

TM 10-3930-235-35

DEPARTMENT OF THE ARMY TECHNICAL MANUAL

DS, GS, AND DEPOT MAINTENANCE MANUAL

TRUCK, LIFT, FORK, GASOLINE 4,000 LB CAPACITY

TOWMOTOR MODELS

ARMY MODEL FSN

462SG4024-100 (SOLID TIRE)

MHE-191 3930-781-3856

462SG4024-144 (SOLID TIRE)

MHE-191 3930-781-3855

502PG4024-144 (PNEUMATIC TIRE) MHE-190 3930-073-9222

This copy is a reprint which includes current
pages from Changes 1 and 2.

HEADQUARTERS,

DEPARTMENT

OF

THE

ARMY

JANUARY 1965

CHANGE

NO. 3

HEADQUARTERS
DEPARTMENT OF THE ARMY
Washington D. C., 30 September 1991

**Direct Support, General Support, and Depot Maintenance Manual
TRUCK, LIFT, FORK, GASOLINE,
4,000-LB CAPACITY**

TOWMOTOR MODELS	ARMY MODEL	NSN
502PG4024-100 (PNEUMATIC TIRE)	MHE-190	3930-00-926-3607
502PG4024-144 (PNEUMATIC TIRE)	MHE-190	3930-00-073-9222
502PG4024-144 (PNEUMATIC TIRE)	MHE-190A	3930-01-044-0075
502PG4024-144 (PNEUMATIC TIRE)	MHE-190B	3930-01-089-8001
462SG4024-144 (SOLID TIRE)	MHE-191	3930-00-781-3855
462SG4024-100 (SOLID TIRE)	MHE-191	3930-00-781-3856
502PG4024-144 (PNEUMATIC TIRE)	MHE-220	3930-00-419-5738

TM 10-3930-235-35.5 January 1965, is changed as follows:

Page 2, the following paragraph is added after **Section II. "DESCRIPTION AND DATA."**

A decal has been developed that warns of NBC exposure. It is to be positioned in a noticeable place on or near the air cleaner or air filter housing. You may order the decal using part number 12296626, CAGEC 19207. Refer to TB 43-0219 for further information. Add the decal to the air cleaner (page 9, *Figure 1. 3/4 Front right side of engine. installed view*).

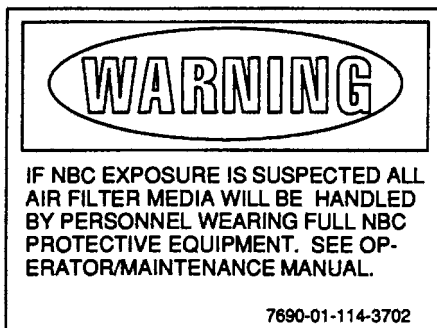
Add the following WARNING to the following locations;

inside front cover;

page 5, preceding the, "Troubleshooting Chart,"

page 14, preceding c. "Remove carburetor air cleaner (TM 10-3930-235-20);"

page 28, preceding j. "Install air cleaner (TM 10-3930-235-20);"



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.

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 in accordance with DA Form 12-25-E, block 3937, Direct and General Support maintenance requirements for TM 10-3930-235-35.

TM 10-3930-235-35

*C 2

CHANGE

No. 2

HEADQUARTERS
DEPARTMENT OF THE ARMY
Washington, D.C., 14 December 1989

**Direct Support, General Support, and Depot Maintenance Manual
TRUCK, LIFT, FORK, GASOLINE,
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TOWMOTOR MODELS	ARMY MODEL	NSN
502PG4024-100 (PNEUMATIC TIRE)	MHE-190	3930-00-926-3807
502PG4024-144 (PNEUMATIC TIRE)	MHE-190	3930-00-073-9222
502PG4024-144 (PNEUMATIC TIRE)	MHE-190A	3930-01-044-0075
502PG4024-144 (PNEUMATIC TIRE)	MHE-190B	3930-01-089-8001
462SG4024-144 (SOLID TIRE)	MHE-191	3930-00-781-3855
462SG4024-100 (SOLID TIRE)	MHE-191	3930-00-781-3856
502PG4024-144 (PNEUMATIC TIRE)	MHE-220	3930-00-419-5738

TM 10-3930-235-35, 5 January 1965 is changed as follows:

Cover. The manual title is changed to read as shown above.

Page 1.

The manual title is changed to read as shown above.

Table of Contents, Chapter 2. Delete the entries for "Section XI" and "Section XIV".

Page 2. Paragraph 1 is superseded as follows:

1. Scope

a. These instructions are published for use of personnel responsible for direct support, general support, and depot maintenance of the Towmotor forklift trucks.

b. 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.

c. If your forklift truck needs improvement, let us know. Send us an EIR. You, the user, are the only one who can tell us what you don't like about your equipment. Let us know why you don't like the design. Tell us why a procedure is hard to perform. Put it on an SF

368 (Quality Deficiency Report). Mail it to us at: Commander, U.S. Army Tank-Automotive Command, ATTN: AMSTA-QRD, Warren, MI 48397-5000. We'll send you a reply.

Paragraph 2. In the Note following paragraph 2, change "TM 10-3930-235-35P" to "TM 10-3930-235-34P".

Paragraph 3 is superseded as follows:

3. Maintenance Forms, Records, and Reports

Maintenance forms, records, and reports which are to be used by maintenance personnel at all maintenance levels are listed in and prescribed by DA Pam 738-750.

Page 4. Paragraph 6h is superseded as follows:

h. Hydraulic Lift.

Oil pressure (relief valve) 1950 psi

Mast column:

Outer to inner column clearance

(MHE-191, MHE-190,

MHE-190A, and MHE-190B) 0.015-0.025

(MHE-220) Free slide fit 0.045

Intermediate to inner column

clearance (MHE-220) Free slide fit 0.045

Mast carriage:

Thrust plate to narrowest sliding

width of inner column 0.020

* This change supersedes C 1, 27 June 1973.

Lifting speed (MHE-191, MHE-190,
MHE-190A, and MHE-190B) 85 feet per minute
(MHE-220) 60 feet per minute

Page 7, Column 3, last line. Change "(para. 55)" to
"(para. 55 or 55.1)".

Page 8.

Change all references to "(para. 55)" to "(para. 55
or 55.1)".

Change all references to "(para. 56)" to
"(para. 56.1)".

Paragraph 9b is superseded as follows:

b. Remove Engine and Transmission Assembly
(figs. 1 through 2.2).

Paragraph 9b(0.1) is added before para-
graph 9b(1).

(0.1) On models MHE-220, MHE-190A, and
MHE-190B, remove the air cleaner
(TM 10-3930-235-20).

Page 9. Change the title of figure 1 to read "3/4 front
right side of engine, installed view (models MHE-191
and MHE-190).".

Page 10.

Change the title of figure 2 to read "3/4 front left
side of engine, installed view (models MHE-191 and
MHE-190).".

Figures 2.1 and 2.2 are added as follows:

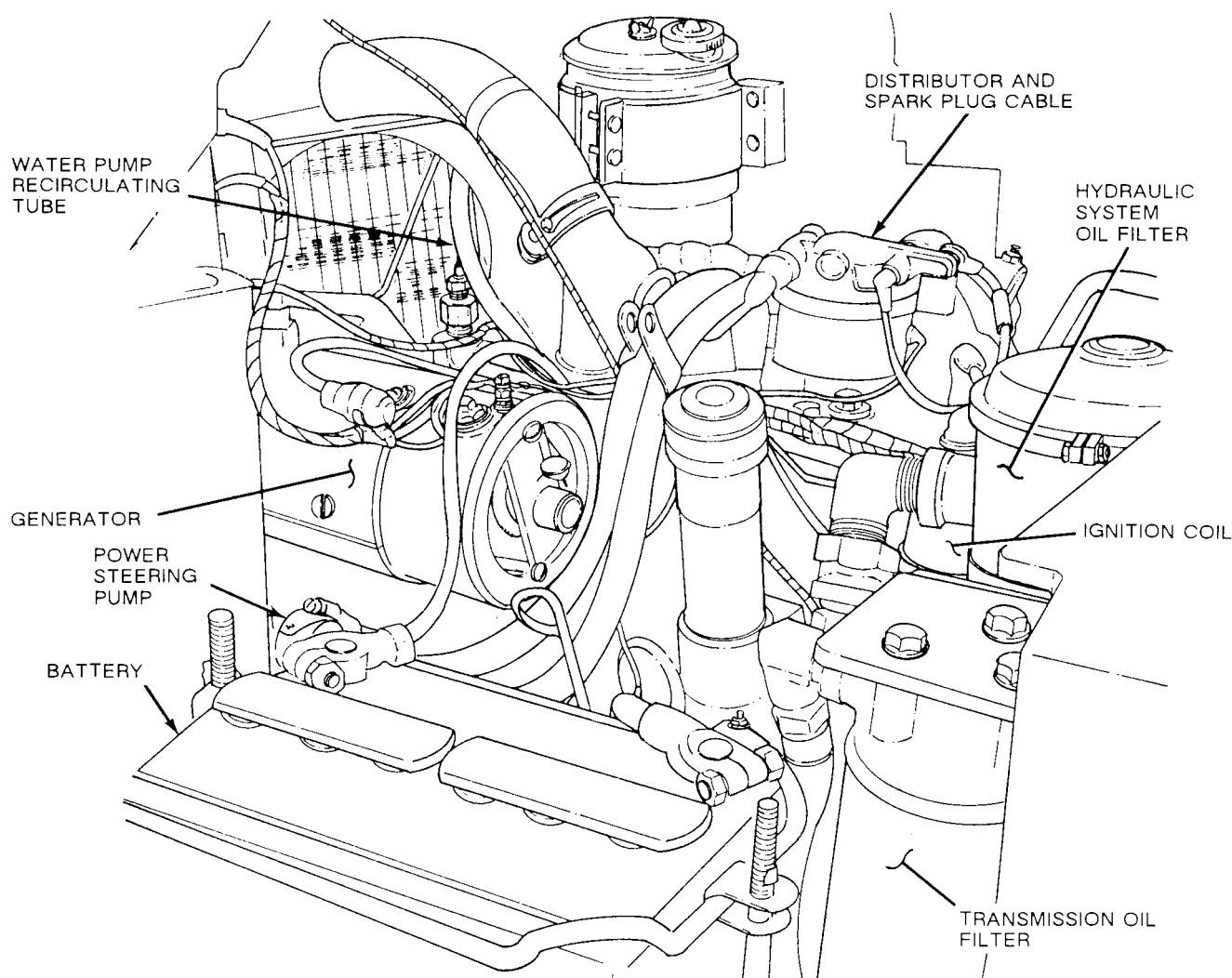
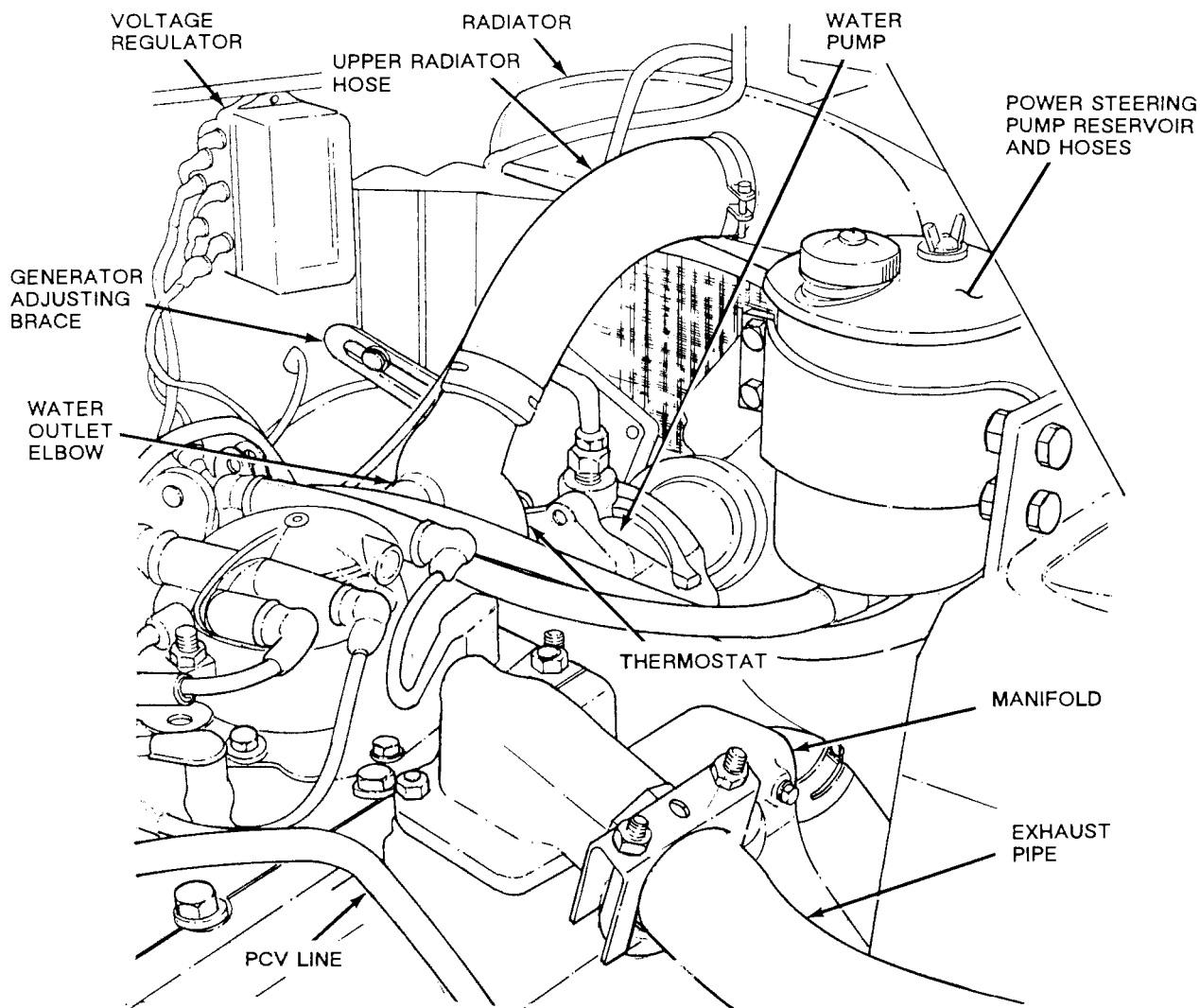


Figure 2.1. 3/4 front right side of engine, installed view (model MHE-220).

TA502055



TA502056

Figure 2.2. 3/4 front left side of engine, installed view (model MHE-220).

Page 11. Figure 3 is superseded as shown on the following page.

Page 13.

Paragraph 9e(16.1) is added after paragraph 9e(16).

(16.1) On models MHE-220, MHE-190A, and MHE-190B, install the air cleaner.

Paragraph 9e(17). Change "LO 10-3930-235-20" to "LO 10-3930-235-12".

Page 14. Paragraph 10c is superseded as follows:

c. On models MHE-191 and MHE-190, remove air cleaner (TM 10-3930-235-20).

Page 15.

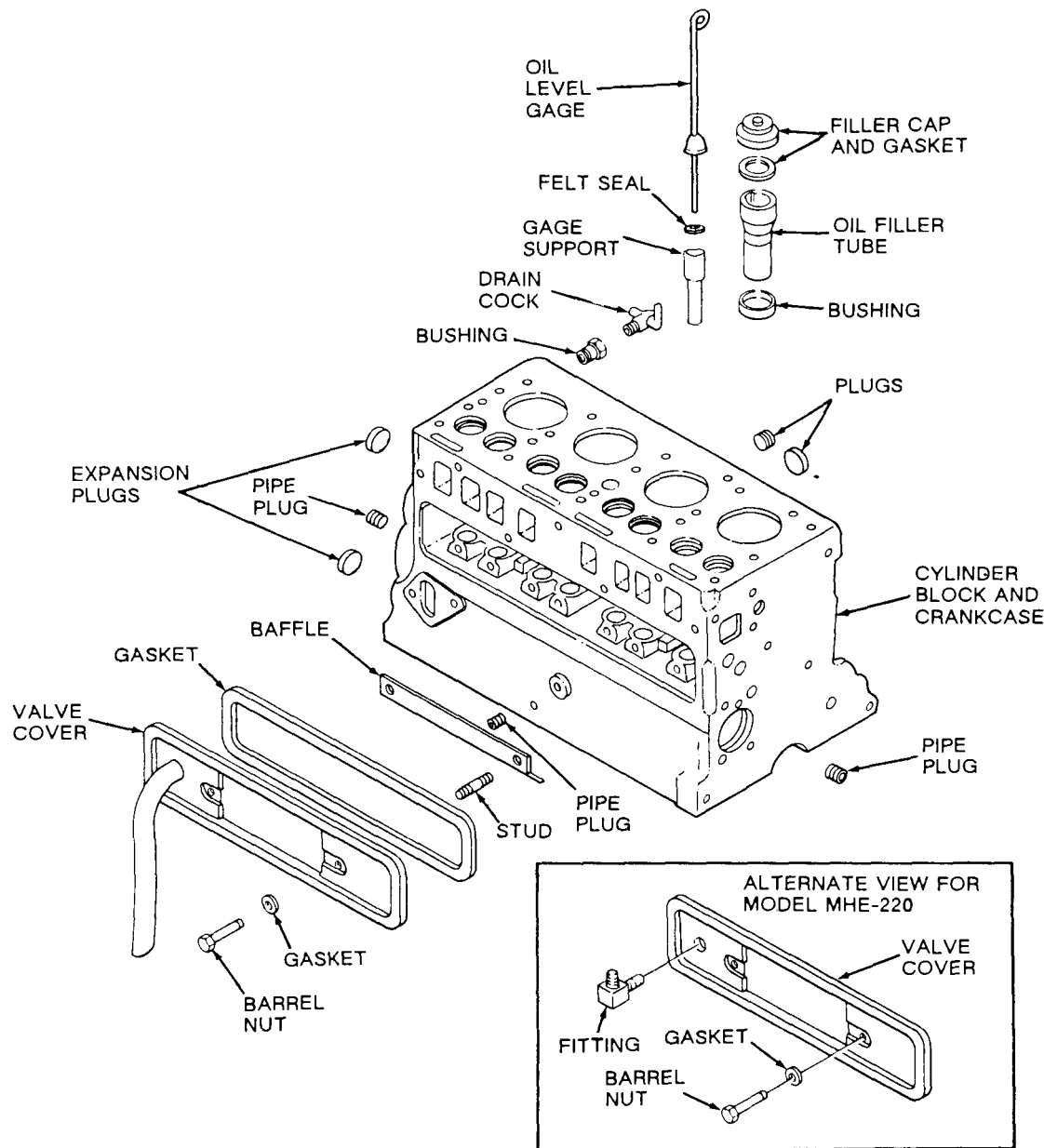
Paragraphs 10k and 10l are added after paragraph 10j.

k. Remove hydraulic oil filter. On model MHE-220, remove transmission oil filter.

l. On model MHE-220, remove the PCV line and valve.

Paragraph 11a is superseded as follows:

a. Disconnect oil filter inlet and outlet hoses at engine. Remove nuts, washers, and engine oil filter.



TA502069

Figure 3. Cylinder and crankcase, exploded view.

Page 21. Figure 16 is superseded as shown on the following page.

Page 24, paragraph 14. In the Note before paragraph 14a, change "TM 10-3930-235-35P" to "TM 10-3930-235-34P".

Page 28.

Paragraph 16u is added after paragraph 16t.

u. Install the engine oil filter and connect inlet and outlet hoses to the engine.

Paragraph 17g.1 is added after paragraph 17g.

g.1. On model MHE-220, install the PCV line and valve.

Paragraph 17j is superseded as follows:

j. On models MHE-191 and MHE-190, install the air cleaner (TM 10-3930-235-20).

Paragraph 17j.1 is added after paragraph 17j.

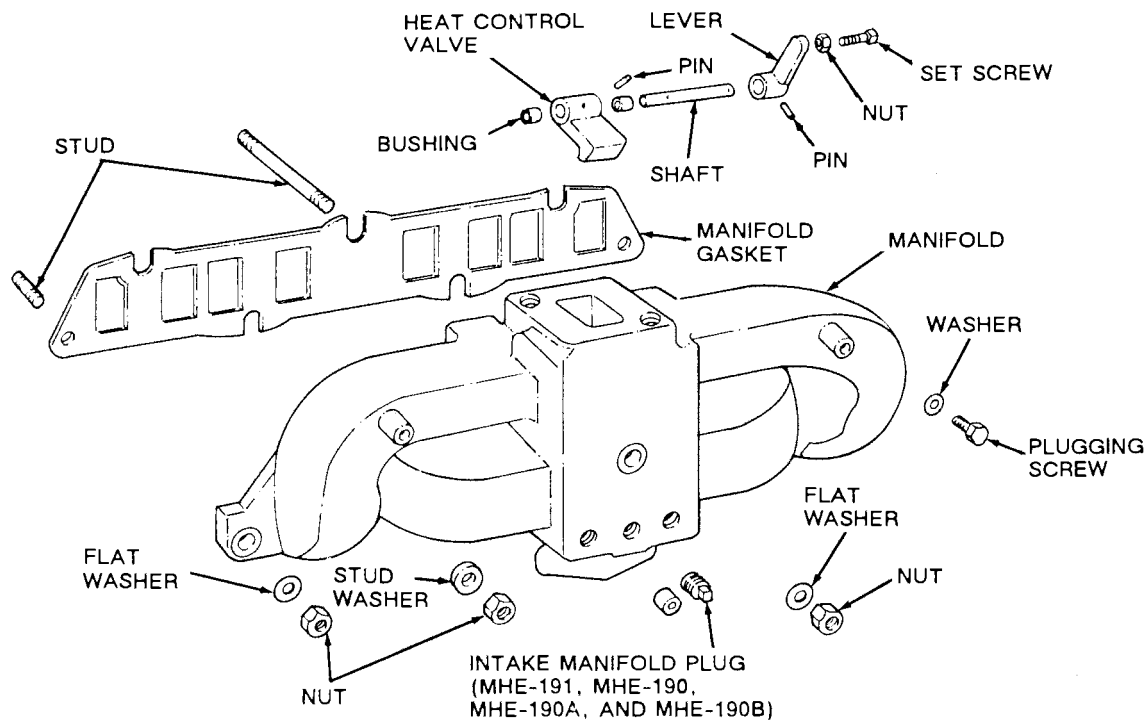
j.1. Install the hydraulic oil filter. On model MHE-220, install the transmission oil filter.

Page 29, paragraph 20h. Change the last sentence to read "Use oil specified in LO 10-3930-235-12."

Page 36. Paragraph 29.1 is added after paragraph 29.

29.1. Batteries

Repair. Refer to TM 9-6140-200-14.



TA502057

Figure 16. Manifold, exploded view.

Page 48. Paragraph 34 is rescinded.

Page 49. Figure 38 is superseded as shown on the following page.

Page 50. Figure 39 is rescinded.

Page 52, paragraph 36d(1). Change "(LO 10-3930-235-20)" to "(LO 10-3930-235-12)".

Page 53, paragraph 37b(1)(c). Change "(TM 10-3930-235-20)" to "(para. 37.1)".

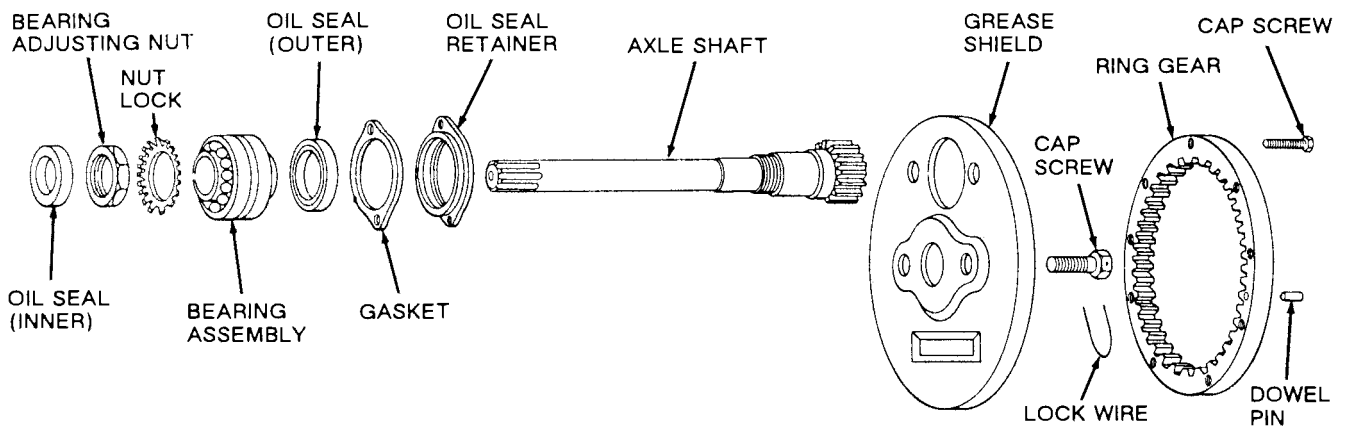
Page 56.

Paragraph 37.1 is added after paragraph 37.

37.1. Drive Axle Shaft

a. Removal.

- (1) Remove drive wheels (TM 10-3930-235-20).
- (2) Cut lock wire (fig. 44.1), then remove four capscrews and grease shield from axle housing.



TA502071

Figure 44.1. Drive axle shaft, exploded view.

