch.

3-150. Starter Push Switch

a. Removal and Installation.

(1) Refer to figure 3-116 and remove starter push switch.

(2) Install in reverse order.

b. Cleaning, Inspection and Repair. Refer to paragraph 3-149 and clean, inspect, or repair starter push switch in a similar manner.

3-151. Horn Push Switch

a. Removal and Installation.

(1) Refer to figure 3-116 and remove horn push switch.

(2) Install in reverse order.

b. Cleaning, Inspection and Repair. Refer to. paragraph 3-149 and clean, inspect, or repair horn switch in a similar manner.

3-152. Electrical Connector (Quick Disconnect) Receptacle

a. Removal.

(1) Remove electrical connector from receptacle at bottom of instrument panel (fig. 2-23).

(2) Remove side panel from control pedestal.

(3) Remove four nuts, lockwashers, and screws, then remove electrical connector receptacle from bottom of control panel.

b. Installation. Install by reversing procedure in a, above.

3-153. Terminal Board and Wiring

a. Removal and Installation.

(1) Refer to figure 3-115 and remove terminal board.

(2) Install in reverse order.

b. Wiring Test and Repair. Refer to paragraph 3-89 for test and repair of wiring.

Section XXI. COUNTERWEIGHTS

3-154. General

Warning:
Do not travel over rough terrain with crane-shovel basic unit (without front end attachment), unless counterweight extension is removed. This will avoid danger of tipping the unit over, damaging the equipment, or injury to personnel.

The counterweight consists of slug punchings

which are stored in, compartments of revolving frame, and the extension, which mounts on rear of revolving frame. Purpose of counterweight extension is to offset extended weights of front end attachment and load. Slug punchings are not ordinarily removed from revolving frame.

3-155. Counterweight Extension

a. Removal.

(1) Position lifting device capable of lifting 10,000 lbs at rear of crane-shovel unit.

(2) Remove two plugs (fig. 3-117) from counterweight extension, and install two lifting eyebolts in counterweight.

(3) Secure lifting hooks in lifting eyebolts, take up slack then remove bolts and washers.

(4) Lift extension up and off revolving frame, and move to a suitable storage area.

b. Installation.

(1) With a suitable lifting device, lift counterweight extension, move to rear of crane-shovel basic unit and position it for installation.

(2) Install bolts and washer to secure extension to frame, then remove lifting hooks.

(3) Remove two lifting eyebolts, then install plugs in bolt holes.

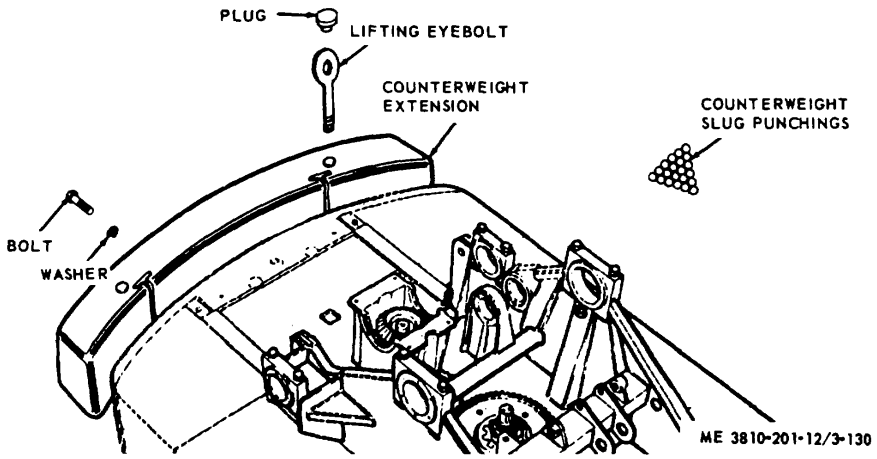


Figure 3-117. Counterweight extension, removal and installation.

Section XXII. CAB, PANELS, DOORS, WINDOWS, AND SEATS

3-156. General

The cab of the crane-shovel basic unit is manufactured of sheet metal sections, panels, doors, and window frames, which are bolted to one another and to the revolving frame. Any part of the cab can be removed for repair, or in sections to provide access to machinery components that require repair or adjustment.

3-157. Door Handrail (Grip)

a. Removal and Installation

(1) Remove two nuts **(**fig. 3-118) and two washers, then remove handrail from cab.

(2) Remove the two remaining nuts from handrail.

(3) Install in reverse order.

b. Cleaning, Inspection and Repair.

(1) Clean handrail in an approved cleaning solvent and dry thoroughly.

(2) Visually inspect handrail for bends, cracks, or burs on threads

(3) Repair by straightening bends, welding cracks, and chase burs off threads. Replace a defective handrail.

3-158. Door and Window Glass

a. Removal.

(1) Insert hook end of channel tool in

NOTE:
REMOVE APPLICABLE MOUNTING HARDWARE, THEN REMOVE PANEL.

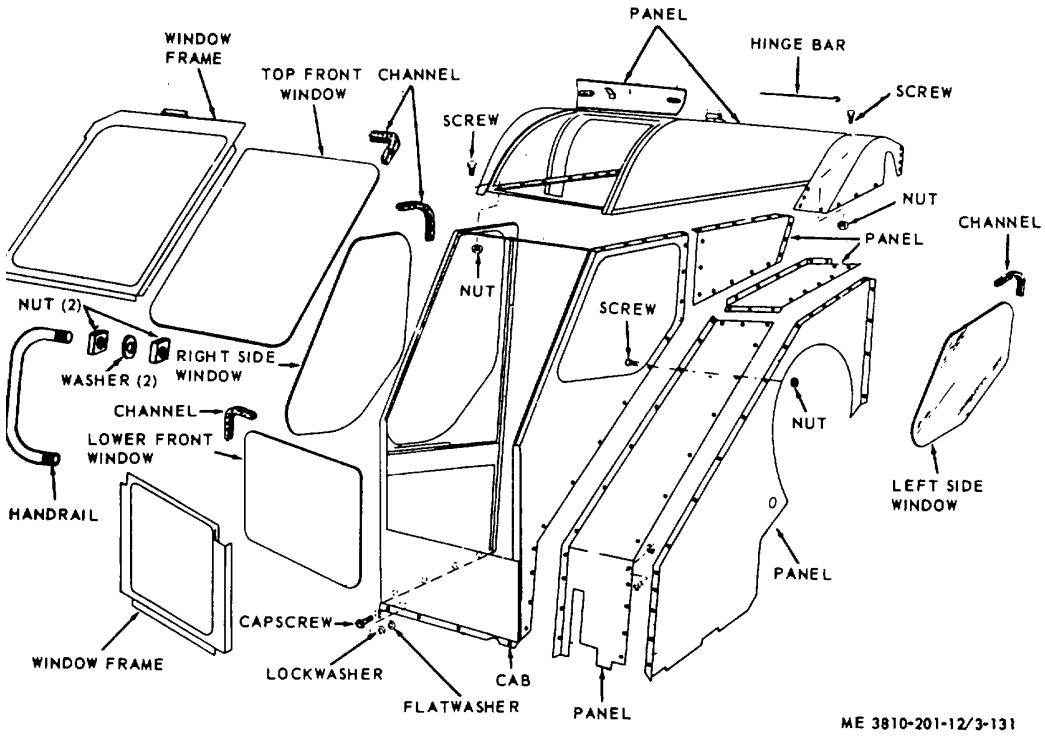


Figure 3-118. Handrail, panel, window frame, and cab, removal and installation.

groove of channel (fig. 3-118) and slide tool completely around channel to break the seal.

(2) Insert. straight end of channel tool between channel and glass, move tool slowly around window or door glass to break seal of channel to glass. Press glass outward gently while breaking seal and the glass will slide out of the frame when seal is completely broken.

b. Installation.

(1) Start channel along the side of opening.

(2) Fit narrow edge of channel over edge of window frame and continue around frame until the two ends of channel are joined.

(3) When glass is in position, insert hooked end of tool into channel, move around window forcing locking strip into position and completing the installation.

Note.
Do not begin locking operation at channel joint. Start around the corners smoothly to avoid buckling or crimping the channel. Use care, and assure weather protection.

c. Cleaning, Inspection and Repair.

(1) Clean edges of window frame, inside and out, with an approved cleaning solvent and dry thoroughly.

(2) Visually inspect channel for cracks, breaks, deterioration or other damage. Inspect window frame or panels for dents or cracks.

(3) Repair by welding cracks and straightening dents in window frame. Replace defective channel or broken glass.

3-159. Swinging Door

a. Removal and Installation.

(1) Unhook latch.

(2) Refer to figure 3-119, remove nine nuts, washers and screws, then remove swinging door.

(3) Install in reverse order.

b. Cleaning, Inspection and Repair.

(1) Clean all parts in an approved cleaning solvent and dry thoroughly.

(2) Visually inspect door for defective hinges, dents, cracks, or other defect.

(3) Repair by straightening bends, welding cracks, or replacing defective hinge or door.

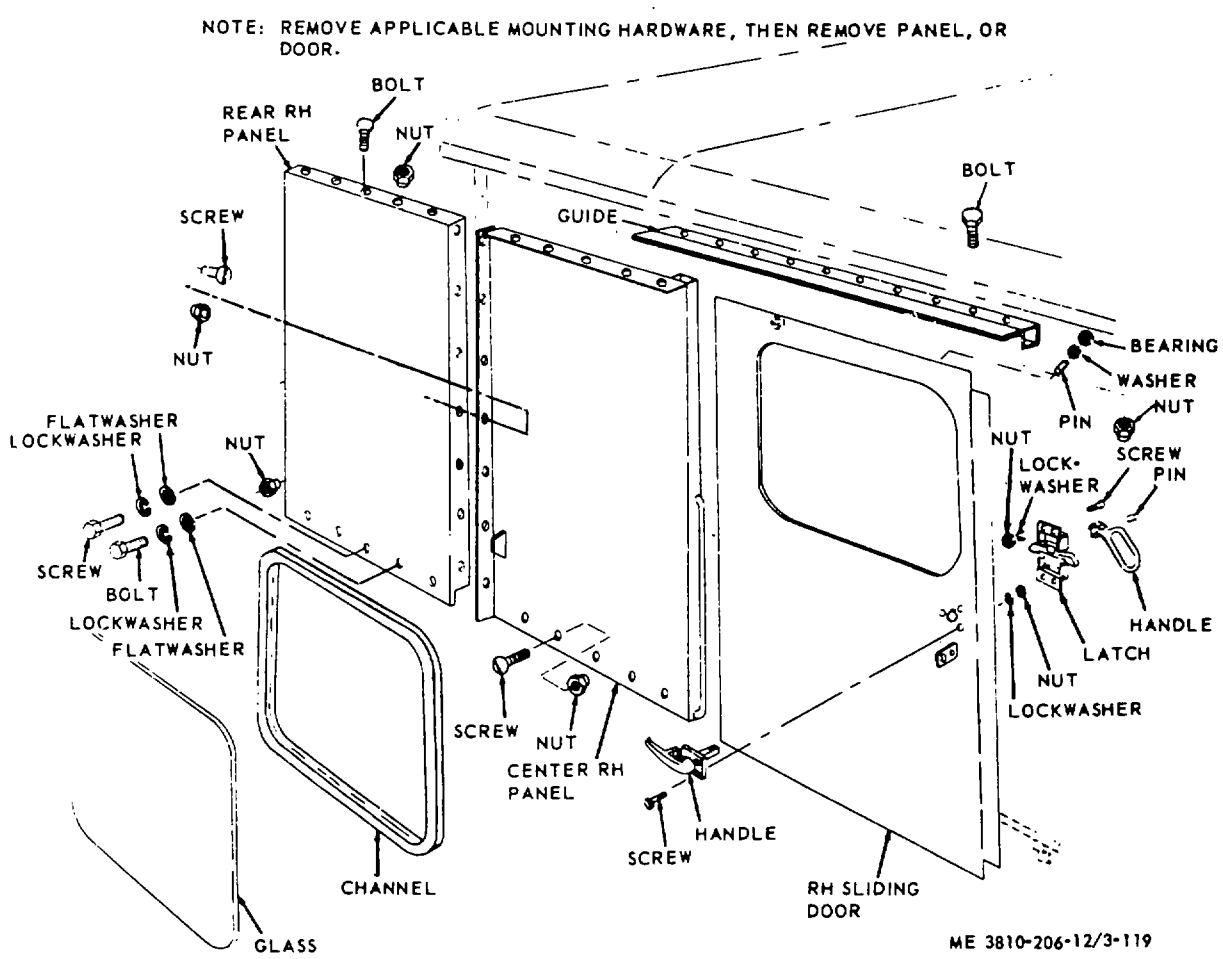


Figure 3-119. Panels and swinging door, removal and installation.

3-160. Sliding Doors

a. Removal and Installation.

(1) Refer to figure 3-120 and unhook latch.

(2) Remove two roller bearings and washers from pins then lift right rear sliding door from guides.

(3) Remove left rear sliding door in similar manner.

(4) Install in reverse order.

b. Cleaning, Inspection and Repair.

(1) Clean door with an approved cleaning solvent and dry thoroughly.

(2) Visually inspect bearings for excessive wear, door for bends, cracks, or other damage.

(3) Repair by straightening bends, welding cracks, or replacing defective bearings or door.

3-161. Center Side Panel

a. Removal and Installation.

(1) Refer to figure 3-119 and remove center panel from left hand side.

(2) Install in reverse order.

b. Cleaning, Inspection and Repair. Clean, inspect, and repair panels in manner similar to that described for doors in paragraph 3-159.

3-162. Left Hand Front Panel

Refer to paragraph 3161 and remove or install left hand front panel in a similar manner.

3-163. Left Front Panel Door

a. Removal and Installation.

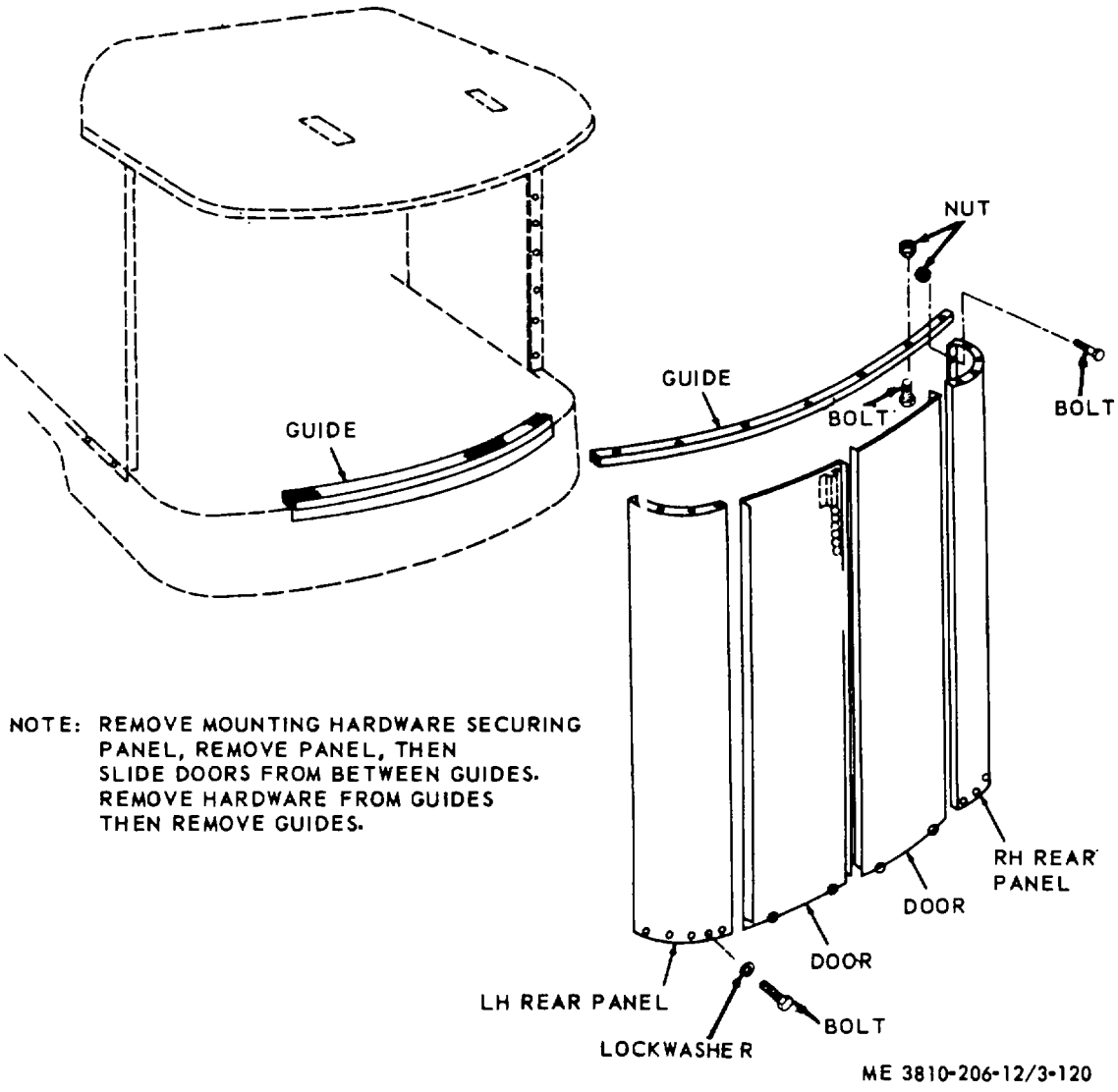
(1) Refer to figure 3-121 and remove left front panel door.

(2) Install in reverse order.

b. Cleaning, Inspection and Repair. Clean, inspect, and repair left front panel door in manner similar to that described in paragraph 3-159.

3-164. Rear Cab Panel

Refer to figure 3-121 and remove or install the rear cab panel.



3-165. Right Rear Side Panel

Remove or install right rear side panel in manner similar to that described for louver panel (para 3-166).

3-166. Louver Panel

a. Removal and Installation.

(1) Refer to figure 3-119 and remove louver panel from left hand side of cab.

(2) Install in reverse order.

b. Cleaning, Inspection and Repair.

(1) Clean panel in an approved cleaning solvent and dry thoroughly.

(2) Visually inspect for dents, cracks, or bent louvers. Inspect mounting hardware for burs, stripped threads, or other damage.

(3) Repair by straightening bends and dents, or welding cracks. Replace defective mounting hardware, or panel.

3-167. Right Hand Side Center Cab Panel

Remove or install right hand side center cab panel in similar manner as described for louver panel (para 3-166).

3-168. Operator's Seat

Refer to figure 3-122 and remove operator's seat. Install in reverse order.

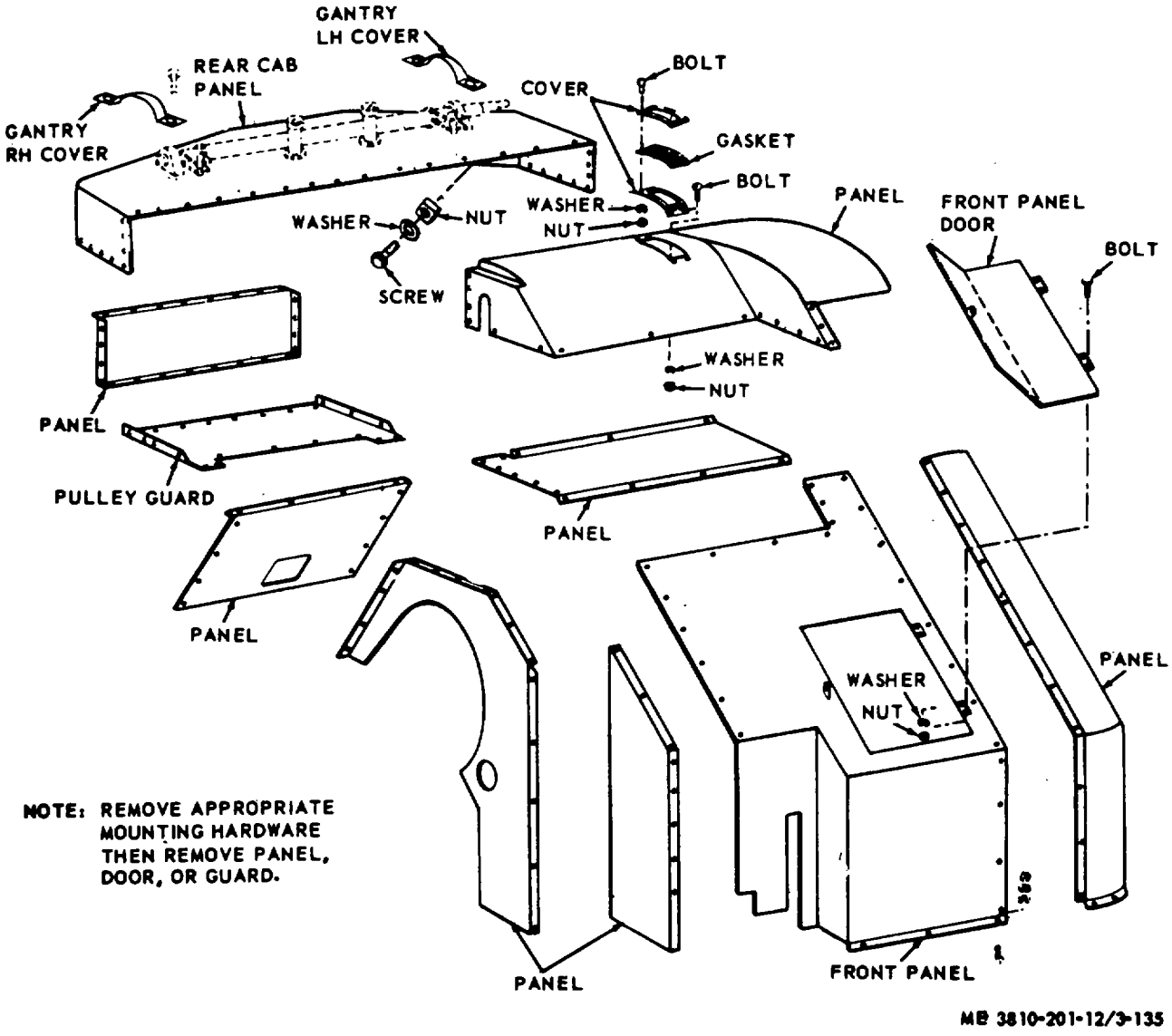


Figure 3-121. Panel, cover, and doors, removal and installation

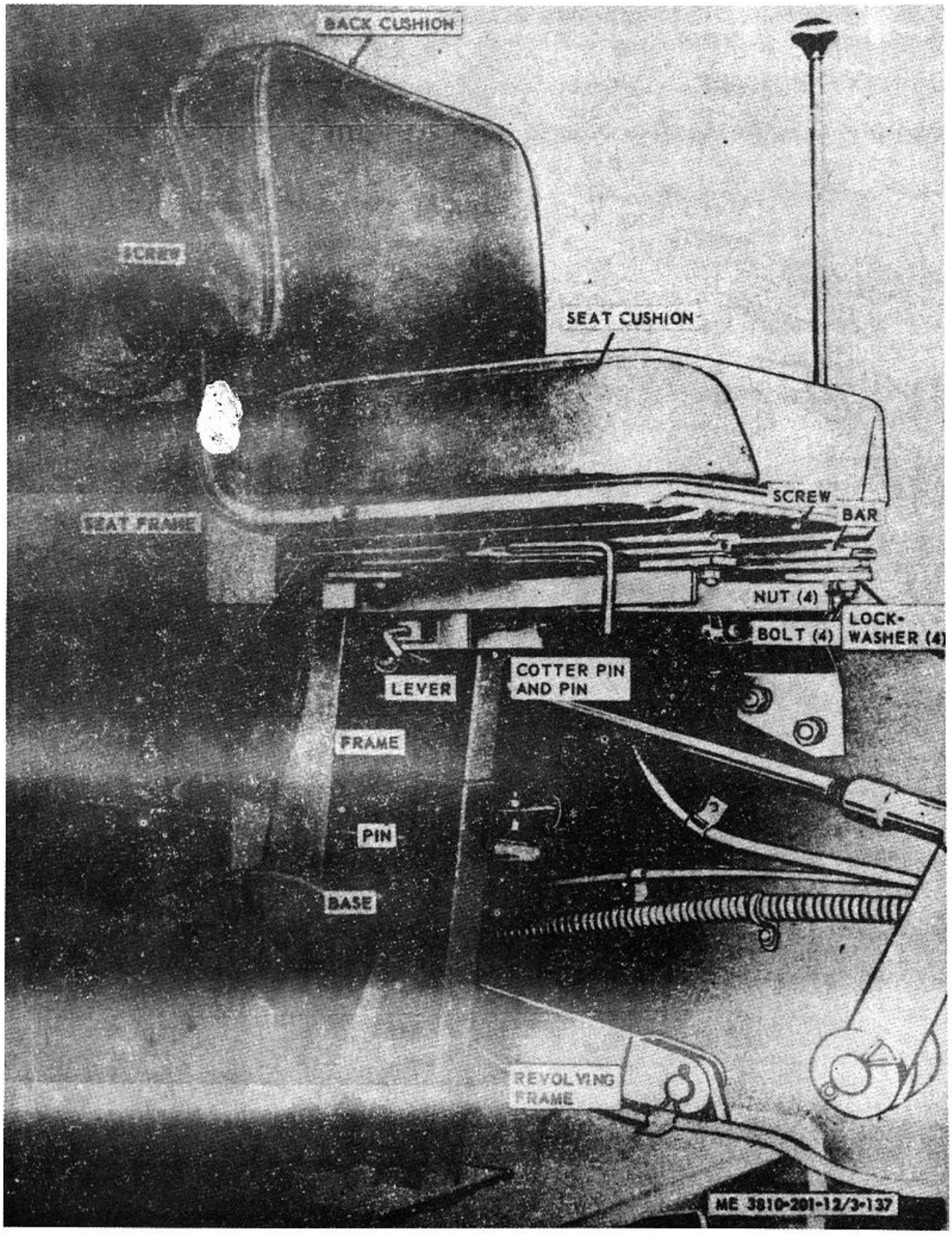


Figure 3-122. Operator's seat, removal and installation.

Section XXIII. LIGHTS, LIGHT ENCLOSURE, AND COMPONENTS

3-169. General

The lightning system consists of upper and lower floodlights, cab lights, and panel lights, with condition from junction boxes to light enclosure, or cab light lampholders. The panel lights are identical with those on instrument control panel and are mounted at top of lighting enclosure.

3-170. Floodlights

a. Removal and *Installations.*

(1) Tag and remove electrical leads.