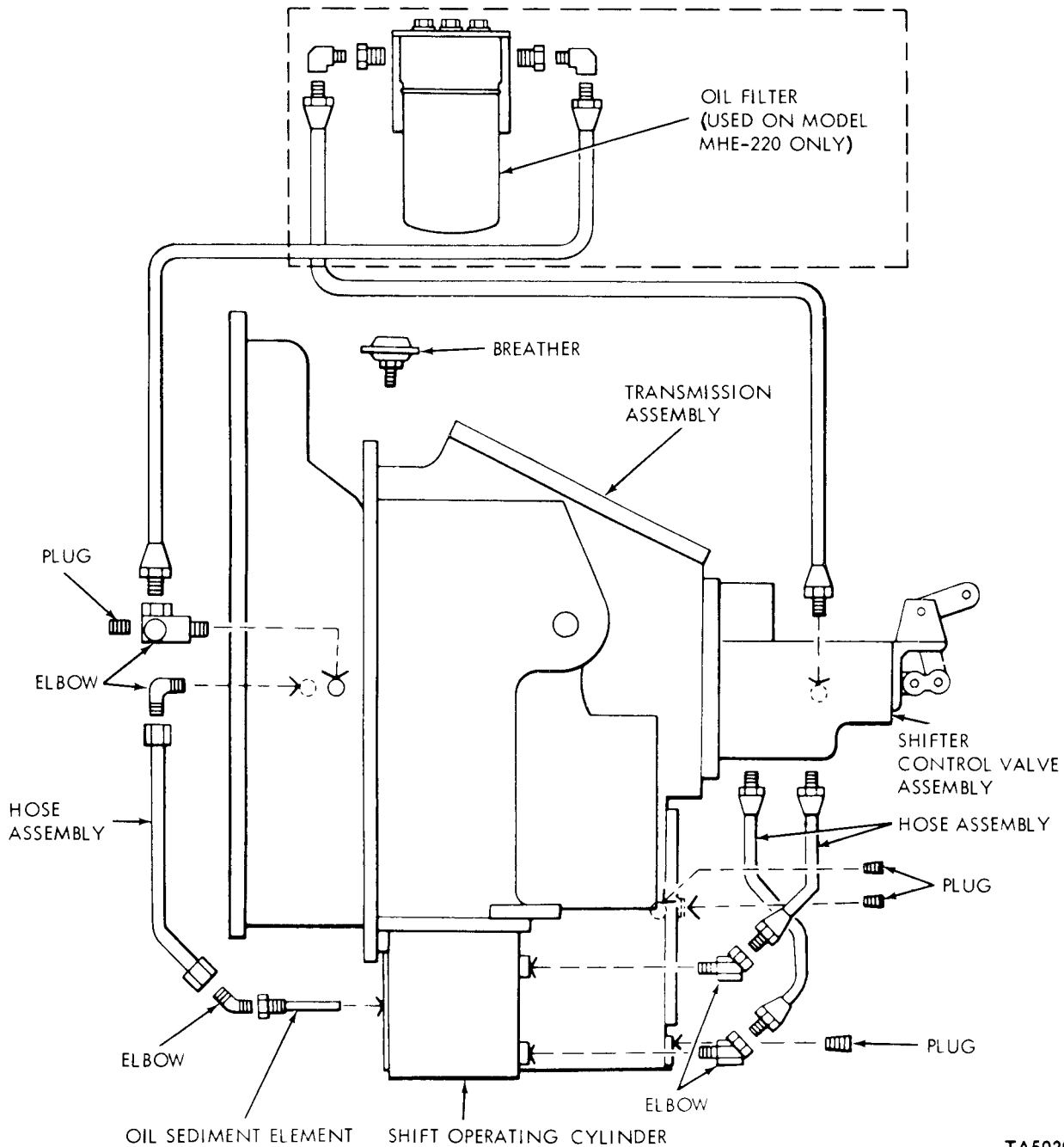


Figure 38. Converter lines and fittings.

TA502070

- (3) Pry out axle shaft and bearing assembly, and note the number of gaskets removed.
- (4) If necessary, remove inner oil seal from axle housing using a suitable puller.
- (5) Repeat the above procedures for other side of truck if necessary.

b. Disassembly.

- (1) Straighten ears of nut lock, then unscrew and remove bearing adjusting nut and lock.
- (2) Remove bearing assembly and oil seal retainer assembly.
- (3) If necessary, remove oil seal from retainer.

c. Inspection.

- (1) Inspect bearing cones and cup for scoring, nicks, or flat spots. If there is evidence of bearing cone or cup wear, the bearing assembly must be replaced as a complete assembly.
- (2) Inspect axle shaft for chipped or broken teeth or splines, and oil seal ring surfaces for scratched or scarred conditions.

d. Repair. If axle shaft oil seal bearing surfaces are scratched or scarred, remove scratches using a fine emery paper, then polish with emery cloth. If axle

shaft surface will not clean up to a fairly smooth finish, replace axle shaft.

e. Reassembly.

- (1) Reverse the procedures in *b* above.
- (2) Tighten bearing adjusting nut until axle shaft binds when turned, then back off nut one-sixth turn, or until axle shaft turns without binding.

f. Installation. Reverse the procedures in *a* above. If gaskets were damaged or lost, it will be necessary to measure the gap between the bearing retainer and the axle housing. Refer to *g* below for adjustment of axle shaft.

g. Adjustment of Axle Shaft. To determine the amount of gaskets required to fill the gap between the bearing retainer and the axle housing, install the axle shaft assembly in the axle housing without gaskets. Measure the clearance between bearing retainer and axle housing with a flat feeler gage. Select gasket thicknesses totaling 0.001 to 0.005 inch less than the measured gap dimension.

Paragraph 38a(3). Change "(para. 47)" to "(para. 48)".

Page 57. Change the title of paragraph 39 as follows:

39. Steering Axle (MHE-190, MHE-190A, MHE-190B, and MHE-220)

Page 58, figure 46. Change the title to read "Steering axle, exploded view (MHE-190, MHE-190A, MHE-190B, and MHE-220).".

Page 59. Section XI and figure 47 are rescinded.

Page 60. Figure 48 is rescinded.

Page 61. Figures 49 and 50 are rescinded.

Page 62.

Section XI.I, Wheels is added after Section XI.

Section XI.I. WHEELS

43.1. Solid Rubber Tires (MHE-191)

a. Removal. Remove tire/wheel assembly (TM 10-3930-230-20).

Note. Some wheel assemblies are tapered on one side to accommodate tire replacement. If the wheel is tapered, removal and installation must be done over the tapered end.

b. Disassembly. Using a suitable press, remove the solid rubber tire with rim from the wheel.

c. Inspection. Inspect wheels and tires for wear, elongated mounting holes, cracks, or separations. Replace any damaged components prior to reassembly.

d. Reassembly. Ensuring the tire and rim are square with the wheel, press the tire and rim onto the wheel until the metal base of the rim is flush with the edge of the wheel.

Paragraph 44a is superseded as follows:

a. Removal.

- (1) Disconnect oil lines and drain oil from reservoir.
- (2) Loosen angle to bracket nuts and bracket adjusting screw. Slide pump toward center of engine and disengage drive belt from pulley.
- (3) Remove nuts and washers fastening pump to mounting bracket. Remove pump.

Page 64.

Paragraph 44d is superseded as follows:

d. Reassembly and Installation. Reverse the procedures in *b* and *a* above, except use new oil seal, gaskets, and seal rings.

Paragraph 44d.1 is added after paragraph 44d.

d.1 Adjust. Refer to TM 10-3930-235-20.

Page 71. Section XIV is rescinded.

Page 75. Change the title of paragraph 55 as follows:

55. Lift Cylinder (MHE-191, MHE-190, MHE-190A, and MHE-190B)

Page 76. Change the title of figure 59 to read "Lift cylinder, exploded view (models MHE-191, MHE-190, MHE-190A, and MHE-190B).".

Page 78.

Paragraph 55.1 is added after paragraph 55.

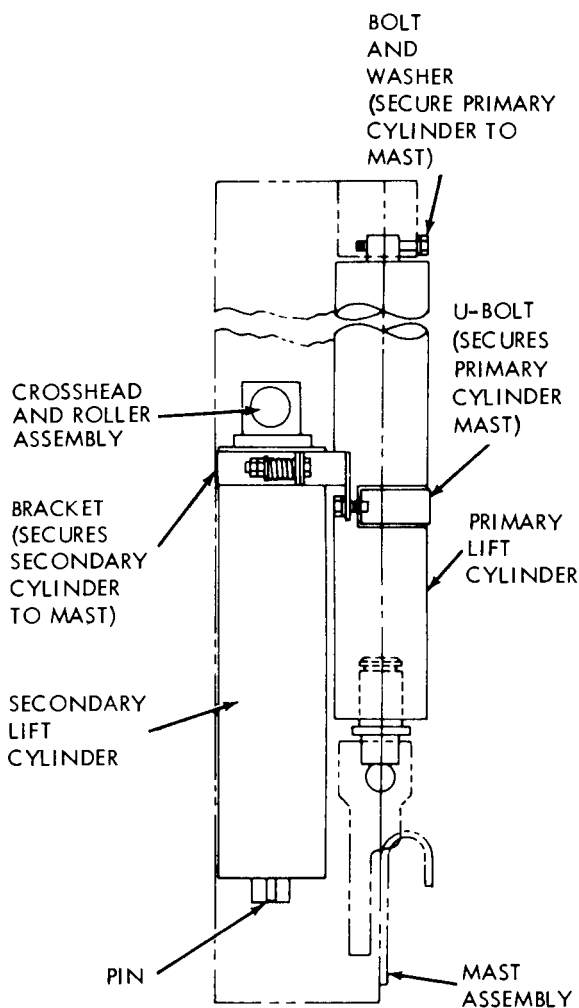
55.1. Lift Cylinders (MHE-220)

a. Inspection and Repair.

- (1) If oil is seeping past the packing boxes, tighten packing boxes.
- (2) Fully extend the mast. Check cylinder rods for scratches or scores. Remove damage using an India stone. If damage is excessive and the rods cannot be smoothed, replace the cylinder.

b. Removal.

- (1) Remove the forks.
- (2) Remove screws and washers, and lift off the backrest.
- (3) Raise the carriage until the mast inner column is lifted about 10 inches. Block carriage and inner slide in this position.
- (4) Remove the bolt and washer securing the primary lift cylinder to the mast (fig. 59.1). Lower the cylinder.
- (5) Disconnect hydraulic lines at the cylinders. Collect fluid in a suitable container. Cap or plug openings.
- (6) Disconnect chains and remove the crosshead and rollers from the secondary lift cylinder.



MEC 3930-235-35/59.1 C 1

Figure 59.1. Lift cylinders removal (MHE-220).

- (7) Remove the bracket and the secondary lift cylinder from the mast assembly.
- (8) Remove the U-bolt and the primary lift cylinder from the mast assembly.

c. Disassembly (fig. 59.2).

Note. These instructions apply to both primary and secondary lift cylinders.

- (1) Remove the lift cylinder packing boxes and rings.
- (2) Remove the rod assembly from the tube assembly.
- (3) Remove the retaining ring, piston, and seal from the rod assembly.
- (4) Remove the packing assembly from the piston.

d. Reassembly. Reverse the procedures in *c* above. Lubricate the tee rings before installing in the stuffing boxes.

e. Installation. Reverse the procedures in *b* above. Position the secondary lift cylinder so that the pin fits into the pin hole in mast.

Change the title of paragraph 56 as follows:

56. Mast Assembly (MHE-191, MHE-190, MHE-190A, and MHE-190B)

Paragraph 56.1 is added after paragraph 56.

56.1. Mast Assembly (MHE-220)

a. Removal (fig. 60.1).

- (1) Extend the mast fully. Remove four nuts and two bolts securing the mast hinge bracket to the frame. Two blocks will fall out. Lower the mast.
- (2) Disconnect hydraulic lines to the lift cylinders. Collect fluid in a suitable container. Cap or plug openings.

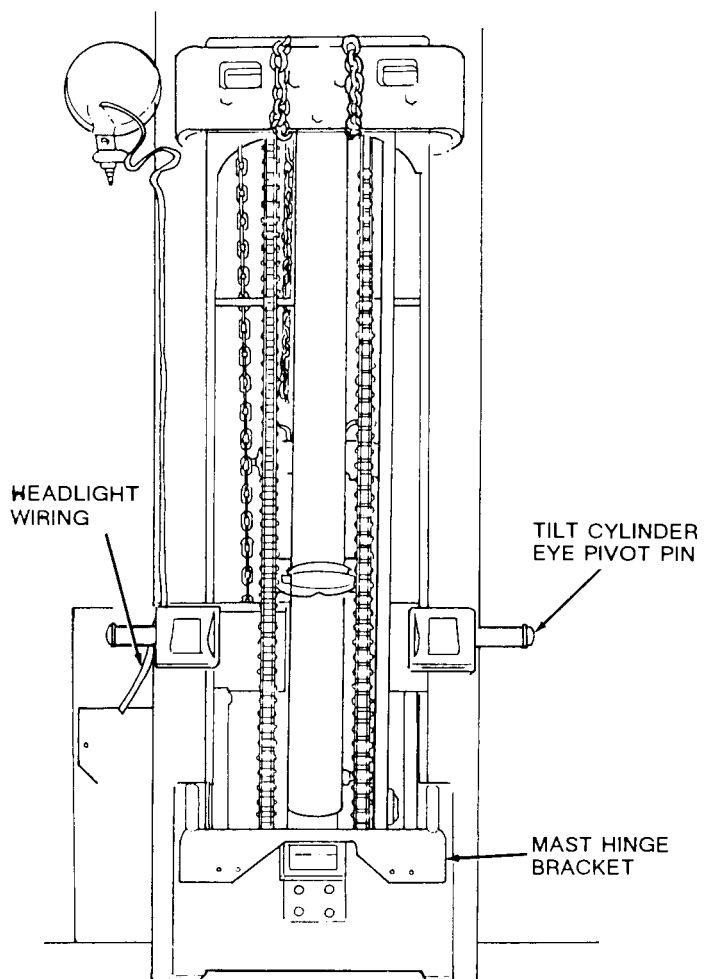


Figure 60.1. Mast assembly removal.

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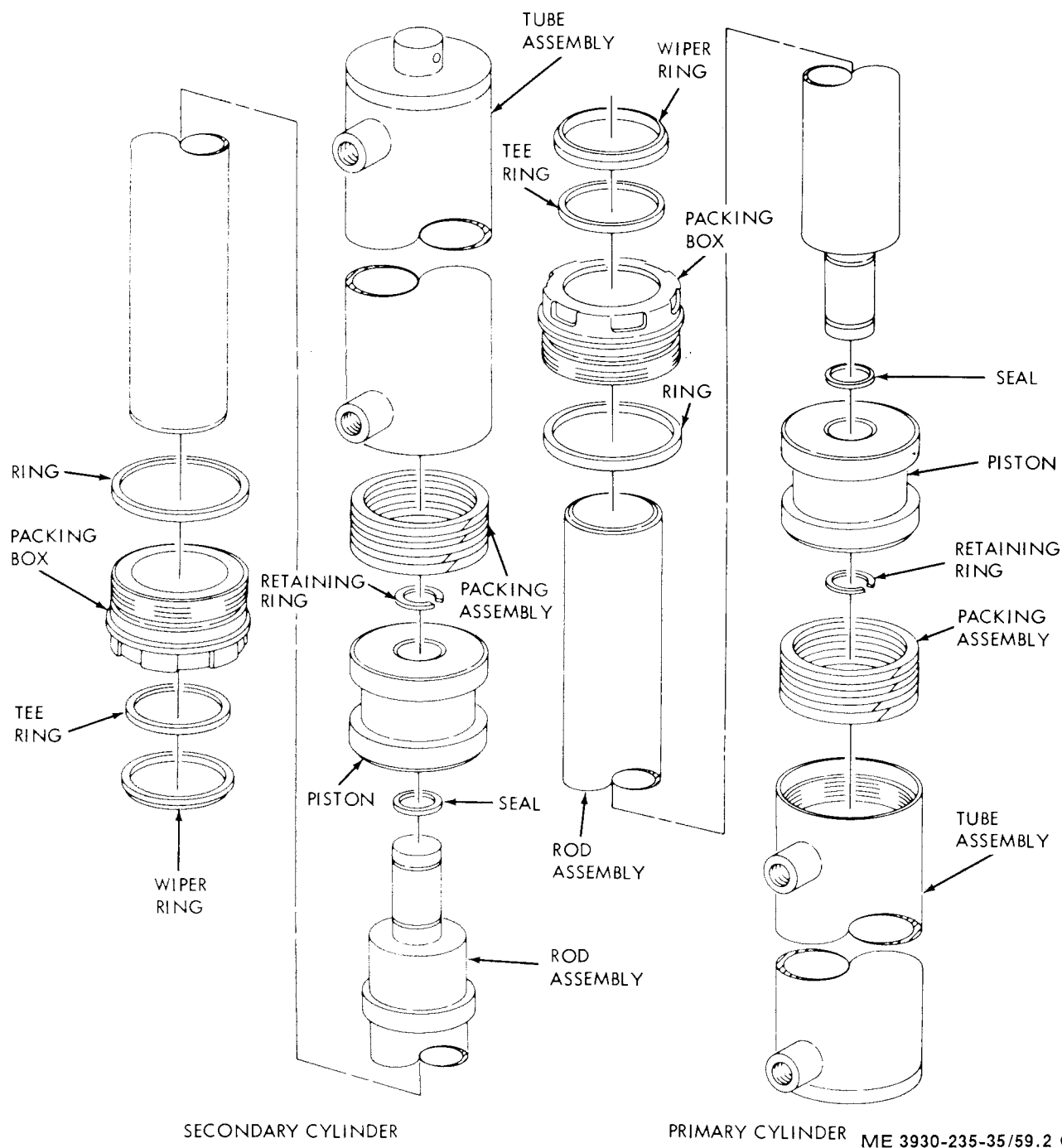


Figure 59.2. Lift cylinders, exploded view (MHE-220).

- (3) Remove forks.
- (4) Disconnect wiring to the headlight.
- (5) Block front and rear tires. Support the mast assembly with a chain hoist.
- (6) Remove lockrings and drive the pivot pins from the tilt cylinder pivot eyes.
- (7) Lift the mast, carriage, and backrest as an assembly from the tilt shaft.

b. Disassembly (fig. 60.2).

- (1) Remove backrest.
- (2) Remove carriage (para. 57).
- (3) Remove the lift cylinders (para. 56.1).
- (4) To separate mast columns, slide the columns apart.
- (5) Remove wear strips, shims, and wear plates.

c. Cleaning and Inspection.

- (1) Clean parts thoroughly with SD and dry with compressed air.
- (2) Inspect the three columns for fractures or breaks in welds.

d. Repair. Repair is limited to rewelding broken welds. Be careful to avoid excessive heat which could distort the columns.

e. Reassembly. Reverse the procedures in *b* above. Add shims as required to maintain a maximum clearance of 0.045 inch. Shim both sides equally.

f. Installation. Reverse the procedures in *a* above.

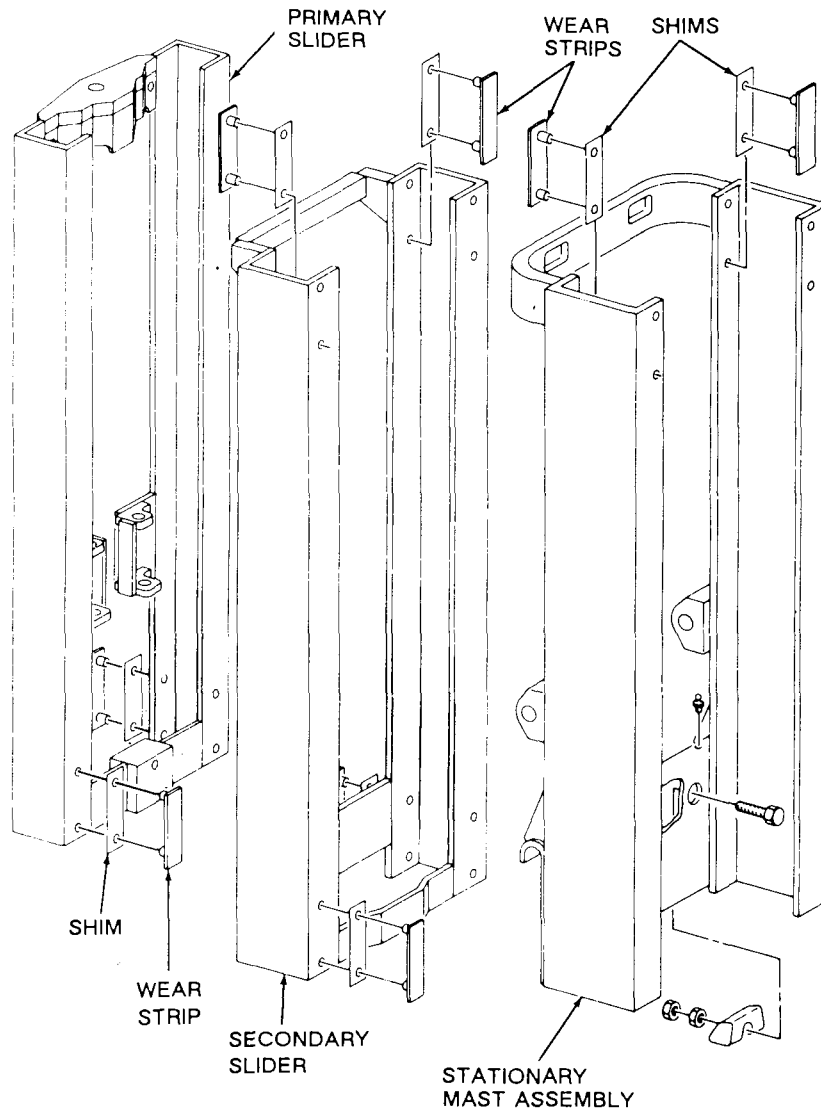


Figure 60.2. Mast assembly, exploded view (MHE-220).

TA502073

APPENDIX I REFERENCES

1. Fire Protection

TB 5-4200-200-100 Hand Portable Fire Extinguishers Approved for Army Users

2. Lubrication

C9100-IL Fuels, Lubricants, Oils, and Waxes

LO 10-3930-235-12 Lubrication Order

3. Painting

AR 740-1 Storage and Supply Activity Operations

AR 746-1 Packaging of Army Materiel for Shipment and Storage

TM 43-0139 Painting Instructions for Field Use

4. Cleaning

TB SIG-327 Harmful Effects of Carbon Tetrachloride of the Human Body

5. Maintenance

DA Pam 738-750 The Army Maintenance Management System (TAMMS)

FM 11-65 High Frequency Radio Communications

TB 750-651 Use of Anti-Freeze Solutions and Cleaning Compounds in Engine Cooling System

TM 5-764 Electric Motor and Generator Repair

TM 9-6140-200-14 Operator's, Organizational, Direct Support and General Support Maintenance Manual for Lead-Acid Storage Batteries

TM 10-3930-235-20 Organizational Maintenance Manual

TM 10-3930-235-20P Organizational Maintenance Repair Parts and Special Tools Lists

TM 10-3930-235-34P Direct Support and General Support Repair Parts and Special Tools Lists

6. Shipment and Storage

MIL-STD-162E Materials Handling Equipment: Preparation for Shipment, Storage, Cyclic Maintenance Routine Testing and Processing

TB 740-97-2 Preservation of USAMECOM Mechanical Equipment for Shipment and Storage

TM 38-230-1 Preservation Packaging and Packing of Military Supplies and Equipment, Volume I

TM 740-90-1 Administrative Storage of Equipment

7. Demolition

TM 750-244-6 Procedures for Destruction of Tank-Automotive Equipment to Prevent Enemy Use

8. Operation

TM 5-331B Utilization of Engineer Construction Equipment: Volume B; Lifting, Loading, and Handling Equipment

TM 10-3930-235-10 Operator's Manual

Pages 83 through 85, Index.

The following entries are added or superseded alphabetically:

	Paragraph	Page
Axles: Steering (MHE-190, MHE-190A, MHE-190B, and MHE-220)	39	57
Cylinders: Lift hydraulic (MHE-191, MHE-190, MHE-190A, and MHE-190B)	55	75
Cylinders: Lift, hydraulic (MHE-220)	55.1	78
Drive axle shaft	37.1	56
Hydraulic system:		
Lift cylinder (MHE-191, MHE-190, MHE-190A, and MHE-190B)	55	75
Lift cylinder (MHE-220)	55.1	78
Mast assembly (MHE-191, MHE-190, MHE-190A, and MHE-190B) . . .	56	78
Mast assembly (MHE-220)	56.1	78
Lift cylinder (MHE-191, MHE-190A, and MHE-190B)	55	75
Lift cylinder (MHE-220)	55.1	78
Maintenance forms, records, and reports	3	2
Mast assembly, lift (MHE-191, MHE-190, MHE-190A, and MHE-190B) . .	56	78
Mast assembly, lift (MHE-220)	56.1	78
Steering: Axle (MHE-190, MHE-190A, MHE-190B, and MHE-220)	39	57
Tires, solid rubber (MHE-191)	43.1	62

The following entries are deleted alphabetically:

	Paragraph	Page
Brakes: (all entries)	40–43	59–62
Creeper pedal and linkage	34	48
Cylinders:		
Master, brake	40	59
Wheel, brake	41	60
Parking brakeshoes	43	62
Pedal, brake	40	59
Record and report forms	3	2
Seat cushion	41	60
Service brakeshoes	43	62
Shoes, service brake	41	60
Shoes, parking brake	41	60
Tests: Starting motor	29	38
Transmission: Creeper pedal	34	48
Wheel cylinder, brake	41	60

By Order of the Secretary of the Army:

Official:

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

WILLIAM J. MEEHAN II
Brigadier General, United States Army
The Adjutant General

Distribution:

To be distributed in accordance with DA Form 12-25F (Block No. 2160), Direct Support and General Support maintenance requirements for Fork Lift, 4000 LB Capacity, Pneumatic & Solid, Gas Tire (Model MHE-190A, 190B, 191, 220).

Change }
No. 1 }

HEADQUARTERS
DEPARTMENT OF THE ARMY
Washington, D.C., 27 June 1973

**DS, GS, and Depot Maintenance Manual
TRUCK, LIFT, FORK; GASOLINE
4,000 LB CAPACITY**

TOWMOTOR MODEL	ARMY MODEL	FSN
462SG4024-100 (Solid Tire)	MHE-191	3930-781-3856
462SG4024-144 (Solid Tire)	MHE-191	3930-781-3855
502PG4024-144 (Pneumatic Tire)	MHE-190	3930-073-9222
	MHE-190A, MHE-190B	
502PG4024-144 (Pneumatic Tire)	MHE-220	3930-419-5738

TM 10-3930-235-35, 5 January 1965, is changed as follows:

The title is changed as shown above.

Page 2. Paragraph I is superseded as follows:

1. Scope

a. These instructions are published for use of personnel responsible for direct support, general support, and depot maintenance of the Towmotor forklift trucks.

b. You can improve this manual by calling attention to errors and by recommending improvements, using DA Form 2028 (Recommended Changes to Publications) or by a letter, and mail direct to Commander, U. S. Army Troop Support Command, ATTN: AMSTS-MPP, St. Louis, MO 63120. A reply will be furnished directly to you.

Page 4. Paragraph 6h is superseded as follows:

h. Hydraulic Lift

Oil pressure (relief valve) 1950 psi
Mast column:

Outer to inner column clearance
(MHE191, MHE-190, MHE-190A and MHE-190B) 0.015 - 0.025 in.
(MHE-220) Free slide fit 0.045 in.

(h. cont.)

Intermediate to inner column clearance

(MHE-220) Free slide fit 0.045 in.

Mast carriage:

Thrust plate to narrowest sliding width

of inner column 0.020 in.

Lifting speed (MHE-191, MHE-190,

MHE-190A and MHE-190B) 85 ft. per minute

(MHE-220) 60 ft. per minutes

Pages 7 and 8. So much of the remedies under "Hydraulic Lift" as reads "(para 55)" is changed to read "(para. 55 or 55.1)". So much as reads "(para. 56)" is changed to read "(para. 56.1)".

Page 8. Title to paragraph 9b is superseded as follows:

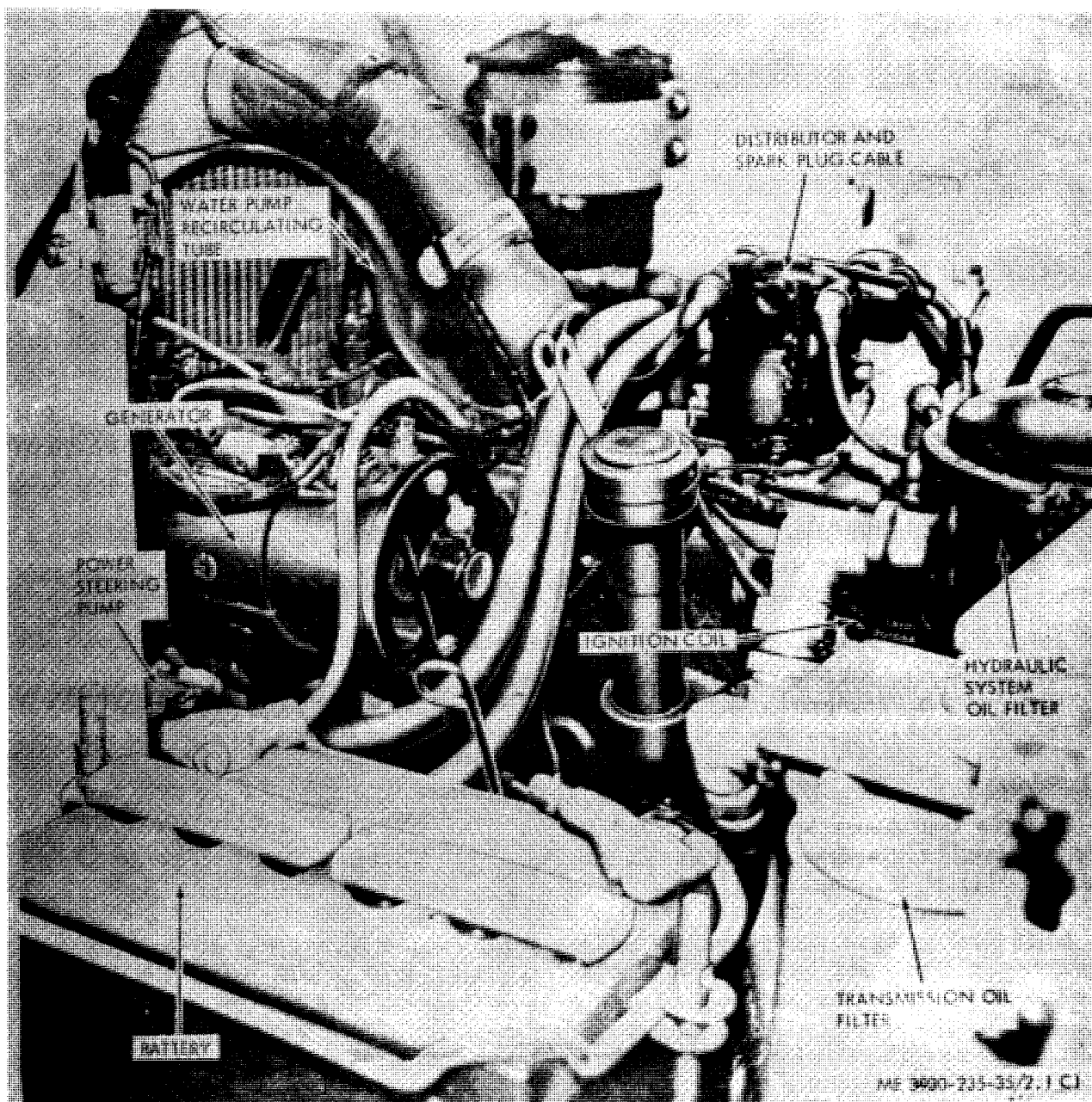
b. Remove Engine and Transmission Assembly (figs. 1 through 2.2).

Subparagraph b(0.1) is added as follows:

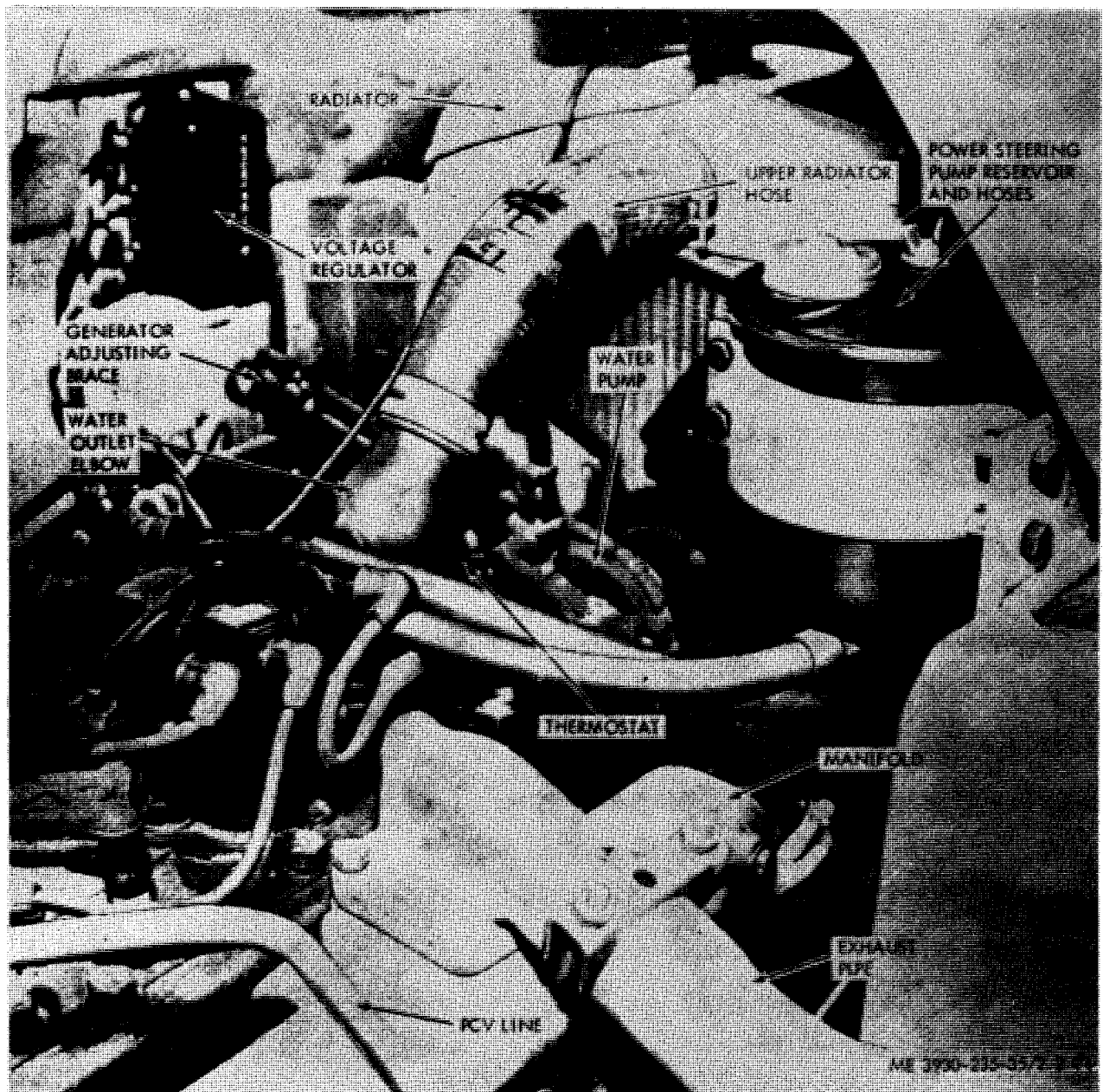
(0.1) On models MHE-220, MHE-190A and MHE-190B, remove the air cleaner (TM 10-3930-235-20).

Pages 9 and 10. Titles to figures 1 and 2 are changed to add "(models MHE-191 and MHE-190)".

Page 10. Figures 2.1 and 2.2 are added.



*Figure 2.1. 3/4 front right side of engine, installed view
(model MHE-220)*



*Figure 2.2 3/4 front left side of engine, installed view
(model MHE-220)*

Page 11. Figure 3 is superseded as follows:

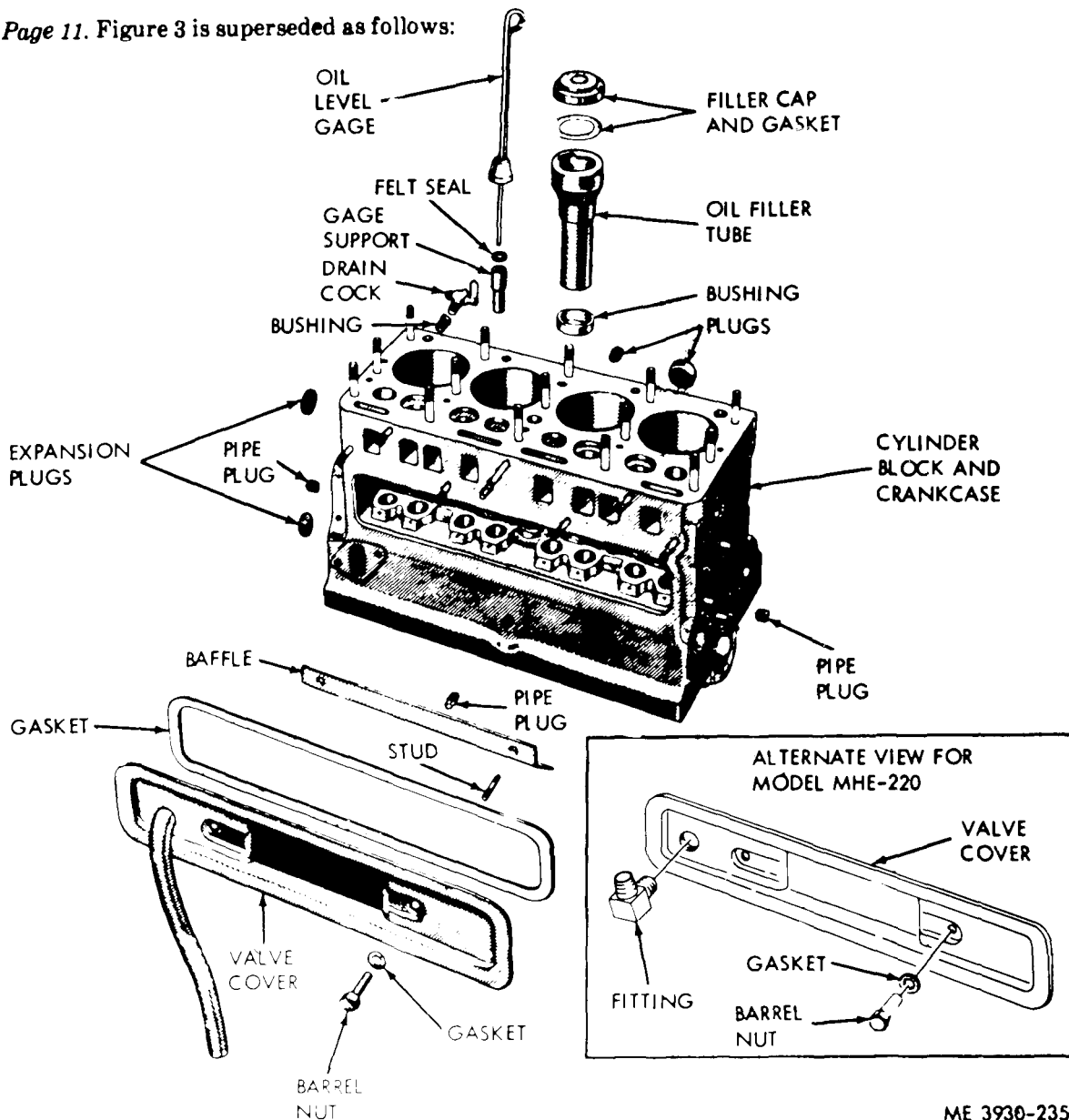


Figure 3. Cylinder and crankcase exploded view

ME 3930-235-35/3 C1

Page 13. Paragraph 9e(16.1) is added as follows:

(16.1) On model MHE-220, MHE-190A and MHE-190B, install the air cleaner.

So much of subparagraph 9e (17) as reads "LO 10-3930-235-20" is changed to read "LO 10-3930-235-12"

Page 14. Paragraph 10c is superseded as follows:

c. On models MHE-191 and MHE-190, remove the air cleaner (TM 10-3930-235-20).

Page 15. Paragraph 10k and 10l are added as follows:

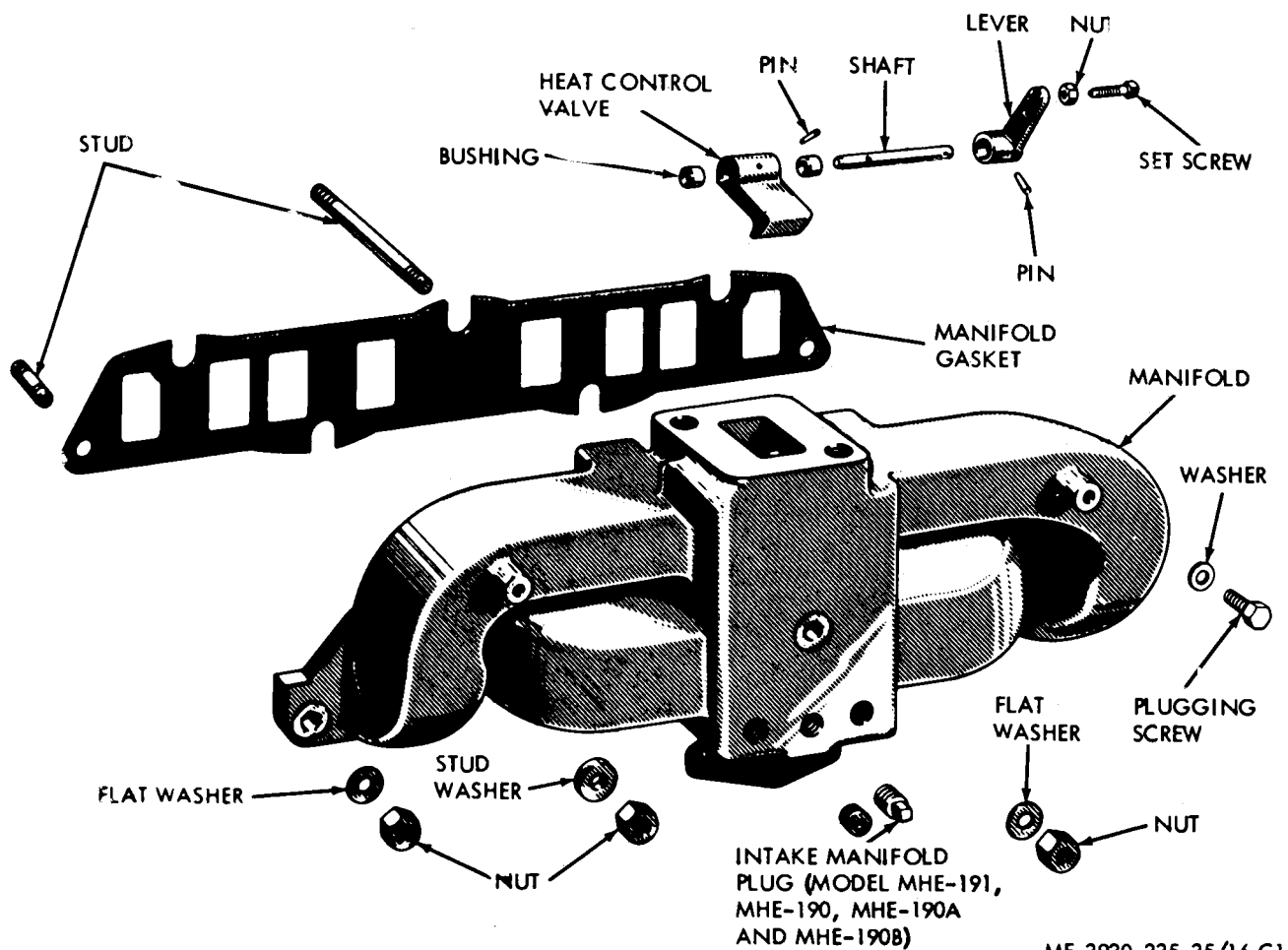
k. Remove the hydraulic oil filter. On model MHE-220, remove the transmission oil filter.

l. On model MHE-220, remove the PCV line and valve.

Paragraph 11a is superseded as follows:

a. Disconnect oil filter inlet and outlet hoses at engine. Remove nuts, washers, and the engine oil filter.

Page 21. Figure 16 is superseded as follows:



ME 3930-235-35/16 C1

Figure 16. Manifold, exploded view.

Page 28. Paragraph 16u is added as follows:

u. Install the engine oil filter and connect inlet and outlet hoses to the engine.

Paragraph 17y.1 is added as follows:

g.1. On model MHE-220, install the PCV line and valve.

Paragraph 17j is superseded as follows:

j. On models MHE-191 and MHE-190, install the air cleaner (TM 10-3930-235-20).

Paragraph 17j.1 is added as follows:

j.1. Install the hydraulic oil filter. On model MHE-220, install the transmission oil filter.

Page 49. Figure 38 is superseded as follows.

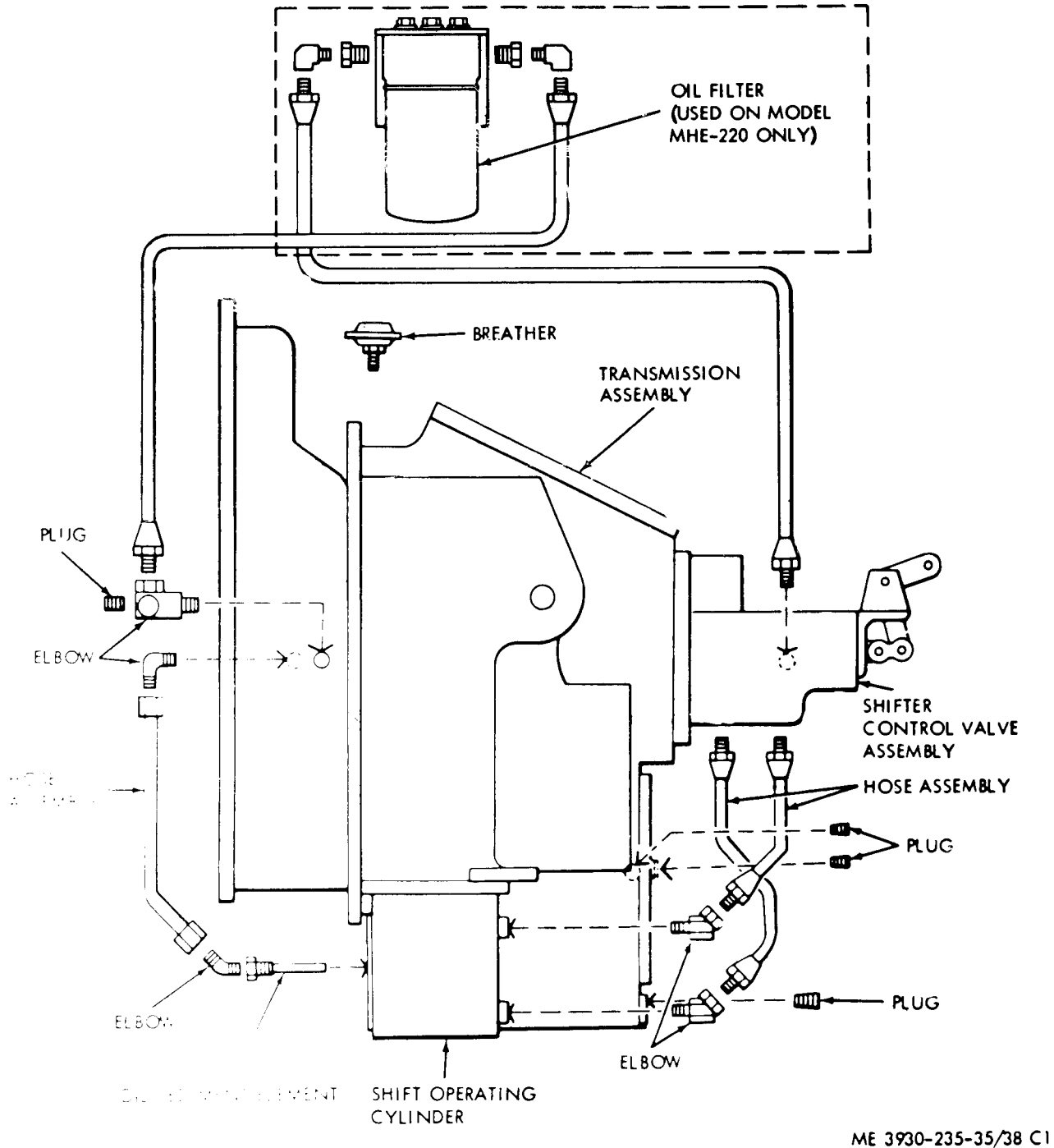


Figure 38. Converter lines and fittings.

Pages 57 and 58. So much of the titles to paragraph 39 and figure 46 as reads "(MHE-190)" is changed to read "(MHE-190, MHE-190A, MHE-190B, and MHE-220)".

Page 75. Title to paragraph 55 is superseded as follows:

55. Lift Cylinder (MHE-191, MHE-190, MHE-190A and MHE-190B).

Page 76. Title to figure 59 is superseded as follows:

Figure 59. Lift cylinder, exploded view (MHE-191, MHE-190, MHE-190A and MHE-190B)

Page 78. Paragraph 55.1 is added as follows:

55.1. Lift Cylinders (MHE-220).

a. Inspection and Repair.

(1) If oil is seeping past the packing boxes tighten packing boxes.

(2) Fully extend the mast. Check cylinder rods for scratches or scores. Remove damage using an India stone. If damage is excessive and the rods cannot be smoothed, replace cylinder.

b. Removal.

(1) Remove the forks.

(2) Remove screws and washers and lift off the backrest.

(3) Raise the carriage until the mast inner column is lifted about 10 inches. Block carriage and inner slide in this position.

(4) Remove the bolt and washer securing the primary lift cylinder to the mast (fig. 59.1). Lower the cylinder.

(5) Disconnect hydraulic lines at the cylinders. Collect fluid in a suitable container. Cap or plug openings.

(6) Disconnect chains and remove the crosshead and rollers from the secondary lift cylinder.

(7) Remove the bracket and the secondary lift cylinder from the mast assembly.

(8) Remove the U-bolt and the primary lift cylinder from the mast assembly.

c. Disassembly. (fig. 59.2)

NOTE

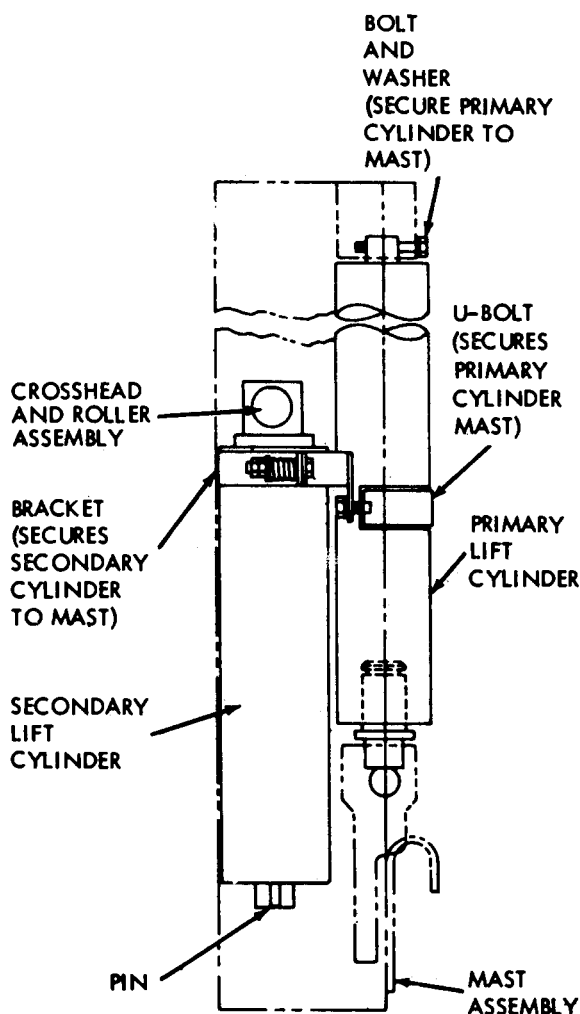
These instructions apply to both primary and secondary lift cylinders.