(2) nut (fig. 3-14) from stem inside adjusting bracket

b. Disassembly and Reassembly. Refer to figure 3-123 and disassemble the floodlight. Reassemble in reverse order.

c. Cleaning, Inspection and Repair.

(1) Clean all metal parts in an approved cleaning solvent and dry thoroughly.

(2) Visually inspect electrical terminals for corrosion or looseness. Inspect and test lamp for serviceable condition. Inspect mounting hardware for stripped threads or other defect Inspect packing for deterioration.

(3) Repair by replacing defective lamp or packing.

3-171. Cab Light

a. Removal and Installation

(1) Remove lamp.

(2) Refer to figure 3-124 and remove cab light lampholder.

(3) Install in reverse order.

b. Inspection and Repair.

(1) Visually inspect wiring at lampholder for good connection. Inspect for frayed or defective leads. Test lamp for serviceability. Inspect hardware for damage or defect.

(2) Repair by replacing defective wiring, lamp, or lampholder.

3-172. Light Enclosure

a. Removal and Installation

(1) Remove two screws and open cover (fig. 3-124).

(2) Tag and disconnect conduit and electrical leads from light enclosure.

(3) Remove four nuts, lockwashers, and screws, then remove light enclosure.

(4) Install in reverse order.

b. Component Removal Installation..

(1) Open cover.

(2) Tag and disconnect applicable lead(s), then remove defective component

(3) Install in reverse order.

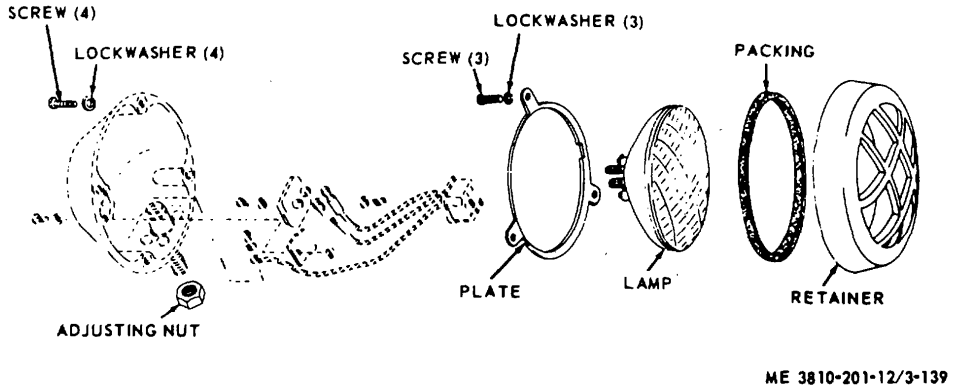


Figure 3-123.Floodlight, disassembly and reassembly

NOTE:
TAG AND REMOVE ELECTRICAL LEADS AND MOUNTING HARDWARE AS REQUIRED.

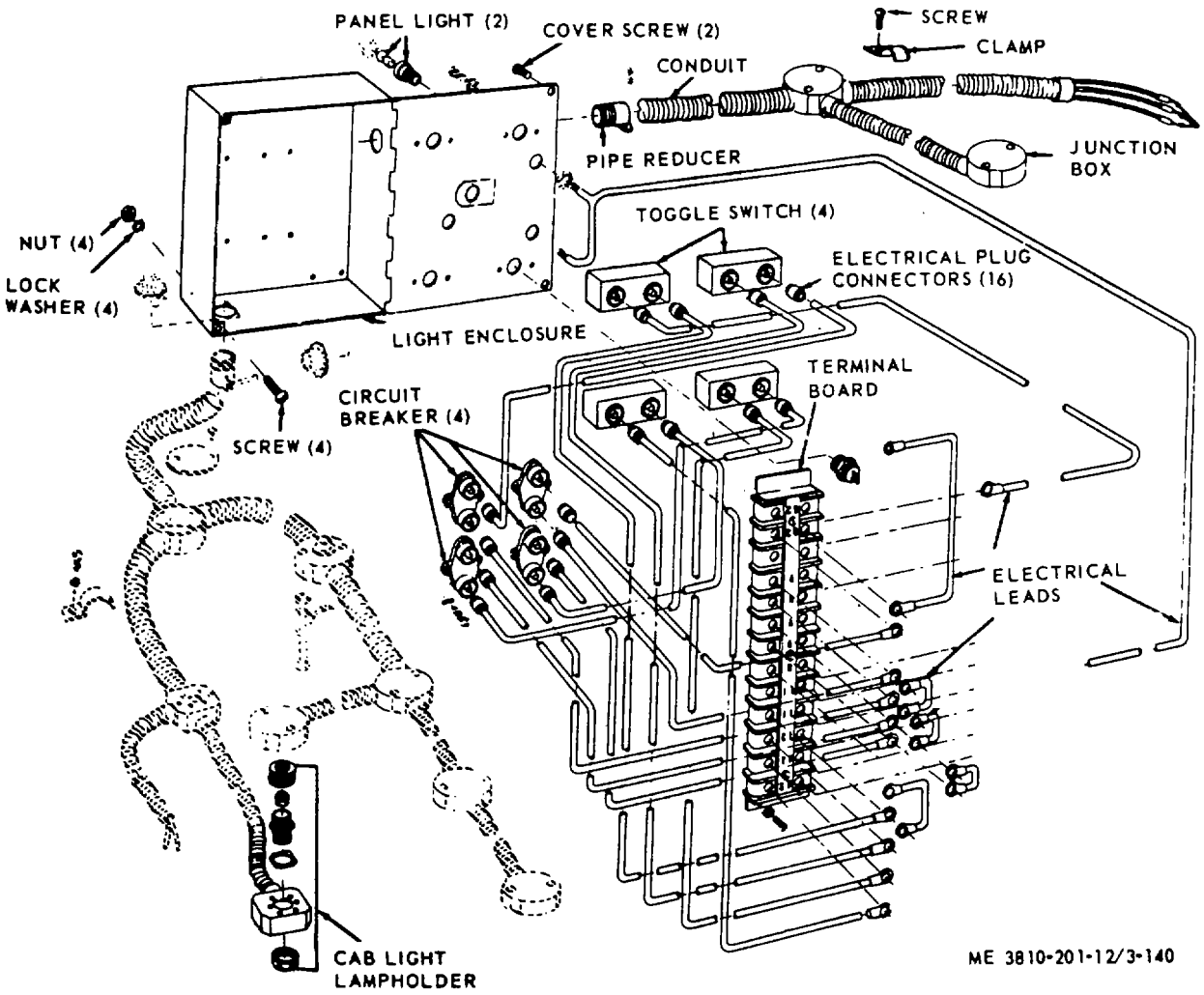


Figure 3-124. Light enclosures and components, removal and installations

3-173. Gun Case and Tool Box

Refer to figure S125 and remove run case or tool box. Install in reverse order.

3-174. Heater

a. Removal and *Installation.* Refer to figure 3-126 and remove the heater. Install in reverse order.

b. Refer to paragraph 2-26 for operating instructions.

3-175. Pressure Primmer Discharge

a. Removal and Installation

(1) Refer to figure 2-29, loosen tubing nut, and remove tube from bushing

(2) Remove four screws, nut and lockwashers that secures primer discharger to cab wall, then remove primer discharger.

(3) Remove tubing clips, then remove tube from air box.

(4) Install in reverse order.

b. Cleaning and Inspect

(1) Clean all parts in an approved cleaning solvent and dry thoroughly.

(2) Inspect tubing for kinks or clogging, mounting hardware for stripped threads or other damage, and cylinder for contents.

(3) Replace a defective tube, damaged or defective mounting hardware, or an empty cylinder.

3-176. Glow Plus (Engine Model D333TA Only)

a. Removal.

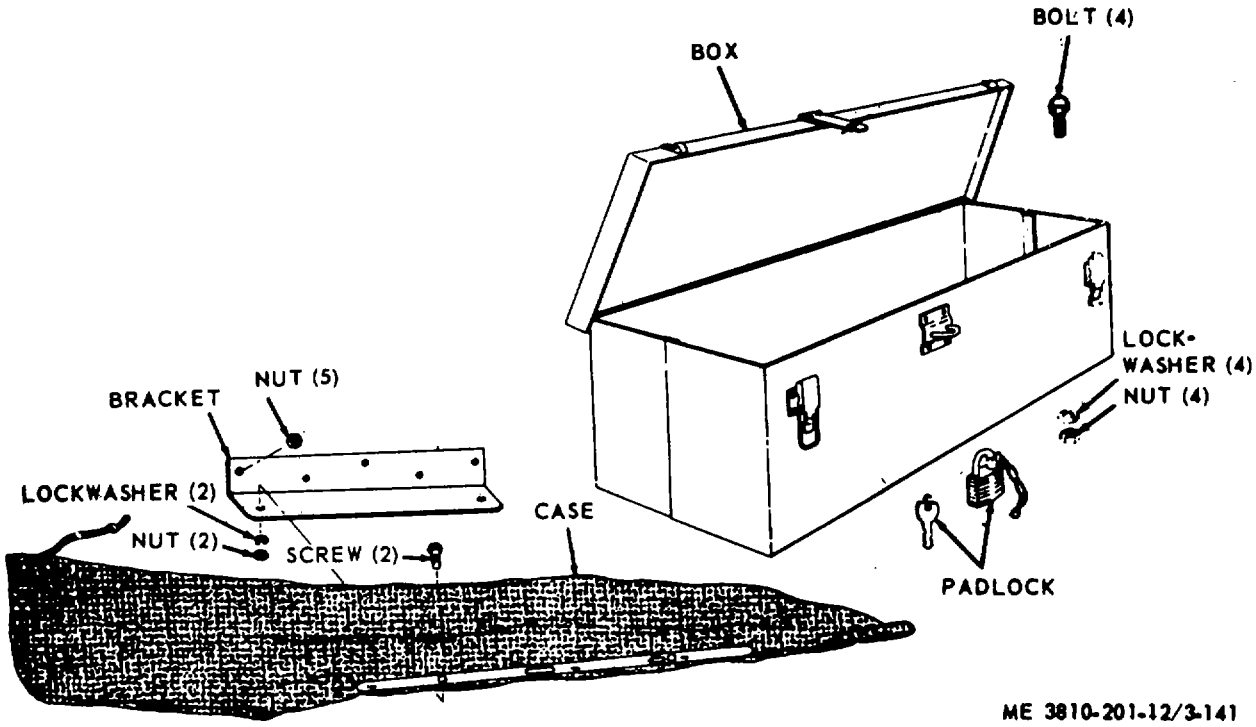


Figure 3-125. Gun case and tool box, removal and installation.

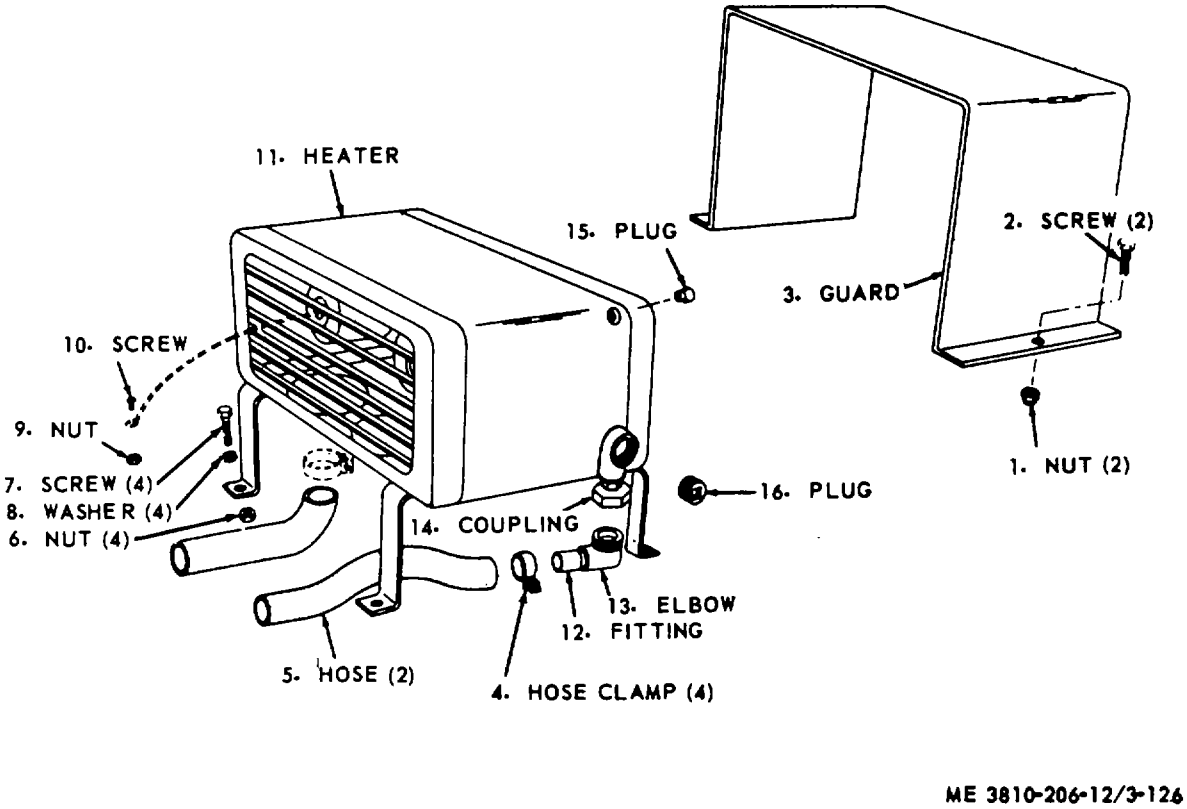


Figure 3-126. Heater, removal and installation.

(1) Tag and disconnect electrical lead at glow plug from precombustion chamber. Remove

(2) Remove glow plug (fig. 3-127) by turning counterclockwise with wrench on wrenching surface until threads are disengaged then lift glow plug from precombustion chamber. Remove remaining plugs in a similar manner.

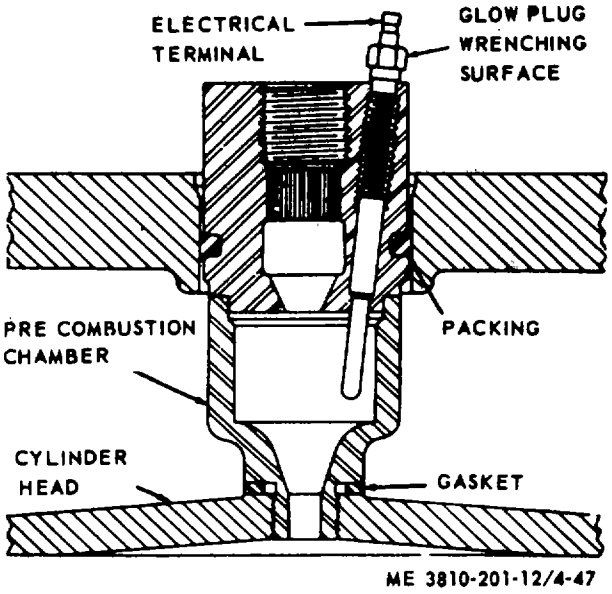


Figure 3-127. Glow plug, removal and installation

b. Cleaning, Inspection, Test and Repair.

(1) Clean electrical lead and glow plug with a rag dampened in an approved cleaning solvent and dry thoroughly.

(2) Visually inspect electrical lead for cracked or deteriorating insulation,. or loose terminals. Inspect glow plug for visible signs of short circuit (discoloration), or' other damage.

(3) Use an ohmmeter, place probe at each end of lead and test for continuity. Replace a defective electrical lead.

(4) Use an ohmmeter, place negative probe at threads and positive probe at glow plug terminal, then test for continuity. Replace a defective glow plug.

Note.

In absence of an ohmmeter the glow plug may be tested by grounding threads at cylinder head, attaching known 24 vdc hot lead at glow plug terminal. If heat cannot be felt at tip, or plug fails to glow, it is defective and must be replaced.

c. Installation.

(1) Install glow plug (fig. 3-127) in precombustion chamber by turning clockwise until threads are seated finger tight.

(2) Use torque wrench on wrenching surface and tighten to between 10 and 12 ft-lbs.

(3) Connect electrical lead and remove tag.

(4) Install remaining glow plugs in a similar manner.

CHAPTER 4
MATERIAL USED IN CONNECTION WITH CRANE-SHOVEL
Section I. SHOVEL FRONT END ATTACHMENT

4-1. General

a. Description. The crane ?

Note.
When crows and retract mechanism is not installed on boom foot, this must be accomplished at direct support maintenance before shovel front end attachment can be installed at organization.

b. Preparation Prior to Installation or Shovel Attachment.

(1) Remove front and attachment currently

4-2. Shovel Front End Attachment

a. General. The shovel front end attachment is normally positioned on cribbing (fig. 4-1) for storage between periods of use , but may be received disassembled as shown on figures 2-2 and 2-3. In the latter case, assembly of the shovel attachment will require the assistance of another crane, or suitable lifting device, and components

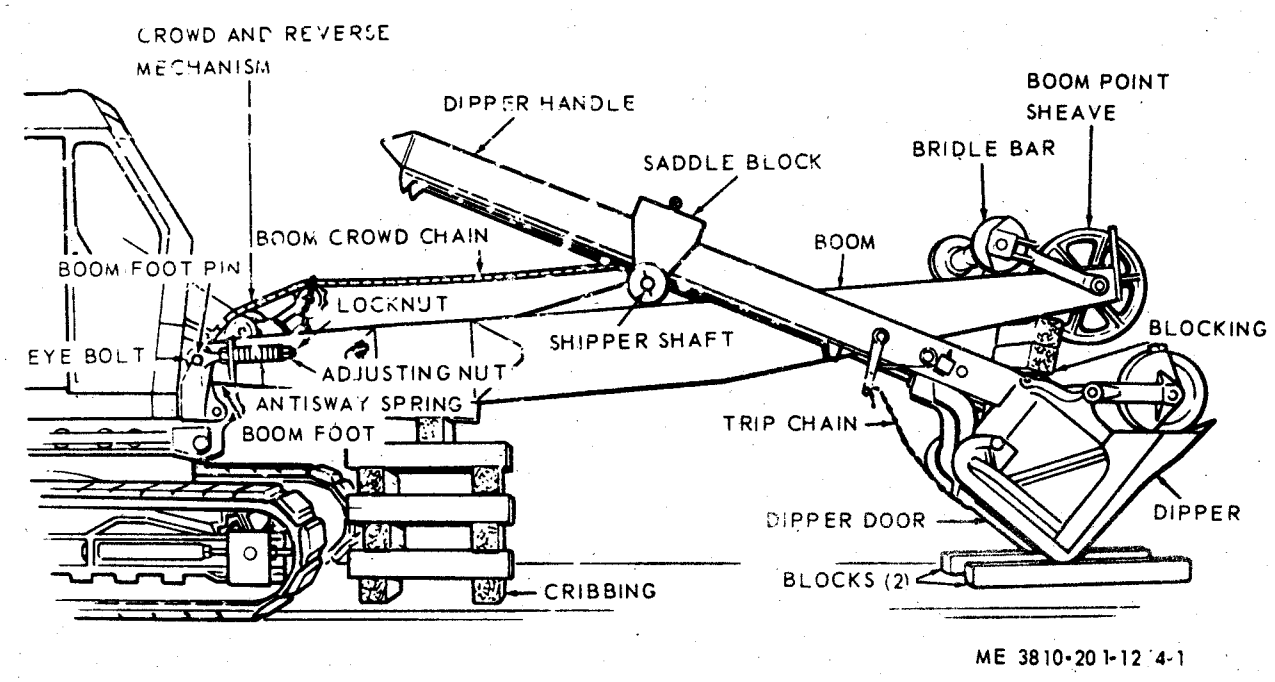


Figure 4-1. Shovel front end attachment, cribbed for removal or installation.

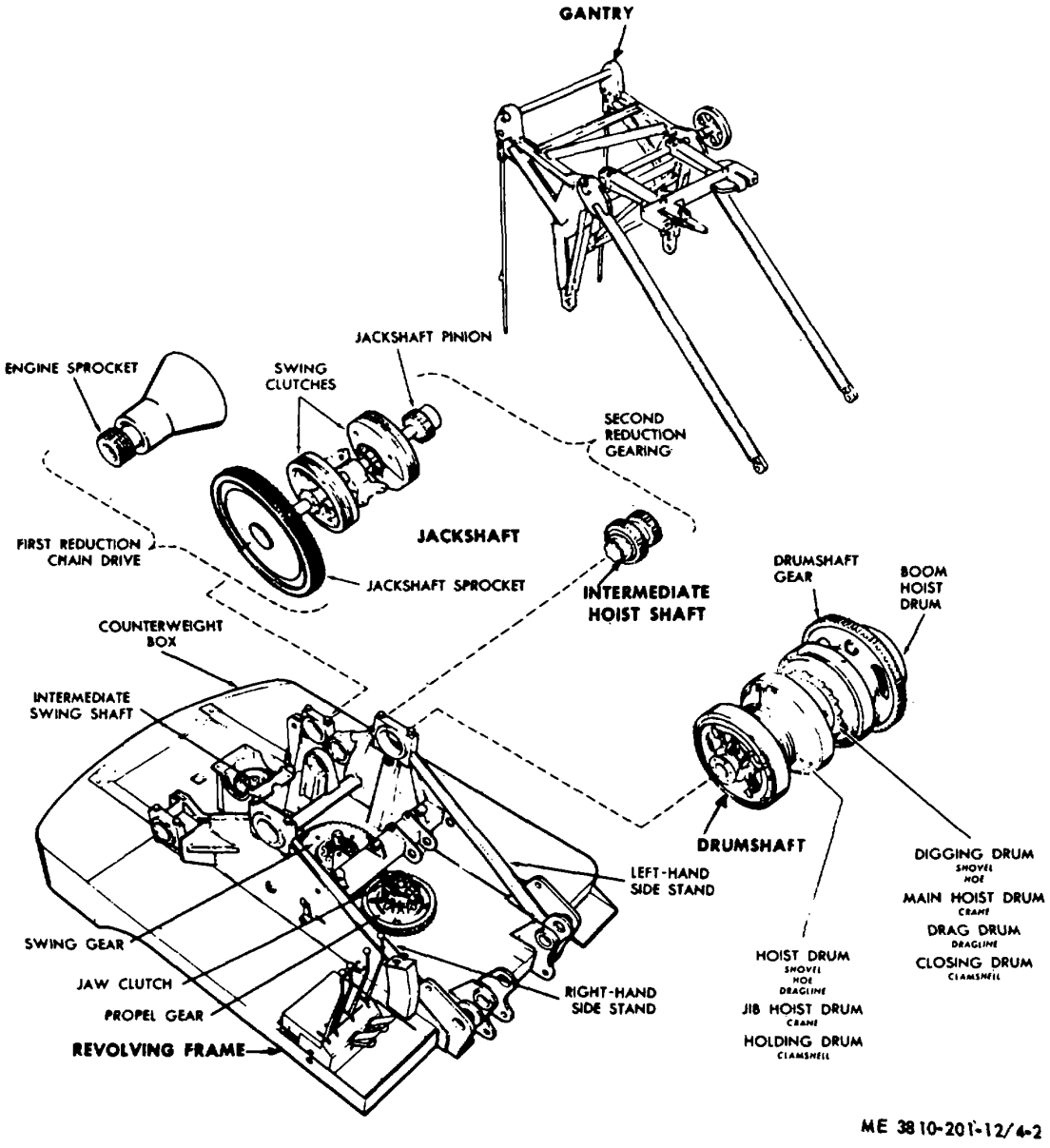


Figure 4-2. Revolving frame component relationship.

should be assembled in the reverse order of removal from shovel boom (para 4-10).

b. Installation.

(1) Assure that crane-shovel basic unit has been prepared for shovel front end attachment installation as outlined in paragraph 4-1b, above.

(2) Install shovel hoist cable (table 1-2) on hoist drum (fig. 4-2) (para 3-39) and shovel boom hoist cable on boom hoist drum. Wind cables an drums.

(3) Position crane-shovel basic unit at end of shovel boom as illustrated in figure 4-1; position antisway spring eye bolt at lug on revolving frame, then install boom foot pins through eye bolt; lugs on revolving frame; lugs on boom foot, then secure with cotterpins.

Note

Be sure boom foot pins are installed from outside to inside.

(4) Install trip cable (from equalizer bracket) through guide sheaves on boom foot, then connect to lever underneath revolving frame.

(5) Refer to figure 2-19 and reeve both hoist cables, securing them at dead end sockets with cable clamps.

(6) Tighten adjusting nuts fig. 4-1) on antisway springs to obtain spring tension, then hold adjustment by tightening locknuts.

(7) Install revolving frame crowd chain on crowd reversing mechanism then on digging drum sprocket, and secure by installing master link (para 4-3), then adjust (para 3-31). Install boom crowd chain on reversing mechanism and sprocket on shipper shaft, then adjust in a similar manner.

(8) Adjust dipper trip (para 3-33) and trip cable (para 3-34).

(9) Perform preventive maintenance checks and services (para 3-6), then raise boom (para 2-12*b*).

c. Removal.

(1) Remove crane-shovel unit to storage area, an area that is level, preferably hard surfaced, under cover, suitable for storage of shovel front end attachment.

(2) Position two blocks, approximately 24 feet from boom foot (fig. 4-1), then lower boom *(*para 2-12 *b)* until dipper rests on blocks. Position blocking between dipper handle and boom point, then lower boom until point rests on blocking.

(3) Build a substantial crib under boom, near foot, until there is just room enough to insert wedges, or jacks, to take weight of boom off boom foot pins.

(4) Remove master pin of revolving frame crowd chain and remove chain from shovel sprocket on digging drum. Reinstall master pin and position crowd chain back over boom crowd chain temporarily, until cleaning and preserving is performed ((10) below).

(5) Loosen locknut and adjusting nut from antisway springs until all tension is removed from springs.

(6) Remove cable clamps from dead end sockets of dipper hoist cable and, boom hoist cable (fig. 2-19) and carefully reel them in on hoist drums, guiding ends through sheaves as this is accomplished.

(7) Disconnect trip cable from lever underneath revolving frame, remove from guide sheave at boom foot and secure it to boom and equalizer bracket.

(8) Remove cotter pins from boom foot pins (2), drive wedges between cribbing and boom foot until weight is off foot pins (or raise jacks), then remove boom foot pins.

(9) Move crane-shovel unit away from shovel front end attachment.

(10) When attachment is to be stored on blocks for a prolonged period, clean with an approved solvent, dry thoroughly, and lubricate attachment in accordance with current lubrication order (LO 53810-20612), paying particular attention to dipper handle, crowd chains, and crowd and reversing mechanism. Protect all unpainted surface from rust or corrosion.