(1) Remove the lift cylinder packing boxes and rings.

(2) Remove the rod assembly from the tube assembly.

(3) Remove the retaining ring, piston, and seal from the rod assembly.

(4) Remove the packing assembly from the piston.



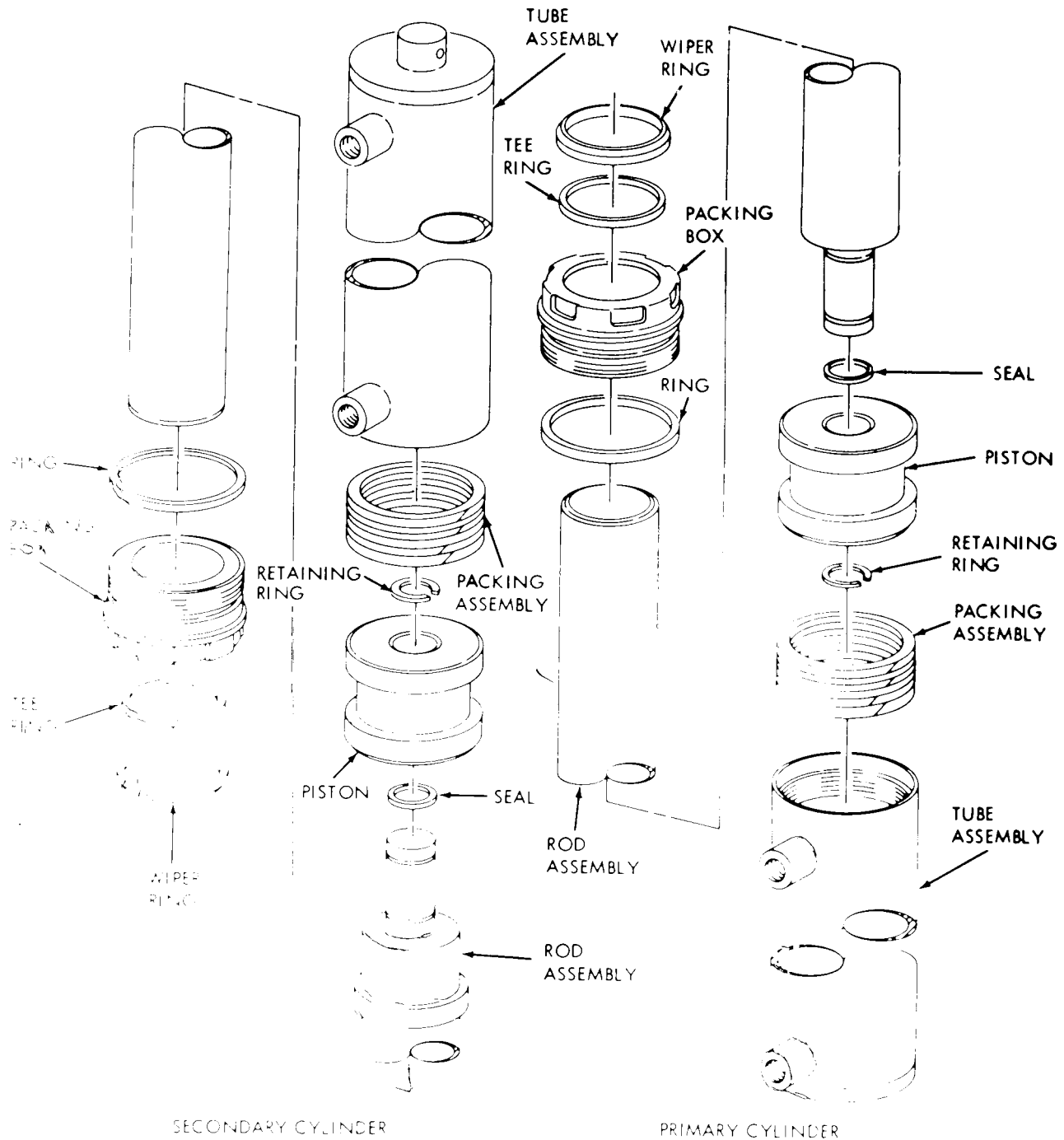
MEC 3930-235-35/59.1 C1

Figure 59.1. Lift cylinders removal (MHE-220)

d. Reassembly. Reverse procedures in c above. Lubricate the tee rings before installing in the stuffing boxes.

e. Installation. Reverse procedures in b above. Position the secondary lift cylinder so that the pin fits into the pin hole in mast.

Page 76. Figures 59.1 and 59.2 are added:



MF 3930-235-35 '59.2 C1

Figure 59.2. Lift cylinders, exploded view (MHE-220)

Page 78. Title to paragraph 56 is superseded as follows:

56. Mast Assembly (MHE-191, MHE-190, MHE-190A and MHE-190B).

Paragraph 56.1 is added as follows:

56.1. Mast Assembly (MHE-220).

a. Removal (fig. 60.1).

(1) Extend the mast fully. Remove four nuts

and two bolts securing the mast hinge bracket to the frame. Two blocks will fall out. Lower the mast.

(2) Disconnect hydraulic lines to the lift cylinders. Collect fluid in a suitable container. Cap or plug openings.

(3) Remove forks.

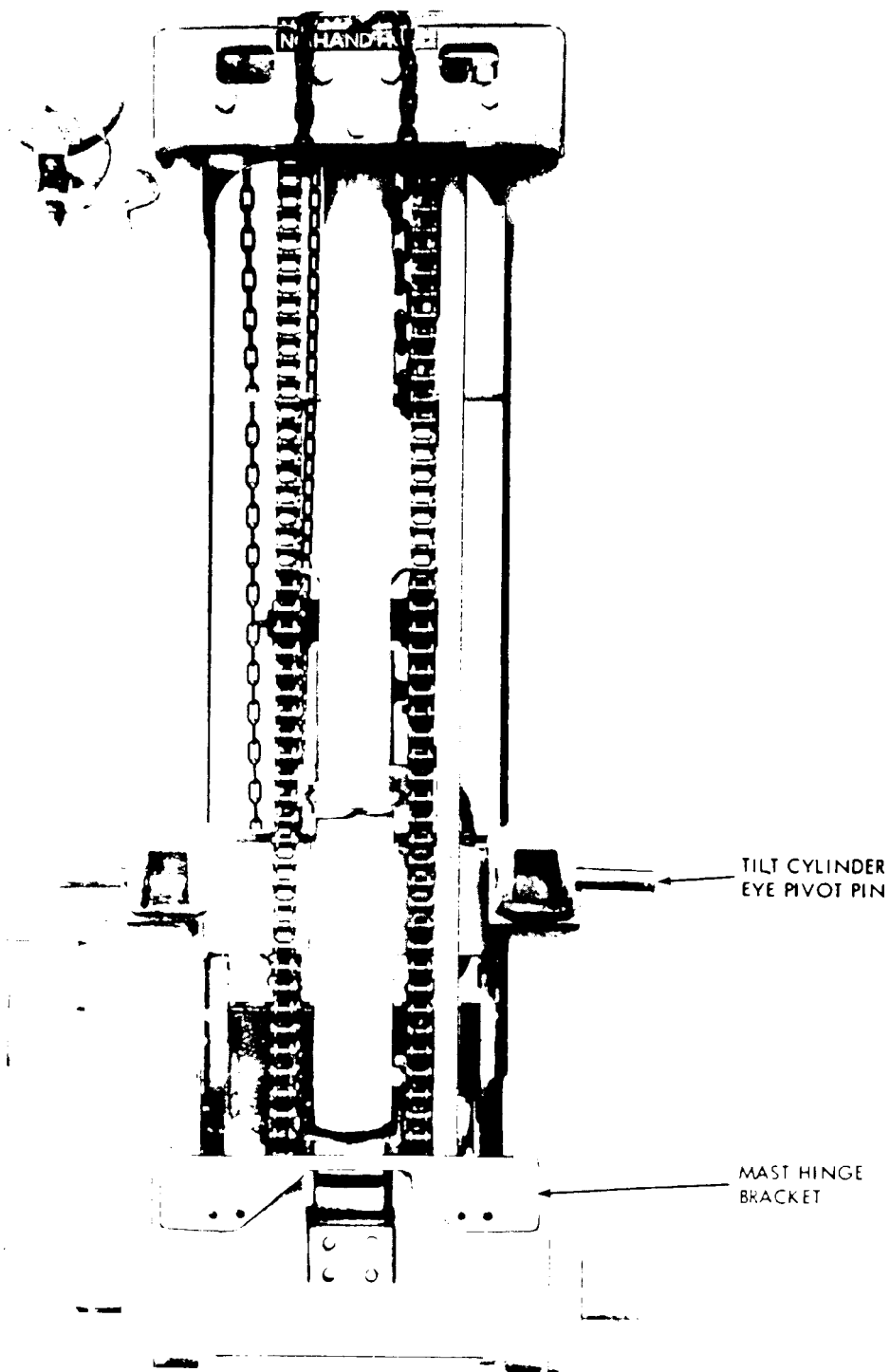
(4) Disconnect wiring to the headlight.

(5) Block front and rear tires. Support the mast assembly with a chain hoist.

(6) Remove lockrings and drive the pivot pins from the tilt cylinder pivot eyes.

(7) Lift the mast, carriage, and backrest as an assembly from the tilt shaft.

Page 79. Figure 60.1 is added as follows.



ME 3930-235-35/60.1 CI

Figure 60.1 Mast assembly removal.

b. Disassembly (fig. 60.2).

(1) Remove backrest.

(2) Remove carriage (para. 57).

(3) Remove the lift cylinders (para. 56.1).

(4) To separate mast columns, slide the columns apart.

(5) Remove wear strips, shims, and wear plates.

c. Cleaning and Inspection.

(1) Clean parts thoroughly with SD and dry with compressed air.

(2) Inspect the three columns for fractures or breaks in welds.

d. Repair. Repair is limited to rewelding broken

welds. Be careful to avoid excessive heat which could distort the columns.

e. Reassembly. Reverse procedure in *b* above. Add shims as required to maintain a maximum clearance of 0.045 inch. Shim both sides equally.

f. Installation. Reverse procedures in *a* above. Page 79. Figure 60.2 is added.

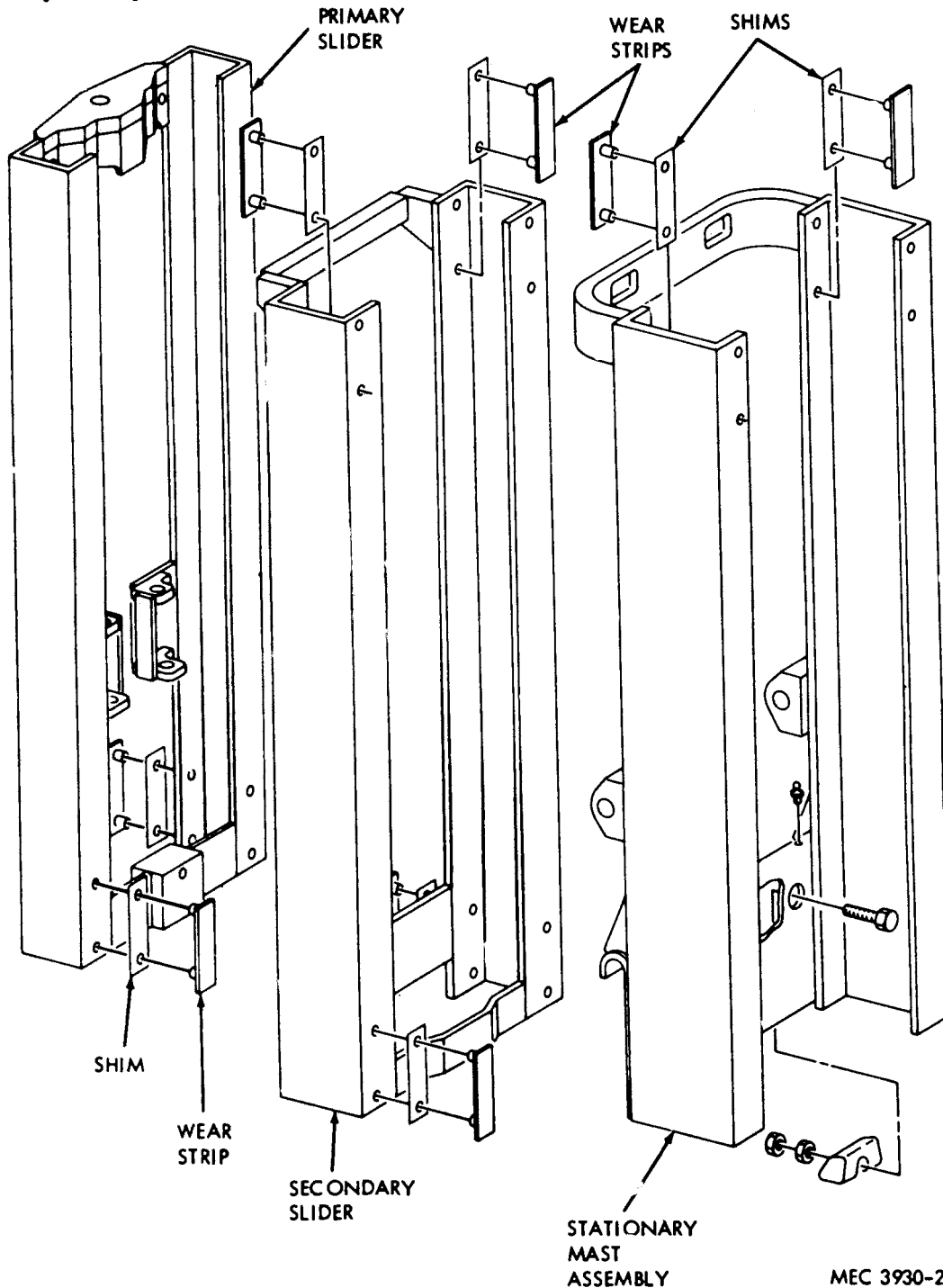


Figure 60.2. Mast assembly, exploded view (MHE-220).

MEC 3930-235-35/60.2 C1

APPENDIX I REFERENCES

A.1. Fire Protection

TB 5-4200-200-10 Hand Portable Fire Extinguishers Approved for Army Users

A-2. Lubrication

C9100I-L Fuels, Lubricants, Oils, and Waxes

LO 10-3930-235-12-1 Truck, lift, fork, gasoline, 4000 lbs capacity, Towmotor models 462SG4024-100 (solid tire), Army model MHE 191; 462SG4024-144 (solid tire), MHE 191; 502PG4024-144 (pneumatic tire), MHE 190, 190A, 190B; 502PG4024-144 (pneumatic tire), MHE 220.

LO 10-3930-235-12-2 Truck, lift, fork, gasoline, 4000 lbs capacity, Towmotor models 462SG4024-100 (solid tire), Army model MHE 191; 462SG4024-144 (solid tire), MHE 191; 502PG4024-144 (pneumatic tire), MHE 190, 190A, 190B; 502PG4024-144 (pneumatic tire), MHE 220.

A-3. Painting

AR 740-1 Storage and Supply Activity operations

AR 746-1 Color, Marking, and Preparation of Equipment for Shipment.

TM 9-213 Painting Instructions for Field Use

TB 740-93-1 Color and Marking of Military Vehicles, Construction Equipment, and Materials Handling Equipment

A-4. Cleaning

TB SIG-327 Harmful Effects of Carbon Tetrachloride on the human body.

A-5. Maintenance

TM 10-3930-235-20 Organizational Maintenance Manual: Truck, Lift, Fork; Gasoline: 4000 lbs. Capacity; Towmotor Models

TM 10-3930-235-20P Organizational Repair Parts and Special Tools List; Truck, Lift, Fork; Gasoline; 4000 lbs. Capacity; Towmotor Models

TM 10-3930-235-35P Direct and General Support and Depot Maintenance Repair Parts and Special Tools Lists: Truck, Lift, Fork; Gasoline; 4000 lbs. Capacity; Towmotor Models

TB 750-651 Use of Anti-Freeze Solutions for Cleaning Compounds in Engine Cooling Systems

TM 5-764 Electric Motor and Generator Repair

TM 9-6140-200-14 Operator, Organizational, DS and GS maintenance manual storage batteries lead-acid type.

TM 11-483 Radio Interference Suppression

TM 38-750 The Army Maintenance Management System (TAMMS)

A-6. Shipment and Storage

TM 740-90-1 Administrative Storage of Equipment

TB 740-97-2 Preservation of USAMECOM Mechanical Equipment for Shipment and Storage

TM 38-230-1 Preservation Packaging and Packing of Military Supplies and Equipment. Volume 1.

MI-STD-162A

Preparation for Delivery of Warehouse Materials Handling Equipment for Domestic and Overseas Shipment and Storage

A-7. Demolition

TM 750-244-3

Procedures for Destruction of Equipment to Prevent Enemy Use (Mobility Equipment Command)

A-8. Operation

TM 5-831B

Utilization of Engineer Construction Equipment Volume B Lifting, Loading, and Hauling Equipment

Pages 83 through 85 (Index). The following entries are added or superseded alphabetically as follows:

	Paragraph	Page
Axles, steering (MHE-190, MHE-190A, MHE-190B, and MHE-220)	39	6
Cylinders, lift hydraulic (MHE-191, MHE-190, MHE-190A and MHE-190B)	55	6
Cylinder, lift, hydraulic (MHE-220)	55.1	7
Hydraulic system:		
Lift cylinder (MHE-191, MHE-190, MHE-190A, and MHE-190B)	55	6
Lift cylinder (MHE-220)	55.1	7
Mast assembly (MHE-191, MHE-190, MHE-190A, and MHE-190B)	56	8
Mast assembly (MHE-220)	56.1	8
Lift cylinder (MHE-191, MHE-190A, and MHE-190B)	55	6
Lift cylinder (MHE-220)	55.1	7
Mast assembly, lift (MHE-191, MHE-190, MHE-190A, and MHE-190B)	56	8
Mast assembly, lift (MHE-220)	56.1	8
Steering Axle (MHE-190, MHE-190A, MHE-190B, and MHE-220)	39	6

By Order of the Secretary of the Army:

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

Official:

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

Distribution:

To be distributed in accordance with DA Form 12-25A (qty rqr block No. 895), Direct/General Support requirements for Warehouse Equipment.

TM 10-3930-235-35

TECHNICAL MANUAL

No. 10-3930-235-35



HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, D.C., 5 January 1965

DS, GS, and Depot Maintenance Manual

**TRUCK, LIFT, FORK, GASOLINE
4,000-LB CAPACITY**

TOWMOTOR MODELS	ARMY MODEL	FSN
462SG4024-100 (Solid Tire)	MHE-191	3930-781-3856
462SG4024-144 (Solid Tire)	MHE-191	3930-781-3855
502PG4024-144 (Pneumatic Tire)	MHE-190	3930-073-9222

	Paragraph	Page
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II. Description and data	5,6	2
CHAPTER 2. MAINTENANCE INSTRUCTIONS		
Section I. Special tools and equipment	7	5
II. Troubleshoot ing	8	5
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CHAPTER 1

INTRODUCTION

Section I. GENERAL

1. Scope

a. These instructions are published for use of personnel responsible for direct support, general support, and depot maintenance of the Truck, Lift, Fork, Solid Rubber Tired Wheels, 4,000-Lb Capacity, Towmotor Models 462SG4024-100, FSN 3930-781-3856 and 462SG4024-144, FSN 3930-781-3855 respectively, Army Model MHE-191, procured under Contract Number DSA-4-014877-MP310, and Towmotor Model 502PG4024-144, FSN 3930-073-9222, Army Model MHE-190, 4,000-Lb Capacity, Pneumatic Tired Wheels, procured under Contract Number DSA-4-014863-MP310.

b. The direct reporting, by the individual user, of errors, omissions, and recommendations for improving this manual, is authorized and encouraged. DA Form 2028 (Recommended Changes to DA Publications) will be used for reporting these improvements. This form will be completed in triplicate using pencil, pen, or typewriter. The original and one copy will be forwarded direct to Commanding General, U. S. Army Mobility Equipment Center, ATTN: SMOME-MMP, Post Office Drawer 58, St. Louis, Mo. 63166. One information copy will be provided to the individual's immediate supervisor (e.g., officer, noncommissioned officer, supervisor, etc.).

c. Report all equipment improvement recommendations as prescribed by TM 38-750.

2. Appendix

Appendix I is a list of current references applicable to direct support, general support, and depot maintenance.

Note. The maintenance allocation chart, which designates the maintenance operations to be performed, is published in TM 10-3930-235-20. Repair parts and special tool lists is published in TM 10-3930-235-35P.

3. Record and Report Forms

For record and report forms applicable to direct and general and depot maintenance, refer to TM 38-750.

Note. Applicable forms, excluding standard form 46 which is carried by the operator, will be kept in a canvas bag mounted on the equipment.

4. Orientation.

Throughout this manual, the use of the terms, right, left, front, and rear with respect to engine and truck are determined with the operator sitting in the seat of the truck.

Section II. DESCRIPTION AND DATA

5. Description

A general description of the truck is to be found in TM 10-3930-235-10. Any required additional description of a component of the truck will be found in that section of the manual which applies to the component.

6. Data

a. Engine.

Make	Continental
Model	FS1 62-6089
Number cylinders	4
Bore	3 $\frac{7}{16}$ inches
Stroke	4 $\frac{3}{8}$ inches

Displacement 162 cu in.
 SAE horsepower rating 18.8
 Brake horsepower at 2200 rpm 46
 Compression ratio 6.3:1
 Governed speed 2400 rpm
 Compression pressures at 1500 rpm or
 starting motor speed 110–120 psi
 Maximum variations between cylinder, 10 lbs
 Camshaft and bushings:
 Fronts:
 Bushings inside diameter 1.8745–1.8755
 Journal diameter 1.8715–1.8725
 Allowable additional wear on
 journal diameter 0.001
 Clearance 0.002–0.004
 Center:
 Bushings inside diameter 1.7495–1.7502
 Journal diameter 1.7457–1.7465
 Allowable additional wear on
 journal diameter 0.001
 Clearance 0.003–0.0045
 Rear:
 Bushings inside diameter 1.2495–1.2505
 Journal diameter 1.2465–1.2475
 Allowable additional wear on
 journal diameter 0.001
 Clearance 0.002–0.004
 End thrust 0.003–0.007
 Crankshaft and bearings:
 Main journal diameter 2.2442–2.2451
 Additional allowable wear on main
 journal diameter 0.0006
 Main bearing thickness 0.0950–0.0953
 Main bearing clearance 0.0002–0.0024
 Connecting rod journal diameter, 2.0600–2.0607
 Additional allowable wear on con-
 necting rod journal diameter, . . . 0.0006
 Connecting rod bearing thickness, . 0.0625–0.0628
 Additional allowable wear clear-
 ance 0.0005
 Connecting rod bearing clearance, . 0.0002–0.0020
 Additional allowable wear clear-
 ance 0.0032
 Journal out-of-round 0.0005 max.
 Journal taper 0.0005 max.
 Crankshaft end thrust 0.004–0.006
 Connecting rod:
 Thrust or bend 0.002 max.
 Cylinder walls:
 Taper 0.0000–0.0005
 Out-of-round 0.0005 max.
 Pistons:
 Cylinder bore 3.4375–3.4395
 Skirt clearance 0.003
 Ring land clearance 3.4045–3.4095
 Taper of skirt 0.0005–0.0015

Piston pins:
 Piston—pin hole diameter 0.8593–0.8596
 Pin bushing inside diameter 0.8593–0.8596
 Pin diameter 0.8591–0.8593
 Additional allowable wear on pin
 diameter 0.001
 Pin fit in piston at 70° F. (21°C.) . . —0.0003—+0.0003
 Pin fit in bushing 0.0000–0.0005
 Piston rings:
 Width:
 Top and second 0.093–0.094
 Third and fourth 0.1545–0.1555
 Thickness:
 Top 0.162–0.172
 Second, third and fourth 0.143–0.153
 Side clearance:
 Top 0.002–0.004
 Second 0.001–0.003
 Third and fourth 0.0005–0.0025
 End gap 0.010–0.020
 Valves:
 Intake:
 Stem diameter 0.3405–0.3415
 Additional allowable wear on
 stem 0.002
 Guide inside diameter 0.3432–0.3440
 Guide to stem clearance 0.0017–0.0035
 Additional allowable guide to
 stem clearance 0.0046
 Valve face 0.120
 Valve seat angle 45°
 Valve seat width 0.066
 Lifter to valve clearance 0.014 (hot)
 Exhaust:
 Stem diameter 0.3405–0.3415
 Additional allowable wear on
 stem 0.002
 Guide inside diameter 0.3452–0.3460
 Guide to stem clearance 0.0037–0.0055
 Additional allowable guide to
 stem clearance 0.0075
 Valve face 0.122
 Valve seat angle 45°
 Valve seat width 0.086
 Lifter to valve clearance 0.014 (hot)
 Valve springs
 Free length 1-45/64 inches
 Load required at closed length, 47 to 53 lbs
 Additional allowable tolerance, 42 lbs
 Oil pump:
 Gear backlash 0.001–0.003
 Gear teeth to body clearance 0.002–0.004
 Gear face to cover clearance
 (with gasket installed) 0.0015–0.006
 Idle shaft diameter 0.5015–0.502
 Drive shaft bushing (in pump
 body) 0.500–0.501
 Additional allowable wear on
 bushing 0.0005
 Drive shaft bushing (in block) . . . 0.9843–0.994

Additional allowable wear on
 bushing 0.0005
 Driveshaft diameter 0.4985–0.4990

b. Fuel System.