(11) When removal is for purpose of installing crane front end attachment, remove shovel hoist cable (para 3-39); shovel boom hoist cable; shovel sprocket and planetary pinion gear from digging drum (para 3-125); reposition planetary brake band (para 3-123), then install crane lagging (para 3-124).

4-3. Crowd and Retract Chain, Idler, and Tightener

a. Crowd and Retract Chain Removal and Installation.

(1) Remove cotterpin, roller, and master pin from link of boom crowd and retract chain (fig. 4-3), then lift chain off crowd and reverse mechanism at foot of boom, chain tightener sprocket and shipper shaft sprocket.

(2) Remove revolving frame crowd and retract chain- from digging drum sprocket, idler roller, and crowd and reverse mechanism in manner similar to (1) above.

(3) Install in reverse order of removal.

b. Chain Tightener Adjustment. Refer to paragraph 3-1 and adjust chain tightener.

c. Idler Roller Adjustment. Adjust in manner similar to that used for chain tightener (para 3-31).

4-4. Shovel Dipper

a. Removal

(1) Lower dipper to rest on blocks, then remove hoist cable from bail sheave only (fig. 2-19).

(2) Refer to figure 4-4, disconnect trip chain from trip lever, remove cotterpins from two pins securing braces to dipper handle, then remove pins.

(3) Remove cotterpin and washer from two handle pins, remove handle pins, then remove dipper from handle.

b. Disassembly and Reassembly of Dipper.

(1) Remove cotterpin and bail pin (fig.4-4), then remove bail.

(2) Remove bolt from chain at latch lever, then remove chain.

(3) Remove cotterpin and pin from two braces, then remove braces.

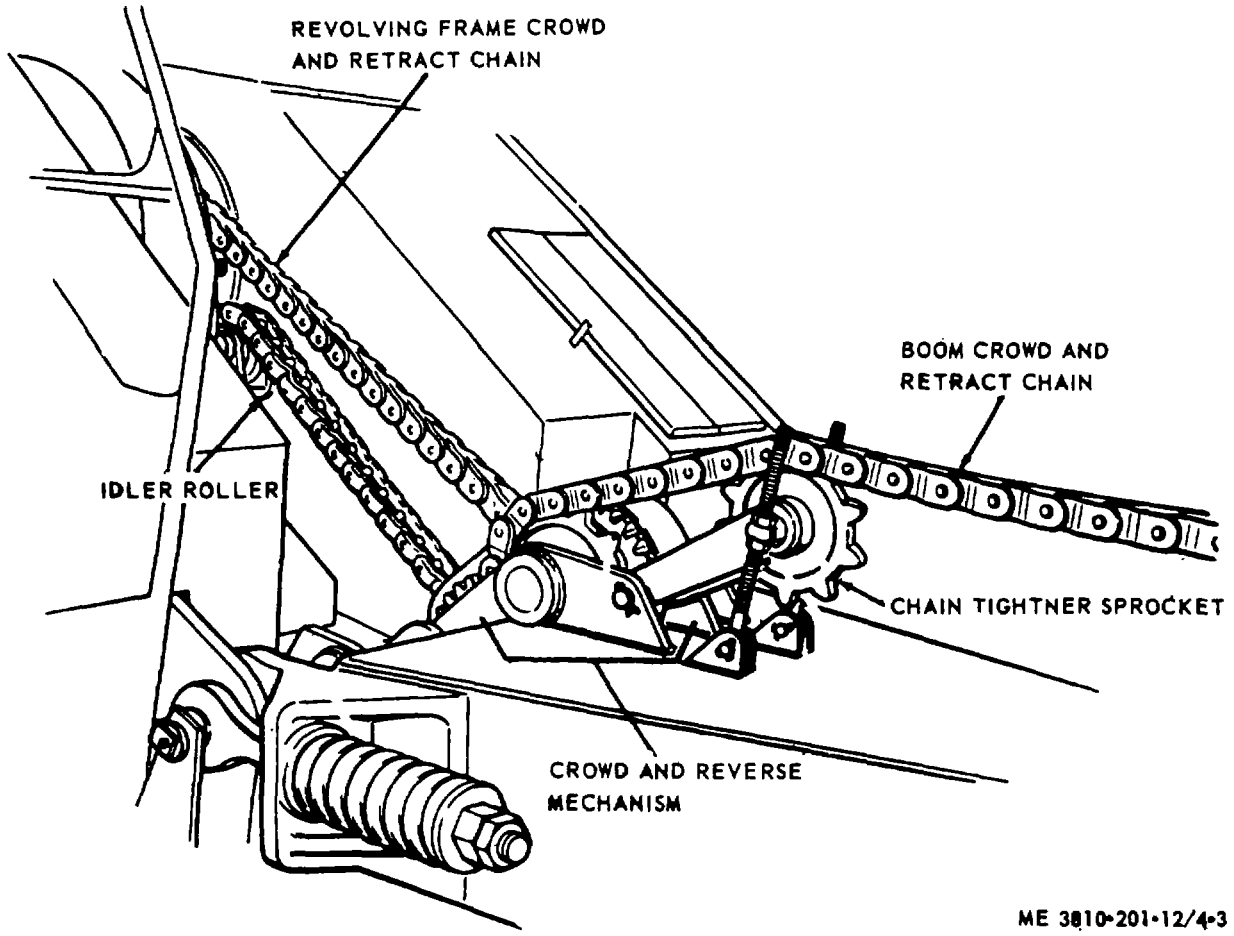


Figure 4-3. Crowd and retract chain, removal, installation, and adjustment.

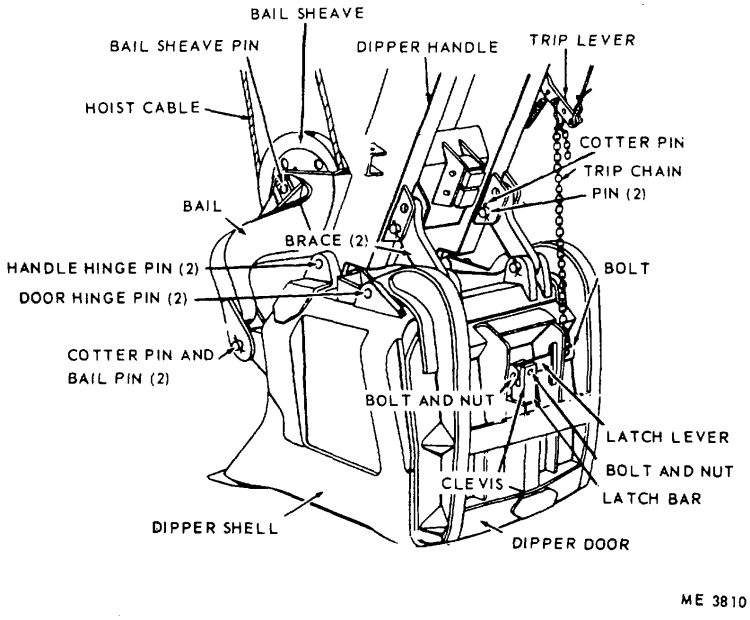


Figure 4-4. Shovel dipper, removal, disassembly, reassembly, and -installation.

(4) Remove two bolt and nut from latch lever, remove latch lever, then remove clevis and latch bar from dipper door.

(5) Remove cotterpin from two door hinge pins, remove pins, then remove dipper door.

(6) When necessary to remove latch keeper for repair or replacement, remove two short and four long rivets then remove keeper.

(7) Disassemble bail (para 4-6).

(8) Reassemble in reverse order of disassembly.

c. Cleaning, Inspection, and Repair.

(1) Clean all parts with an approved cleaning solvent and dry thoroughly.

(2) Visually inspect all parts for signs of excessive wear, cracks, breaks, bends, stripped threads on hardware, or elongation of holes.

(3) Repair by welding cracks or breaks, straightening bends and replacing all defective hardware or excessively worn parts.

d. Installation.

(1) Position dipper at end of dipper handle, install two handle pins and secure each with washer and cotterpin.

(2) Place two braces at lugs on dipper handle, install pins and secure with cotterpins.

(3) Connect door trip chain to trip lever, then reeve hoist cable (fig. 2-19).

4-5. Dipper Handle

a. Removal.

(1) Open boom crowd chain by removing cotterpin, roller, and master pin, then lifting chain off sprocket on shipper shaft.

(2) Remove shovel bucket (para 4-4).

(3) Remove dipper trip cable from dipper handle (para 4-8).

(4) Lash saddle blocks to boom so that they are prevented from changing angles when dipper handle is removed from shipper shaft.

(5) Fasten one end of a heavy rope about three feet from dipper end of handle, the other end of rope to boom point of lifting device. Move dipper handle until pointed end is almost at shipper shaft, and almost free of saddle blocks.

(6) Lower dipper end, if necessary, then work points of handle over pinions, carefully, and lower dipper handle to ground.

b. Installation.

(1) Position shovel boom to receive dipper handle, making sure saddle blocks are lashed secure to boom.

(2) Position lifting device, and clamp hoist cable -round dipper handle at balance point (about three feet from dipper end).

(3) Lash a heavy rope to point end of handle, thread it through, or over shipper shaft, then station one man on each side of boom to help guide dipper handle into saddle blocks.

(4) Pull hoist cable in slowly and move lifting device forward.

(5) Guide dipper handle into saddle blocks, making sure that racks engage with pinions on shipper shaft.

(6) Install boom crowd chain over sprocket on shipper shaft and crowd and reversing mechanism at foot of boom and secure with master pin, roller, and cotter pin (para 4-3).

(7) Install dipper trip cable on dipper handle (para 4-8).

(8) Install shovel dipper (para 4-4).

4-6. Dipper Bail and Sheave

a. Removal.

(1) Remove shovel dipper (para 4-4).

(2) Remove bail (para 4-4*b*(1)).

b. Disassembly and Reassembly.

(1) Remove cotterpin and slotted nut from sheave pin.

(2) Remove sheave pin, then remove sheave from bail.

(3) Reassemble by reversing steps (1) and (2) above.

c. Cleaning and Inspection.

(1) Clean all parts in an approved cleaning solvent and dry thoroughly.

(2) Visually inspect sheave for scored sleeve bearing, cracks, worn groove, or other defect. Inspect bail for cracks, breaks, elongated mounting holes, or defective mounting hardware. Replace all defective parts.

d. Installation.

(1) Install bail on dipper (para 4-4*b*).

(2) Install shovel dipper (para 4-4*d*).

47. Dipper Teeth

Caution:

Never dig with shovel front end attachment while a tooth is missing from dipper, even for a short time. The tooth socket will wear to such an extent that a replacement tooth will never fit properly. Reinstall old worn tooth and use until new one is available, when continued operation is imperative.

a. Tooth Removal.

(1) Lower dipper to rest on blocking or

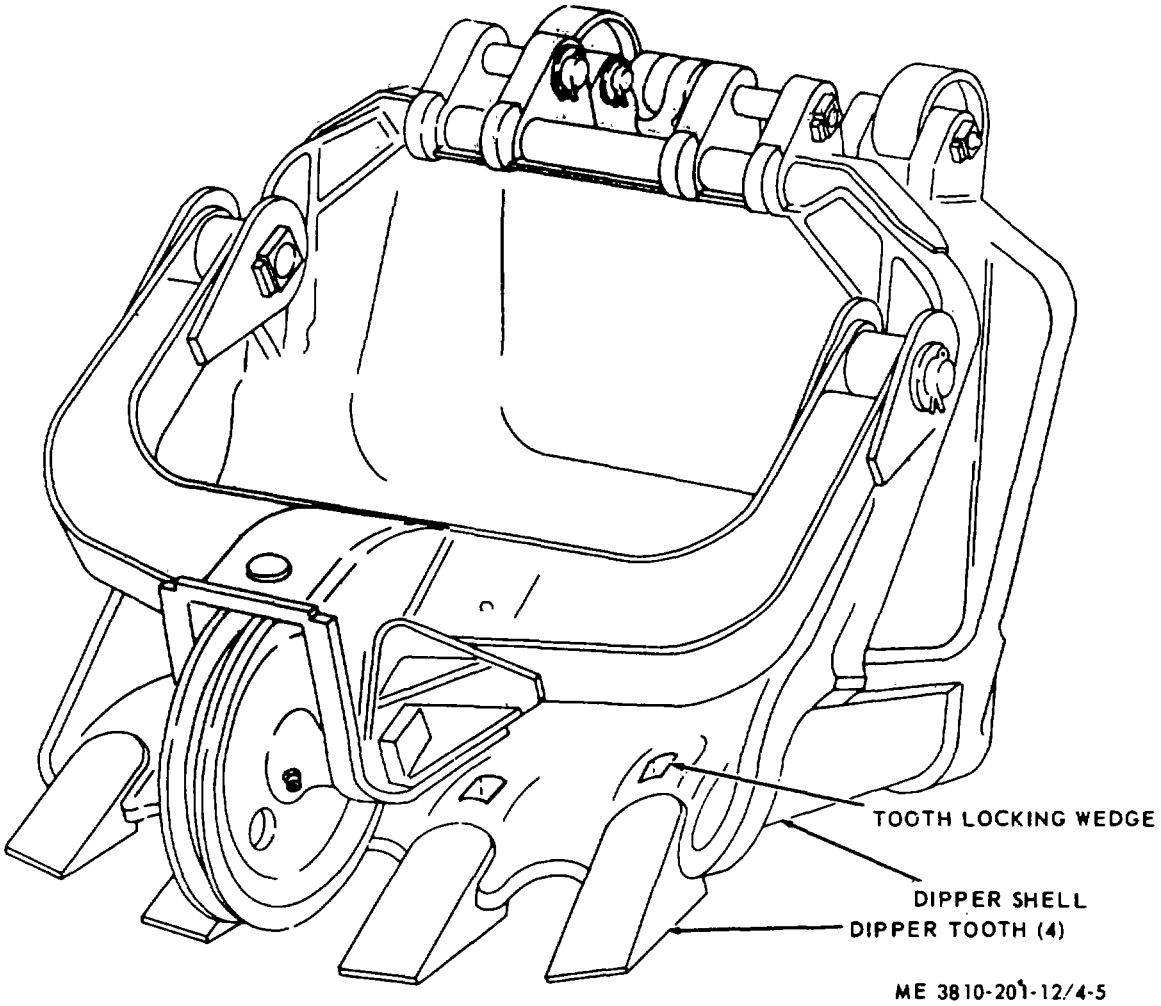


Figure 4-5. Dipper teeth, removal and installation..

cribbing at door end, allowing crewman room to drive tooth locking wedge from tooth (fig. 4-5).

(2) Use drift punch ,or other suitable tool at small point (bottom of wedge), then drive upward until wedge is free of tooth.

(3) Loosen tooth in socket with side-to-side taps of hammer, then remove defective tooth.

(4) Remove remaining teeth in a similar manner.

b. Tooth Installation.

(1) Clean tooth and wedge socket, insert tooth in position, then drive tooth until it is seated in socket.

(2) Position tooth locking wedge and drive it into place until tooth is secure.

(3) Install remaining teeth in a similar manner.

4-8. Dipper Trip Mechanism and Trip Lines

a. General. The dipper trip mechanism (fig.4-6) is used for opening the door of shovel dipper only, but once installed on main hoist drum shaft, need not be removed when shovels is converted to any other front end arrangement. The boom trip line, consisting of chain from bucket door latch to dipper handle trip lever; trip line from trip lever over idler sheave on shipper shaft, through equalizer sheave on equalizer bracket back to take up drum on shipper shaft (fig. 4-7). The revolving frame trip line runs from equal-

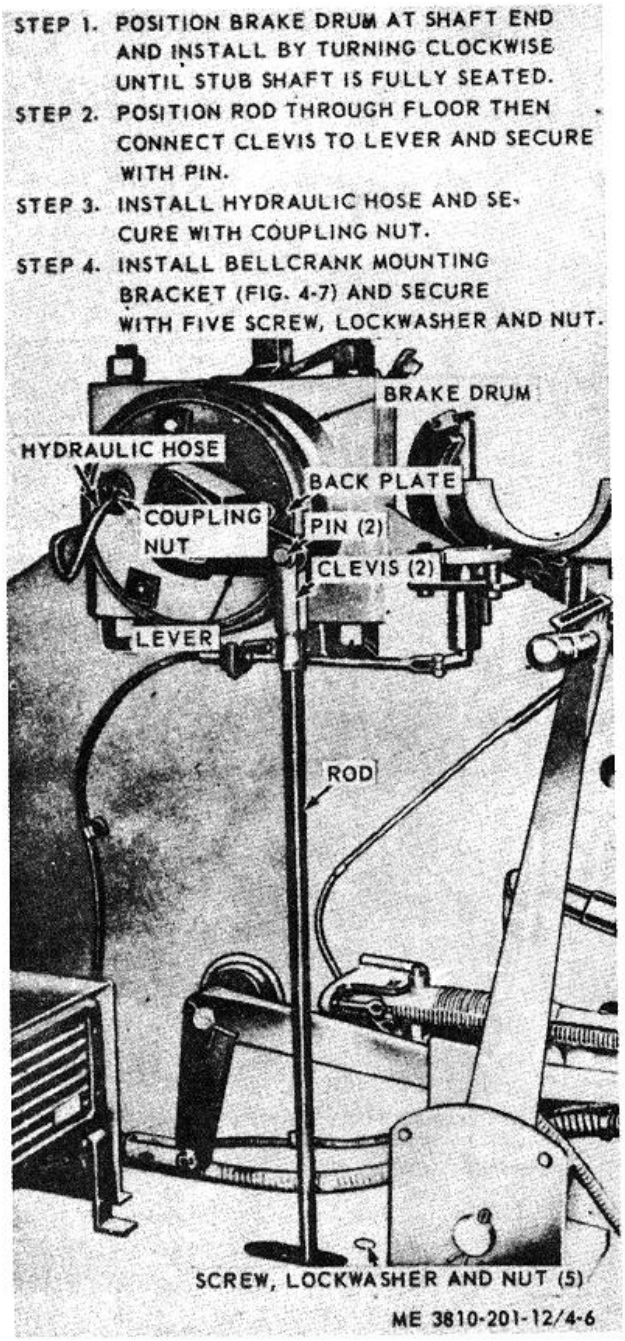
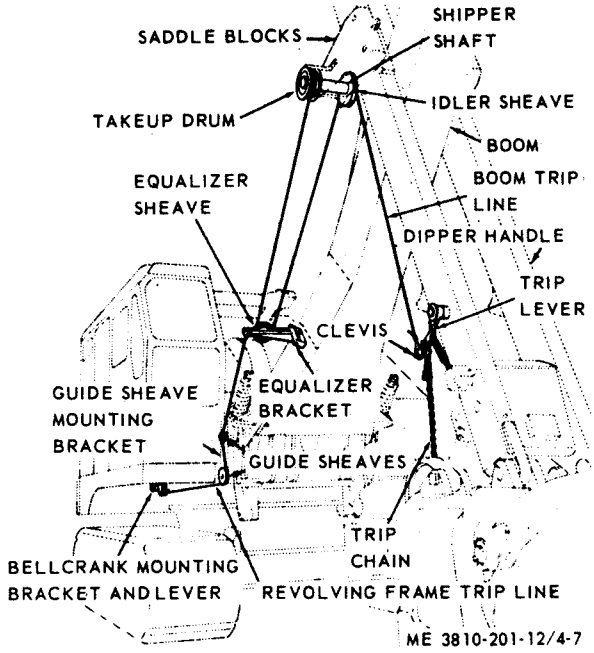


Figure 4-6. Dipper trip mechanism, removal or installation.

izer bracket on boom, through guide sheaves on bracket mounted on revolving frame at boom foot to bell crank lever mounted. underneath revolving frame. When properly adjusted (para 3-33 and 3-34), dipper is tripped when dipper trip lever (fig. 2-93) is actuated.

b. Installation.

(1) Install dipper trip lever (fig. 2-23) and secure with pin



to mounting bracket. Install hydraulic compensator and line to main header (paras 3-111, 3-112 and 3-113).

(2) Refer to figure 4-6 and install dipper trip mechanism.

(3) Install bellcrank mounting bracket under revolving frame, and guide sheave mounting bracket on revolving frame at boom foot (fig. 4-7) .

(4) When shovel front end attachment is installed, install revolving frame trip line.

(5) Adjust dipper trip mechanism (paras 3-33 and 3-34).

Note.

The above procedure assumes that shovel tripping mechanism is installed on boom of shovel front end attachment.

c. Removal. The entire dipper trip mechanism may be removed for replacement or repair as follows:

(1) *Dipper trip clutch mechanism removal.*

(*a*) Remove pin from clevis at lever (fig. 4-6) and remove clevis from lever.

(*b*) Lossen coupling nut and remove hydraulic hose from wheel brake cylinder.

(*c)* Grasp brake drum firmly and turn counterclockwise to remove mechanism from end of main hoist 6rum shaft.

(2) *Disassembly and reassembly.* Refer to figure 4-8 and disassemble dipper trip clutch mechanism in numerical sequence. Assemble in reverse order.

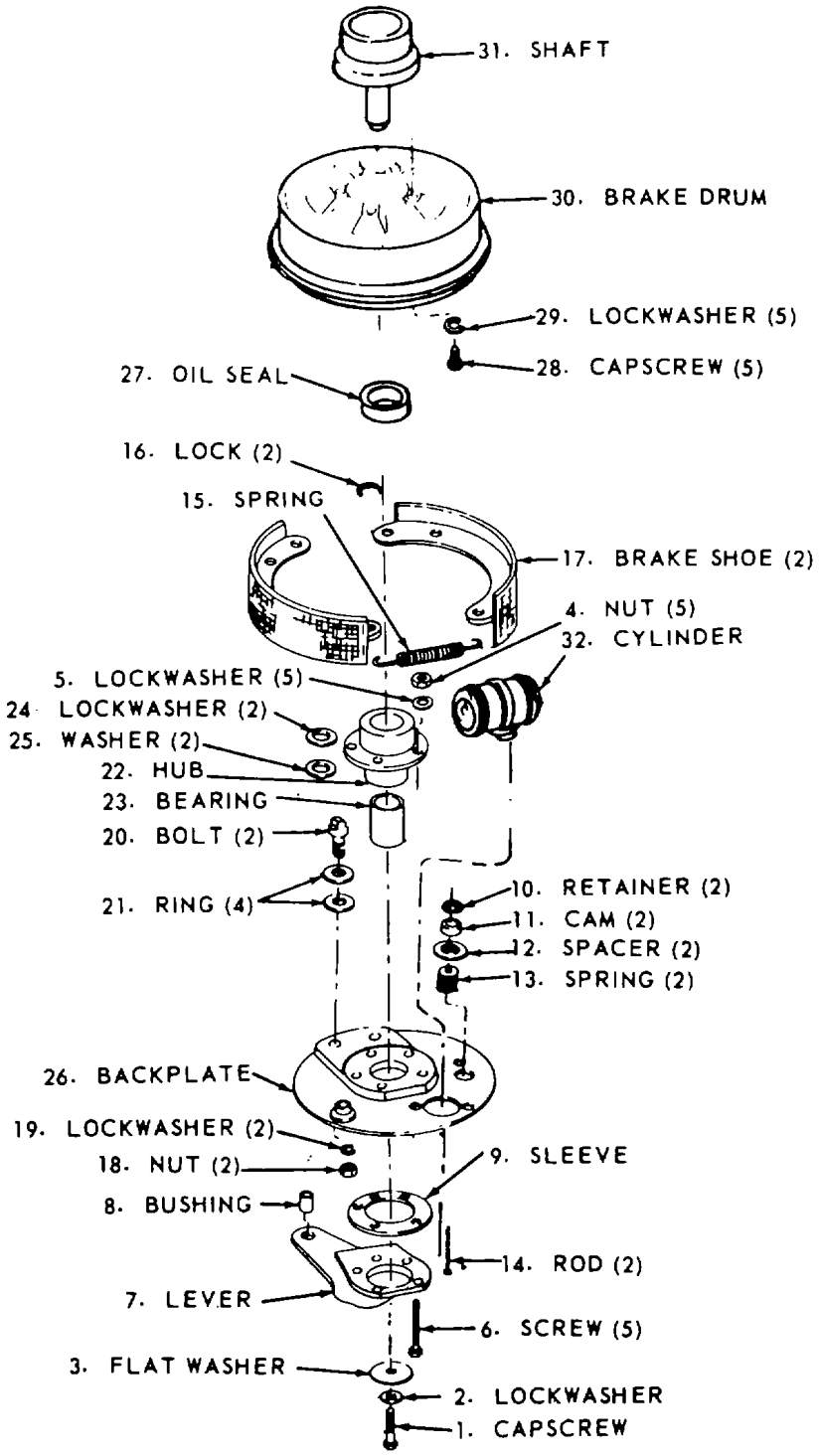


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Figure 4-8. Dipper trip clutch mechanism, disassembly and reassembly.

(3) *Cleaning,* inspection and repair.

(*a*) Clean all parts in an approved cleaning solvent and dry thoroughly.

(*b*) Visually inspect brakeshoes for excessively worn, or defective lining. Replace brakeshoes when lining defective.

(*c*) Visually inspect brakedrum for scored or damaged friction surface. Replace a damaged or defective brakedrum.

(*d*) Visually inspect mounting hardware, seals, springs or retainers for defects. Replace defective parts.

(*e*) Visually inspect hydraulic cylinder for leakage, or lack of freedom in movement of piston. Replace a defective cylinder.

4-9. Dipper Trip Clutch Brakeshoe

a. Removal.

(1) Remove pin (fig. 4-6) from clevis at lever and disconnect clevis.

(2) Disconnect hydraulic hose at coupling unit

(3) Remove capscrew (fig. 4-9), lock-washer, and flatwasher, then remove backplate from brake drum.

(4) Remove two retainers, springs, and brake spring rods.

(5) Disconnect and remove brake return spring.

(6) Remove two locks, brakeshoes, washers, and flatwashers from back plate.

b. Cleaning, inspection and Repair.

(1) Clean all parts with an approved cleaning solvent and dry thoroughly.

(2) Visually inspect brakeshoes for excessively worn or cracked lining. Replace both shoes when lining is defective.

(3) Check brake drum for scored or damaged friction surface. Replace a defective brake drum (para 4-8 above).

c. Installation.

(1) Position brakeshoes (fig. 4-9) on back plate, install washer and flatwasher, then secure with locks.

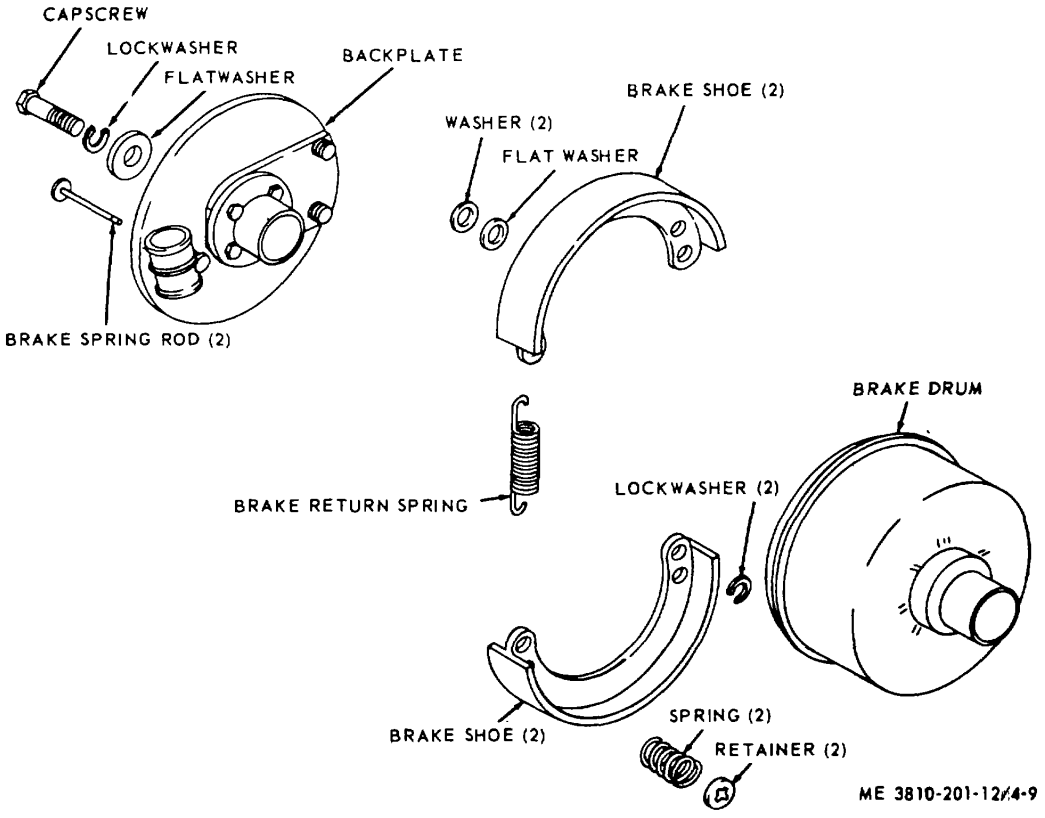


Figure 4-9. Clutch brakeshoes, removal and installation.

(2) Install brake return spring.

(3) Install two brake spring rods, springs, and secure with retainers.

(4) Install back plate in brake drum. Make sure lever (fig. 4-6) is in proper position, then secure back plate to mechanism with flatwasher (fig. 4-9) lockwasher, and capscrew.

(5) Connect hydraulic hose at coupling nut, position clevis on lever, then secure pin.

4-10. Shovel Boom

a. Removal.

(1) Remove shovel dipper (para 4-1).

(2) Remove dipper handle (para 4-5).

(3) Lower shovel boom (para 2-12*b*) to cribbing similar to that shown in figure 4-1 and disconnect boom from crane-shovel unit (para 4-2).

b. Cleaning, Inspection and Repair.

(1) Clean shovel boom with an approved cleaning solvent and dry thoroughly.

(2) Visually inspect boom for cracks, breaks, or excessive wear at boom foot, point, or saddle blocks. Inspect bumper blocks for excessive wear.

(3) Repair boom by replacing worn bumper blocks, or welding small cracks. Report large cracks, bends, or excessive wear beyond scope of organization repair to direct support maintenance.

Note.

When shovel boom has been returned to direct support for repair or replacement, be sure the returned or replacement boom comes equipped with boom point sheaves, bridle bar, shipper shaft, and crowd and reverse mechanism.

c. Installation.

(1) Install shovel boom (para 42).

(2) Install dipper handle (para 4-5).

(3) Install shovel dipper (para 4-4).

(4) Perform preventive maintenance checks and services (para 3-6).

Section II. CLAMSHELL, CRANE, AND DRAGLINE FRONT END ATTACHMENTS

4-11. General

The clamshell, crane, and dragline front end attachments use a similar boom arrangement, which consists of the base section, an upper section, and which may be lengthened by insertion of boom section(s) (para 4-13). For crane operation, there is the jib boom attachment that may be installed as required (para 4-21). For clamshell operation, a tagline winder (para 4-14) is used to stabilize the bucket. For dragline operation, a fairlead and sheaves (para 4-16) is installed at revolving frame. All of these attachments use the boom backstop (para 4-22), radius (boom angle) indicator (para 4-23) and boom harness spreader (para 4-15). All use drum cable lagging (para 3-124) and cables (table 1-2), although size and lengths differ according to operation being performed, or length of boom in use. This section will cover organizational maintenance as outlined in Maintenance Allocation Chart.

412. Drum Cable Lagging

The drum lagging for crane, clamshell, and dragline are removed or installed, in manner similar to that described in paragraph 3124.

4-13. Boom

a. Removal.

(1) Disconnect boom backstop from gantry (para 4-22).

(2) Lower boom (para 2-12*b*) to rest on cribbing (fig. 2-6).

(3) Refer to reeving diagram of front end attachment in use, disconnect boom hoist, hoist, digging, or drag cables at dead end socket, then wind cables on drums slowly, while guiding cable end through sheaves.

(4) Use wedges between cribbing at boom foot and boom; drive them in from each side to take weight off boom foot pins; remove cotterpins, then remove boom foot pins (fig. 4-10).

(5) Move crane-shovel basic unit away from boom.

b. Disassembly and Reassembly.

(1) Remove two cotter pins (fig. 4-10) and pin, then remove boom backstop. Disassemble boom backstop (para 4-20).

(2) Remove radius (boom angle) indicator (para 4-23).

(3) Remove two pendant cables (fig. 4-10) from boom point, remove cotterpins and pins, then remove cables from boom spreader.

(4) Remove 16 nuts, lockwashers, and bolts securing base section to upper section, or boom (extension) section (fig. 4-11).

Note.

When boom (extension) section is installed in boom, proceed as in step (5) below.

(5) Remove 16 nuts, lockwashers, and bolts securing boom (extension) section to upper section, then remove boom (extension) section from upper section.

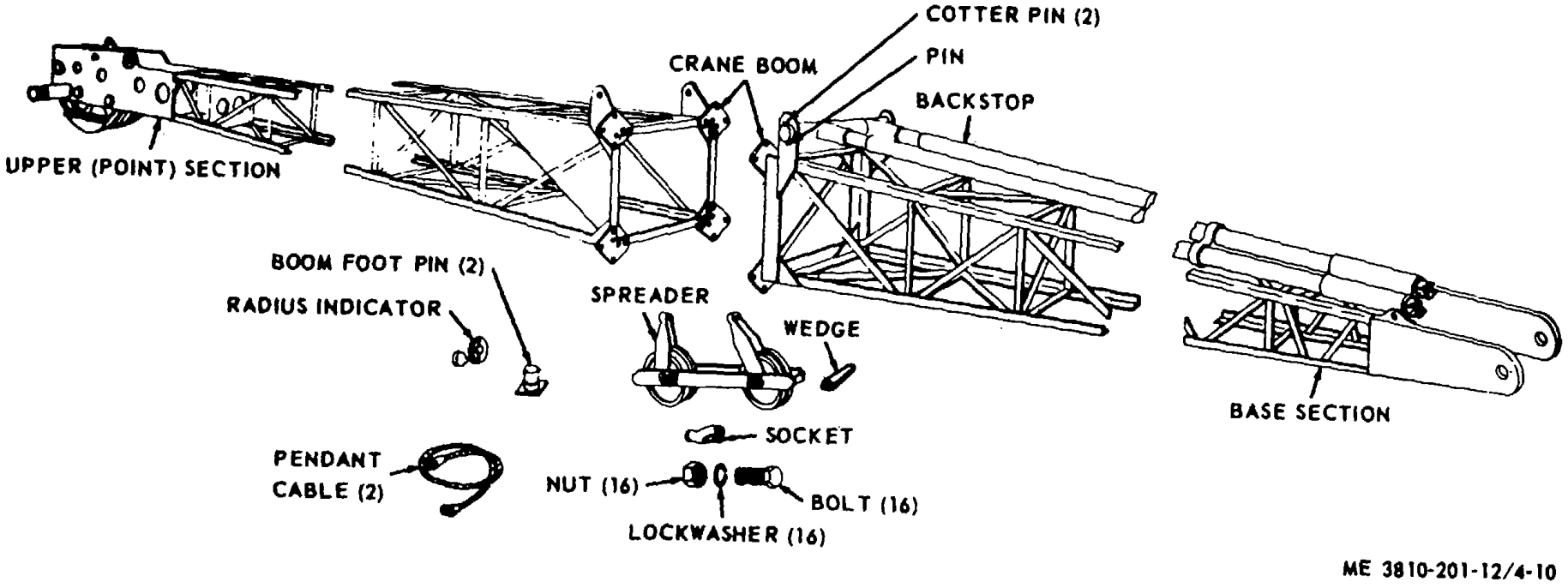


Figure 4-10. Boom disassembly and reassembly.

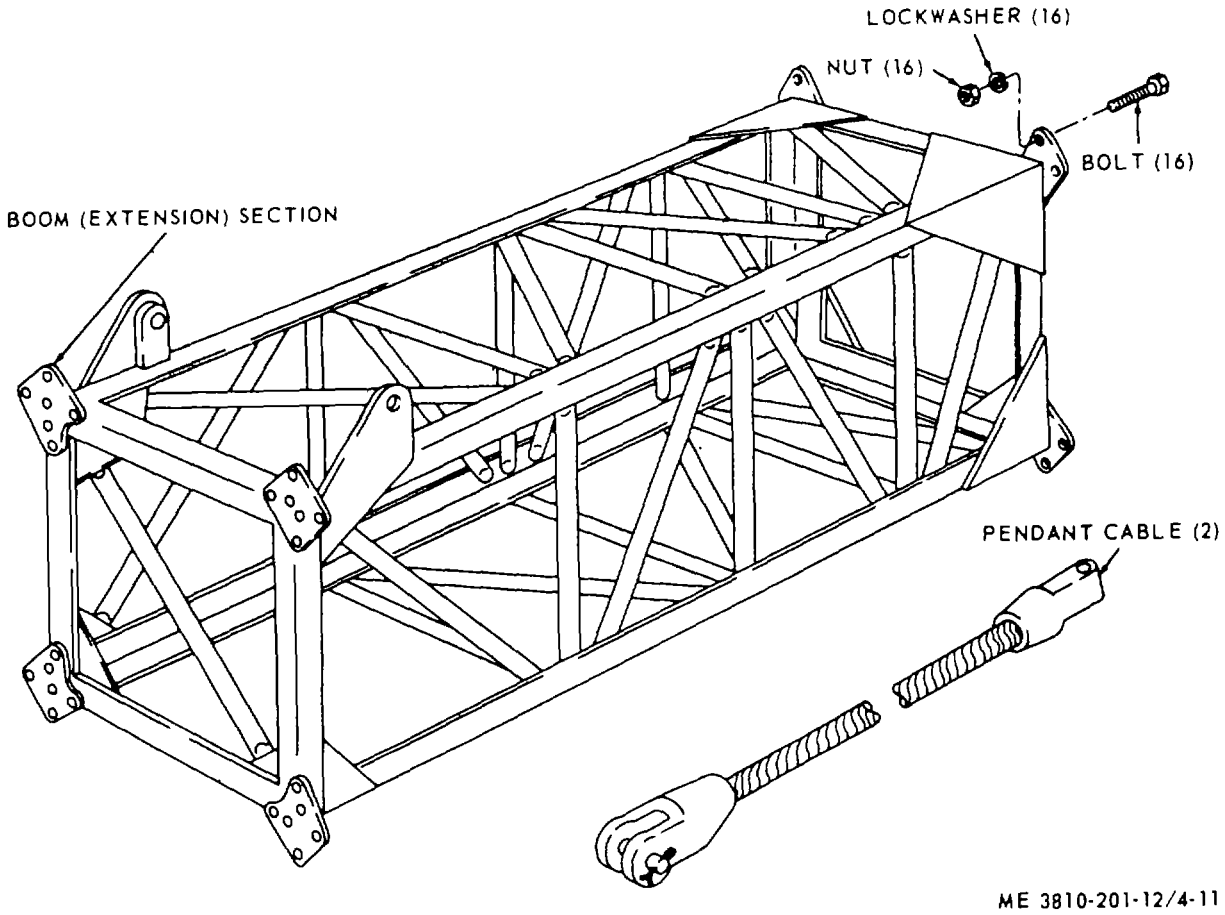


Figure 4-11. Boom (extension) section, removal and installation

(6) Separate the two 10 foot pendant cables from the 25 foot cables by removing cotterpins and pins from rope sockets.

(7) Remove boom point sheaves (para 4-20) from upper section.

(8) Reassemble by reversing steps (7) through (1) above.

Note.

When boom (extension) section is not used, eliminate steps (5) and (6) above.

c. Cleaning, inspection and Repair.

(1) Clean all parts in an approved solution and dry thoroughly.

(2) Visually inspect all parts for signs of excessive wear, damaged threads, scored bushings, damaged bearing, or other defects.

(3) Repair by replacing worn or defective parts.

4-14. Tagline Winder

a. Removal.

(1) Disconnect tagline from clamshell bucket and remove line from reel (fig. 4-12), or wind on reel and secure loose end.

(2) Remove four nuts, lockwashers, bolts, and two places securing left end of tagline winder to boom.

(3) Remove four nuts, lockwashers, two bolts, and two plates securing right end of winder to boom, then lift tagline winder from boom.

b. Cleaning and Inspection

(1) Clean tagline winder with an approved cleaning solvent and dry thoroughly.

(2) Inspect mounting hardware for burrs, stripped threads, or cracked plates. Replace defective hardware. Replace a defective tagline winder.

c. Installation.

(1) Position tagline winder in boom Install two U-bolts, and two plates, then secure right end of winder with four lockwashers and nuts.

(2) Install two plates, four bolts, and four lockwashers, to secure left end of winder to boom with four nuts.

(3) Install tagline on winder, then attach line to clamshell bucket.

4-15. Boom Harness Spreader

a. Removal and Installation.

(1) Lower boom (para 2-12*b*) to rest on cribbing (fig. 2-6), then slack off on boom hoist cable until spreader rests on boom.

(2) Disconnect boom hoist cable from dead end socket on gantry, then wind cable on boom hoist drum slowly while guiding cable end through sheaves (fig. 43).

(3) Remove two cotterpins and pins, then remove two cable sockets from boom harness spreader.

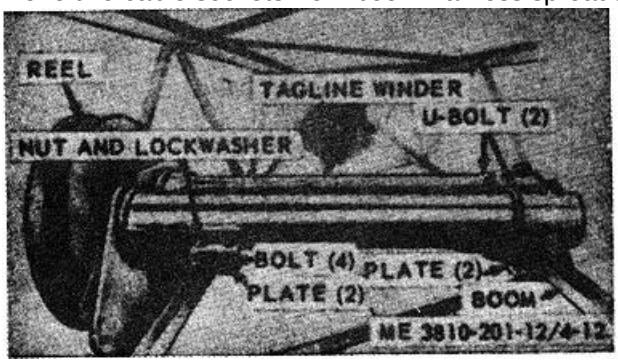


Figure 4-12. Tagline under, removal and installation.

(4) Lift the spreader off the boom.

(5) Install in reverse order.

b. Disassembly ad Reassembly.

(1) Remove four capscrews, lockwashers, and two keeper plates which secure two pins in spreader.

(2) Remove two pins and lift four sheaves from spreader.

(3) Reassemble by reversing above procedure.

c. Cleaning, Inspection and Repair.

(1) Clean all parts in an approved cleaning solvent and dry thoroughly.

(2) Visually inspect mounting hardware for stripped threads or burs; inspect sheaves for cracks or excessive wear, then inspect spreader for bent, cracked, or defective condition.

(3) Repair by replacing defective components, or mounting hardware.

4-16. Fairlead and Sheaves

a. Removal and Installation.

(1) Lower dragline bucket to ground and remove all tension from cables.

(2) Disconnect drag cable at dead end socket on bucket (fig. 2-12), then wind drag

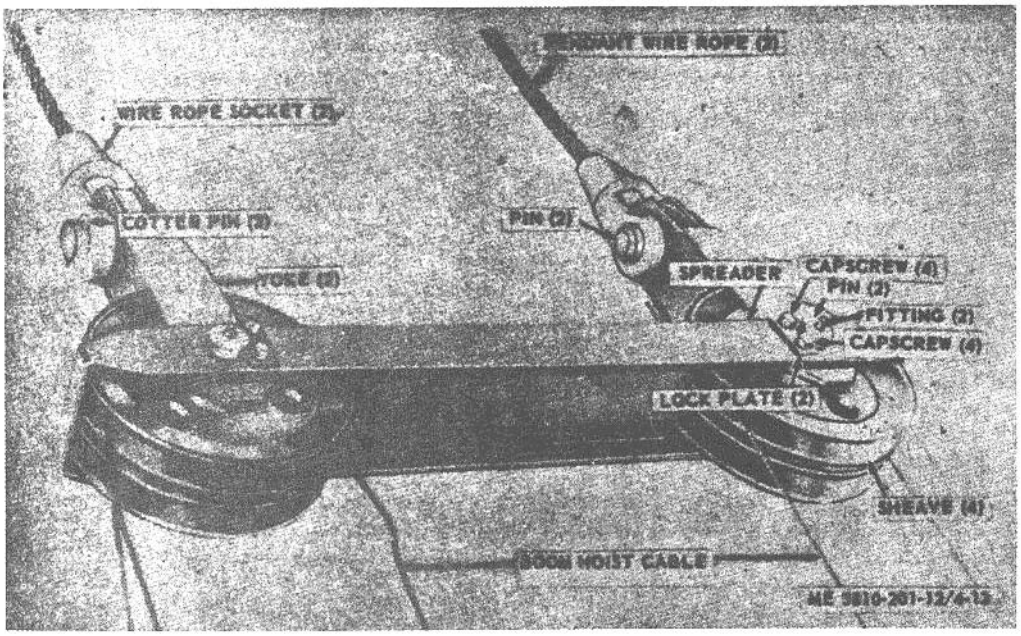
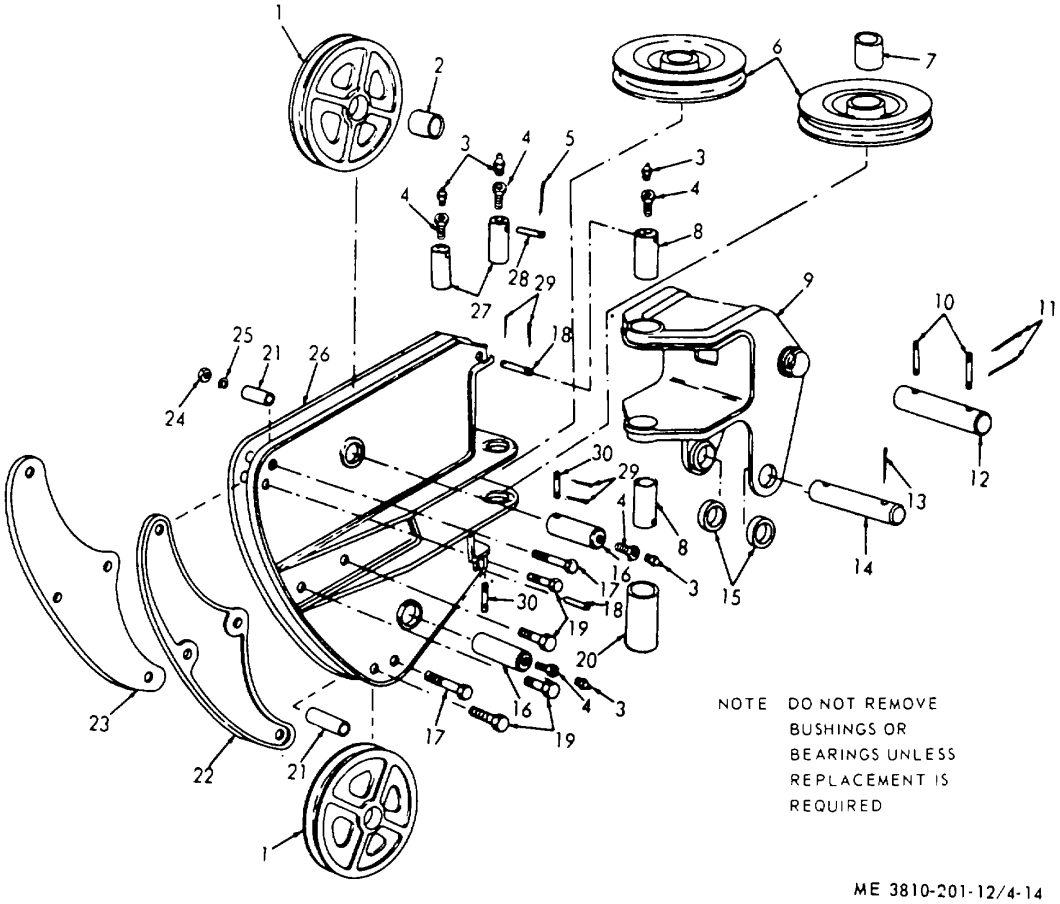


Figure 4-1. Boom harness spreader, removal and installation.



1	Sheave (2)	16	Shaft (2)
2	Bearing (2)	17	Bolt (2)
3	Fitting (6)	18	Pin (2)
4	Bushing (6)	19	Capscrew (8)
5	Cotter pin (4)	20	Bearing (2)
6	Sheave (2)	21	Spacer (2)
7	Bearing (2)	22	Guide plate, lh
8	Pin (2)	23	Guide plate, rh
9	Base	24	Nut (10)
10	Lock pin (2)	25	Lockwasher (10)
11	Cotter pin (4)	26	Frame
12	Rod	27	Shaft (2)
13	Cotter pin (2)	28	Pin (2)
14	Shaft, lower	29	Cotter pin (4)
15	Thrust collar (2)	30	Pin (2)

Figure 4-14. Fair lead and sheaves, disassembly and reassembly.

cable on drum, slowly, while guiding cable end through sheaves.

(3) Remove fairlead from revolving frame by removing four cotterpins (11, fig. 4-14) securing pins (10) in upper base rod (12); remove two cotterpins (13) from lower base shaft (14) then remove upper base rod and lower base shaft. Remove two thrust collars (15).

(4) Install in reverse order.

b. Disassembly or Reassembly.

(1) Remove four cotter pins (29, (fig. 4-14) and two pins (18) from the two pivot pins (8); remove two pivot pins, then separate frame (26) from base (9).

(2) Remove four cotter pins (5) and two pins (28) from two horizontal sheave shafts (27), then remove shafts and sheaves (6) from frame (26).

(3) Remove two nuts (24), lockwvashers (25), bolts (17), and spacers (21) from frame (26).

(4) Remove two nuts (24), lockwashers (25), and capscrews (19) which secure right and left hand guide plates (23 and 22) to frame (26), then remove guide plates.

(5) Remove four cotter pins (29) and two pins (30) from vertical sheave shafts (16) Drive vertical sheave shafts (16) out and remove two sheaves (1) from frame (26).

Note.

Do not remove bushings or bearings unless replacement is required.

(6) Remove bearings (7) from two horizontal sheaves (6).

(7) Remove bearings (2) from two vertical sheaves (1).

(8) Remove six lubrication fittings (3) and bushings (4) from two shafts (16 and 27), and two pins (8).

(9) Reassemble by reversing steps (8) through (1) above.

c. Cleaning, Inspection, and Repair.

(1) Clean all parts with an approved cleaning solvent and dry thoroughly.

(2) Visually inspect all bushings and bearings for scoring, or excessive wear; sheave shafts for excessive wear; sheaves for cracks, bends, or excessive wear; mounting base and frame for bends, cracks, or breaks, and mounting hardware for stripped threads, elongated hole, or other defects.

(3) Repair by welding cracks, or breaks; straightening bends, or replacement of parts, repair of which is beyond scope or organizational maintenance. Replace defective bearings, bushings, or mounting hardware.

4-17. Clamshell Bucket Teeth

a. Description. The clamshell bucket consists of two half-scoops, hinged together at top so that they will close over material to be picked up Bucket opens when closing line is allowed to run free, closes when pressure on hoist brake is slackened and crowd and retract clutch is engaged.

b. Removal.

(1) Lower open bucket to ground until there is slack in the holding and closing cables.

(2) Disconnect tagline from bucket and wind tagline on winder drum.

(3) Disconnect both holding and closing cables at dead and sockets on bucket (fig. 2-9)

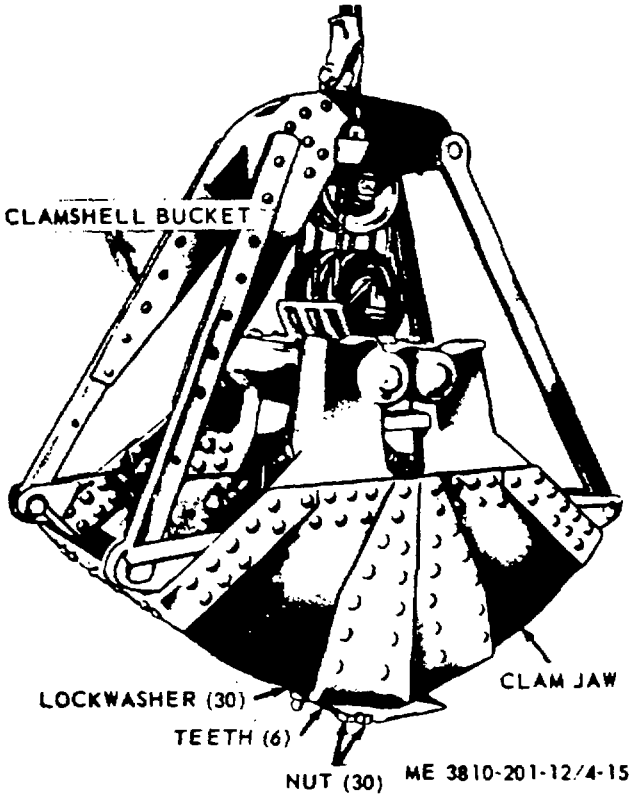


Figure 4-15. Clamshell bucket teeth replacement.

and slowly wind cables on drums, as ends are guided through sheaves.

c. Clamshell Bucket Teeth Replacement.

(1) *Removal.* Position bucket on its side, remove 30 nuts, (fig. 4-15), lockwashers, and bolts, and six teeth from clam jaws.