Jet sizes:

Discharge jet No. 60
 Fuel valve No. 35
 Idle jet No. 10
 Main jet No. 23–1
 Venturi No. 19
 Well vent jet No. 22

Float adjustment (measured from top
 of float to machined surface of
 body) $1\frac{1}{2}$

c. Electrical System.

Generator:

Rated voltage 12
 Rotation Clockwise
 Ground polarity Negative
 Brush spring tension 18 to 36 ounces
 Field current draw 1.6 to 1.7 amps at
 10 volts
 Motoring draw 2.9 to 3.0 amps at
 10 volts
 Output 25 amps at 15 volts
 at 2200 rpm

Brush length:
 New $\frac{3}{4}$
 Permissible worn length $\frac{7}{8}$

Starting motor:

Rated voltage 12 volts
 Rotation (drive end) Clockwise
 Brush spring tension 42 to 53 ounces
 Armature end play 0.005 in
 No load test 55 amps, 10 volts,
 5200 rpm
 Stall torque test max 235 amps, 4
 volts

Brush length:
 New $\frac{1}{2}$
 Permissible worn length $\frac{5}{8}$

d. Transmission.

Oil pressures (Para. 30b)
 Converter output shaft and bushing:
 Bushing inside diameter 1.063–1.066
 Shaft diameter 1.0615–1.0620
 Forward clutch shaft and bushing:
 Bushing inside diameter 1.2515–1.2545
 Shaft diameter 1.2490–1.2495
 Clutch facing thickness 0.046–0.062
 Clutch adjustment neutral setting
 (fig. 37) 0.375–0.390

e. Universal Joint.

Alignment (adjust at engine
 mountings) max. $\frac{1}{8}$ in.

f. Drive Axle.

Differential:
 Bevel pinion bearing adjustment. 0.000–0.002 (tight)
 Differential bearing adjustment. . . . 0.000–0.005 (tight)
 Bevel gear to pinion backlash. . . . 0.006–0.010

g. Power Steering System.

Oil pressures (Para. 44f)
 Hydraulic pump cam end clearance. . . max. 0.002

h. Hydraulic Lift.

Oil pressures (Para. 52)
 Mast column:
 Outer to inner column clearance. . . 0.015–0.025
 Mast carriage:
 Thrust plate to narrowest sliding
 width of inner column 0.020
 Lifting speed 85 feet per minute

CHAPTER 2

MAINTENANCE INSTRUCTIONS

Section I. SPECIAL TOOLS AND EQUIPMENT

7. Special Tools and Equipment

No special tools or equipment are required for

direct support, general support, or depot maintenance of these lift trucks.

Section II. TROUBLESHOOTING

8. General

a. This section lists troubleshooting information, and checks which can be made to determine the cause of trouble that may develop. Each symptom of trouble is recorded under an individual symptom

and is followed by a possible cause of the trouble and the remedy.

b. In the troubleshooting chart below, each symptom of trouble is followed by a list of probable causes and a suggested procedure for locating and remedying the trouble.

Troubleshooting Chart

ENGINE AND FUEL SYSTEM		
Trouble	Probable cause	Remedy
Engine hard to start.	Low compression	Valves not seating properly. Either adjust (TM 10-3930-235-20), or grind valves (para. 14).
Engine misses	Warped valves	Replace (para. 14).
	Sticking valves	Remove valve cover and with screwdriver, free the sticking valve. Valve stem and guide will have to be cleaned to restore proper clearance. If condition continues, valves need regrinding (para. 14).
Engine knocks	Loose connecting rod bearings (sharp knock, low oil pressure).	Replace bearings (para. 14).
	Loose main bearings (heavy knock, low oil pressure).	Replace main bearings (para. 14).
	Loose piston pins (sharp double knock)	Replace pins or bushings (para. 14).
Engine overheats	Piston and cylinder wear	Recondition cylinder walls (para. 14).
	Leaky radiator	Repair radiator (para. 23).
Loss of power	Cracked engine block or head.	Replace damaged part (para. 14).
	Leaky valves.	Either adjust (TM 10-3930-235-20) or grind valves (para. 14 f).
Smoky exhaust	Worn piston rings.	Replace rings (para. 14a).
	Carburetor float sticking (black smoke)	Tap carburetor lightly with hammer handle. If this does not correct the situation, carburetor must be cleaned (para. 21).
	Worn piston rings, and out-of-round and tapered cylinders (blue smoke).	Replace rings and rebore cylinder (para. 14a).
	Thin lubrication oil (blue smoke)	Use oil of correct viscosity, LO 10-3930-235-20.

ENGINE AND FUEL SYSTEM - Continued

Trouble	Probable cause	Remedy
Carburetor leaks gasoline when idling,	Float stuck (dirty needle valve).	Tap carburetor gently to dislodge the dirt in the fuel valve. If this does not correct the condition, remove the carburetor, and clean the valve (para. 21).
	Drain plug not tight	Tighten (para. 21).
	Float level incorrect	Adjust (para. 21),

ELECTRICAL SYSTEM

Ammeter shows rapid fluctuation.	Shorted or loose connections.	Trace wiring for breaks or looseness.
	Dirty, loose or worn generator brushes.	Clean and tighten brushes. Replace if worn (para. 24).
Generator does not charge.	Defective generator	Repair or replace (para. 24).
	Broken external connection.	Repair connections.
	Shorted armature	Replace or repair (para. 24).
Starting motor failure.	Shorted field	Replace or repair (para. 24).
	Faulty switches	Check ignition switch or starter solenoid.
	Commutator dirty	Clean (para. 27).
	Worn brushes	Replace (para. 27).
	Broken starting motor drive.	Replace (para. 27).
	Bad teeth on flywheel,	Replace ring gear (para. 14).

TRANSMISSION

Oil foams or is discharged from breather.	Oil level too high	Drain until oil level is correct.
	Incorrect oil in transmission.	Drain and refill with correct oil.
Vehicle will not move.	Air leak in pump suction line	Locate and repair.
	Low oil pressure	Check oil pressure (para. 30b).
	Linkage worn	Replace worn linkage (paras. 34 and 35).
Lack of acceleration and power under full throttle.	Transmission faulty	Repair or replace transmission (para. 30).
	Low oil pressure	Check oil pressure (para. 30b).
	Air leak in pump suction line	Locate and repair.
Low oil pressure (refer to para. 30b for oil pressure check).	Transmission and converter parts worn.	Repair or replace transmission (para. 30).
	Low oil level.	Fill to correct level.
	Leak in pump suction line	Locate and repair.
	Oil pump faulty	Replace transmission (para. 30).

DRIVE AXLE

Failure to operate.	Broken axle shaft	Replace axle shaft (para. 37).
	Broken teeth on ring gear or pinion.	Replace ring gear and pinion (para. 37).
Axle noise on drive or coast.	Excessive wear at ring gear and pinion.	Replace (para. 37).
	Worn pinion gears or side gears in differential case.	Replace worn gears (para. 37).
Continuous axle noise.	Excessive wear in gear train.	Replace worn parts (para. 37).
	Uneven tire wear.	Replace tires.
Excessive backlash in unit.	Worn ring gear, pinion or differential case pinions.	Replace gear and pinions (para. 37).
	Loose or worn universal joints.	Tighten or replace (para. 36).

HYDRAULIC BRAKE SYSTEM

Pedal goes to toe board.	Low fluid level in master cylinder,	Fill reservoir and bleed lines (para. 42),
	External leak in brake system or leak past master cylinder piston cup.	Check system for leak and repair (para. 40).
	Air trapped in hydraulic system.	Bleed system (para. 42).

HYDRAULIC BRAKE SYSTEM - Continued

Trouble	Probable cause	Remedy
Both brakes drag.	Mineral oil in brake system	Clean out system, replace cups in brake cylinders, and refill with brake fluid (para. 41).
One wheel drags	Breather port in master cylinder clogged	Clean out breather port (para. 40).
	Weak or broken brakeshoe return springs.	Replace broken or weak springs (para. 41).
	Obstruction in brake line	Remove obstruction or replace line.
	Swollen wheel cylinder piston cups or piston binding.	Replace defective or damaged parts (para. 41).
Truck pulls to one side.	Grease or brake fluid on brake lining.	Replace with new lining (para. 41).
	Uneven tread wear	Replace tires.
	Lining charred or drum scored.	Replace lining (para. 41) or, repair and replace drum.
Spongy pedal pressure.	Air trapped in hydraulic system	Bleed brake system (para. 42).
	Shoe surface not square with drum	Repair (para. 41).
Excessive pedal pressure.	Oil or fluid soaked lining	Replace lining (para. 41).
	Lining making only partial contact.	Realign brake shoes (para. 41).
Brakes too severe.	Brake shoes twisted	Replace (para. 41).
Brakes squeak	Particles of metal or dust imbedded in lining.	Remove foreign material and sand lining and drum (para. 41).

STEERING

Hard steering	Failure of pump	Replace or repair (para. 44).
	Badly worn pump	Recondition pump (para. 44).
	Broken or weak relief valve spring.	Replace spring (para. 44).
	Binding relief valve	Free up valve (para. 44).
	Low pump pressure	Replace worn or faulty parts (para. 44).
	Line leakage	Tighten connections.
	Lack of lubrication	Lubricate (LO 10-3930-235-20).
	Leakage in steering cylinder.	Repair (para. 46).
	Faulty control valve	Recondition valve (para. 47).
	Binding steering gear	Repair or adjust (para. 45).
Steering too sensitive.	Pump pressure too high	Check for binding relief valve (para. 44).
	Faulty flow control valve	Recondition; free up any binding parts (para. 44).
Loose steering	Loose king pins	Repair or recondition (para. 38 or 39).
	Steering gear out of adjustment.	Adjust cam and worm shaft (para. 45).
Low oil pressure	Low oil level	Fill reservoir to correct level (LO 10-3930-235-20).
	Worn pump	Recondition or replace (para. 44).
	Weak relief valve	Replace spring (para. 44).
	Relief valve stuck open	Remove and free up valve (para. 44).
	Flow control valve open	Free up flow control valve (para. 44).
	External leakage	Tighten or replace fittings, hoses or seals.
	Internal leakage	Replace seals in pump (para. 44) or cylinder (para. 46).

HYDRAULIC LIFT

Unable to lift or tilt load.	Load too heavy.	Lighten load to maximum capacity (4000 pounds).
	Insufficient or no oil	Check tank for proper oil level and plugged suction line.
	Air leak at suction line	Tighten connections.
	Damaged or worn pump.	Remove and repair (para. 50).
	Relief valve binding open	Remove and repair (paras. 51 and 52).
	Damaged lift cylinder	Check for binding or any cause to make plunger inoperative (para. 55).

HYDRAULIC LIFT - Continued

Trouble	Probable cause	Remedy
Lift and tilt too slow.	Control valve	Inspect for internal leakage or damaged parts and repair (para. 51).
	Internal leakage at pump	Inspect for worn or damaged pints (Para. 50).
	Excessive leakage at cylinder packing.	Repair or replace packing (paras. 54 and 55).
	Air leaks in system	Tighten all connections.
Load creeps tilting or lowering.	Misalignment	Check masts (para. 56), carriage (para. 57) or tilt cylinder (para. 54) for cause of binding.
	Faulty relief valve	Check for worn or damaged parts. Repair or replace. Check relief valve setting (paras. 51 and 52).
	Internal leakage in cylinders.	Repair or replace packing (paras. 54 and 55).
	Oil leak at parking glands	Repair or replace packing (paras. 54 and 55).
Noisy pump	Leak in control valve	Check for worn or damaged plungers (para. 51).
	Leak in oil lines	Tighten all connections or replace damaged lines.
	Insufficient or no oil	Check tank for proper oil level or restricted suction line.
	Air leaks	Tighten intake connections.
Oil overheating	Oil bubbles in intake oil	Use hydraulic oil with antifoaming characteristics.
	Pump loose	Tighten (para. 50).
	Worn or broken parts	Replace (para. 50).
	Relief valve set too high	Valve should be set as recommended (para. 52).
	Internal oil leakage	Repair or replace pump (para. 50).
	Pump too tight after overhaul.	Remove and repair (para. 50).
	Restricted lines	Check and repair.

Section III. ENGINE

9. Removal and Installation of Engine Assembly

a. General. Remove engine with accessories installed and remove as engine and transmission assembly. Use Safety Lift, or equivalent tool, when removing engine.

b. Remove Engine and Transmission Assembly (figs. 1 and 2).

- (1) Remove overhead guard.
- (2) Remove operator's seat.
- (3) Remove engine hood.
- (4) Remove body side plates and grill.
- (5) Remove floor plates.
- (6) Remove counterweight hood and counterweight.
- (7) Remove battery and cables.
- (8) Drain coolant, disconnect transmission, cooling pipes, then remove radiator.

- (9) Remove screws and washers that hold hydraulic pump to engine timing gear cover. Separate pump, with hoses connected, from timing gear cover.
- (10) Disconnect hoses at steering hydraulic pump and drain oil from reservoir. Disengage hoses from clamps that are mounted on cylinder head and transmission cover.
- (11) Remove exhaust pipe.
- (12) Remove nut and washer to disconnect ball joint on accelerator cable at relay lever. Remove clamp at control cable support. Loosen screw to disconnect choke control cable at carburetor. Remove fuel tank to fuel pump tubing.
- (13) The following disconnect points are located at left side of frame below rear floor plate. Disconnect ammeter to regulator cable at connectors. Disconnect chassis

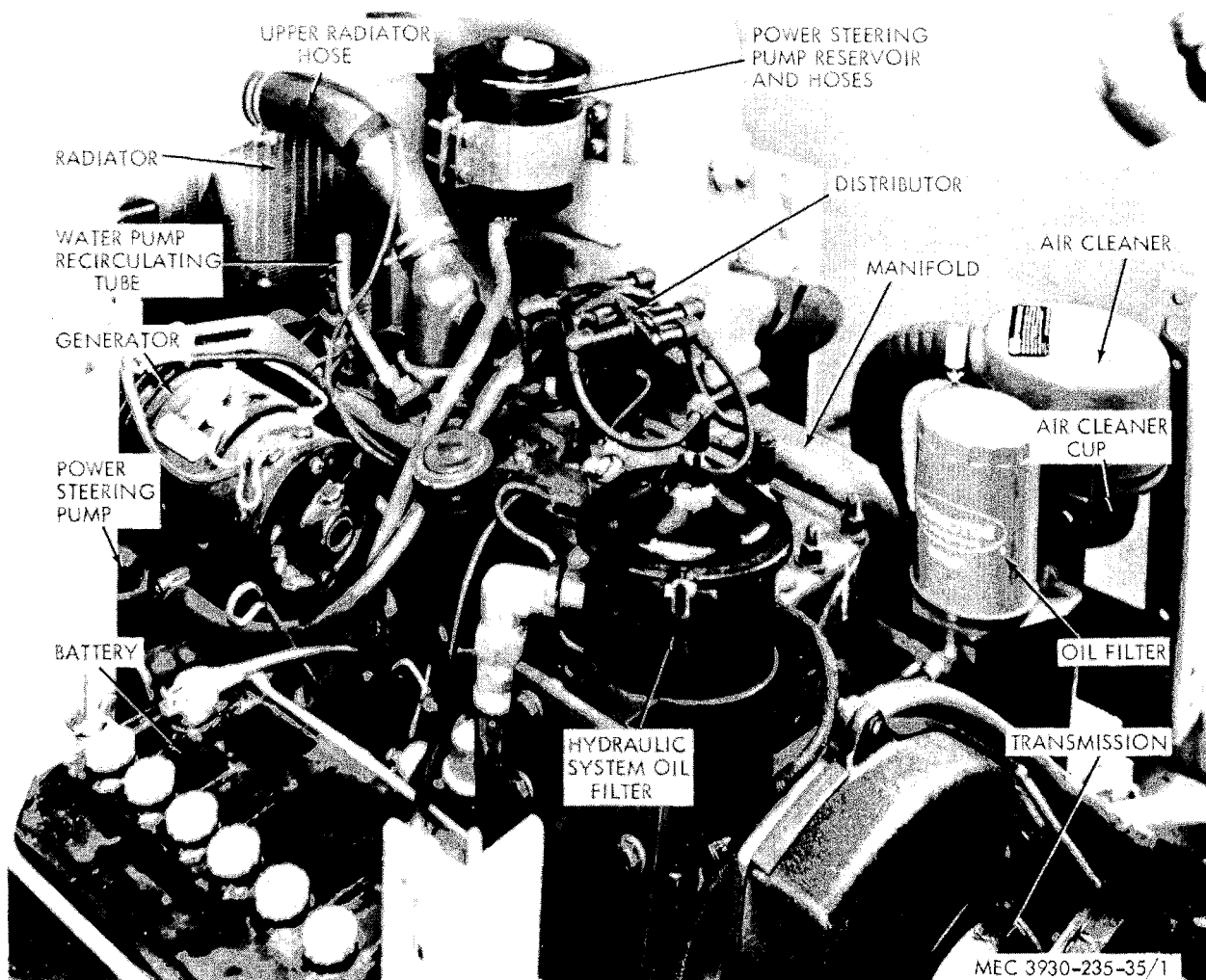


Figure 1. 3/4 Front right side of engine, installed view.

wiring harness from engine wiring harness at disconnect plug. Disconnect tail and stoplight wires and thermocouple wire at terminal junction.

- (14) Remove cotter pin and clevis pin, then disconnect shift lever linkage at transmission control valve plunger. Remove ball joint nut and lockwasher at creeper pedal, then remove ball joint from pedal.
- (15) Remove nuts and washers to disconnect wires at generator. Disconnect battery wire at generator regulator.
- (16) Remove cotter pin, nut, and washer fastening engine front mounting stud (in timing gear cover) to frame.
- (17) Remove nuts and washers fastening engine side mountings to brackets.

Note. Use Safety Lift or equivalent tool to fasten engine assembly to hoist during removal and installation. Connect one end of engine sling under cylinder head nut (located in center of head on second stud from fan end of engine.) Install other end of engine sling on the top center bolt that fastens torque converter case and transmission case together.

- (18) With Safety Lift or equivalent tool in place on engine and hoist, raise engine carefully, move engine toward rear of vehicle to disengage transmission output shaft from universal joint splined yoke, then raise engine and transmission assembly up and out of chassis.

c. Remove Transmission from Engine.

Caution: The following procedure must be followed to prevent damage to torque converter.

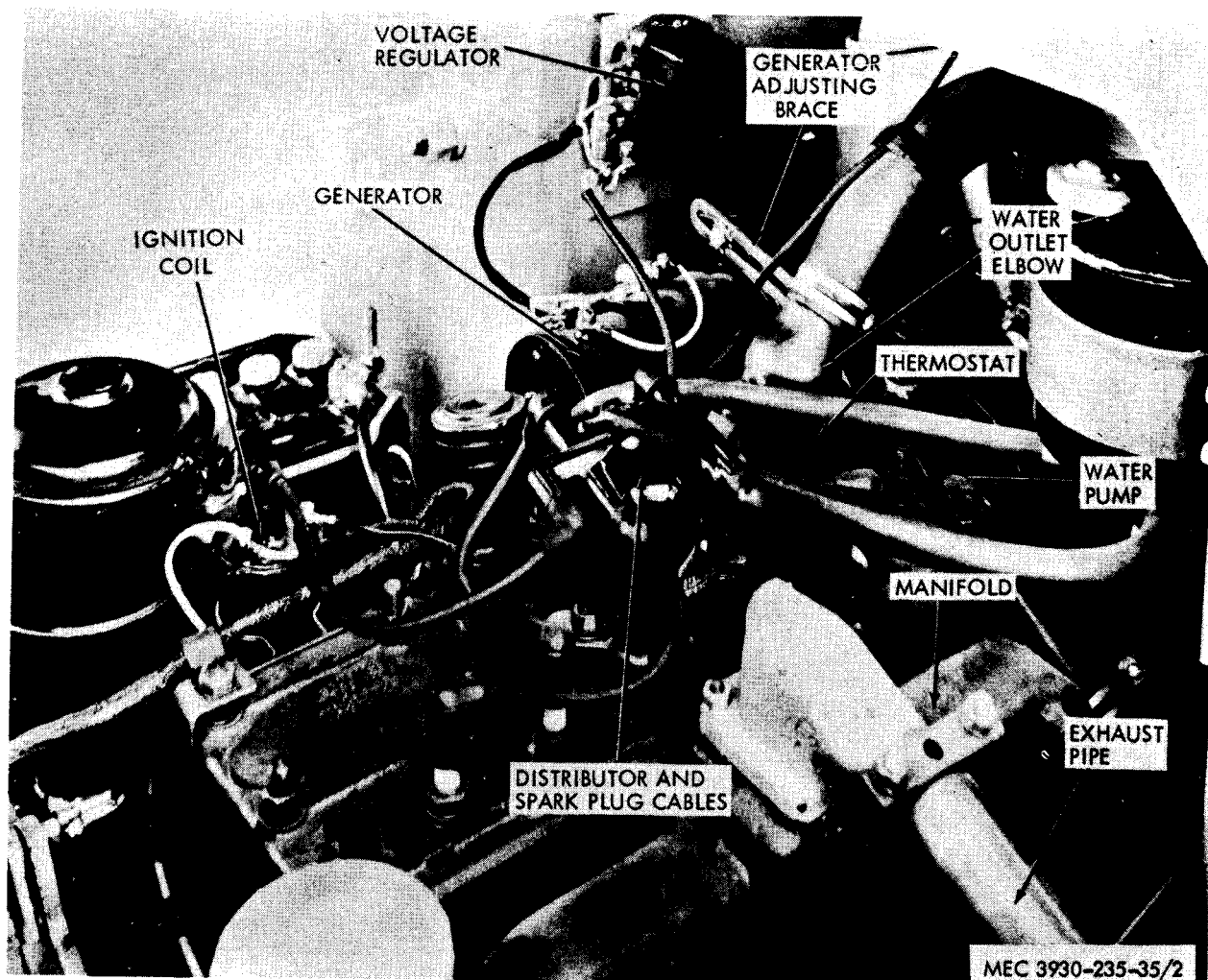


Figure 2. 3/4 Front left side of engine, installed view.

Do not allow total weight of transmission to hang on converter.

- (1) Remove screws, washers, and nuts, then remove cover and seals.
- (2) Remove screws and washers fastening torque converter to engine flywheel. Support weight of transmission with hoist, then remove screws and washers. Remove transmission assembly from engine. Slide torque converter off transmission to prevent damage.

d. Install Transmission on Engine.

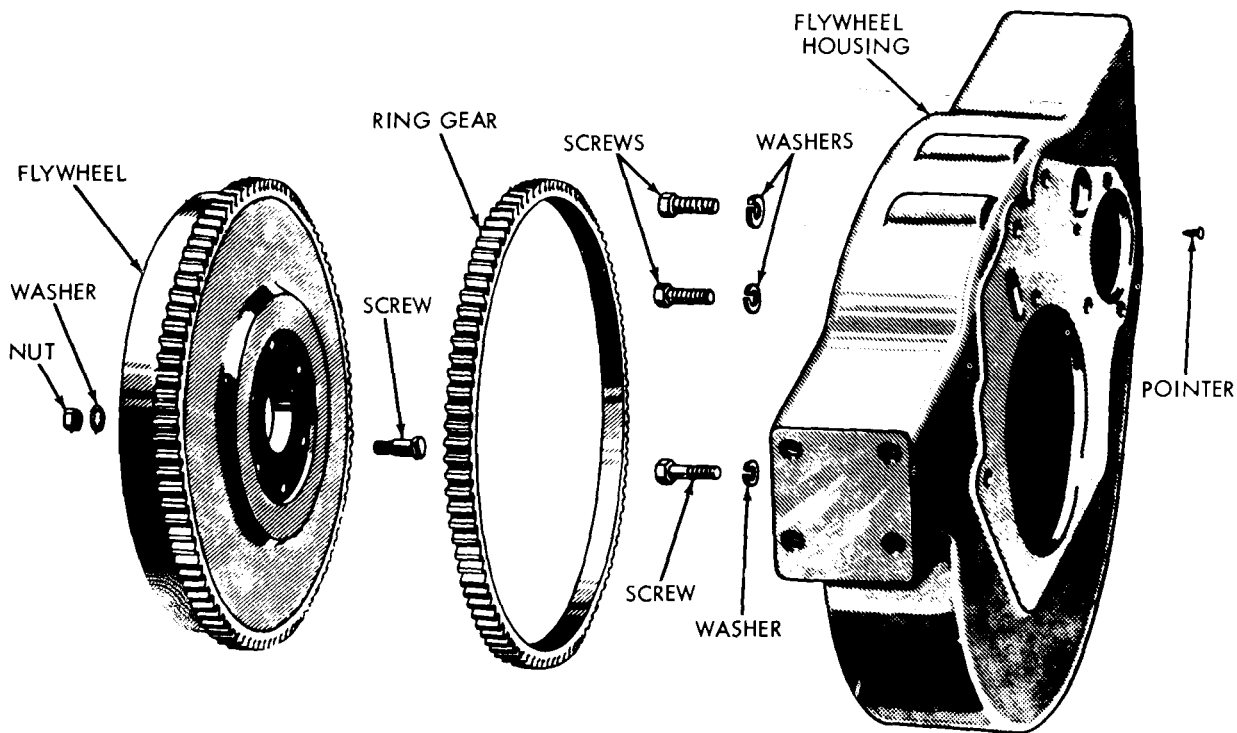
Caution: The following procedure must be followed to prevent damage to torque converter. Do not allow total weight of transmission to hang on converter.