(2) *Cleaning, Inspection and Repair.*

(*a*) Clean all parts with an approved cleaning solvent and dry thoroughly.

(*b)* Visually inspect mounting hardware for stripped threads or other defects; inspect teeth for bent, cracked, or excessively worn condition.

(*c*) Replace damaged or defective parts.

(3) *Installation of Teeth.* Install teeth on jaws (fig. 4-15) and secure with bolts, lockwashers, and nuts.

d. Bucket Installation.

(1) Position boom over bucket, reeve holding and closing cables (fig. 2-9), and secure to dead end sockets on bucket.

(2) Attach tagline to bucket.

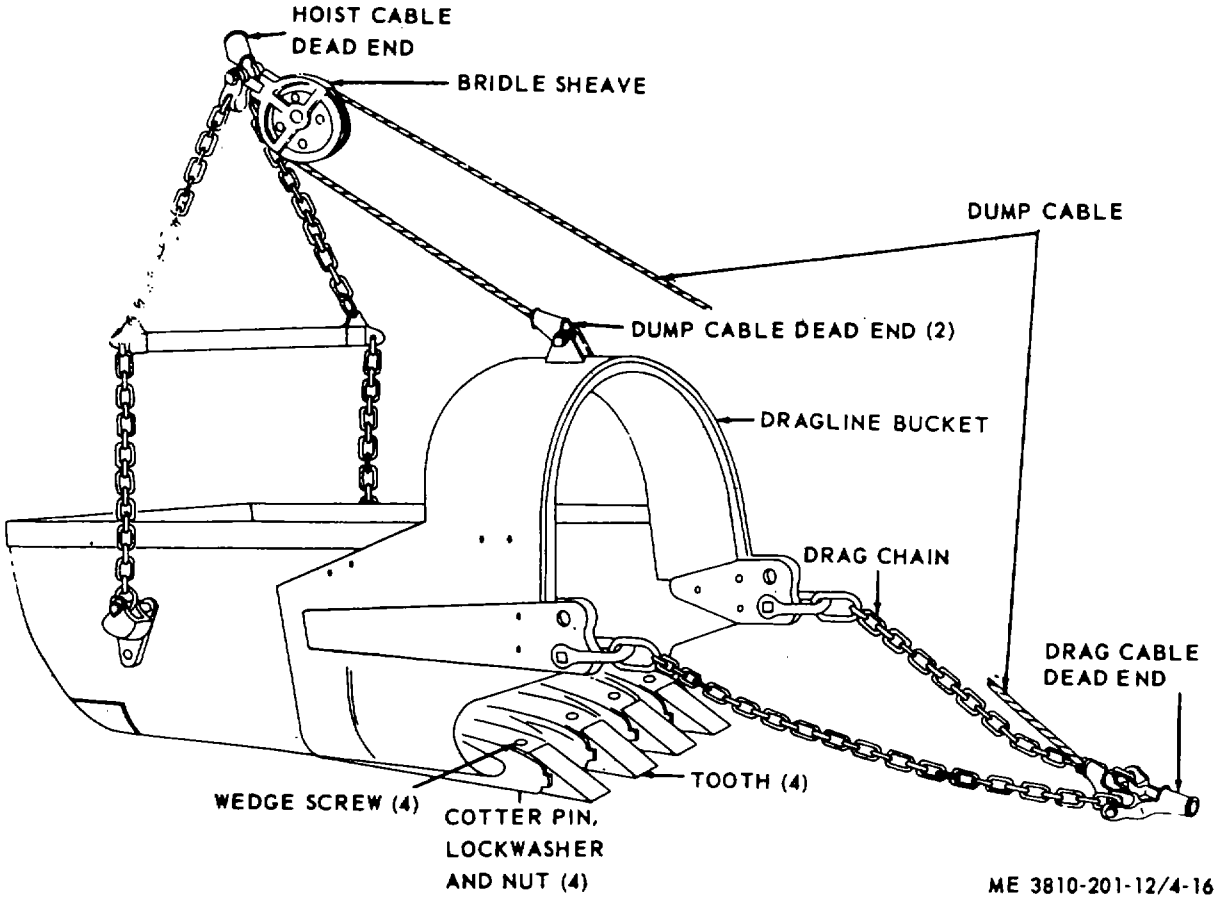


Figure 4-16. Dragline bucket, teeth replacement.

4-18. Dragline Bucket and Teeth

a. Removal

(1) Lower dragline bucket to ground then slacken hoist and drag cable.

(2) Remove drag, hoist, and dump cables from dead end (fig. 416).

(3) Wind cables on drums, slowly, as cable ends are guided through sheaves (fig. 2-12).

b. Bucket Teeth Replacement.

(1) *Removal.* Position bucket on its side and remove four cotter pins, nuts, and lockwashers from recess in teeth, then remove four wedge screws and teeth from bucket.

(2) *Cleanings, Inspection and Repair.*

(a) Clean all parts in an approved cleaning solvent and dry thoroughly.

(b) Visually inspect teeth for excessive wear, and mounting hardware for stripped threads or other defects.

(c) Replace all defective parts.

(3) *Teeth Installation*

(a) Position teeth on lip of bucket.

(b) Insert wedge screw and secure tooth (4)in position with lockwasher, nut, and cotter pin (4).

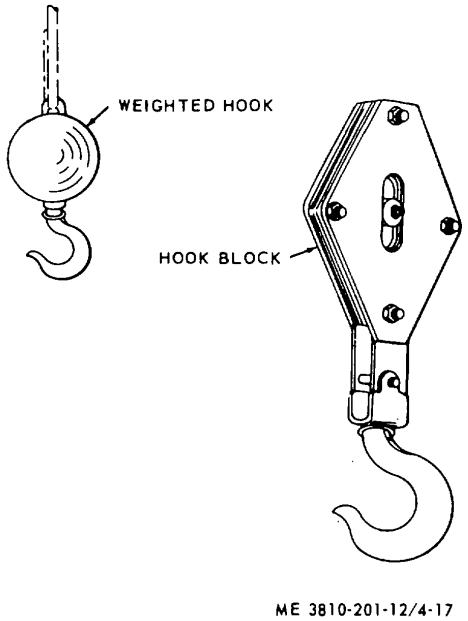


Figure 4-17. Hook block and weighted hook, removal or installation.

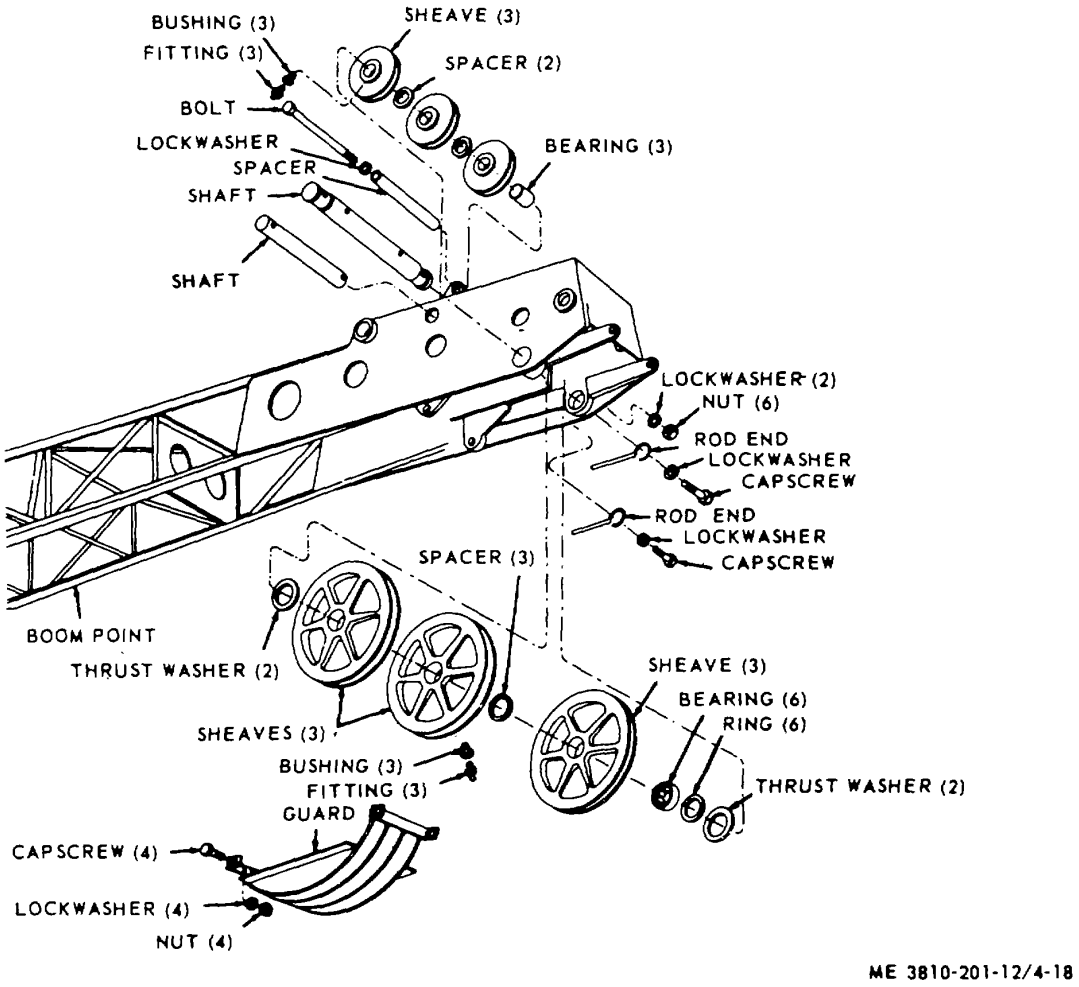


Figure 4-18. Boot point and idler sheaves, removal and installation

c. Installation of Bucket. Reeve drag cable, hoist cable, and dump cable and connect to dead ends (fig. 4-16).

419. Hook Block and Weighted Hook

Refer to reeving diagram (fig. 2-7) and figure 4-17 for removal and installation of hook block or weighted hook.

420. Boom Point and idler Sheaves

a. Removal

(1) Lower boom (para 2-12*b*).

(2) Remove hook (para 4-19) or bucket (paras 417 or 418), that is currently is use, then wind cables on drum(s).

(3) Remove nut (fig. 4-18), two lock-washers, bolt, and spacer.

(4) Remove capscrew, lockwasher, and rod end securing idler sheave shaft, remove shaft, two spacers, and three idler sheaves.

(5) Remove capscrew, lockwasher, and rod end that secures boom point sheave shaft, drive out shaft, then remove spacers and sheaves.

(6) Remove four nut, lockwasher, and cap screw, then remove guard.

Note
Do not remove bearings unless replacement is required.

b. Cleaning, Inspection and Repair.

(1) Clean all parts with an approved clean*ing* solvent and dry thoroughly.

(2) Visually inspect all parts for signs of excessive wear, cracks, breaks, bends, or stripped threads.

(3) Replace all defective, damaged, or worn parts.

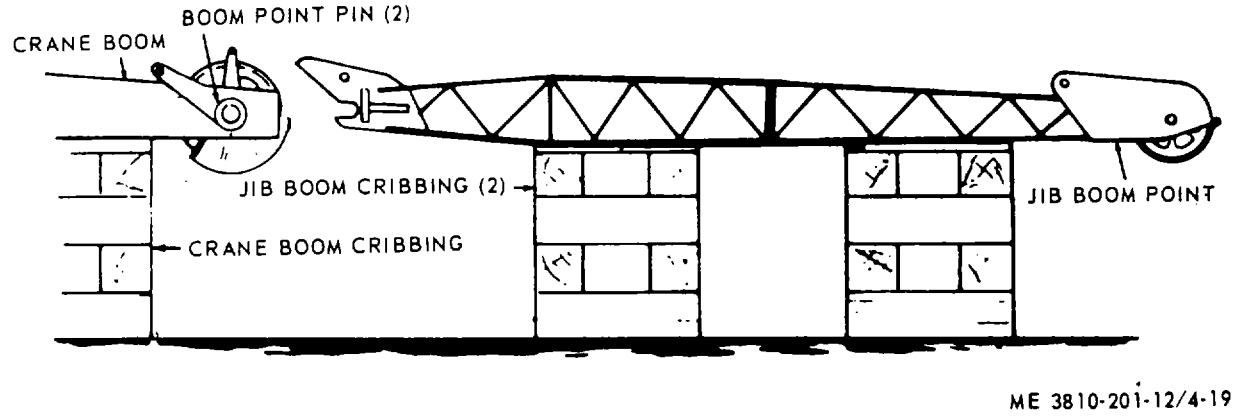


Figure 4-19. Jib boom, cribbed for installation, or removal.

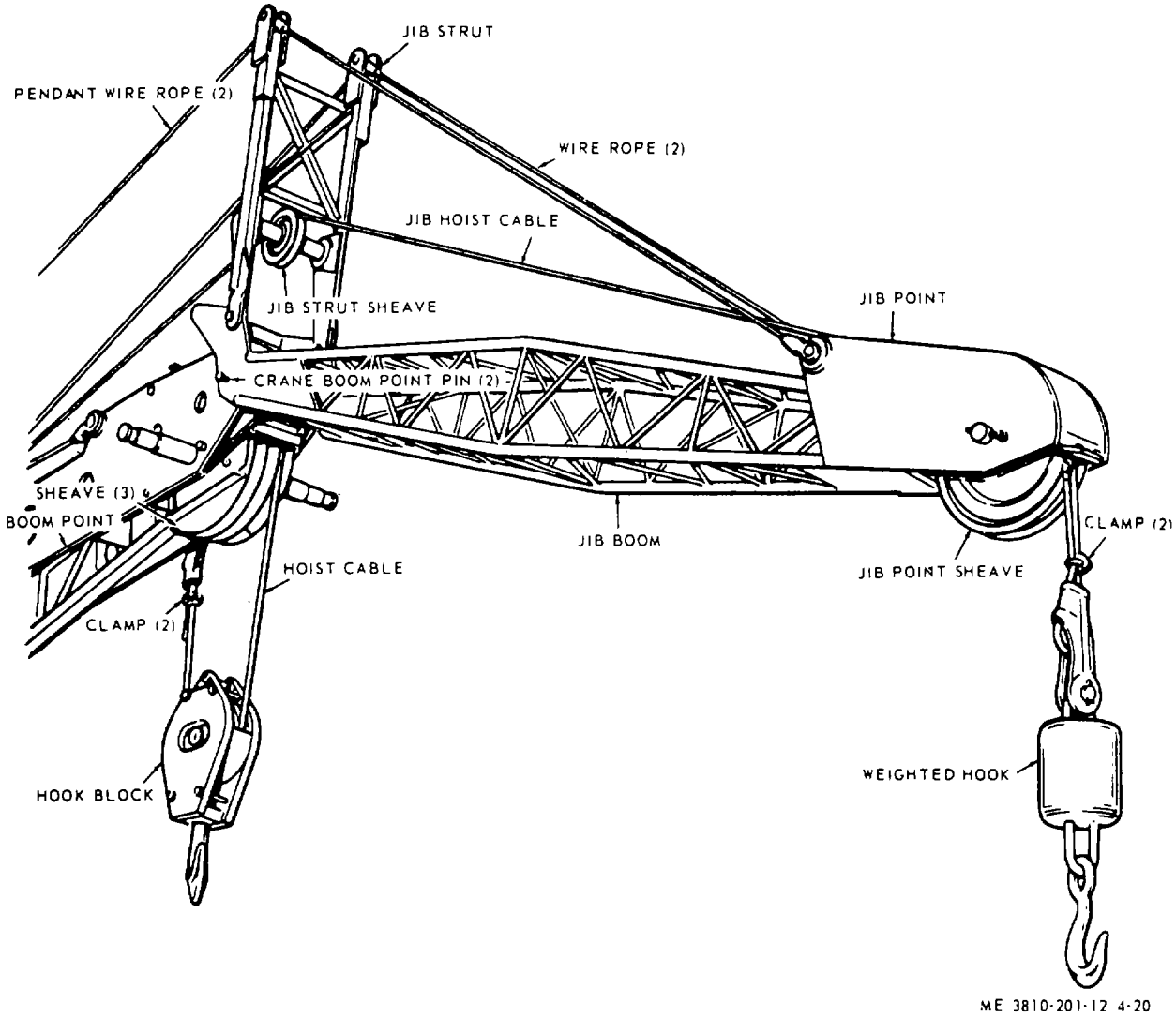


Figure 4-20. Crane boom with jib, installed view.

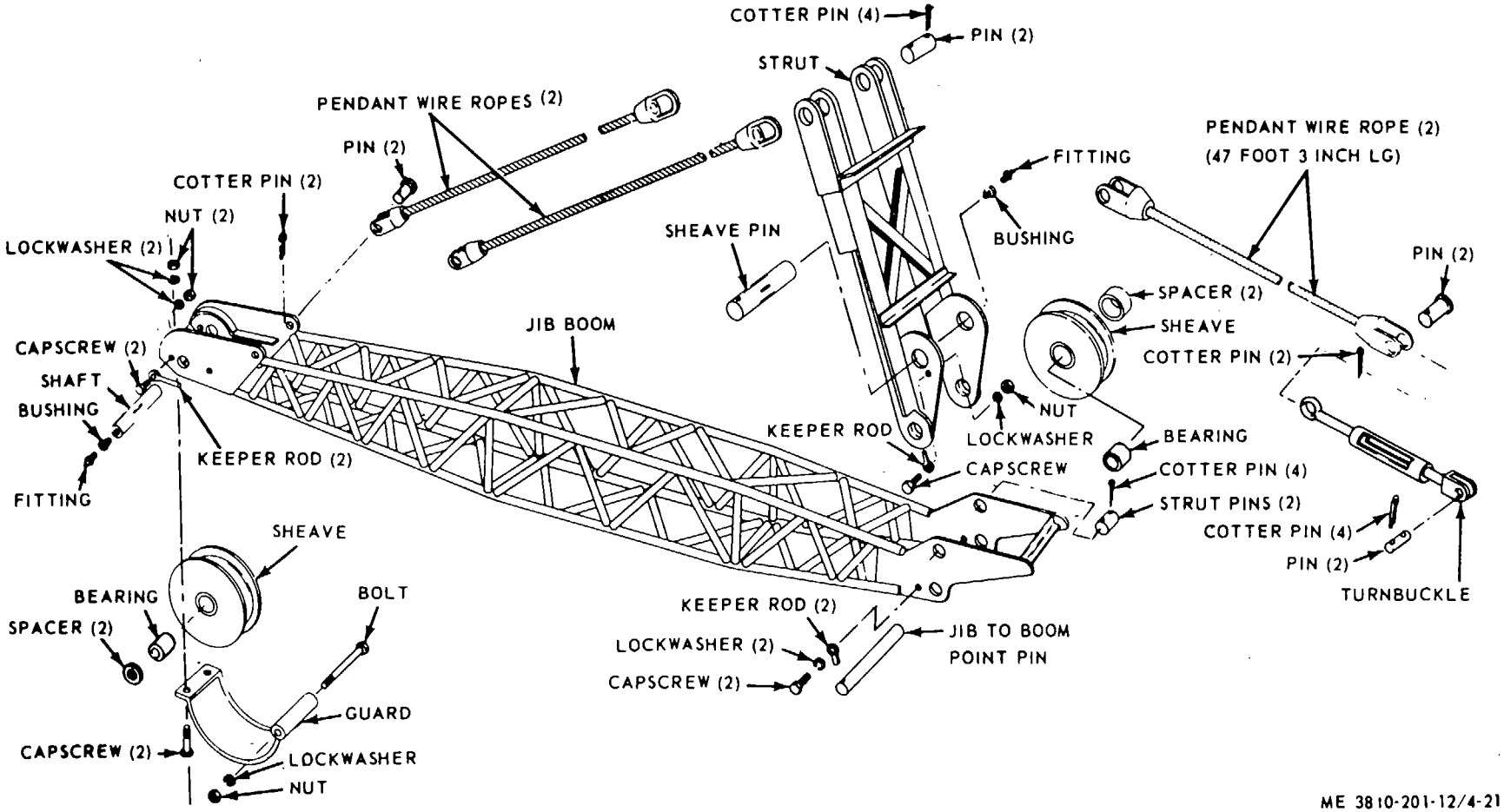


Figure 4-21. Jib boom, disassembly or reassembly.

c. Installation. Install boom point and idler sheaves by reversing steps (6) through (1) in a above.

4-21. Jib Boom, Strut, and Sheaves

a. Installation. When use of jib boom is required, it will be installed as follows:

(1) Build cribbing at end of cribbed jib boom (fig. 4-19) in line with and of equal height for crane boom.

(2) Lower hook block to ground, remove two clamps (fig. 4-20) from hoist cable, remove hook block, then wind hoist cable onto drum.

(3) Lower crane boom (para 2-12*b*) to rest on cribbing (fig. 4-19).

(4) Move jib boom into position over crane boom point and install jib to boom point pin (fig. 4-21) then install keeper rod and secure with lockwasher and capscrew.

(5) Install strut on jib boom, install two strut pins, and secure pins with four cotterpins.

(6) Position pendant wire ropes at strut, install pins through sockets and secure with cotterpins.

(7) Connect wire ropes to jib boom point, install pins and secure pins with cotterpins.

(8) Connect longer wire ropes to eyebolt of turnbuckle, connect turnbuckle to crane boom foot, install pins and secure with cotter pins.

(9) Refer to figure 2-7 and reeve crane hook block and jib boom hoist cables.

(10) Raise boom (para 2-12*b*).

b. Removal of Jib Boom.

(1) Move crane-shovel unit into position for placement of jib boom, then build cribbing (fig. 4-19).

(2) Lower jib boom weighted hook to ground, remove clamps, then cable from weighted hook. Wind cable onto hoist drum.

Note.

If crane boom is to be removed, remove hook block in a manner similar to (2) above, winding cable onto digging drum.

(3) Lower boom (para 2-12*b*) until jib boom rests on prepared cribbing, then disconnect two pendant wire rope turnbuckles from crane boom foot.

(4) Remove capscrew, lockwasher, and keeper rod securing jib boom point pin, then remove pin.

Note.

If crane boom is to be removed, proceed as directed in paragraph 4-2.

(5) Move crane-shovel unit away from cribbed jib boom.

c. Disassembly and Reassembly.

(1) Remove cotterpins, pins, and two turnbuckles from pendant wire ropes (fig. 4-21), then remove cotterpins and pins from pendant wire ropes and remove wire ropes from jib boom and strut.

(2) Remove capscrew, lockwasher, and keeper rod securing strut sheave pin; remove sheave pin, spacer and sheave from strut. Remove fitting and bushing from strut sheave pin**.**

Note

Do not remove bearings from sheaves unless replacement is required.

(3) Remove four cotterpins from two strut pins, remove pins, then remove strut from jib boom.

(4) Remove three nuts and lockwashers from two capscrews and bolt, remove bolt and capscrews, then remove sheave guard.

(5) Remove nut, lockwasher, capscrew, and keeper rod securing jib boom point sheave shaft, remove shaft, spacer, and sheave. Remove fitting and bushing from sheave shaft.

Note.

Do not remove bearings unless replacement is required.

(6) Reassemble by reversing procedure of steps (5) through (1) above.

d. Cleaning, Inspection and Repair.

(1) Clean all parts with an approved cleaning solvent and dry thoroughly.

(2) Visually inspect jib boom for cracks, breaks, or bent sections. Inspect sheave pins and shafts for excessive wear. Inspect mounting hardware for stripped threads or elongated holes.

(3) Repair breaks and cracks by welding, straighten all bends, and replace all worn, damaged, or defective parts.

4-22. Boom Backstop

a. Removal and Installation.

(1) If necessary, raise boom (para 2-12*b*) to a moderate angle and take pressure off mounting hardware; remove four nuts, lockwashers, and capscrews (fig. 4-22) then lift tow bearings from gantry.

(2) Lower boom to a horizontal position with cribbing at boom point (fig. 2-46).

(3) Remove two cotterpins from pin securing bearing (fig. 4-22) at boom; drive pin from bearing, then remove boom backstop.

(4) Install in reverse order.

b. Disassembly and Reassembly.

(1) Slide bottom bearing, spring, seat, and pipe as an assembly (fig. 4-22) off of two pipes connected to upper bearing; unscrew two pipes

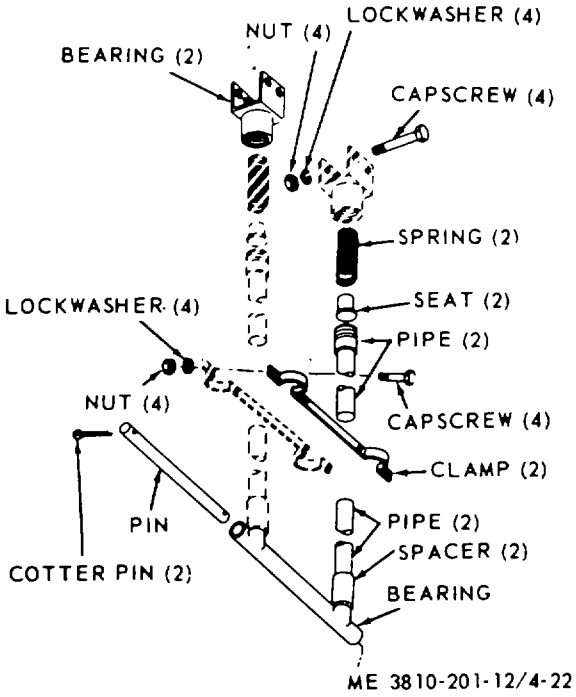


Figure 4-22. Boom, backstop, removal, disassembly, reassembly, and installation.

from bearings, then remove pipes, seats, and springs.

(2) Remove two pipes and spacers from upper bearing.

(3) Reassembly by reversing procedure in steps (2) and (1) above.

c. Cleaning, Inspection and Repair.

(1) Clean all parts with an approved cleaning solvent and dry thoroughly.

(2) Visually inspect parts for excessive wear, bends, cracks, or other defects.

(3) Repair by straightening bends, welding cracks, or replacement of all parts damaged beyond repair.

4-23. Radius Indicator (Boom Angle Indicator)

a. Removal and installation . Refer to figure 2-27, remove three mounting capscrews and lockwashers, then remove radius indicator from crane boom. Install in reverse order.

b. Disassembly and Reassembly.