- (1) Prior to installing transmission on engine, install torque converter carefully aligning driving lugs with oil pump drive gear. When mounted properly, converter should touch the converter case. With converter in this position, assemble transmission to engine and secure with washers and screws. Slide converter toward engine flywheel and align screw holes. Install screws and washers.
- (2) Position seals on cover, then secure with screws, washers and nuts.

e. Install Engine and Transmission Assembly.

Note. Install engine with accessories installed and install as engine and transmission assembly.

- (1) Connect Safety Lift or equivalent tool as in b(18) above.



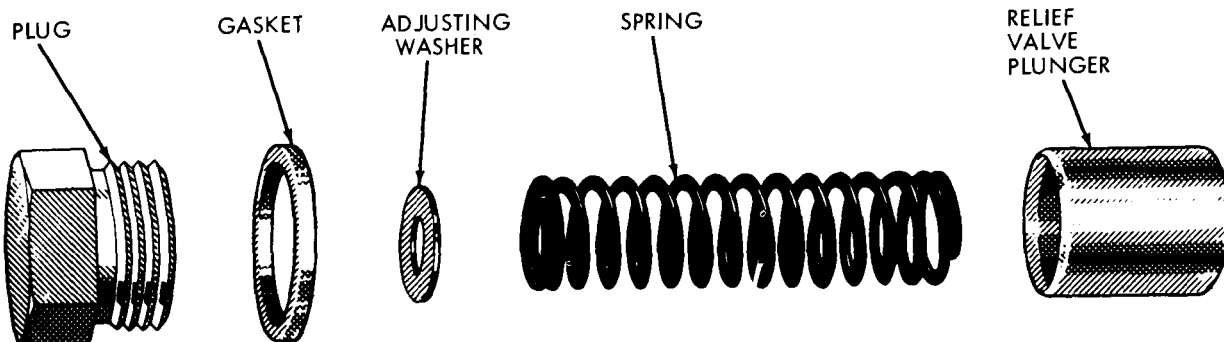
MEC 3930-235-35/4

Figure 4. Flywheel and housing, exploded view.

- (2) With sling correctly installed on engine and attached to chain hoist, lower and maneuver engine into chassis and at the same time engage transmission output shaft with universal joint splined yoke. Lower engine on side mountings and secure with washers and nuts. Fasten engine front mounting stud to frame with washer, nut, and cotter pin. Visually check uni-

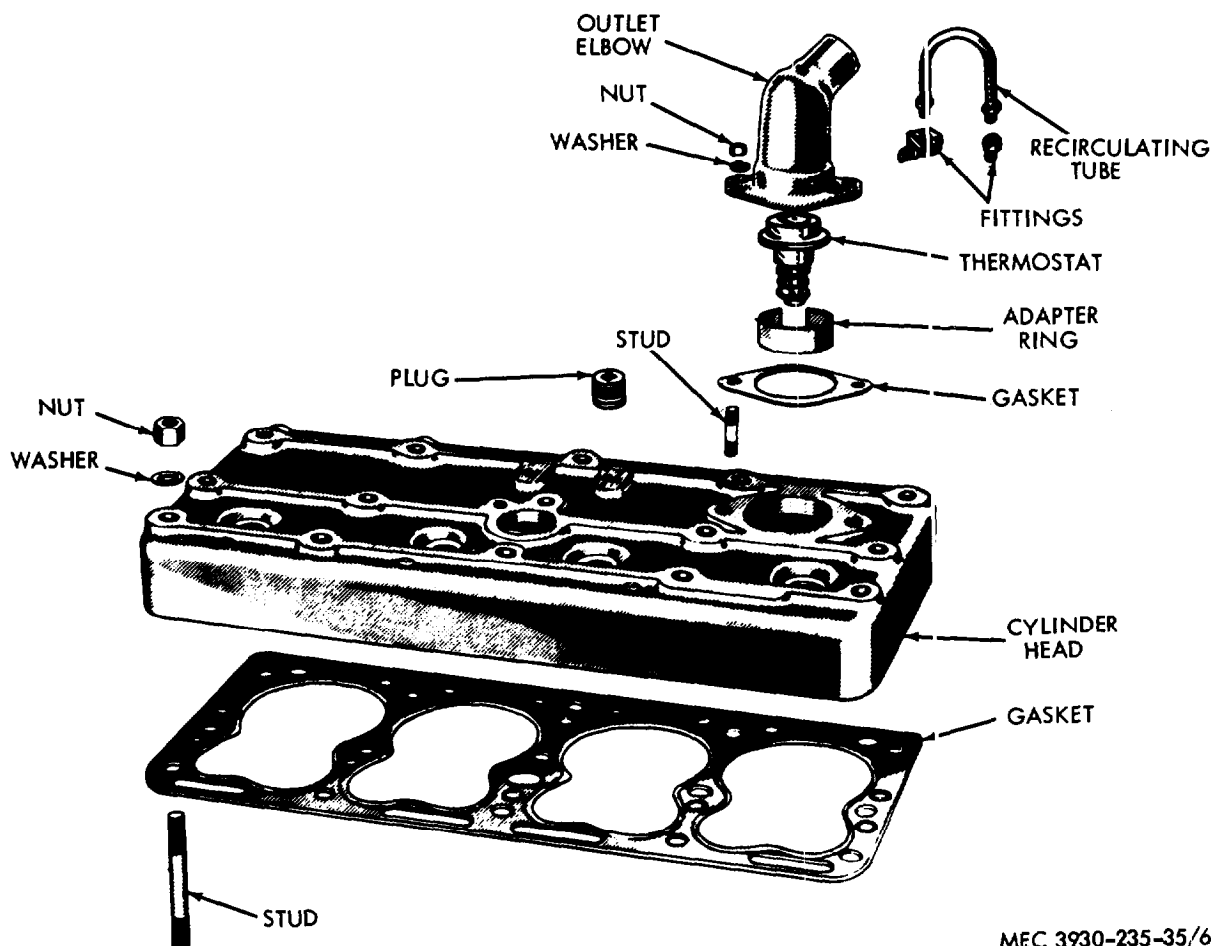
versal joint alignment. Permissible maximum misalignment is $\frac{1}{8}$ of an inch. Adjust by removing or installing shims at engine mountings.

- (3) Connect battery wire at generator regulator. Connect armature and field wires to generator and secure with nuts and washers.



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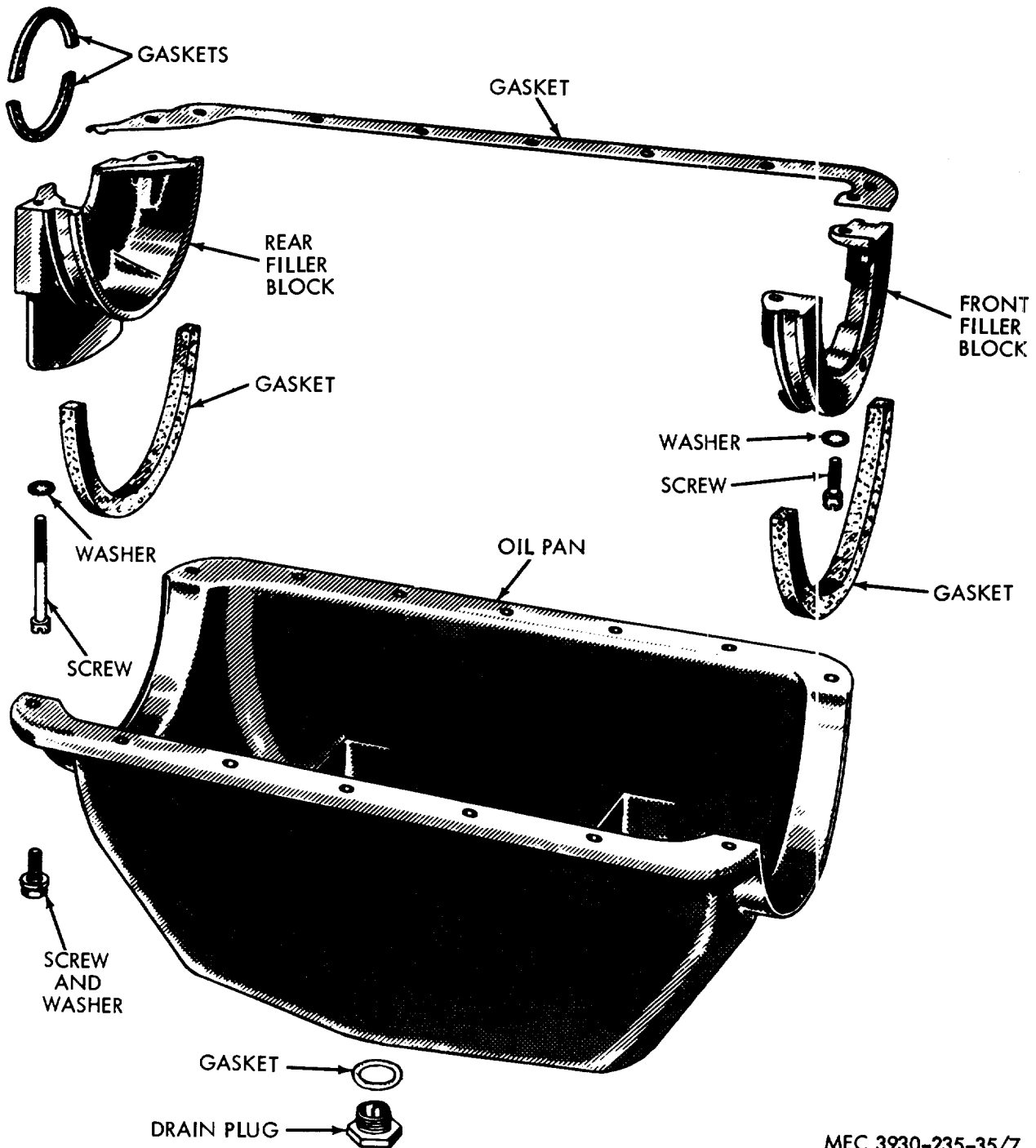
Figure 5. Relief valve, exploded view.



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Figure 6. Cylinder head, exploded view.

- (4) Connect creeper pedal linkage and shift lever linkage at transmission control valve plungers and secure with clevis pins and cotter pins.
 - (5) Match wire colors when making the following electrical connections: connect thermocouple wire and tail- and stop-light wires at terminal junction. Connect ammeter to regulator cable at connectors. Connect engine wire harness to chassis wire harness at disconnect plug.
 - (6) Install muffler and pipes.
 - (7) Engage hoses in clamps mounted on transmission cover and cylinder head, then connect hoses to steering hydraulic pump. Fill power steering system and check for leaks.
 - (8) Install new gasket on timing gear cover studs, then install hydraulic lift pump, with hoses connected, on timing gear cover studs. Secure with nuts and washers.
 - (9) Install radiator. Fill to level with proper coolant and check for leaks.
 - (10) Install battery and cables.
 - (11) Install counterweight and hood.
 - (12) Install floor plates.
 - (13) Install body side plates and grill.
 - (14) Install engine hood.
 - (15) Install operator's seat.
 - (16) Install overhead guard.
 - (17) Fill engine crankcase, transmission and power steering system with correct lubricant (LO 10-3930-235-20).
- 10. Removal of Engine Accessories**
- a. Remove generator (TM 10-3930-235-20).



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Figure 7. Oil pan, filler blocks and gaskets, exploded view.

- b. Remove starting motor (TM 10-3930-235-20).
- c. Remove carburetor air cleaner (TM 10-3930-235-20).

- d. Remove accelerator pedal and linkage (TM 10-3930-235-20).

- e. Remove carburetor (TM 10-3930-235-20).

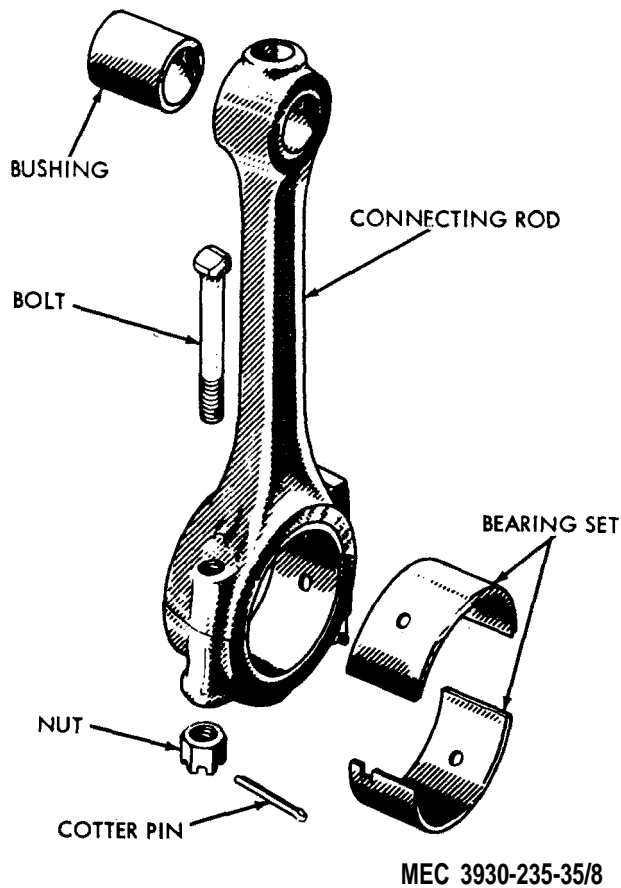


Figure 8. Connecting rod, exploded view.

- f. Remove fuel pump (TM 10-3930-235-20).
- g. Remove power steering hydraulic pump (para. 50).
- h. Remove exhaust pipe (TM 10-3930-235-20).
- i. Disconnect and remove ignition wires from spark plugs and distributor cap. Disconnect and remove high tension wire from coil and distributor cap. Disconnect low tension wire at distributor. Remove nut, washer, distributor clamp, and distributor. Remove distributor drive shaft. Disconnect low tension and capacitor wire from coil. Remove nuts, washers, and screws, then remove coil and capacitor.
- j. Disconnect wires from temperature indicator sending unit, oil gage unit, and hour meter pressure switch. Unscrew and remove temperature sending unit from cylinder head. Unscrew and remove oil gage unit and pressure switch from cylinder block.

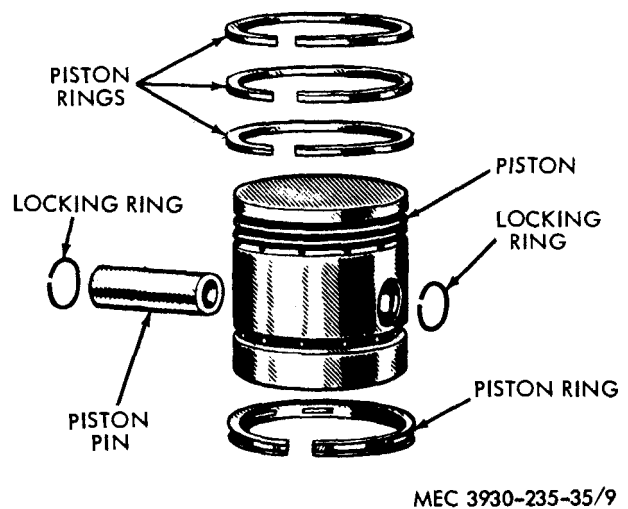


Figure 9. Piston and rings, exploded view.

11. Disassembly of Engine into Subassemblies

- a. Disconnect oil filter inlet and outlet hoses at engine. Remove nuts, washers, screws, and oil filter, assembled on bracket, from air cleaner mounting bracket.
- b. Remove screws, washers, and fan from fan hub. Remove recirculating tube. Remove screws and washers fastening water pump to block, then remove water pump and gasket.
- c. Remove nuts, washers, water outlet elbow, gasket, adapter ring, and thermostat from cylinder head.
- d. If replacement is necessary, unscrew and remove filler cap and oil filler body. Remove oil gage rod and felt seal (fig. 3).
- e. Remove flywheel nuts (fig. 4) and washers from bolts. Flywheel is provided with two puller screw holes. Remove flywheel from crankshaft flange using puller screws. If necessary to remove ring gear from flywheel (para. 14). If replacement is necessary, remove screws and washers, then remove mounting brackets from flywheel housing. Remove screws and washers, then remove flywheel housing from cylinder block.
- f. Remove nuts (fig. 16), washers, manifold assembly, and gasket from cylinder block.
- g. Remove relief valve plug (fig. 5), gasket, adjusting washer, spring, and relief valve from crankcase.

h. Remove nuts (fig. 6), washers, cylinder head, and gasket.

i. Remove drain plug (fig. 7) and gasket and drain engine oil. Remove screw assemblies, oil pan, gaskets, and filler block. Remove screws and washers, then remove front filler block. Remove screws and washers, then remove rear filler block. Remove oil pan gaskets.

j. Remove nut, washer, oil pump, and washer from crankshaft bearing cap.

k. Remove cotter pin (fig. 8) and nut from bolt. Remove connecting rod cap and bearing. Push connecting rod and piston assembly out through top of cylinder block (fig. 9).

l. Remove nuts (fig. 3), gaskets, valve cover, and gasket. Using a valve spring compressing tool, compress valve spring (fig. 10), then remove keys, valve, and cap. Release spring compressor, then remove seat and spring. Remove all valves in the same manner.

m. Remove screws and washers fastening timing gear cover (fig. 14) to cylinder block, then remove gear cover assembly and gasket.

n. Cut lock wire and remove screws and washers, then remove crankshaft main bearing caps (fig. 11) and bearing halves. Remove crankshaft assembly and other bearing halves from crankcase. Remove rear filler block seal, rear bearing oil guard, and oil guard felt from crankcase. To disassemble crankshaft, remove snap ring. Remove screw, then remove coupling gear and timing gear from crankshaft. Remove keys and thrust plate from crankshaft.

o. Remove screws (fig. 12) and washers, then remove camshaft assembly from cylinder block. To disassemble camshaft, remove nut and governor driver. Pull timing gear (fig. 13) off camshaft, then remove key and thrust plate. Remove valve lifters (fig. 10) and adjusting screws from cylinder block.

p. If necessary, remove camshaft bushings (fig. 12), exhaust valve inserts (fig. 10), and valve guides from cylinder block (para. 14).

Note. Before removing valve guides, measure the distance from the top of the guide to the top surface of the cylinder block for identification upon reinstallation.

12. Disassembly of Engine Subassemblies

a. Disassembly of Piston and Connecting Rod.

- (1) Remove retainers, then push piston pin out of piston. Remove piston rings from piston.

- (2) If replacement is necessary, remove bushing from connecting rod (para. 14).

b. Disassembly of Engine Timing Gear Cover (fig. 14).

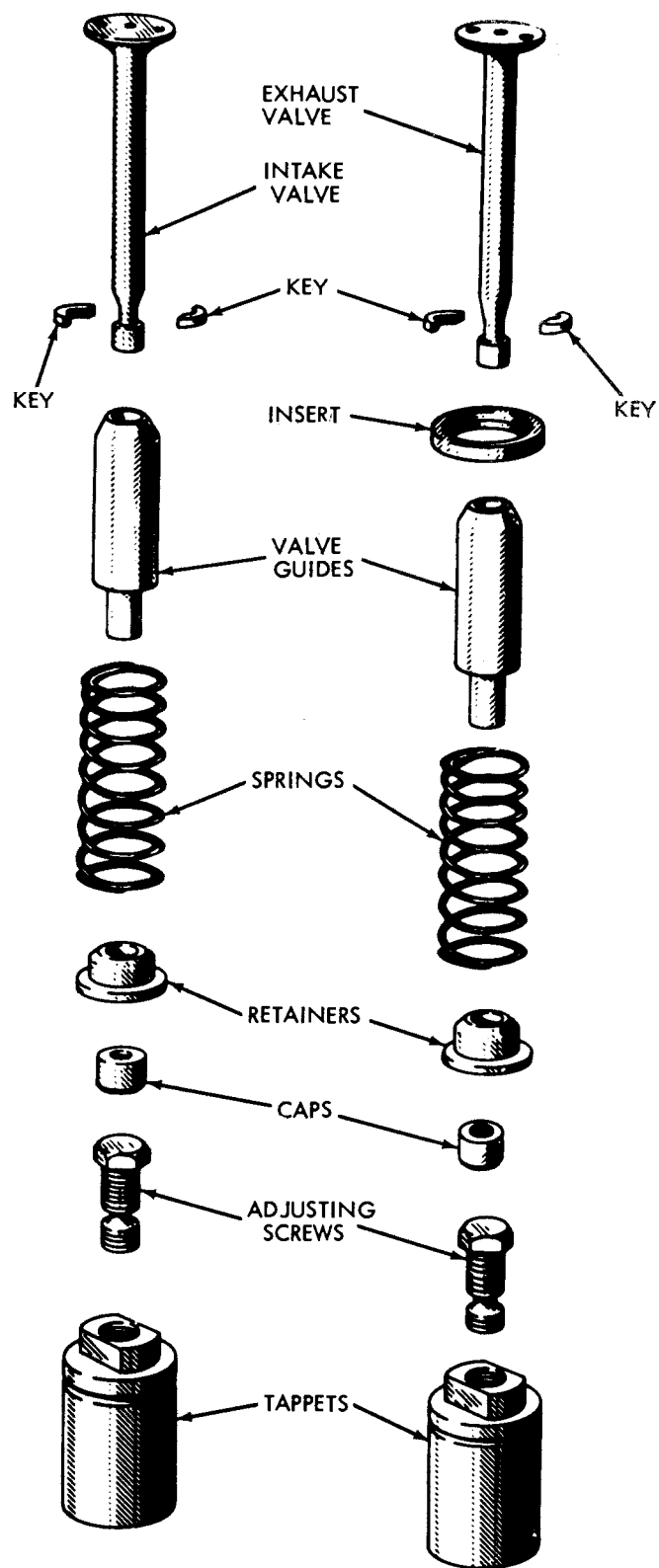
- (1) Remove screw and washer, fan drive assembly, and gasket from gear cover. To disassemble fan drive (fig. 17), remove pulley from shaft. Loosen nut and remove screw. Remove adapter from shaft. Remove gear from shaft and bearing.
- (2) Loosen nut (fig. 18), then remove governor adjusting screw and spring.
- (3) Remove pin and arm, then remove lever assembly (fig. 18) from timing gear cover. If replacement is necessary, remove oil seal, felt seal, and bearings from gear cover.
- (4) Remove governor cup and shaft assembly from camshaft. Remove nut, then remove governor driver assembly from camshaft.

c. Disassembly of Engine Oil Pump (fig. 15).

- (1) Unfasten lock wire and remove screen from pump.
- (2) Remove screw assemblies, spacer, frame, and gasket from pump.
- (3) Remove screw assemblies, cover assembly, and gasket from pump body. Remove idler gear from body.
- (4) Remove pin from drive gear, then press shaft out of drive gear and remove drive shaft and driven gear assembly.
- (5) Press driven gear on drive shaft approximately one-fourth of an inch to permit removal of snap ring. Remove snap ring, then press gear off shaft. Remove key from shaft.
- (6) If replacement is necessary, remove idler gear shaft and bushing from pump body (para. 14).

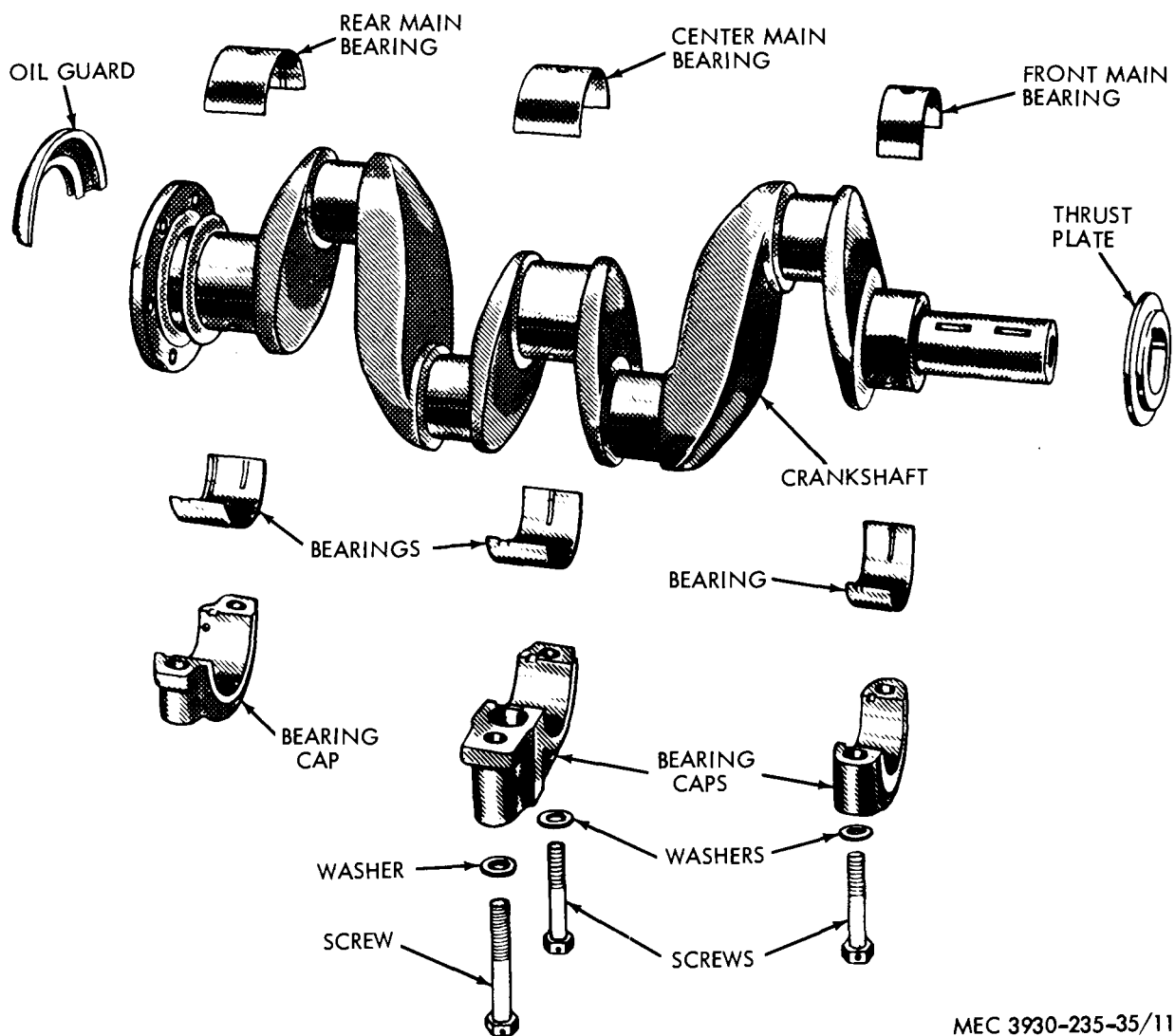
d. Disassembly of Manifold (fig. 16).