(1) Remove eight screws (fig. 4-23), flatwashers, and two plates to expose bearings and

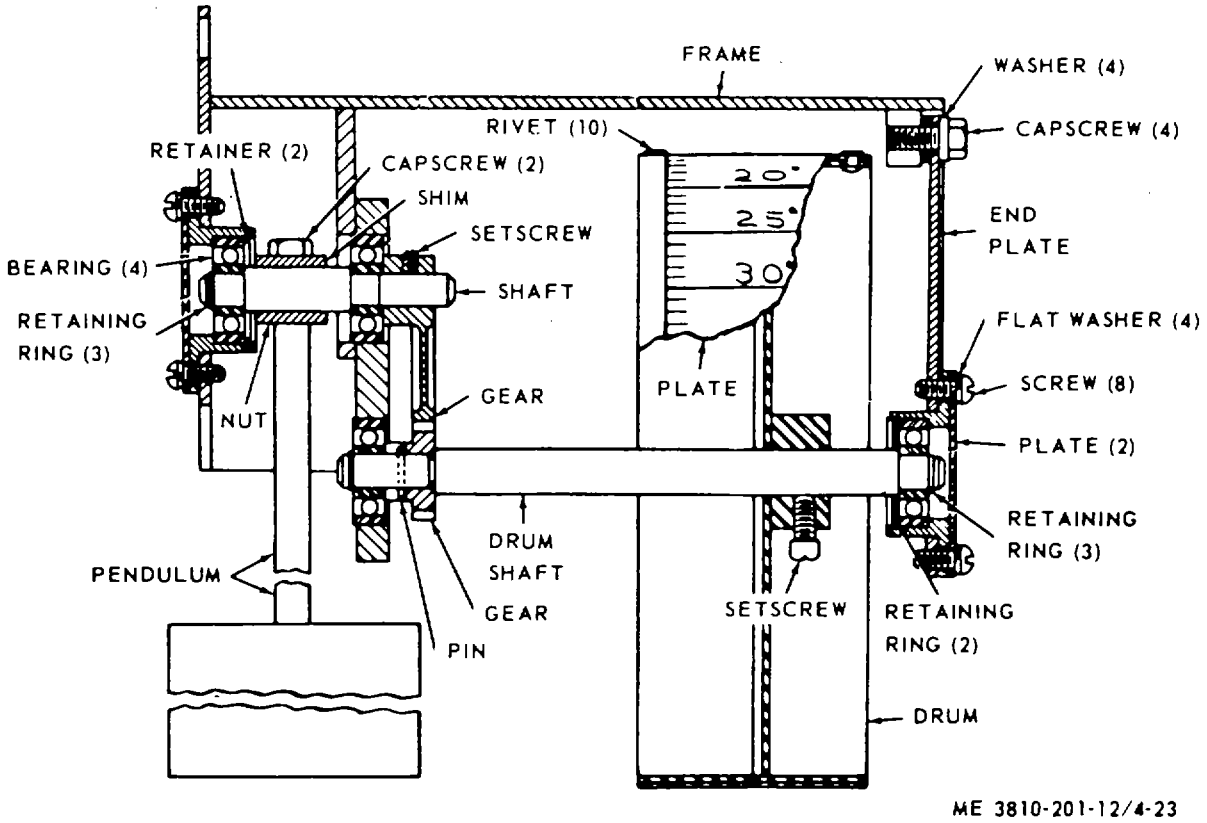


Figure 4-23. Radius (boom angle) indicator, disassembly and reassembly.

shafts. Remove four capscrews and washer, then remove end plate.

(2) Remove retaining rings from ends of drum shaft; move pendulum aside, move drum shaft against bearing and press bearing out of frame until drum shaft is free of remaining bearing; remove bearing from drum shaft, then remove drum and shaft from frame.

(3) Loosen setscrew securing drum to shaft and remove drum from shaft. Remove bearing retaining ring, then remove remaining drum shaft bearing from frame. Drive pin from gear and shaft, then remove gear from shaft.

(4) Loosen setscrew and remove gear from pendulum shaft. Remove capscrew and shim from pendulum, then remove pendulum from shaft.

(5) Remove retainer from outer shaft bearing; drive bearing inward until free of frame; remove bearings from pendulum shaft, then remove shaft.

Note.

Do not remove rivets from plate on drum unless plate is to be replaced.

(6) Reassemble by reversing procedure in steps (,5) through (1) above.

Note.

At reassembly, assure that pendulum and bind. Test by moving frame back and forth through drum measurement are.

c. Cleaning, Inspection and Repair.

(1) Clean -all parts, except bearings, in an approved cleaning solvent and dry thoroughly.

(2) Visually inspect bearings for signs of scoring in races, excessive wear, or other defect.
Clean serviceable bearings by wiping exterior with a cloth dampened' in engine lubricating oil, then lay them aside protected from contamination until reassembly. Replace all defective bearings.

(3) Visually inspect all parts for signs of excessive wear or other defect. Replace all defective parts.

Section III. BACKHOE FRONT END ATTACHMENT

4-24. General

The backhoe front end attachment (fig, 4-24) does not use the planetary pinion gear of the shovel, therefore if the crane-shovel unit is so equipped, they must be removed (para 3-125). Backhoe attachment consists of boom, bucket handle, brace, bucket, auxiliary gantry, spreader bar, backstop, boom foot adapters and backhoe lagging for digging drum. Cables for backhoe operation are listed in table 1-2, and are reeved as shown in figure 2-16.

Caution:

When reeving the digging cable, be sure that a second layer does not wrap on drum. Over wrapping causes very rapid cable wear.

4-25. Lagging

Backhoe lagging for digging drum is installed, or removed, in manner described in paragraph 3-124.

4-26. Backhoe Front End Attachment

a. Removal.

(1) Select a firm level area in which to work.

Caution:

If attachment will not be used for a considerable period of time, arrangements should be made to protect the machinery from damage by the elements.

(2) Pull bucket under boom and lower boom gradually until blocking may be placed between pitch brace and boom (fig. 2-15).

(3) Build cribbing at boom point and foot (fig. 2-15); lower boom to cribbing, disconnect backstop (para 4-30); lower auxiliary gantry toward boom until blocking can be positioned (fig. 2-15).

(4) Disconnect backhoe digging cable, boom hoist cable and boom (gantry) hoist cable from dead end sockets, then unreeve by winding cables on drums (fig. 2-16). Wind cables slowly, while ends are carefully guided through sheaves.

(5) Use wedges or jacks to raise boom foot enough to take weight off pins; remove pins which attach backhoe boom adapters to revolving frame lugs. The backhoe boom and gantry remain attached to boom foot adapters. Secure backstop in closed position on gantry.

(6) Move crane-shovel unit away from backhoe front end attachment.

b. Disassembly and Reassembly.

(1) Remove backstop (para 4-30).

(2) Remove auxiliary gantry (para 4-27).

(3) Remove backhoe bucket (dipper) (para 4-28).

(4) Remove backhoe bucket (dipper) stick (para 4-29).

(5) Disassemble or reassemble backhoe boom (para 4-30).

(6) Disassemble and reassemble components as described in the paragraphs listed above.

(7) Reassemble backhoe attachment by reversing steps (4) through (1) above.

c. Installation. When backhoe front end attachment is to be installed, assure that backhoe lag-

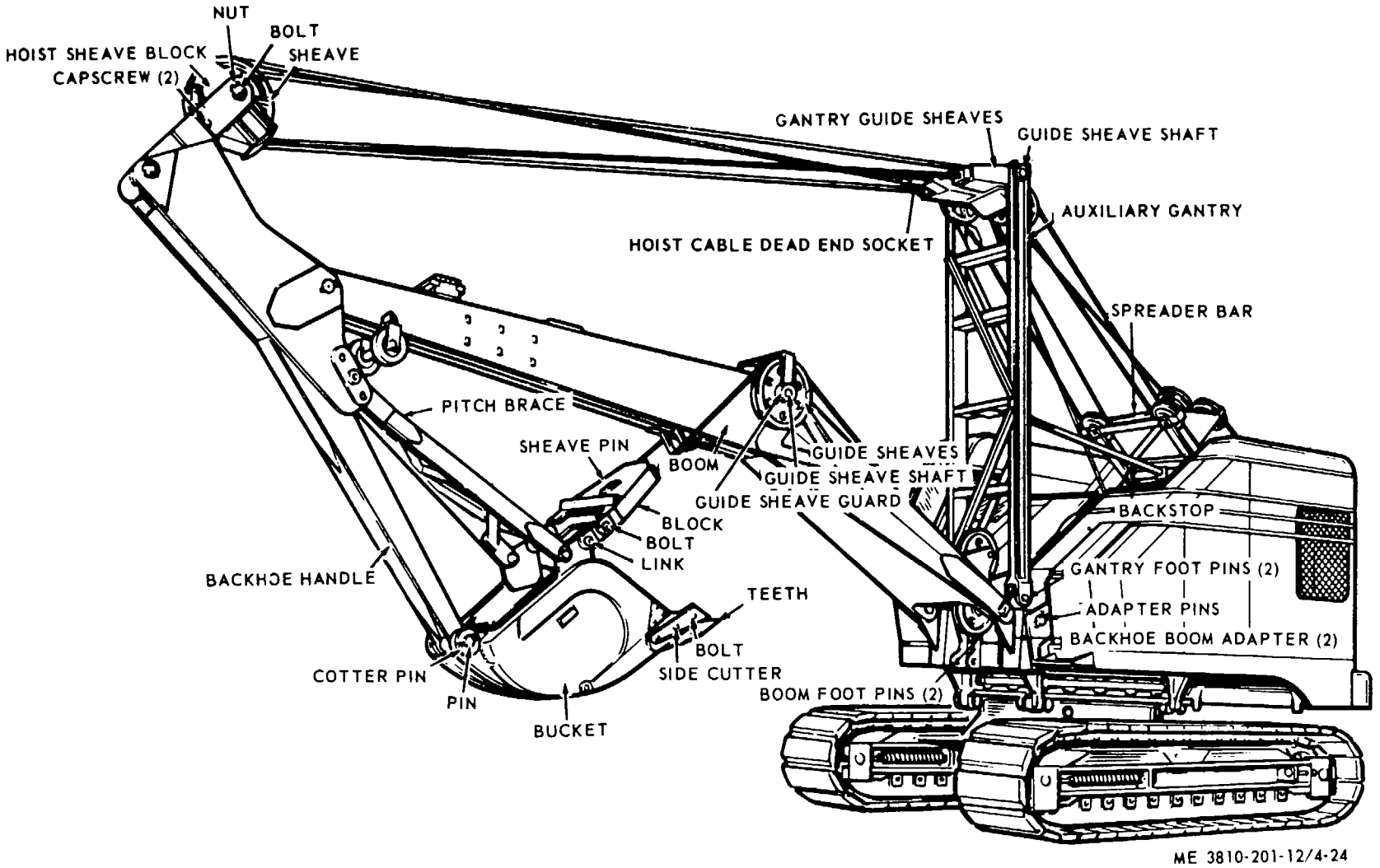


Figure 4-24. Backhoe front end attachment, installed view.

ging is installed on digging drum (para 3-124) then proceed as follows:

(1) Move crane-shovel unit into position at cribbed backhoe attachment as shown in figure 2-15.

(2) Use wedges or jacks to raise boom from cribbing so that adapters line up with revolving frame foot lugs, install pins that secure boom foot adapters to revolving frame and secure pins with cotter pins (fig. 4-24).

(3) Lift auxiliary gantry from boom, lean it toward crane-shovel, then attach backstop to revolving frame gantry pin (para 4-30).

(4) Remove blocking that is between auxiliary gantry and boom (fig. 2-15); install backhoe cables shown in table 1-2 as described in paragraph 3-29, and reeve (fig. 2-16).

(5) Adjust boom hoist cable on drum until auxiliary gantry is vertical; use hoist cable to raise boom and remove cribbing at point and foot of boom, then release digging cable and allow bucket to drop so blocking can be removed from between brace and boom (fig. 2-15).

(6) Perform preventive maintenance checks and services (para 3-6).

4-27. Backhoe Auxiliary Gantry

a. Removal.

(1) Lower boom (para 2-12*b*) to rest on cribbing (fig.2-15*b*).

(2) Disconnect boom hoist, hoist, and digging cables at dead end sockets (fig. 2-16) then wind on drums (unreeve).

(3) Remove backstop (para 4-30).

(4) Remove four cotterpins (fig 4-25) from two pins securing gantry to left and right hand boom foot adapters, remove pins, then remove auxiliary gantry.

b. Disassembly and Reassembly.

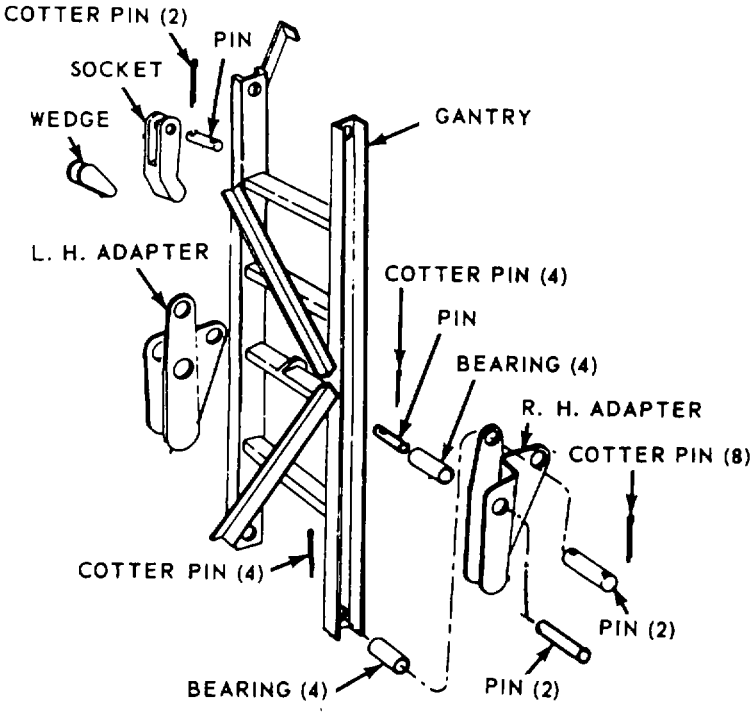
(1) Refer to figure 4-26, remove items 1 through 9 is numerical sequence, then remove sheave frames from gantry.

(2) Refer to figure 4-25 to remove adapters and wire rope socket from gantry frame.

(3) Complete disassembly, numerically, as shown on figure 4-26.

(4) Reassemble in reverse order.

c. Installation. Install the auxiliary gantry by reversing procedure in steps (4) through (1) in a above.



NOTE: DO NOT REMOVE BEARINGS OR BUSHINGS UNLESS REPLACEMENT IS REQUIRED.

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Figure 4-25. Auxiliary gantry and boom foot adapters.

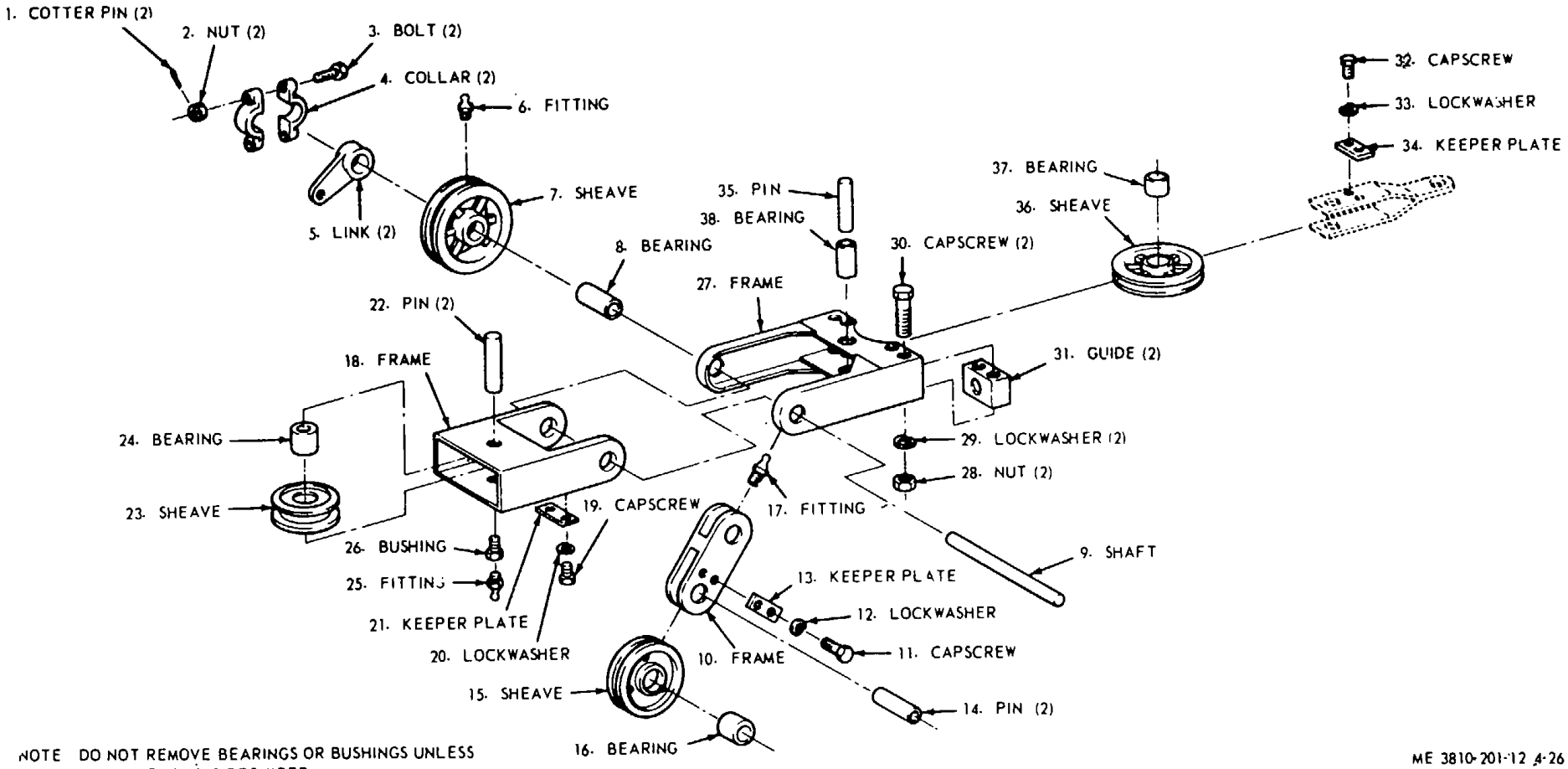

Figure 4-26. Auxiliary gantry sheaves.

NOTE:

DO NOT REMOVE BEARINGS OR BUSHINGS UNLESS REPLACEMENT IS REQUIRED.

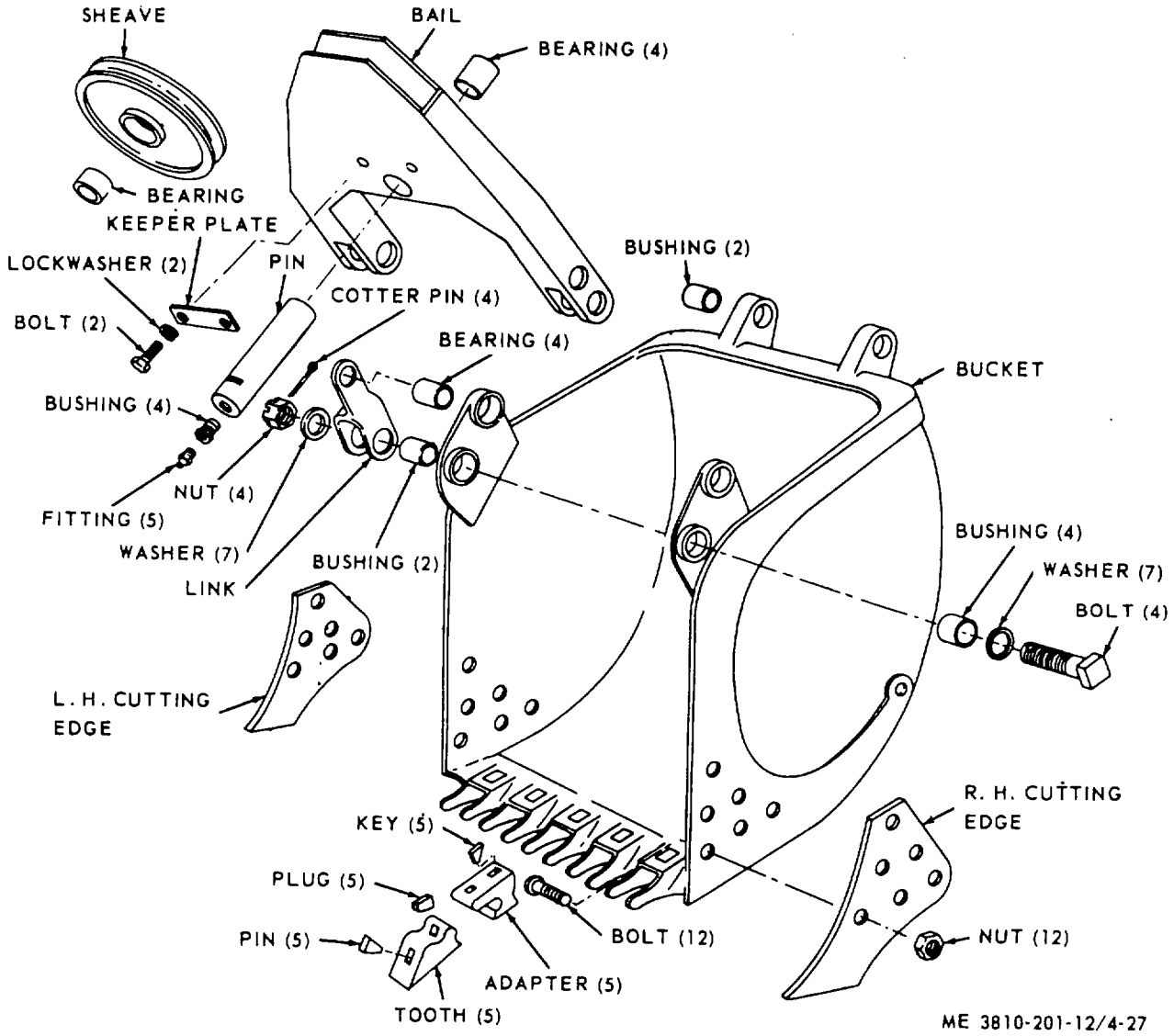

Figure 4-27. Backhoe bucket, disassembly and reassembly.

d. Cleaning, Inspection, and Repair.

(1) Clean all parts in an approve cleaning solvent and dry thoroughly.

(2) Visually inspect all parts for cracks, breaks, bends or other defect.

(3) Repair by welding cracks or breaks, straightening bends, or replacing defective mounting hardware.

4-28. Backhoe Bucket, Bail, and Teeth

a. Removal.

(1) Raise boom (par, 2-12*b*) build cribbing under boom near foot, lower boom to rest, then disconnect and unreeve the digging cable (fig. 2-16).

(2) Remove bail and link by removing cotter pins, nuts, washers, and bolts (fig. 4-27).

(3) Remove cotter pin, nut, washers and bolt securing brace to bucket. Remove cotter pins ,and pin (fig. 4-28) securing bucket to bucket stick, then remove bucket.

b. Disassembly and Reassembly.

(1) Disassemble bail by removing two bolts, lockwashers, and keeper plastic (fig. 4-27), remove pin, then remove sheave from bail.

(2) Remove 12 nuts and bolts, and remove left and right hand cutting edges.

(3) Drive pins and plugs out of five teeth then remove teeth from adapter.

(4) Drive key out of five adapters, then remove adapters from bucket.

NOTE
DO NOT REMOVE BUSHINGS OR BEARINGS UNLESS REPLACEMENT IS REQUIRED.

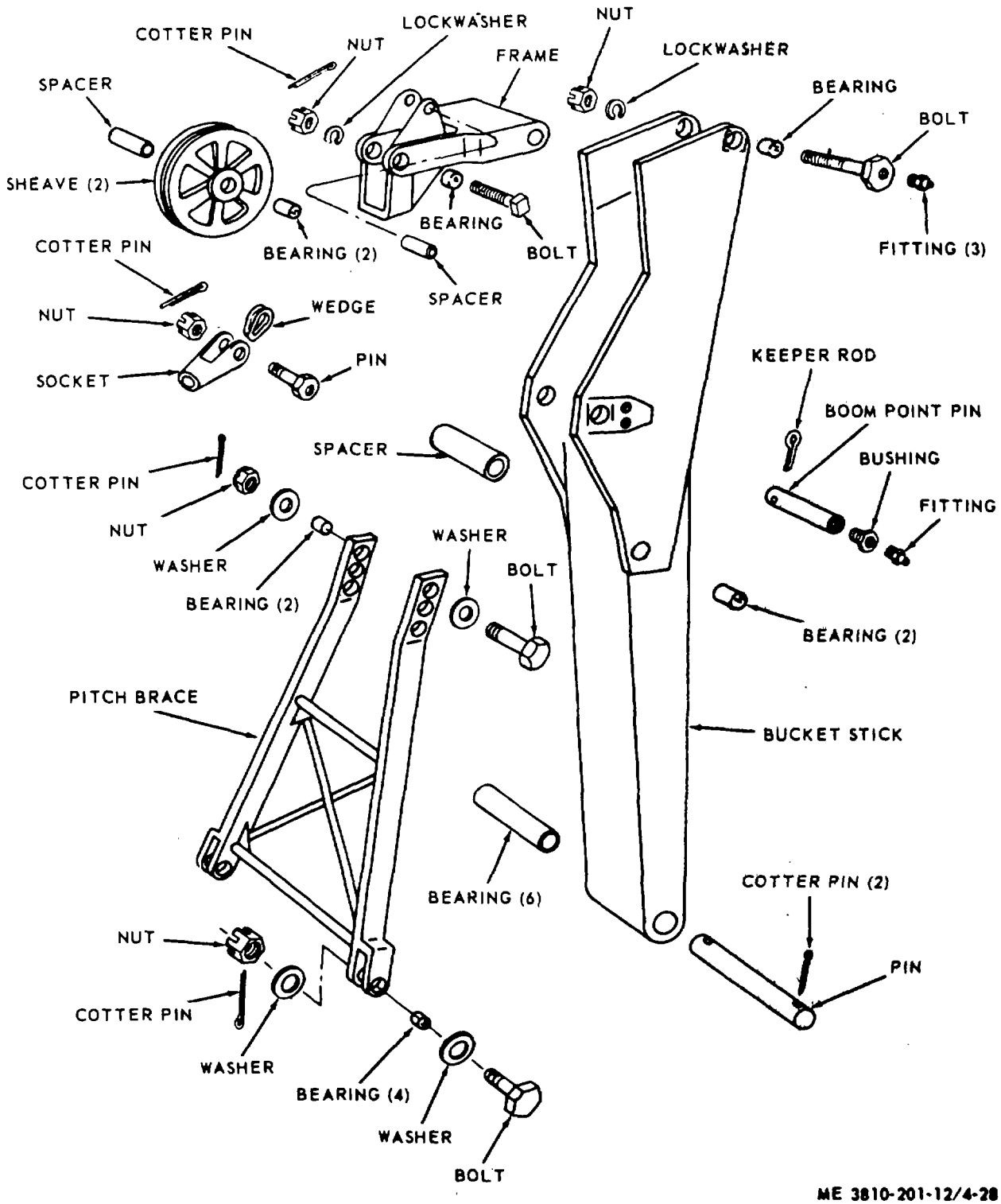

Figure 4-28. Backhoe bucket stick, disassembly and reassembly.

(5) Reassemble by reversing procedure of steps (4) through (1) above.

c. Cleaning, Inspection and Repair.

(1) Clean all parts with an approved cleaning solvent and dry thoroughly.

(2) Visually inspect all parts for cracks, breaks, bends or excessive wear.

(3) Repair by welding cracks or breaks, straightening bends, or replacing excessively worn parts.

d. Installation. Install bucket, bail, and teeth by reversing procedure in steps (3) through (1) in a above.

4-29. Backhoe Bucket Stick

a. Removal.

(1) Lower boom to rest on cribbing, near foot, then unreeve hoist and digging cables (fig. 3-16).

(2) Attach lifting device to bucket stick, remove keeper rod (fig. 4-28) and boom point pin, then remove bucket stick from boom.

b. Disassembly and Reassembly.

(1) Remove bucket (para 4-28).

(2) Remove cotterpin, nut, washers, and bolt from pitch brace (fig. 4-28) then remove brace from stick.

Note.

At reassembly, depth of bucket slice is adjusted by position of bolt in brace. For deep excavation put bolt through lower hole. Where maximum dumping height is required put bolt in upper hole. For normal operation the bolt should be in center hole.

(3) Remove nut, lockwasher and bolt then remove sheave frame from bucket stick.

(4) Remove cotter pin, nut, lockwasher. spacer, sheave, and bolt from frame.

(5) Remove cotter pin, nut, wedge socket, and pin from frame.

(6) Reassemble by reversing procedures in steps (5) through (1) above.

c. Cleaning, inspection and Repair.

(1) Clean all parts in an approved cleaning solvent and dry thoroughly.

(2) Visually inspect parts for cracks, breaks, bends, or excessive wear.

(3) Repair by welding cracks or breaks, . Lightening bends, or replacing worn or defective parts.

d. Installation. Install bucket stick by reversing procedure used in removal (*a* above).

4-30. Backhoe Safety Backstop

a. Removal.

(1) Remove four locknuts, nuts, and two U Figure 4-19.

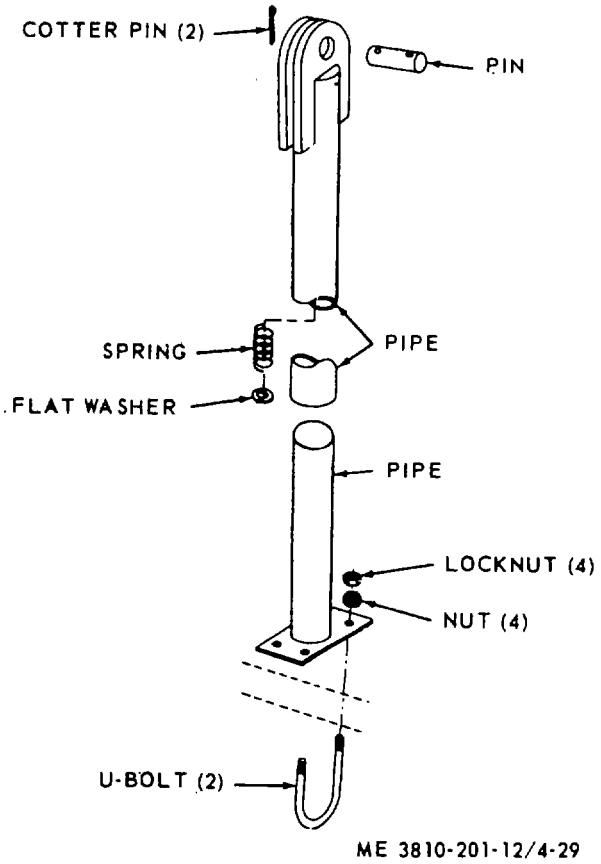

Figure 4-29. Backhoe safety backstop, removal, disassembly, reassembly, and installation.

Backhoe safety backstop, removal, disassembly, reassembly, and installation bolts (fig. 4-9), and disconnect backstop from revolving frame gantry pin.

(2) Remove two cotter pins from pin, remove pin, then remove backstop from auxiliary gantry.

b. Disassembly and Reassembly.

(1) Separate the two pipes by pulling smaller out of the larger (fig. 4-29).

(2) Remove washer and spring from the larger pipe.

(3) Reassemble by reversing procedure in steps (2) and (1) above.

c. Cleaning, Inspection and Repair.

(1) Clean all parts with an approved c ing solvent and dry thoroughly..

(2) Visually inspect pipes for bend or other defect, and spring for compression strength.

(3) Repair by straightening bends, or replacing defective parts.

d. Installation. Install backstop by reversing procedure in a above.

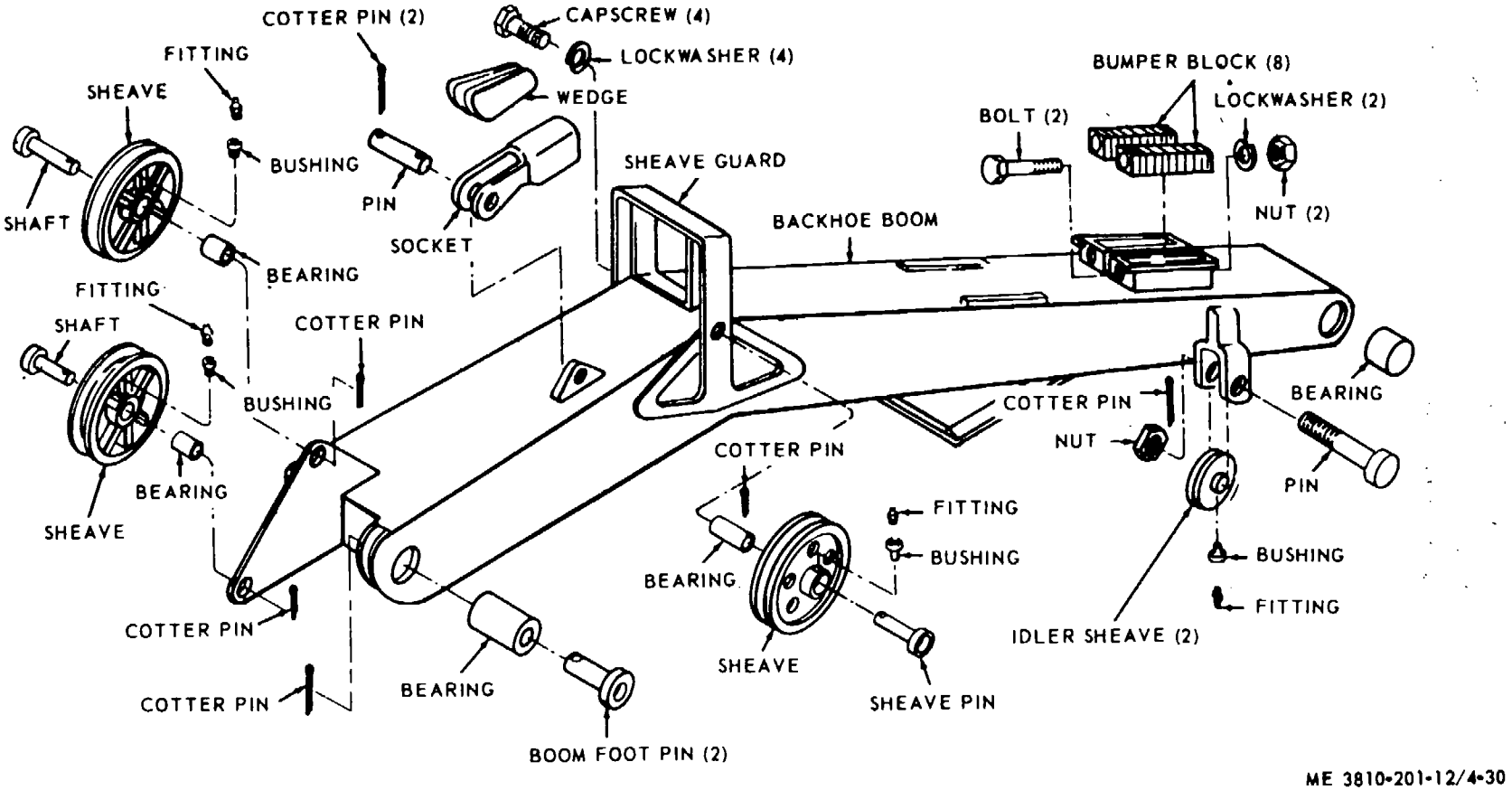

Figure 4-30. Backhoe boom disassembly and reassembly.

4-31. Backhoe Boom

a. Removal. When boom must be repaired, or replaced, proceed as follows:

(1) Pull bucket under boom and lower boom to rest on cribbing at boom foot only, then unreeve all cables (fig. 2-16), winding them carefully on drums.

(2) Remove boom safety backstop (para 4-30).

(3) Remove auxiliary gantry (para 4-27).

(4) Remove bucket stick (para 4-29).

(5) Build cribbing under boom point, use wedges or jacks to take weight off boom foot pins (fig. 4-30) remove pins, then move crane-shovel unit away from boom.

b. Disassembly and Reassembly.

(1) Remove two cotter pins, pins, and guide sheaves from boom foot.

(2) Remove cotter pin, pin, and guide sheave from under sheave guard.

(3) Remove two cotterpins, pin, wedge, then remove cotter pin, nut, socket, lockwasher and bolt from boom.

(4) Remove two nuts, lockwashers, and bolts from bumper blocks, then remove bumper blocks from boom.

Note.

Do not remove bushings or bearings unless replacement is required.

(5) Reassemble boom and components by reversing procedure in steps (4) through (1) above.

c. Cleaning, Inspection and Repair.

(1) Clean all parts with an approved cleaning solvent and dry thoroughly.

(2) Visually inspect all parts for cracks, breaks, bends, scored or worn bearings, worn bumper blocks, or other defects.

(3) Repair by welding cracks or breaks, straightening bends, and replacing worn or defective parts.

d. Installation. Install backhoe boom by reversing procedures in a above.

Section IV. PILEDRIVER FRONT END ATTACHMENT

4-32. General

The piledriver front end attachment (fig. 2-14) consists of a standard crane boom (para 4-13) with one 10 foot boom section inserted between base and point sections, pile leads, hangers, catwalk, adapters, hammer, pile cap, pile collar, and special cables for hoist and digging drums (table 1-2).

Caution:

Crane-shovel unit must be level when using piledriver attachment. If it is impracticable to grade site level, timbers must be used to level the unit.

4-33. Piledriver Front End Attachment

a. Installation. Assuming the shovel front end attachment has been installed, proceed as follows:

(1) Remove shovel front end attachment (para 4-2).

(2) Remove shovel cables from drums (para 3-39), remove shovel sprocket and planetary pinion gear, (para 3-125), install crane lagging (para 3-124), and reposition planetary clutch band to crane configuration (para 3-123).

(3) Install piledriver cables (table 1-2) (para 3-39) and wind boom hoist, pile handling, and hammer cables on drums.

(4) Move crane-shovel unit into position to install boom similar to that shown in figure 26, connect boom to revolving frame (para 4-13), then reeve boom hoist cable (fig. 2-7).

(5) Raise boom (para 2-12b) just enough to allow cribbing to be removed. Remove cribbing, then install pile leads (para 4-35).

(6) Reeve hammer and pile handling cables (fig. 2-13), run off enough slack in pile handling cable to keep looped end in reach, then guide hammer cable down through pile threads. Raise boom (para 2-12*b*) and travel unit forward (para 2-12*c*) simultaneously until pile leads are suspended vertically (fig. 2-14) with bottom of leads touching the ground.

Caution:

Do not drag bottom of leads on ground by raising boom without traveling crane-shovel unit, and avoid damage to leads.

(7) Install adapters on catwalk (para 4-47) then install catwalk.

(8) Install pile hammer, pile cap, and pile collar (para 4-36).

(9) Lower hammer, cap, and collar to ground, then perform preventive maintenance checks and services (para 3-6).

b. Removal. When piledriver front end attachment is to be removed and stored so that craneshovel unit may be converted for other use, proceed as follows:

(1) Move piledriver unit to a suitable area for storage, then remove collar, cap, and hammer (para 4-36).

(2) Remove pile leads (para 4-35).

(3) When shovel or backhoe front end at-

tachment is to be installed, remove crane boom (para 4-13).

Note.

When crane, clamshell, or dragline front end attachment is to be installed, disregard step (3) above and proceed as in step (4) below.

(4) Remove pile driver cables (para 3-39), and after referal to appropriate paragraph, install lagging and cables (table 1-2) for the new front end attachment.

Caution:

When it is intended to store any removed front end attachment for a considerable period of time, all components must be lubricated in accordance with current lubricating order (LO 5381020612), and protected against deterioration by the elements during period of storage.

4-34. Pile Lead Hangers

a. Removal. Remove six nuts, lockwashers, and bolts from each hanger (fig. 4-31), then remove hangers from pile lead.

b. Cleaning, Inspection and Repair.

(1) Clean all parts in an approved cleaning solvent and dry thoroughly.

(2) Visually inspect hangers for cracks, bends, or breaks, and mounting hardware for stripped threads, or other defects.

(3) Repair by straightening bends, welding cracks or breaks, or replacement of defective part.

c. Installation. Position lead hangers on lead, then secure each one with six bolts, lockwashers, and nuts.

4-35. Pile Leads

a. Installation.

(1) Remove one lead hanger (para 4-34) move crane-shovel unit with proper boom installed into position at cribbed pile leads, position installed hanger over boom point sheave pin, position loose hanger over boom point sheave pin, then secure it to lead with six bolts, lockwashers, and nuts.

(2) Position two spacers (fig. 4-32) on boom point sheave pin ends, install two split collars, and secure each with bolt, lockwasher and nut.

b. Removal.

(1) Remove collar, cap, and hammer (para 436).

(2) Remove catwalk and adapters (para 0 4-37).

(3) Position cribbing for foot of pile lead (fig. 4-31) then lower boom (para 2-12b) and travel crane-shovel unit (para 2-12c) backward simultaneously, until boom point is just above the horizontal, then build cribbing to support top and center of pile leads (fig. 4-31).

Caution:

Be sure cribbing is high enough to keep boom point above the horizontal.

(4) Use wedges or jacks to take weight off of pile hangers, remove two nuts, lockwashers, and bolts securing split collars (fig. 4-32), remove two collars, and two spacers.

(5) Remove one lead hanger (para 4-34) work remaining hanger off boom point sheave pin, move crane shovel unit away; from leads, then reinstall removed hanger on lead.

(6) Raise boom and move crane-shovel unit to area for boom removal, if required.

4-36. Hammer, Pile Cap, and Pile Collar

a. Installation.

(1) Raise pile leads above hammer, swing

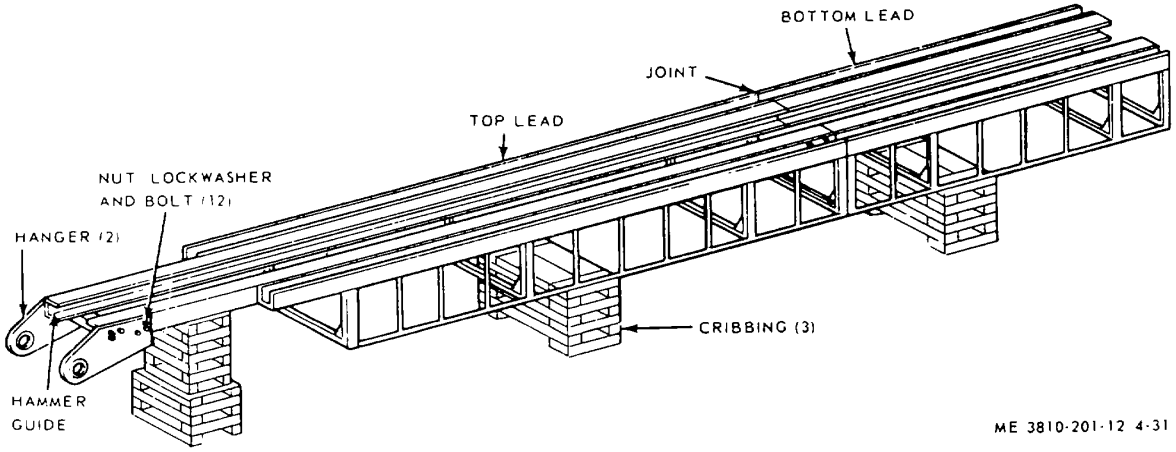

Figure 4-31. Pile leads, cribbed for removal or installation.

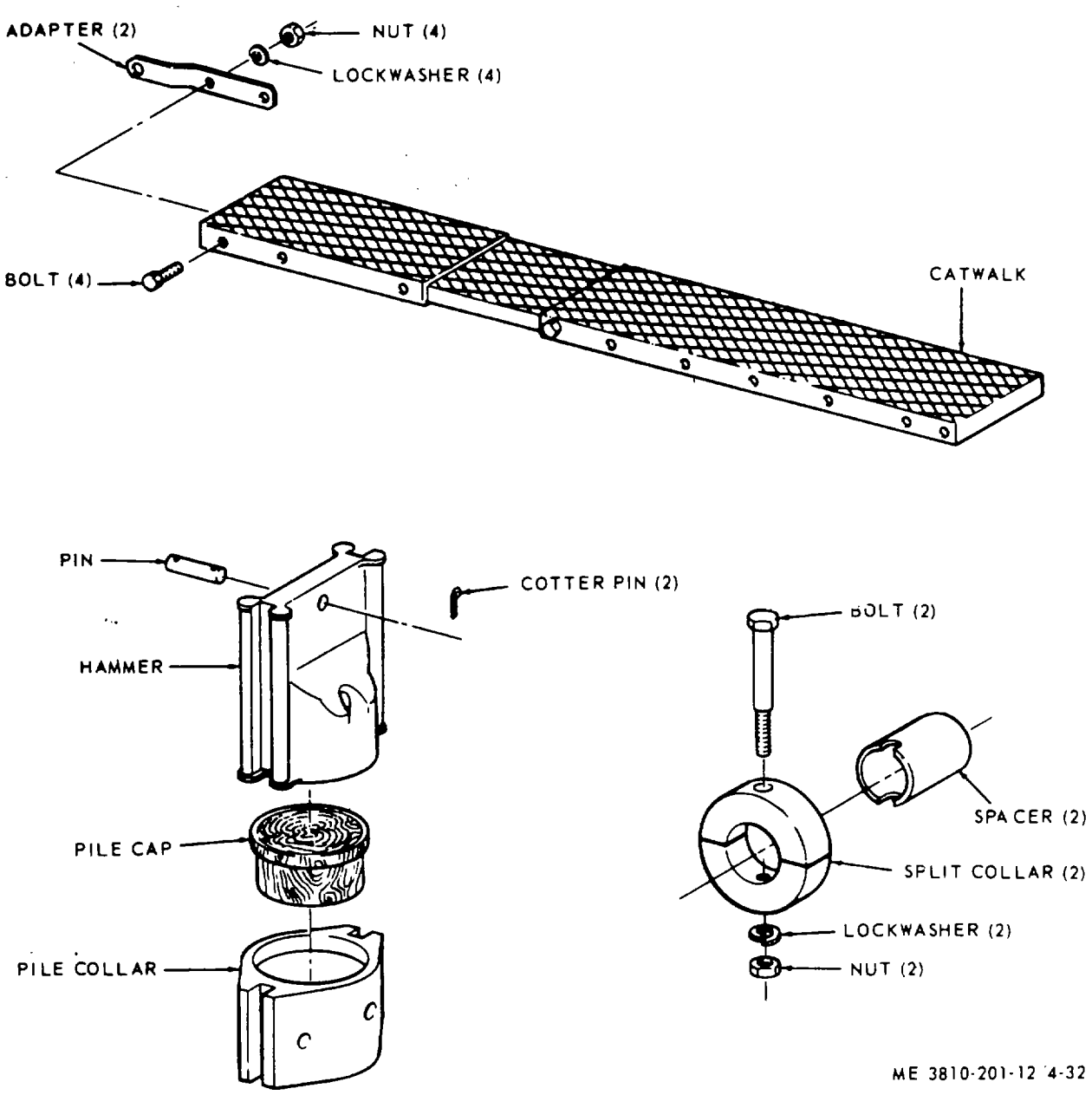

Figure 4-32. Pile lead attaching hardware.

boom until leads are over hammer, then install hammer cable to pin (fig. 4-32).

(2) Lift hammer up into pile leads, making sure guides of hammer engage pile guides.

(3) Position pile leads over pile cap and collar, lower hammer to rest on cap, then place two collar cable loops over hooks on hammer.

b. Removal

(1) Lower hammer to ground, lift two collar cable loops off hooks on hammer and leave collar and cap on ground.

(2) Raise hammer and pile leads clear of cap and collar, swing it to one side, lower hammer to ground, then disconnect hammer cable from pin and remove hammer by raising pile leads and swinging them aside.

4-37. Catwalk and Adapters

a. Installation.

(1) Install two adapters (fig. 4-34) on end of catwalk, and secure each with two capscrews, lockwashers, and nuts.

(2) Position adapters and connect to revolving frame, then extend the telescoping catwalk toward pile lead and install two capscrews. Secure with lockwashers and nuts.

b. Removal

(1) Remove two nuts, lockwashers, and capscrews securing catwalk to pile lead (fig. 2-14).

Telescope catwalk to its shortest length, then disconnect adapters from revolving frame.

(2) Remove four nuts, lockwashers and capscrews (fig, 4-32), then remove two adapters from catwalk.

Section V. ACCESSORIES

4-38. General

The accessory items installed on crane-shovel units include horn and extension (trouble) light.

This section will describe organizational maintenance responsibilities for these items.

4-39. Horn

a. Removal.

(1) Tag and disconnect two electrical leads (fig. 4-33).

(2) Remove two nuts, lockwashers, clamp, and screws that secures horn to underside of revolving frame and remove horn.

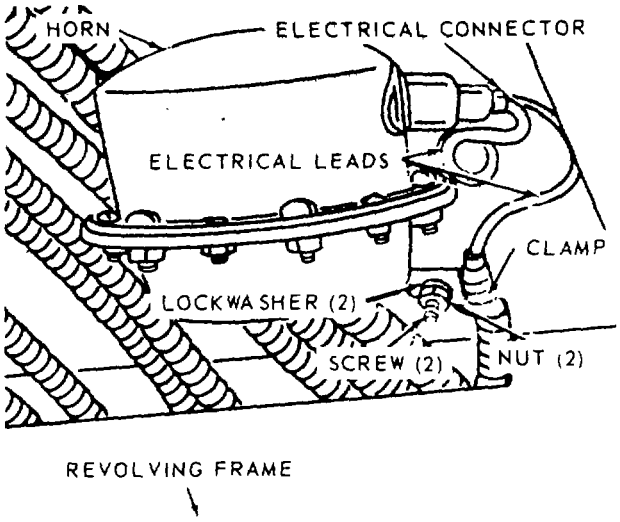

Figure 4-33. Horn, removal and installation.

b. Cleaning, Inspection and Repair.

(1) Clean all parts with an approved cleaning solvent and dry thoroughly.

(2) Visually inspect horn and mounting hardware for damage or defect. Inspect electrical leads for defective insulation or connectors.

Test leads and horn for continuity.

(3) Replace defective horn, lead, or mounting hardware.

c. Installation.

(1) Position horn on revolving frame (fig. 4-33), install two screws, clamp, lockwashers, and secure with two nuts.

(2) Install two electrical leads as tagged and remove tags. Insure that ample electrical connector plugs are well seated in the female half.

Figure 4-33. Horn, removal and installation.

4-40. Extension (Trouble) Light

The trouble light hangs in cab ready for installation of quick connector plug into trouble light socket (fig. 2-24) on lighting control panel.

Length of light cord allows use of light at any place inside cab enclosure.

CHAPTER 5

SHIPMENT AND LIMITED STORAGE, AND DEMOLITION TO PREVENT ENEMY USE

Section I. SHIPMENT AND LIMITED STORAGE

5-1. General

When mobile equipment is being transported from place to place in the zone of interior, other than by it's own locomotion, it is considered as being in administrative storage during the period of shipment. Administrative storage is defined as limited storage, a storage period of up to 90 days, when equipment must be preserved from deterioration caused by the elements.

5-2. Preparation for Limited Storage

Refer to TM 740-90-1, Administrative Storage of Equipment, for detailed instructions on preparation of the crane-shovel basic unit for administrative storage and maintenance during storage.

5-3. Loading Crane-Shovel for Shipment

a. Rail Shipment. Blocking, bracing, and tiedown of the crane and attachments shall be in accordance with Section No. 1 (General Rules) and applicable figure(s) in Section 4 of the Association of American Railroads, "Rules Governing the Loading of Commodities on Open Top Car."

b. Anti-Rotation Rods and Crane Cab (Swing) Lock. Secure the crane cab (swing) lock in the locked position to prevent displacement. The anti-rotation rods shall be installed (fig. 2-20 and 2-21) and positive means provided to prevent nuts from working loose.

c. Movement to New Worksite. Instructions covering move to new worksite are provided in paragraph 2-5.

Section II. DEMOLITION OF MATERIAL TO PREVENT ENEMY USE

5-4. General

When capture or abandonment of the crane-shovel is imminent, the responsible unit commander must make the decision either to destroy the equipment or render it inoperative. Based upon this decision, orders are issued which cover the desired extent of destruction. Whatever method of destruction is employed, -it is essential to destroy the same vital parts of all crane-shovel units and all corresponding spare parts in the critical area. When lack of time or personnel prevents complete destruction of the crane-shovel, the following priority will be used in destruction of essential parts:

Priority	*Part*
1	Engine clutch and drive sprocket, jackshaft drive sprocket, drive pinion, gears, drum clutches, swing clutches, and boom hoist mechanism.
2	Engine block, head, fuel injectors, and all control mechanisms.
3	Machinery side frame castings.
4	Boom foot connections.
5	Shovel attachment, backhoe attachment, piledriver, crane and jib booms.
6	Clamshell and dragline buckets.
7	Gantry.
8	Hook rollers and roller circle.
9	Cables (all).
10	Propelling gear, sprockets, crawler sprockets, and treads.