- (1) Remove pin, then remove lever from valve shaft.
- (2) Remove pin, then remove valve shaft from manifold, and heat control valve. Lift out heat control valve.
- (3) If replacement is necessary, press bushings out of manifold.



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Figure 10. Intake and exhaust valves, exploded view.



MEC 3930-235-35/11

Figure 11. Crankshaft, bearings and caps, exploded view.

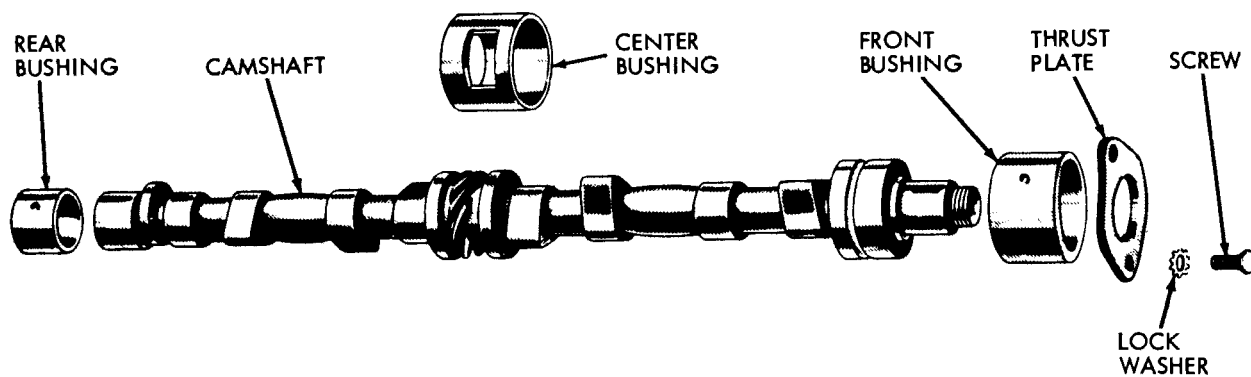
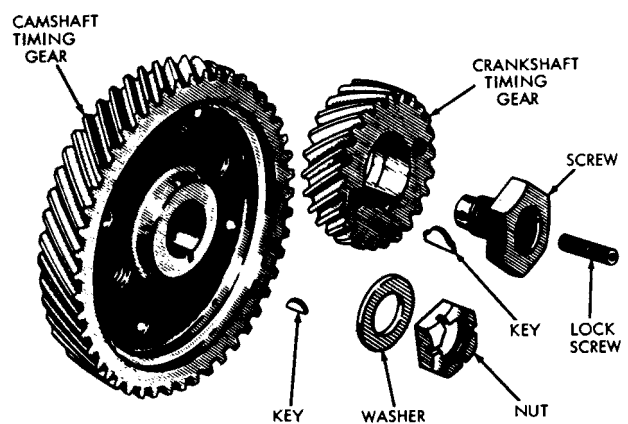


Figure 12. Camshaft, exploded view.

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MEC 3930-235-35/13

Figure 13. Timing gears, exploded view.

13. Engine Inspection

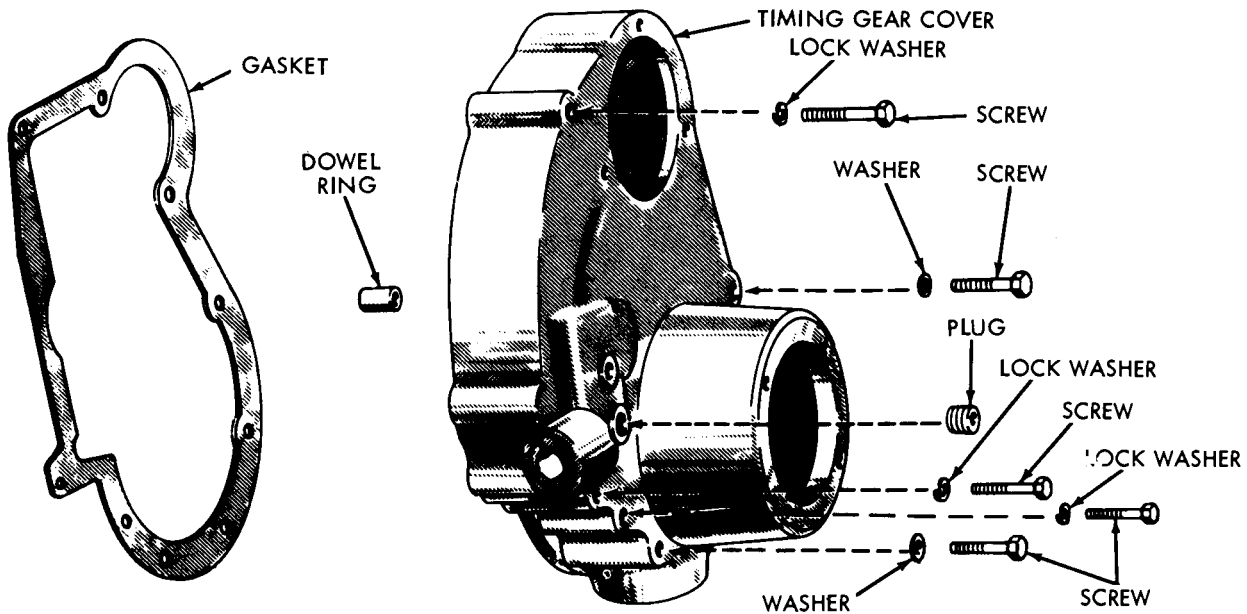
a. *Cylinder and Crankcase* (fig. 3). Inspect cylinder and crankcase. (fig. 3) for cracks or erosion of water passages. Inspect cylinder walls for scored, tapered, or out-of-round condition. If cylinder is worn beyond limits given in paragraph 6, recondition cylinder walls and install new oversize pistons and rings.

b. *Pistons* (fig. 9).

(1) Inspect pistons for scored, cracked, or worn

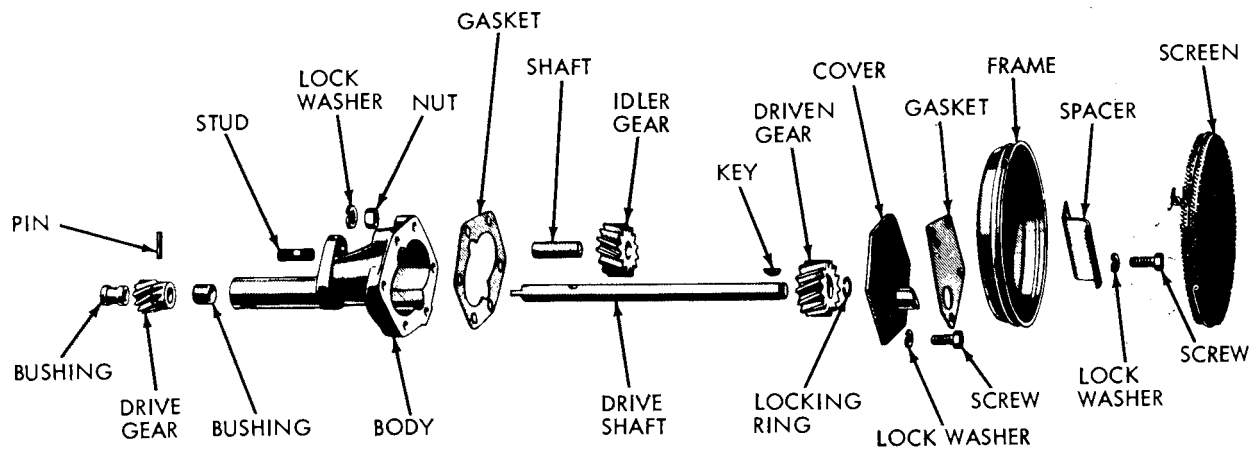
condition. If pistons are worn beyond limits given in paragraph 6, install new pistons and rings.

(2) To measure piston to cylinder wall clearance, place a 0.0015-inch feeler ribbon between piston and cylinder walls and withdraw piston and feeler ribbon from cylinder with a spring scale. Correct clearance is indicated when feeler ribbon is removed with 5 to 10 pound pull.



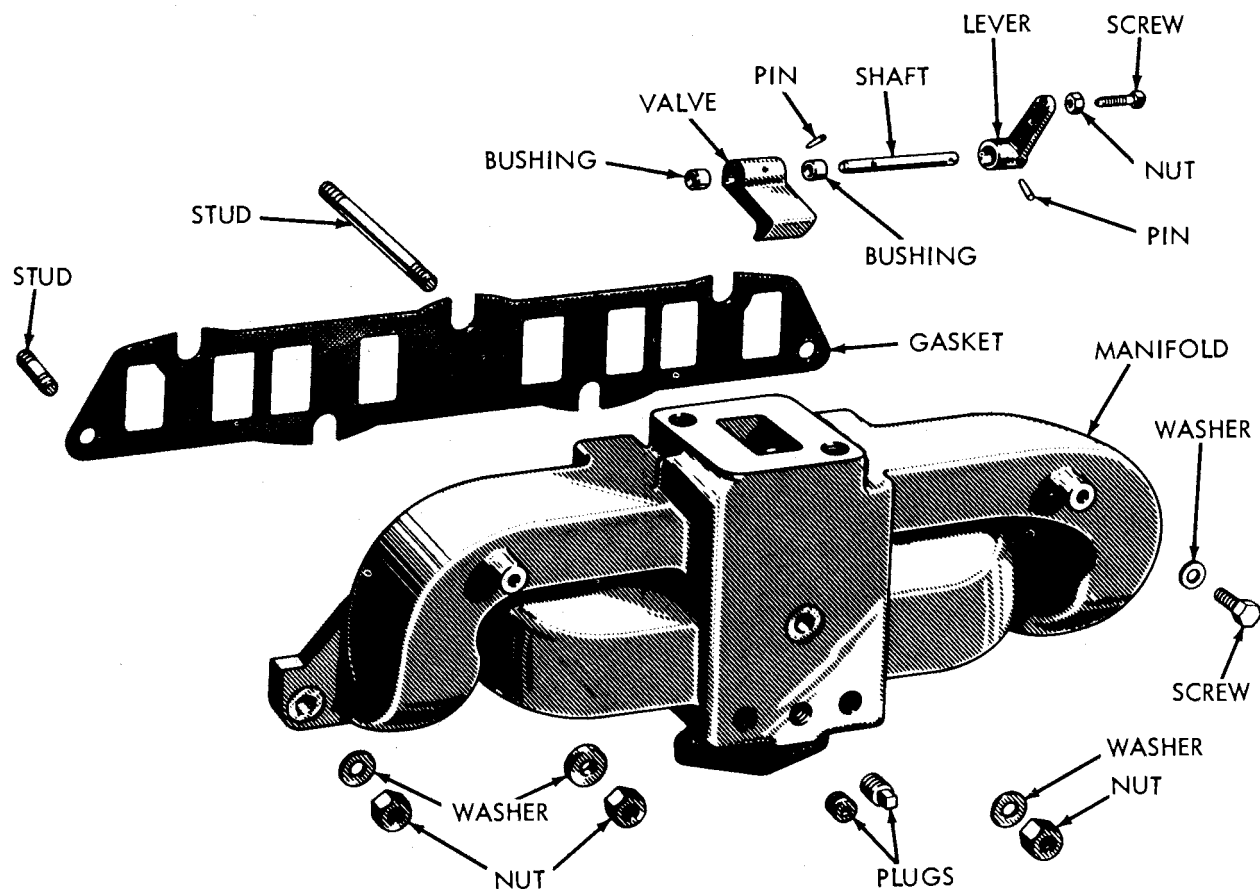
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Figure Timing gear cover, exploded view.



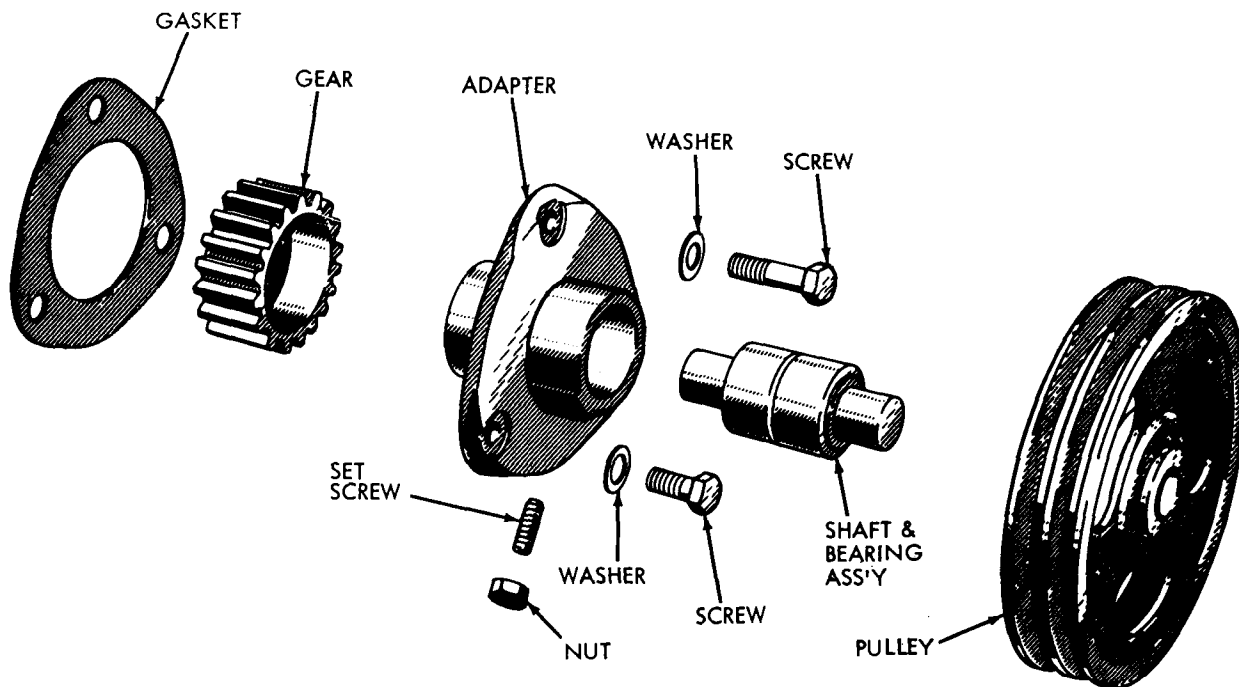
MEC 3930-235-35/15

Figure 15. Oil pump, exploded view.



MEC 3930-235-35/16

Figure 16. Manifold, exploded view.



MEC 3930-235-35/17

Figure 17. Fan drive, exploded view.

c. Piston Rings (fig. 9).

- (1) Inspect for broken or worn piston rings. If rings are broken or worn beyond limits given to paragraph 6, install new rings.
- (2) To measure piston ring side clearance, temporarily install rings in piston grooves and measure clearance with a feeler gage. To measure end gap, insert ring in cylinder and square the ring in the cylinder with head of piston. Ring should be positioned in the cylinder to a depth of the length of the piston. Measure end gap with a flat feeler gage. Clearances should be within limits given in paragraph 6.

d. Piston Pins (fig. 9). Inspect pin, piston pin bore, and connecting rod bushing for scored or worn condition. If dimensions and fits exceed those given in paragraph 6, replace worn parts.

e. Inspect connecting rod for twisted or bent condition. Straighten connecting rod if twisted beyond limits indicated in paragraph 6.

f. Crankshaft and Bearings (fig. 11).

- (1) Inspect crankshaft journals and bearings for scored or worn condition. Inspect

crankshaft journals for tapered or out-of-round condition. If bearing and journal dimensions exceed limits indicated in paragraph 6, replace worn parts.

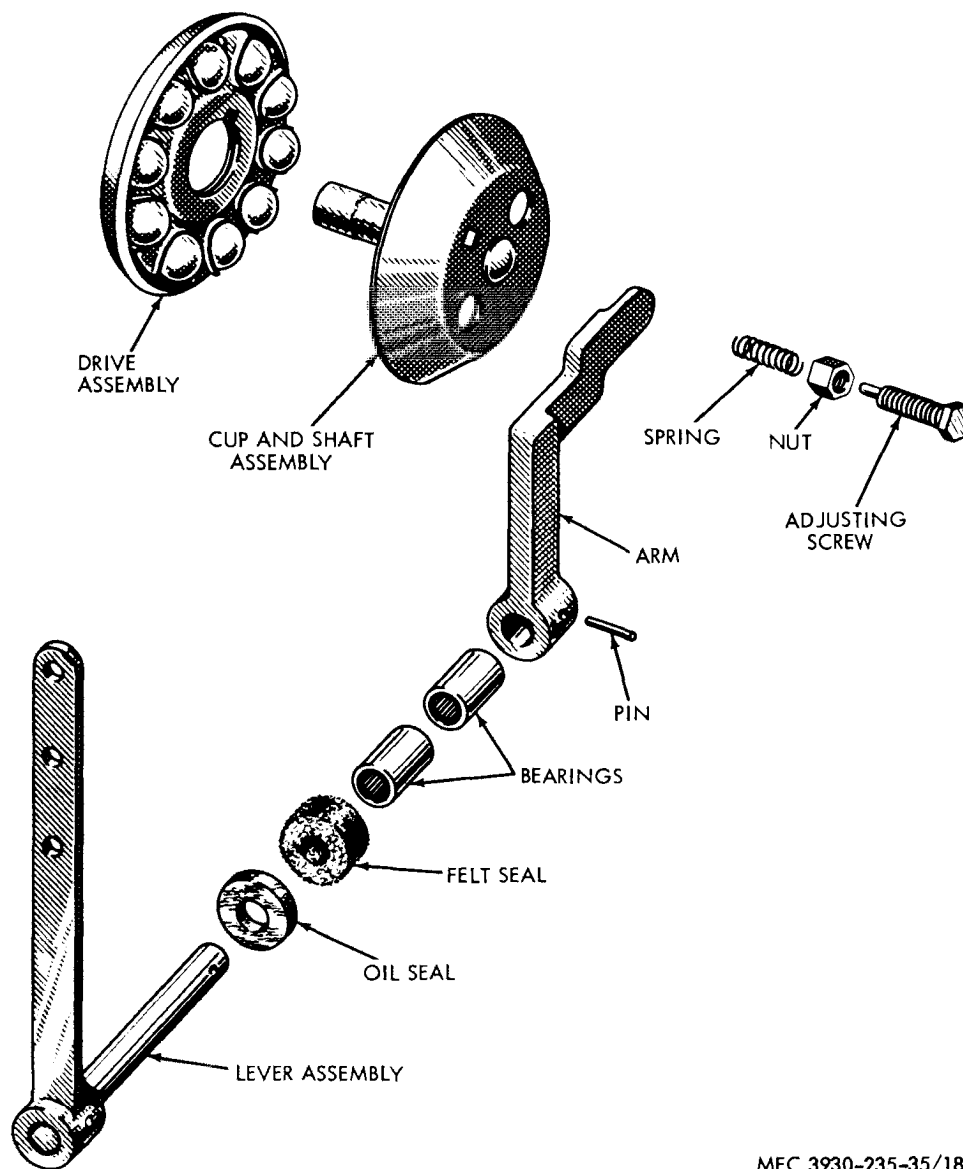
- (2) To measure crankshaft journal to bearing clearances, use a well-oiled 0.002 inch brass shim (1/2 inch wide and approximate length of bearing) as follows: Place shim between bearing and journal. Tighten bearing cap and loosen all other bearing caps. If there is a light drag resistance to turning rod or crankshaft, correct clearance is indicated.

g. Camshaft and Bushings (fig. 12).

- (1) Inspect camshaft journals and bushings for scored or worn condition. If dimensions or clearances exceed limits given in paragraph 6, replace worn parts.
- (2) Inspect camshaft thrust plate for scoring or wear. Inspect camshaft end thrust during reassembly (para. 6). If thrust plate is scored or if camshaft end thrust is beyond limits given in paragraph 6, replace thrust plate.

h. Valves (fig. 10).

- (1) Inspect valve faces and seats for pitted or



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Figure 18. Governor, exploded view.

burned condition. Reface faulty seating surface (para. 14) or replace faulty parts.

- (2) Inspect valve and guide for wear. If valve or guide dimensions and clearances exceed limits given in paragraph 6, replace worn parts.
- (3) Inspect for broken or weak valve springs. If spring lengths are beyond specifications given in paragraph 6, replace springs.

i. *Timing Gears* (fig. 13). Inspect timing gears for chipped, broken, or worn teeth. If one or more

gears are faulty, replace both gears. Inspect timing gear backlash during reassembly (para. 6). If backlash is beyond limits given in paragraph 6, replace both gears.

j. *Flywheel Ring Gear* (fig. 4). Inspect ring gear for chipped or broken teeth. Replace faulty gear (para. 14h).

k. *Cylinder Head* (fig. 6). Inspect cylinder head for cracks or warped condition. Inspect for erosion of water passages. Replace cylinder head if faulty or warped.

l. *Gear Cover* (fig. 14). Inspect gear cover for cracks or damage. Replace faulty cover.

m. *Fan Drive* (fig. 17).

- (1) Inspect bearing for binding or excessive looseness. Bearing should rotate freely on shaft without perceptible side play or looseness. Replace a binding or loose bearing.
- (2) Inspect gear for chipped or broken teeth.

n. *Governor* (fig. 18).

- (1) Inspect fit of governor lever shaft in bearing. Shaft should rotate freely without perceptible side play. Replace worn shaft or bearing.
- (2) Inspect ball race for scoring or evidence of wear. Inspect bearing balls for flat spots or scoring. Replace faulty parts.

o. *Oil Pump* (fig. 15).

- (1) Inspect gears for chipped or broken teeth. Inspect idler shaft for scored or worn condition. Inspect gear backlash and clearances during reassembly (para. 6). Replace parts worn beyond limits given in paragraph 6.
- (2) Inspect body bushings and drive shaft for scored or worn condition. If worn beyond limits given in paragraph 6, replace worn parts. Refer to paragraph 14i.

p. *Manifold* (fig. 16).

- (1) Inspect manifolds for cracked or warped condition. Replace faulty manifold.
- (2) Inspect heat control valve shaft and bushing for binding. Shaft should rotate in bushing with hand pressure. Replace faulty parts.

q. *Drive Belts*. Inspect as indicated in TM 10-3930-235-20.

r. *Thermostat*. Inspect and test thermostat. Refer to TM 10-3930-235-20.

14. Engine Repair

Note. Refer to TM 10-3930-235-35P for available repair kits referenced in Engine Repair.

a. *Cylinder Walls, Pistons and Rings* (figs. 3 and 5).

- (1) Recondition worn cylinder walls and fit new pistons and rings as necessary.

- (2) Recondition cylinder walls with cylinder hone or boring machine. Remove only enough material to clean and true-up cylinder, then hone or bore until the next available oversize piston fits with correct clearance (para. 6). If removal of 0.004 inch of material will clean worn cylinder, recondition with a cylinder hone. If necessary to remove over 0.004 inch material, recondition with a boring machine, then polish with a finishing hone. If boring or honing operation is performed with crankshaft and camshaft installed, cover these parts to protect them from chips and emery dust. After reconditioning procedure, thoroughly clean cylinder walls and engine parts, using SD.
- (3) Select new oversize rings to match oversize pistons. Before installing rings on pistons, temporarily insert rings in cylinder and

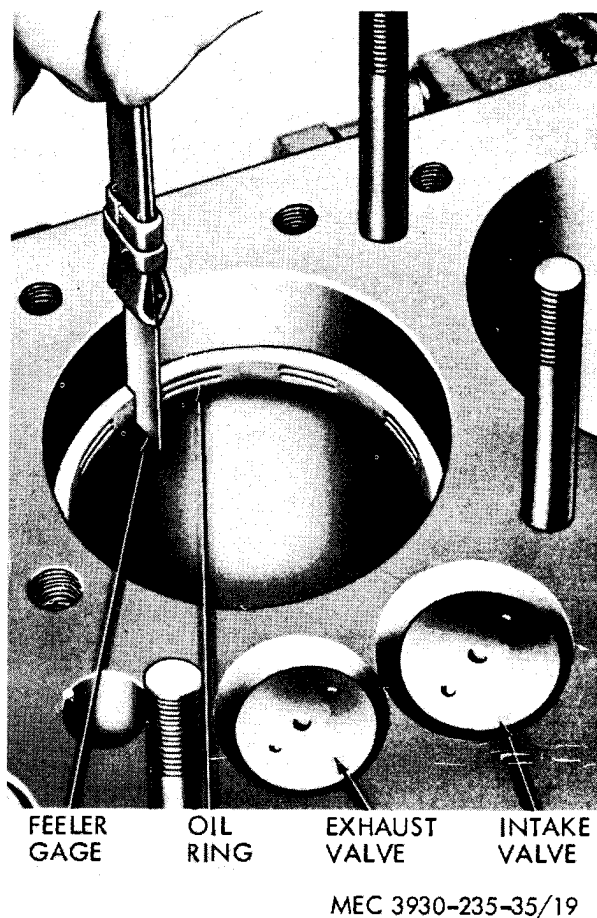


Figure 19. Measuring ring gap.