5-5. Demolition to Render Crane-Shovel Inoperative

a. Demolition by Mechanical Means. Use sledge hammers, crowbars, picks, axes, cutting, or any other tools which may be available to demolish items in the priority established in paragraph 5-4 above.

b. Demolition by Misuse.

(1) Drain engine radiator and crankcase.

(2) Throw sand or other abrasive material into engine clutch main drive chain case, jackshaft bevel gear case, horizontal gear train, and propelling shaft oil pan.

(3) Start engine and engage clutch.

(4) Operate the front end attachment forci

bly into a bank or tree, or another object, to damage boom and break cables.

(5) Drop bolts, nuts, and tools into gear trains.

(6) Operate unit until failure occurs.

5-6. Demolition by Explosives or Weapons Fire

a. Demolition by Explosives. Place as many of the following charges as the situation permits, and detonate them simultaneously with detonating cord and a suitable detonator.

(1) One 4-pound charge on engine drive sprocket and jackshaft sprocket.

(2) One 4pound charge against the main clutch and machinery side frame castings at each end of main drum shaft.

(3) One 4-pound charge against boom hoist mechanism.

(4) One 2-pound charge against each of the swing clutches on the jackshaft.

(5) One 4-pound charge in the jackshaft bevel gear case.

(6) One 4-pound charge on top of the vertical propelling shaft.

(7) One 2-pound charge between starter and engine.

(8) One 4-pound charge at each of the boom hinges.

(9) One 4-pound charge against each of the hook rollers.

(10) One 4-pound charge against side of engine.

Note.

The above charges are considered minimum requirements for this method.

(11) One 8-pound charge on shipper shaft of shovel boom.

(12) One 8-pound charge on dipper handle-bucket connection.

(13) One 1-pound charge on each of boom hoist sheaves.

(14) One 8-pound charge at bucket-dipper stick connection of backhoe attachment.

(15) One 4-pound charge at stick point, and another at stick pivot of backhoe attachment.

(16) One 6-pound charge against auxiliary gantry of backhoe attachment.

(17) One 1-pound charge against each corner angle at midpoint of crane boom.

(18) One 6-pound charge at boom point sheaves on crane.

(19) One 4-pound charge at dragline pins and a 2-pound charge at hoist line pins of dragline bucket.

(20) One 4-pound charge on upper closing sheaves and one 4pound charge at lower closing sheaves and hinges of clamshell bucket.

(21) Three 4-pound charges along piledriver leads.

(22) One 6-pound charge in propelling gear oil pan.

(23) One 4-pound charge on each of the crawler tracks at crawler drive sprocket.

(24) One 4pound charge on each chain drive sprockets on end of horizontal propelling shaft.

b. Demolition by Weapons Fire. Fire on craneshovel unit with the heaviest weapon available.

5-7. Other Demolition Methods

a. By Scattering and concealment. Remove all easily accessible vital parts, such as fuel injectors, hydraulic lines, control levers, brake and clutch cylinders, starting motor, and hook rollers. Scatter these parts through dense foliage; bury them in dirt or sand, or throw them in lake, stream, well, or other body of water.

b. Burning. Pack rags, clothing or canvas under and around unit, particularly around engine, clutches, brakes, and fuel tanks saturate this packing with gasoline, oil or diesel fuel and ignite it.

c. Submersion. Totally submerge the craneshovel unit in a body of deep water to provide water damage and concealment. (Salt water does most damage to metal parts).

5-8. Training

All operator's should receive thorough training in methods of destroying the crane-shovel unit. Refer to FM 5-25. Simulated destruction, using methods listed above, should be included in operator training programs. It must be emphasized in training that demolition operations are only necessitated by critical situations, when time available for destruction is limited. For this reason, it is necessary that operators be thoroughly familiar with all methods of destruction and be able to perform demolition without refering to this or any other manual.

APPENDIX A

REFERENCES

A-1. Fire Protection

TB 5-4200-200-10	Hand Portable Fire Extinguishers for Army Users

A-2. Lubrication

C9100-IL L0 5-3810-206-12-1-2-3-4-5	Fuels, Lubricants, Oils and Waxes Lubrication Order

A-3. Painting

TM 9-213	Painting Instructions for Field Use

A-4. Radio Suppression

TM 11-483	Radio Interference Suppression

A-5. Maintenance

TM 38-750	Army Equipment Record Procedure
TB ORD 651	Use of Antifreeze Solutions and Cleaning Compounds in Engine Cooling Systems
TM 5-3810-206-20P	Organizational Maintenance Repair Parts and Special Tools Lists
TM 9-61 40-200-15	Operation and Organizational, Field and Depot Maintenance Storage Batteries, Lead/Acid Type
TB 385-101	Safety Use of Cranes, Crane-Shovel Dragline, and Similar Equipment Near Electric Power Lines

A-6. Shipment and Storage

TM 740-90-1	Administrative Storage of Equipment

APPENDIX B

BASIC ISSUE ITEMS LIST

Section I. INTRODUCTION

B-1. Scope

This appendix lists items which accompany the crane-shovel basis unit or are required for installation, operation, or operator's maintenance.

B-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 crane-shovel basic unit 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.

B-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), Column (1):

Note.

Common hardware items known to be readily available in Army supply will be assigned Maintenance Codes only. Source Codes, Recoverability Codes, and Quantity Authorized will not be assigned this category of items.

(1) Source code, indicates the selection status and source for the listed item. Source codes are:

Code	*Explanation*
P	Applied to repair parts which are stocked in or supplied from GSA/DSA or Army supply system, and authorized for use at indicated maintenance categories.

(2) Maintenance code, indicates the lowest category of maintenance authorized to install the listed item. The maintenance level code is:

Code	*Explanation*
R	Applied to repair parts and assemblies which are economically repairable at DSU and GSU activities and are normally furnished by supply on an exchange basis.
S	Applied to 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	Applied to 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	Applied to repair parts specifically selected for salvage by reclamation units because of precious metal content, critical materials, or high dollar value reusable casings or castings.

(3) Recoverability code, indicates whether unserviceable items should be returned for recovery or salvage. Items not coded are expendable. Recoverability codes are:

b. Federal Stock Number, Column (2). This column indicates the Federal stock number assigned to the item and will be used for requisitioning purposes.

c. Description, Column (3). This column indicates the Federal item name and any additional description of the item required. The abbreviation “w/e", when used as a part of the nomenclature, indicates the Federal stock number includes all armament, equipment, accessories, and repair parts issued with the item. A part number or other reference number is followed by the applicable five-digit Federal supply code for manufacturers in parenthesis. The physical security classification of the item is indicated by the parenthetical entry repair parts quantities included in kits, sets, and assemblies are shown in front of the repair part name.

d. Unit of Measure (u/m), Column (4). 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 Column (5).

This column indicates the quantity of the item used in the functional group or the assembly

group. A "V" appearing in this column in lieu of a quantity indicates that a definite quanity cannot be indicated (e.g. shims, spacers, etc).

f. Quantity Furnished with Equipment, Column (6). This column indicates the quantity of an item furnished with the equipment.

g. Illustration, Column (7). This column is divided as follows:

(1) Figure Number, Column (7) (a). Indicates the figure number of the illustration in which the item is shown.

(2) Item Number, Column (7) (b). Indicates the callout number used to reference the item in the illustration.

B-4. Explanation of Column in the Tabular List of Maintenance and Operating Supplies-Section III

a. Component Application, Column (1) . This column identifies the component application of each maintenance or operating supply item.

b. Federal Stock Number, Column (2). This column indicates the Federal stock number assigned to the item and will be used for requisitioning purposes.

c. Description, Column (8). This column indicates the item name and brief description.

d. Quantity Required for Initial Operation, Column (4). 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, Column (5). This column indicates the estimated quantity required for an average 8 hours of operation.

f. Notes, Column (6). This column indicates informative notes keyed to data appearing in a preceding column.

B-5. Federal Supply Code for Manufacturers

Code	Manufacture
27315.....	Harnischfeger Corporation, 4400 W. National Ave., Milwaukee, Wisconsin 53246

Section II. BASIC ISSUE ITEMS

(1) SMR Code	(2) Federal Stock Number	(3) Description Reference Number & Mfr. Code / Usable On Code	(4) Unit of meas	(5) Qty inc in unit	(6) Qty furn with equip	(7) Illustration (A) Fig No.	(7) Illustration (B) Item No.
		GROUP 31-BASIC ISSUE ITEMS, MANUFACTURER INSTALLED 3100-BASIC ISSUE ITEMS MANUFACTURER OR DEPOT INSTALLED					
PC	7510-889-3494	BINDER, LOOSELEAF: U. S. Army Equipment Log Book	EA		1		
PC	2590-045-9611	CASE ASSEMBLY, RIFLE	EA		1		
PC	7520-559-9618	CASE: operation and maintenance publications, water repellant, mildew resistant, MIL-B-11743B	EA		1		
		DEPARTMENT OF THE ARMY LUBRICATION ORDER LO 5-3810-206-12-1	EA		1		
		LO 5-3810--206-12-2	EA		1		
		LO 5-3810--206-12-3	EA		1		
		LO 5-3810-206-12-4	EA		1		
		LO 5-3810-206-12-5	EA		1		
		DEPARTMENT OF THE ARMY OPERATOR AND ORGANIZATIONAL MAINTENANCE MANUAL TM 5-3810206-12	EA		1		
		DEPARTMENT OF THE ARMY ORGANIZATIONAL MAINTENANCE REPAIR PARTS AND SPECIAL TOOLS LISTS TM 5-3810--206-20P	EA		1		
PC	4210-889--2221	EXTINGUISHER, FIRE DIRY CHEMICAL: hand type, 2/2 lb. Stored pressure 1 wall bracket	EA		1		
PC	5120-690-7948	PULLER, MECHANICAL: 92172 (27315)	EA		1		

(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 (1)		LUBRICATING OIL, ENGINE: 55 gal drum 18 gage, as follows:	4 1/2 (1)	(3)	(1) Included in quantity required to fill system as follows:
	9150-680-1105 (2)	HDO-10	62 ½ qt (1)	(3)	32 qts Crankcase
	9150-680-1104 (2)	HDO-30	62 ½ qt (1)	(3)	2 qts Oil filters
	9150-242-7604 (2)	OES	62 ½ qt (1)	(3)	4 1/2 Air Cleaner
		WATER	36 qt		8 qts Air Cleaner
COOLING SYSTEM		ANTIFREEZE: Ethylene glycol	(4)		16 qts Tagline Winder
		ANTIFREEZE: Compound arctic	(4)		(2) See C9100-IL for additional data and for requisitioning procedures.
CRANKCASE (1)	9150-234-5199 (2)	LUBRICATING OIL, ENGINE: (1) (same as item 1 above)	32 qt (1)	(3)	(3) See current LO for grade application and replenishment intervals.
EXPOSED GEAR CHAINS	9150-234-5199 (2)	LUBRICATING OIL, CHAIN-WIRE ROPE EXPOSED GEAR: 5-lb can, CW-11, B type 11	5 lb	4 lb (3)	(4) See TB ORD 651 for quantities, CW-11, B ambient temperatures specific gravities and replenishment data.
FUEL TANK		FUEL OIL, DIESEL: Bulk as follows:	90 gal (5)	60 gal (6)	(5) Tank capacity.
	9140-286-5294 (2)	Regular grade (DF-2)			(6) Average fuel consumption is 7 1/2 gal per hour of continuous operation.
GREASE POINTS	9150-190-0907 (2)	GREASE, AUTOMOTIVE AND ARTIL- 35-lb pail, Type GAA	10 lb	8 lb (3)	(7) Includes ½ qt in swing brake master S''' cylinder and 1t it in dipper trip master cylinder.
HYDRAULIC SYSTEM		BRAKE FLUID, AUTOMOTIVE: Non-mineral oil, 1 gal cans			(8) Includes 20 qts in jackshaft gear case and 12 qts in propel shaft gear case.
	9150252-6375	Type HBA	13 pts (7)	(3)	(9) Quantity required is determined by number or times engine is shut down, and low temperatures.
STARTING AID	2910-646-9727	Tank, fuel, cold starting aid (61112) LP535	1 ea	(9)	
TRANSMISSION		LUBRICATING OIL, GEAR: 6 gal drums as follows:			
	9150-577-5841	GO-80	10 gal (8)	(3)	
	9150-577-5844 (2)	GO-90	10 gal (8)	(3)	
	9150-257-5440 (2)	GOS	10 gal (8)	(3)	

APPENDIX C

MAINTENANCE ALLOCATION CHART

Section I. INTRODUCTION

C-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 lists the special tools and test equipment required for each maintenance function as referenced from Section II.

d. Section IV contains supplemental instructions, explanatory notes and/or illustrations required for a particular maintenance function.

C-2. Explanation of Columns in Section 11

a. Group Number, Column (1). The functional group is a numerical group set up on a functional basis. The applicable functional grouping indexes (obtained from TB 750-931, Functional Grouping (;odes) are listed on the MAC in the appropriate numerical sequence. These indexes are normally set up in accordance with their function and proximity to each other.

b. Functional Group, Column (2). This column contains a brief description of the components of each functional 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, to paint, and to add fuel, lubricants, cooling agents, and air.

D Adjust: To rectify to the extent necessary to bring into proper operating ranges specific maintenance function the item is to be used with. The letter is representative of columns A through K on the MAC.

E Aline: 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 measurement. Consists of the 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 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 assemblies, subassemblies, or parts.

I Repair: To restore an item 1 to serviceable condition.
This includes but is not limited to, inspection, cleaning, preserving, adjusting, replacing, welding, riveting, and strengthening.

J Overhaul: To restore an item to a completely serviceable condition as prescribed by maintenance serviceability standards using the Inspect and Repair Only as Necessary (IROAN) technique.

K Rebuild: To restore all item to a standard as nearly as possible to original or new condition in appearance, performance, arid life expectancy. This is accomplished through complete disassembly of the item, inspection of all parts or components, repair or replacement of worn or unserviceable elements (items) using original manufacturing tolerances and specifications, and subsequent reassembly of the item.

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.

C-3. Explanation of Columns in Section III

a. Reference Code. This column consists of a number and a letter separated by a dash. The number references the T&TE requirements column on the MAC. The letter represents the

specific maintenance function the item is to be used with. The letter is representative of columns A through K on the MAC.

b. Maintenance Category. This column shows the lowest level of maintenance authorized to use the special tool or test equipment.

c. Nomenclature. This column lists the name or identification of the tool or test equipment.

d. Tool Number. This column lists the manufacturer's code and part number, or Federal: Stock Number of tools and test equipment.

a. Reference Code. This column consists of two letters separated by a dash, both of which are references to Section II. The first letter references column 5 and the second letter references a main, tenance function, column 3, A through K.

b. Remarks. This column lists information pertinent to the-maintenance function being performed, as indicated on the MAC, Section II.

C-4-. Explanation of Columns in Section IV

Section II. MAINTENANCE ALLOCATION CHART

(1) GROUP NUMBER	(2) Functional Group	(3) Maintenance functions											(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		
01	ENGINE													
0100	Engine Assembly (687C-18-ES)	C	F	C				H	O	H	D			A
	Engine Assembly (D383TA)	C	F	C				F	O	H	D			
0101	Crankcase, Block Cylinder Head													
	Crankcase assembly	O						H	H				1,2,3, & 4	
	Head and valve assembly (D3S3TA)							H	F				5	
	Head and valve assembly (687C-18-ES)							H	H					
0102	Crankshaft													
	Cover assembly							F	F					
	Crankshaft assembly							H	D				6	B
	Damper assembly							F	F					
0103	Flywheel Assembly (D333TA)							.H	H					C
	Flywheel Assembly (687C-18ES)							F	F					
0104	Pistons, Connecting Rods .	H						H	H				7, 8	
0106	Valves, Camshaft, and Timing System													
	Arm assembly, rocker				O			F	F					
	Cover assembly, cam pocket							FF						
	Cover assembly, valve gear-	O						O						
	Camshaft assembly	H						H	H				10	
	Valves, seats (687C-18-ES)	H						H	H				9	D
	Valves, seats (D333TA)	F						F	F					
0106	Engine Lubrication System													
	Cooler, oil (DS38TA)	0						F						
	Filter assembly, oil			C				O	O					
	Pan, oil (687C-18-ES)							-H	H					
	Pan, oil (D338TA)							.F	H					
	Pump, oil	H						H	H					
	Strainer, oil pump-		H					H						
	Strainer, lube oil		C					O						
0108	Manifolds, exhaust	O						O						
0109	Accessory Driving Mechanisms (687C-18-ES)							H	H					
	Accessory Driving Mechanisms (D333TA)							FF						

Section II. MAINTENANCE ALLOCATION CHART

(1) GROUP NUMBER	(2) Functional Group	(3) Maintenance functions											(4) Tools and equipment	(5) Remarks
		A	B	C	D	E	F	G	H	I	J	K		
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL	REBUILD		
02	CLUTCH													
0200	Clutch Assembly	H		C	C				H	H				
0202	Clutch Release Mechanism													
	Cable, flexible control			C					O					
	Linkage; lever				O				O	O				
	Shaft; bearing; yoke	H							H					
03	FUEL SYSTEM													
0301	Fuel injector		F						O	F			11, 12	
0302	Fuel Pump,													
	Pump fuel injection		H			H			F	H			13, 14, 15, 16, 17, 18, 19, 20	
0304	Air Cleaner			C						O	O			
0305	Blower-Turbocharger													
	Blower assembly (687C 18-ES)								F	F				
	Manifold (687C-18-ES)	O							O					
	Manifold (D333TA)	O							F					
	Turbocharger (D333TA)								F	H			21, 22, 23, 24, 25	
0306	Tanks, Lines, Fittings													
	Cap, fuel tank	C							C					
	Tank, fuel	C		C					O	O				
0308	Engine speed Governor and Controls													
	Governor (D833TA)								F	H				
	Shaft assembly, governor drive								H	H				
0309	Fuel Filters			C					O	O				
0311	Engine Starting Aids								O	O				
0312	Accelerator, Throttle or Choke													
	Controls				O				O	O				
04	EXHAUST SYSTEM													
0401	Muffler and Pipes	O							O					
06	COOLING SYSTEM													
0501	Radiator													
	Cap, radiator		O						O					
	Guard	O							O					
	Radiator (D333TA)	C	O	C					O	F				
	Radiator (687C-18-ES)	C	F	C					F	F				
0502	Shroud		O						O	O				
0503	Water Manifold, Headers, Thermostat, and Housing Gasket		O						O					
0504	Water Pump								F	F			26	
0505	Fam Assembly													
	Belt, V drive	C			C				O					
	Fan Assembly	O							O					
	Support assembly (687C-18-ES)								O	F				
06	ELECTRICAL SYSTEM													
0601	Generator-Alternator													
	Alternator (D333TA)			O					O	F				
	Belt, V drive	C			C				O					
	Generator (687C-18-ES)		O						O	O	F			E
0602	Generator Regulator	O							O					
0602	Alternator Regulator		O		O				O					

Section II. MAINTENANCE ALLOCATION CHART

(1) GROUP NUMBER	(2) Functional Group	(3) Maintenance functions											(4) Tools and equipment	(5) Remarks
		A	B	C	D	E	F	G	H	I	J	K		
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL	REBUILD		
- 0603	Starting Motor													
	Cable assemblies								O	O				
	Starter		O	C						O	O	F		F
0606	Engine Safety Controls													
	Governor assembly, overspeed (687C-18-ES)								O	F				
	Switches								O					
	Wires								O	O	.			
0607	Instrument or Engine Control Panel													
	Control box: gages; switches; lights; indicator; panels; terminal boards	O	O							O				
	Lamps	C								C				
	Wiring									O	O			
0608	Miscellaneous items													
	Circuit breaker; light; junction boxes, receptacles	C								O				
	Lamps	C								C				
	Wiring									O	O			
0609	Lights													
	Floodlights and cab lights	C			C					O				
0611	Horn	O								O				
0612	Batteries		O	C						O				
0613	Chassis Wiring Harness									H	F			
0615	Radio Interference Suppression													
	Capacitors (687C-18-ES)		O							O				
	Lead, ground	O								O				
08	TRANSFER ASSEMBLY													
0801	Power Transfer Assembly	C		C						H	H			
0804	Lubrication Components													
	Breather, assembly			C						O				
13	TRACKS													
1302	Track Support Rollers and Brackets													
	Roller assembly, lower			C	C					F	F			
	Roller assembly, upper			C	C									
1303	Track idlers and Brackets													
	Shaft assembly, drive			C						F	F			
	Rod, spring				O					O				
1304	Track Drive Sprockets													
	Chain, drive				C					O	O			
	Shaft assembly, drive			C						F	F			
1305	Track Assembly				C					O	O			G
15	FRAME													
1501	Frame Assembly													
	Mud guard	O								O				
	Counterweights	O								O				
18	BODY, CAB, HOOD AND HULL													
1801	Body, Cab, Hood, Hull Assemblies													
	Brace: angle; lug; shackle	H								H				
	Cab assembly									H	O			
1806	Seats									O	O			
1808	Boxes, Carrying Cases	O								O				
22	BODY CHASSIS OR HULL, AND ACCESSORY ITEMS													
2202	Accessory items													
	Heater assembly, personnel			C							O	O		

Section II. MAINTENANCE ALLOCATION CHART

(1) GROUP NUMBER	(2) Functional Group	(3) Maintenance functions											(4) Tools and equipment	(5) Remarks
		A	B	C	D	E	F	G	H	I	J	K		
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL	REBUILD		
2210	Data Plates													
	Plate, data (C.O.E.)	F								F				
	Plate, instruction	O								O				
43	HYDRAULIC SYSTEMS													
4301	Strainers Filters, Hose, Pipe Fittings, Tubing									O	O			
4305	Mainfold and/or Control Valves									O	F			
4307	Hydraulic Cylinders									O	F			
4308	Liquid Tank			C						O				
4309	Manual Controls			C	O					O	O			
47	GAGES													
4701	Instruments			C						O				
74	CRANES, SHOVELS, AND EARTH MOVING EQUIPMENT COMPONENTS													
7410	Shovel Front Attachments													
	Bail assembly, dipper; sheave			C						O	F			
	Bar assembly, bridle; boom point assembly; shipper shaft assembly; tightener assembly, chain			C						F	F			
	Boom assembly, shovel			C						C	O			
	Chain, crowd				C					O	O			
	Lagging, sprockets, planetary pinion gear	O								O				
	Shell assembly, dipper; handle, dipper	C								O	F			
	Teeth, dipper	C								O	F			
7411	Crane Dragline or Clamshell Attachment			C						C	O			
7412	Back Hoe Attachment			C						C	O			
7413	Pile Driver Attachment			C						C	O			
7414	Base Deck													
	Frame Assembly, Crane			C						H	O			
	Rollers, hook			C	C					O	F			
	Rollers; pin (ratchet)			C						O				
7416	Shafts													
	Brake bands; and clutch shoes				C					H	F			
	Case assembly, chain			C						OF				
	Chains				O					O				
	Clutch assembly				C									
	Dipper trip assembly and cables	C		C	O					C	O			
	Guards; covers									O	O			
	Jackshaft assembly			C						H	H			
	Shaft assembly, drum and idler			C						H	H			
	Sproket, power take-off drive	O								O				
7419	Turntable													
	Brake band assembly			C	C					F	F			
	Drum	H								H				
	Swing lock assembly									O	O			
7420	Machinery Gear Case or Frame													
	Breathers			C						C				
	Pan assembly, oil			C						H	H			

Section II. MAINTENANCE ALLOCATION CHART

(1) GROUP NUMBER	(2) Functional Group	(3) Maintenance functions											(4) Tools and equipment	(5) Remarks
		A	B	C	D	E	F	G	H	I	J	K		
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL	REBUILD		
7421	Independent or Precision Boom Hoist													
	Brake bands, and clutch shoes				C				O	F				
	Drum, cable; spider assemblies			C					H	H				
	Planetary brake, holding pawl				C				O					
7422	Machinery Mechanism Controls			C	C				O	O				
7423	Gantry													
	Gantry								F	F				
	Spreader bar assembly; sheaves			C					O	F				
7424	Crawler Bed; Frame and Ring Gear													
	Frame and axle assembly			C	C				H	H				
7425	Propel and steering Mechanism													
	Brake band assembly			C	O				O	H				
	Shaft assemblies; gear assembly, steering			C	O				F	H				
7499	Cables	C							C					
76	FIRE EXTINGUISHERS													
7603	Extinguishers, fire	C							C					

Section III. SPECIAL TOOL AND SPECIAL TEST EQUIPMENT REQUIREMENTS

Reference code	Maintenance level	Nomenclature	Tool number
1-I	H	Puller	5120-417-2952
2-I	H	Plate (11083)	5F7362
3-I	H	Puller, Mechanical	5120-766-4747
4-I	H	Puller, Mechanical	5120-707-1266
5-I	H	Wrench (11083)	5F8353
6-H	H	Adapter	5120-316-9170
7-H	H	Expander (11083)	5F9059
8-H	H	Compressor (11083)	5F6502
9-H	H	Lifter, Valve Spring	5120-679-3416
10-H	H	Puller	5120-293-1430
11-I	F	Maintenance Fixture	4910-657-7429
12-I	F	Cleaning Tool Group	5120-423-9520
13-I	H	Tool Kit, Roosamaster; injector pump	5180-679-3417
14-I	H	Wrench: Box, halfmoon opening	5120-649-9184
15-I	H	Extractor	5120-861-4015
16-I	H	Wrench	5120-861-4014
17-I	H	Gage	4910-861-1344
18-I	H	Gage: Rack setting	5210-861-1345
19-I	H	Seal Tamping Tool	Fabricate
20-I	H	Seal tamping tool guide	Fabricate
21-I	H	Wrench	Fabricate
22-I	H	Fixture Adapter	Fabricate
23-I	H	Fixture	Fabricate
24-I	H	Ring Expander Sleeve	Fabricate
25-I	H	Spacer Block	Fabricate
26-I	F	Puller, Mechanical	5120-766-4748

Section IV. REMARKS

Reference code	Remarks
A—B	Test of engine includes operation and compression.
B--I.	Repair of Crankshaft includes metalizing, grinding, and alining
C--I	Repair of flywheel includes replacing ring gear.
D--I	Repair of valves and seats includes refacing.

Reference code	Remarks
E—I	Repair of generator includes brush replacement only.
F—I	Repair of starter includes brushes and solenoid replacement only.
G—I	Organizational repairs track by replacing trackshoes.

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 II, (qty rqr block No. 350) organizational maintenance requirements for Crane-Shovel, Crawlers, 40 Ton.

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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: 012229-004