Figure 20. Filing ring gap.

measure end gap (fig. 19). If end gap is not sufficient, file ends of rings (fig. 20) to obtain correct gap. Temporarily insert rings in piston grooves and measure side clearances. See figure 21.

b. Pins, Pistons, and Connecting Rod Bushings (fig. 9).

- (1) If pin is a loose fit in piston pin bore, replace pin or piston. If necessary, ream new piston to specifications given in paragraph 6.
- (2) If pin is a loose fit in connecting rod bushing, replace pin or bushing. Use arbor press to replace bushing in connecting rod. If necessary, ream to specification given in paragraph 6.

c. Connecting Rod. If connecting rod is bent or twisted beyond limits (para. 6), straighten rod using suitable bending tools.

d. Crankshaft and Bearings (fig. 11).

- (1) Crankshaft main and connecting rod bearings are of the split insert type and should not be repaired or altered. Replace bearings that are worn or faulty.
- (2) Clean up slightly scored or scratched crankshaft bearing journals with an india stone. Replace crankshaft with journals worn beyond limits given in paragraph 6.

e. Camshaft and Bushings (fig. 12). Replace worn camshaft bushings. Drive old bushings out of

cylinder block using a brass pilot drift. The rear bushing is accessible after removal of the expansion plug at the flywheel end of the cylinder. When installing center bushing, make certain that bushing hole is aligned with opening for oil pump drive gear and that slotted edges are aligned with up and down movement of tappets. When installing front and rear bushings, be sure bushing oil holes are aligned with holes in block. Use a brass pilot to install new bushing. If necessary, ream new bushings to specifications given in paragraph 6.

f. Valves and Seats (fig. 10).

- (1) Recondition faulty seating face of valve heads using a valve refacing machine. Machine seats at angles indicated in paragraph 6. Do not burn face of valve or remove more material than is necessary to eliminate burned or pitted areas.
- (2) Recondition valve seats in cylinder block with a cutter or grinding machine. Machine seats to angles specified in paragraph 6. If exhaust valve seat will not refinish within specification, replace seat insert as follows. Remove exhaust valve seat insert from cylinder block using a suitable puller. To install, chill inserts with dry ice, then tap insert in cylinder block with a driving tool. Make certain that seat insert is aligned squarely with counterbore during installation.

g. Valves and Guides (fig. 10). Replace worn guides or valves with scored or worn stems as follows: Remove guides with a pilot drift. Install guides with a pilot drift, positioning guide in block so that the distance between top surface of cylinder block and top of valve guide is the same measurement made before removal of old guide. If necessary, ream new guides to specifications given in paragraph 6.

h. Flywheel Ring Gear (fig. 4). Replace faulty ring gear. To remove gear from flywheel, heat gear, then press or tap gear off flywheel. To install new gear, chill flywheel in dry ice and press or tap new gear on flywheel.

i. Oil Pump (fig. 15)

- (1) Replace worn body bushings. Use arbor press to remove and install bushings. If necessary, ream bushing to fit drive shaft, within limits given in paragraph 6.



Figure 21. Measuring ring groove clearance.

- (2) Replace worn or scored idler gear shaft. Use arbor press to remove and install shaft. Press shaft into body until end of shaft is flush with body. Make certain that shaft does not extend past idler gear face on cover side.
- (3) If gears are worn or faulty, it is recommended that parts contained in repair kit be replaced.

15. Reassembly of Engine Subassemblies

a. Reassembly of Manifold (fig. 16).

- (1) If bushings were removed from exhaust manifold, install new bushings using an arbor press.
- (2) Position valve in recess of exhaust manifold, then install valve shaft through manifold and heat control valve and secure with pin.
- (3) With valve in closed position, install lever on valve shaft and position so that valve can be opened or closed when rotating lever. Secure lever to shaft with pin. Se-

lect the required valve position opening, then secure with screw and nut. Adjust sector to fully open position for temperature below 32° F. (0° C); fully closed position for temperature above 70 F. (21° C) and between open and closed for temperatures between 32° F. and 70° F. (0° C and 21° C).

b. Reassembly of Oil Pump (fig. 15).

- (1) If idler gear shaft or bushing were removed from pump body, install new bushing or shaft (para. 14i).
- (2) Insert key in drive shaft slot, then press driven gear on drive shaft until snap ring groove extends one-fourth of an inch out of gear. Install snap ring, then press gear toward snap ring until snap ring is firmly seated in gear bore shoulder. Install drive shaft in body.
- (3) Install idler gear on idler gear shaft, then inspect gear backlash as follows: Place dial indicator pin on driven gear tooth, then secure idler gear with one hand and rotate drive shaft back and forth and observe dial indicator reading for gear backlash. Backlash should be within limits given in paragraph 6. Inspect gear face to body cover clearance as follows: Position lead gasket (0.007-inch-thick) on body, then place a straight edge on gasket and measure clearance between straight edge and outer gear face, using a flat feeler gage. Clearance should be within limits given in paragraph 6. Inspect gear tooth to body clearance as follows: Insert a flat feeler gage between gear teeth and pump body and measure clearance. Clearance should be within limits given in paragraph 6.
- (4) Place drive gear, hub end toward pump body, on shaft end. Press gear on shaft and install pin. Peen ends to secure pin.
- (5) Before installing cover, lubricate gears and shafts with engine oil OE 10. Install gasket, cover, screw assemblies, gasket, frame, spacer, and screw assemblies. Install screen and secure with lock wire.

c. Reassembly of Timing Gear Cover (fig. 14).

- (1) If bearings, dust seal, oil seal, dowel, and

pipe plug were removed from gear cover, install new parts.

- (2) Install lever assembly in cover. Install arm on lever assembly and secure with pin.
- (3) Press shaft and bearing in adapter until groove of bearing is aligned with setscrew hole in adapter. Install setscrew and tighten screw against bearing. Secure setscrew with nut. Press gear and pulley on ends of shaft. Position gasket on gear cover, then install fan drive assembly and secure with washers and screws.

d. Reassembly of Piston and Connecting Rod (figs. 8 and 9).

- (1) If bushing was removed from connecting rod, install new bushing (para. 14b).
- (2) Position connecting rod in piston and install piston pin and retainers.
- (3) Install rings on piston.
- (4) Install connecting rod bearings during engine reassembly.

16. Reassembly of Engine

Note. When reassembling engine, lubricate internal moving parts with OE.

a. If camshaft bushings; exhaust valve seat inserts or valve guides were removed, install new parts as necessary (para. 14).

b. With cylinder and crankcase inverted, install valve lifters and adjusting screws in cylinder block, then insert camshaft, and adjust end play. Refer to paragraph 6 for permissible end play. Secure camshaft with thrust plate, washers, and screws.

c. Install thrust plate, key, timing gear, key, and coupling gear on crankshaft, then secure with screw and lock screw. Install snap ring on coupling gear.

d. Install upper halves of bearings in cylinder block. Make certain bearing oil holes are aligned with oil holes in cylinder block and that bearing lugs rest in slot provided. Install oil guard felt, rear bearing oil guard, and half of filler block seal in crankcase. Carefully install crankshaft in cylinder block. Install lower halves of bearings in bearing caps. Install bearing caps, aligning dowels with holes in caps and crankcase. Secure caps with screws and washers. Tighten screws to torque of 100 to 110 foot pounds then lock wire screw heads.

Note. Timing gears are punch marked for correct valve timing. When installing camshaft gear, engage gears so that

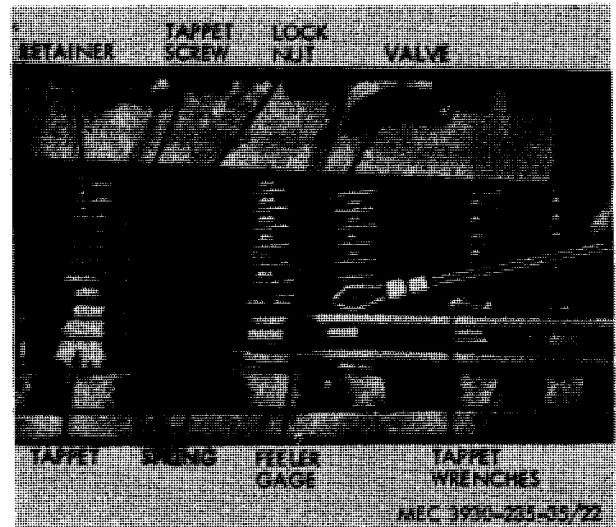


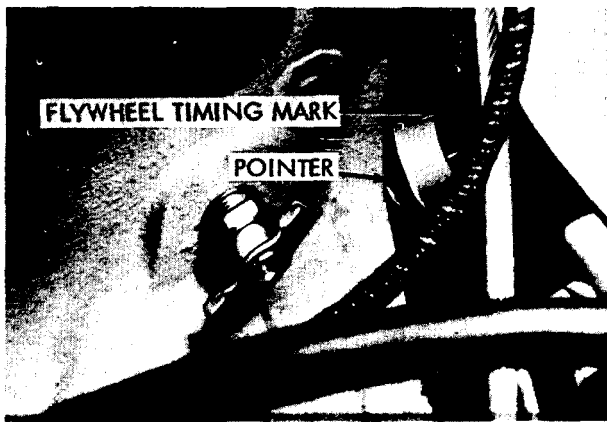
Figure 22. Measuring and adjusting tappet clearance.

marked tooth on crankshaft gear rests between the two marked teeth in the camshaft gear.

e. Install key, timing gear, and governor driver on camshaft, engaging timing gears for correct valve timing. Secure parts with nut.

f. Install valve spring and retainer on boss in cylinder block. Using a valve spring compressing tool, compress valve spring, then install valve, keys, and cap. Remove spring compressor. Install all valves in the same manner. Adjust valve to lifter clearances (fig. 22) by holding lifter and turning adjusting screw. Measure clearance with a feeler gage. When engine is assembled and operating, recheck valve to lifter clearance (0.014 inch, hot), then install gasket, valve cover, gaskets, and nuts.

g. Place upper half of bearings in connecting rod making certain that bearing lugs rest in slots. Install lower half of bearings in connecting rod cap. Lubricate piston rings and piston with OE, then install ring compressor over piston rings. Position connecting rod assembly in top of cylinder, then carefully tap piston with a wood block or hammer handle until piston and rings enter cylinder. Tap piston further until connecting rod upper half engages crankshaft journal. Install connecting rod cap and bearings on crankshaft and secure with bolts and nuts. Tighten nuts to a torque of 35 to 40 foot pounds, then install cotter pins. Install all piston and connecting rod assemblies in the same manner.



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Figure 23. Flywheel timing mark.

h. Place washer on stud in crankshaft bearing cap, then install oil pump assembly and secure with washer and nut.

i. Install new oil pan gaskets on crankcase. Install front and rear filler blocks and secure with washers and screws. Install filler block gaskets.

j. Install oil pan and secure with screw assemblies. Install gasket and drain plug.

k. Place head gasket, with side marked TOP up or if not marked install with seams on top, and cylinder head on cylinder block and secure with washers and nuts. Tighten nuts to a torque of 35 to 40 foot-pounds following tightening sequence shown in figure 24.

l. Install relief valve, spring, adjusting washer, gasket, and plug in crankcase.

m. Install governor cup and shaft in camshaft bore. Install gasket and timing gear cover assembly on cylinder block, then secure with screws and washers. Copper washers are used on screws and these screws and washers are to be installed in the two lowest holes of the timing gear cover. Install nut and spring on screw, then install screw assembly in timing gear cover. Adjust governor after engine is installed and operating.

n. Install gasket and manifold assembly on cylinder block and secure with washers and nuts.

o. Position flywheel housing against cylinder block and secure with washers and screws. Install left and right hand mounting brackets on flywheel housing, then secure with washers and screws. Install screws in crankshaft, then install engine flywheel and secure with washers and nuts.

p. Install distributor drive shaft assembly in cylinder head and engage slot in oil pump.

q. Install oil gage rod and felt seal in crankcase. Install oil filler body, and filler cap in crankcase.

r. Position water pump gasket on block, then install water pump and secure with screws and washers.

s. Install thermostat and adapter ring in water outlet elbow. Position gasket on cylinder head, then install water outlet elbow and secure with washers and nuts. Install elbows in water outlet elbow and water pump and install recirculating tube.

t. Install fan on water pump and secure with washers and screws. Install drive belt on fan drive pulley and fan hub and adjust (TM 10-3930-235-20).

17. Installation of Accessories on Engine

a. Place engine wire harness in clips, then secure to cylinder head studs with nuts.

b. Install pressure switch, oil gage and thermo unit, then connect wires to terminals.

c. Install coil and capacitor and secure with screws, nuts, and washers. Connect low tension wire and capacitor wire to coil.

d. Install distributor (TM 10-3930-235-20).

e. Install exhaust pipe (TM 10-3930-235-20).

f. Install power steering hydraulic pump (para. 50).

g. Install carburetor (TM 10-3930-235-20).

h. Install accelerator pedal and linkage (TM 10-3930-235-20).

i. Install fuel pump (TM 10-3930-235-20).

j. Install air cleaner (TM 10-3930-235-20).

k. Install starting motor (TM 10-3930-235-20).

l. Install generator (TM 10-3930-235-20).

18. Installation of Transmission on Engine

see paragraph 9d.

19. Installation of Engine and Transmission Assembly

See paragraph 9e.

Note. With engine assembled, start and operate engine and perform necessary adjustments as indicated in paragraph 20.

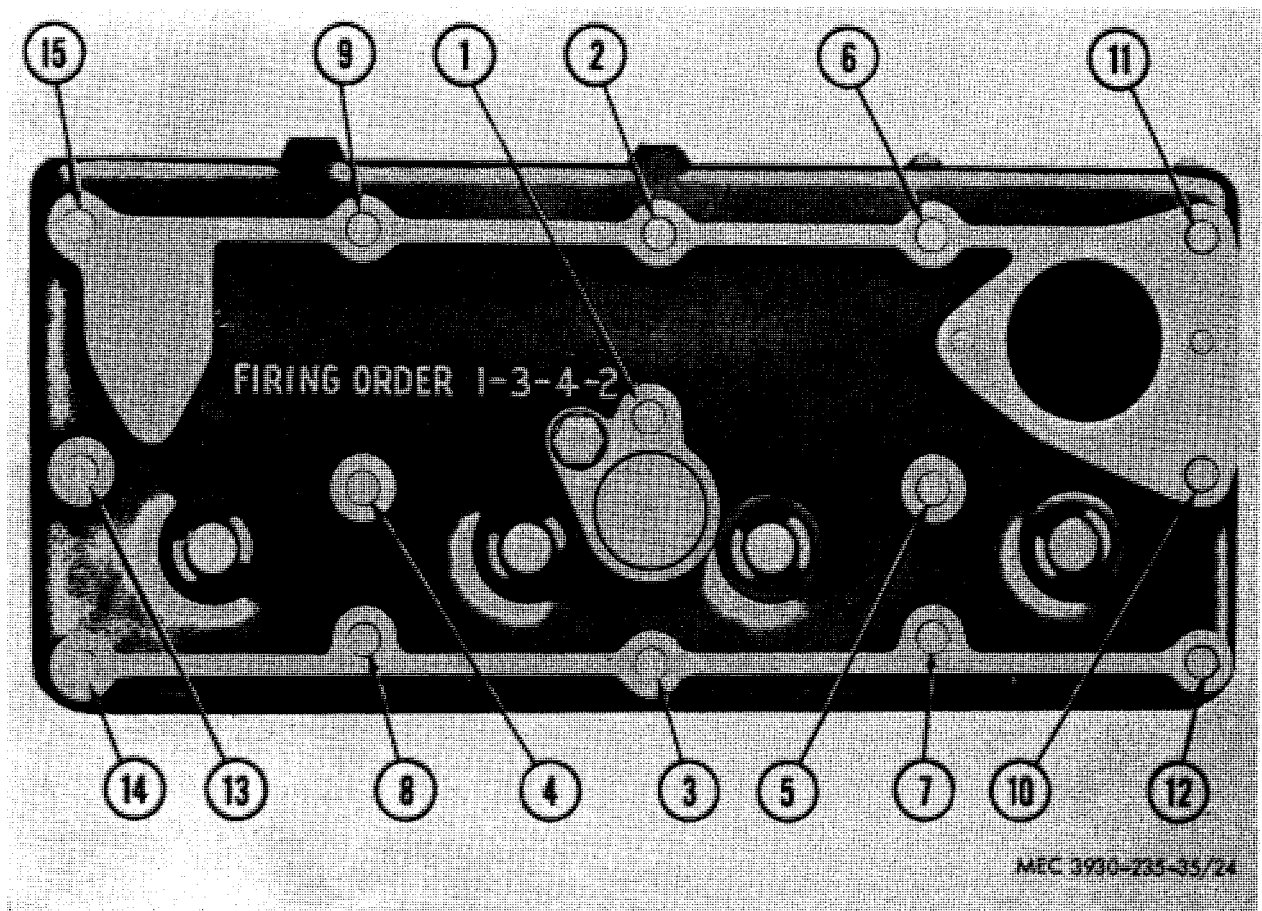


Figure 24. Sequence for tightening cylinder head nuts.

20. Run-In Procedure After Engine Overhaul

a. Make certain oil and coolant levels are correct, then start engine and accelerate to a fast idle speed (approx. 1000 rpm). Immediately after starting, check for correct engine oil pressure (30 to 40 psi) and listen for unusual noise which may indicate faulty operation of engine parts.

b. Keep engine operating at fast idle speed during warmup period. Reset choke during warmup period to assure smooth engine operation and prevent over-choking.

Caution: Operating engine at idle speed will not provide adequate lubrication for newly fitted cylinders, rings and pistons and may result in scuffing. Over-choking will wash lubricating oil off pistons and rings and will cause crankcase oil dilution.

c. With engine at normal operating temperatures, recheck valve lifter clearances (fig. 22), then install gasket, valve cover, gaskets, and nuts.

d. Adjust carburetor idle (TM 10-3930-235-20).

e. Adjust governor (TM 10-3930-235-20).

j. After engine is operating satisfactorily, observe the following schedule for run-in period.

g. Operate overhauled engines for a period of 2 hours at fast idle before carrying loads with vehicle.

h. Change engine oil after the first 25 hours operation. Thereafter, change oil every 50 hours operation. Use oil specified in lube order LO 10-3930-235-20 published in TM 10-3930-235-20.

Section IV. FUEL SYSTEM

21. Carburetor.

a. *Description.* The carburetor used in this fuel system is a single-barrel up-draft type with fixed jets covering all speeds except idle. The flow of fuel through the main jet system is controlled by the size of the main jet. The idle adjusting screw controls the fuel mixture for the idle system. Refer to paragraph 6 for specific jet sizes.

b. *Removal.* Refer to TM 10-3930-235-20.

c. *Disassembly* (fig. 25).

- (1) Remove screws and washers, then separate throttle body assembly from fuel bowl assembly.
- (2) To disassemble throttle body, remove venturi and gasket. Remove axle, float, fuel valve and seat, and washer. Remove idle adjusting screw and spring. Remove idle jet.
- (3) To remove throttle valve and shaft from throttle body, remove screws and throttle plate, then withdraw throttle valve and shaft from throttle body. If replacement

is necessary remove shaft seal retainer, shaft seal, shaft bushings, and plug from throttle body.

- (4) To disassemble throttle shaft, remove throttle stop screw, taper pin, and stop lever from throttle shaft.
- (5) To remove choke valve and shaft, remove screws and washers and choke plate, then withdraw choke shaft and lever. If replacement is necessary, remove screws, choke bracket, and retainer felt seal plug from fuel bowl.
- (6) To disassemble fuel bowl, remove main jet channel screw, washer, main jet, and washer. Remove well vent jet. Remove discharge jet and washer. Remove idle channel filler tube. If necessary, remove plug and intake drain, disk.

d. *Cleaning and Inspection.*

- (1) Clean all parts except gaskets and fiber washers in SD.
- (2) Blow out all passages in the fuel bowl and throttle body with compressed air.
- (3) Inspect float for leaks. Inspect top side of float lever for wear where it contacts fuel valve needle and float axle bearing points. Inspect float axle for wear.
- (4) Inspect throttle and choke plates for burrs or damaged edges.
- (5) Inspect throttle and choke shafts for bent condition and wear.

e. *Adjustment.*

- (1) Three adjustments should be made when assembling the carburetor. Preliminary adjustments, (3) and (4) below, should be repeated after carburetor is installed on engine (TM 10-3930-235-20).
- (2) With the float assembled to the throttle body, adjust the float lever (fig. 27) to $1\frac{5}{32}$ inch. Measure from the machined surface to the highest point at top side of float with the throttle body inverted. To increase or decrease distance between float and machined surface, use long-nosed pliers and bend lever close to throttle body.
- (3) Install idle adjusting screw (fig. 27) and spring in throttle body. Seat lightly with screwdriver and back out $1\frac{1}{4}$ full turns.

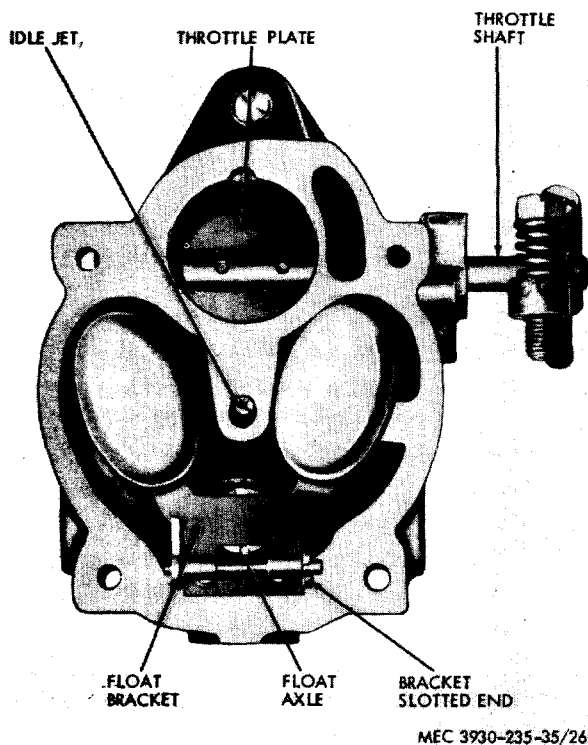


Figure 26. Throttle body, bottom view.

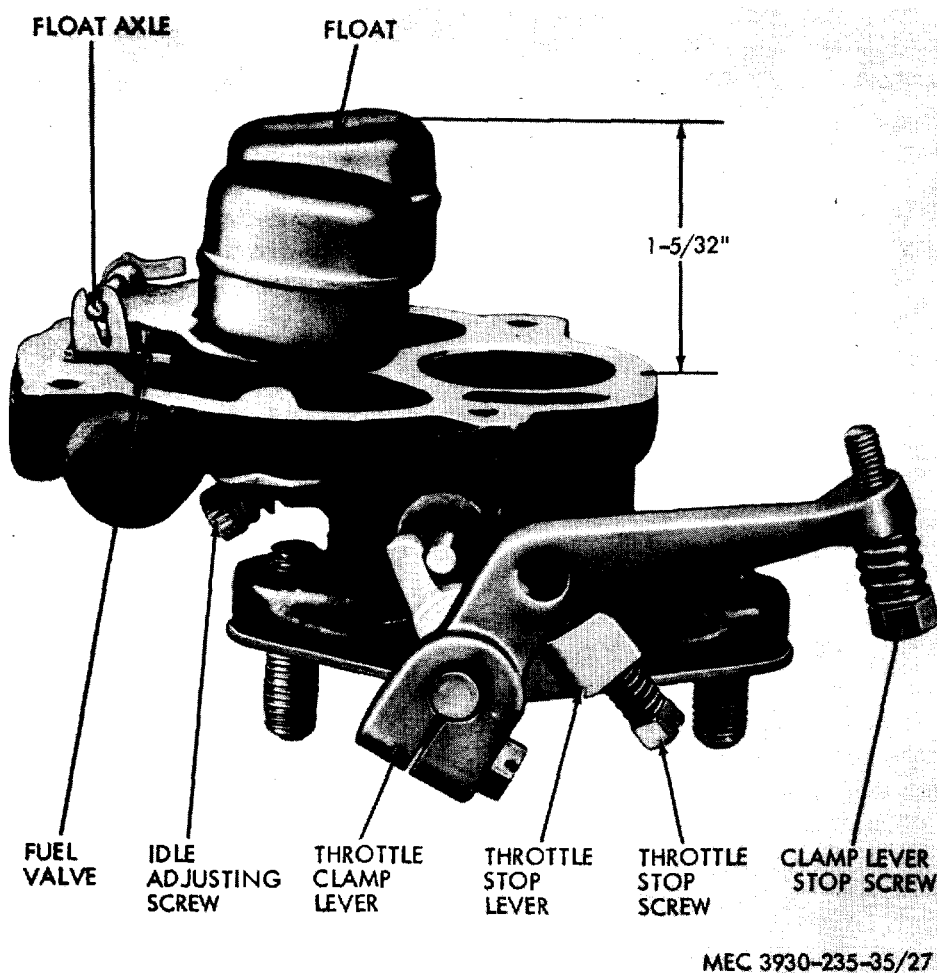


Figure 27. Throttle body—side view.

- (4) Hold the throttle lever (fig. 27) in a closed position and turn the throttle stop screw in until it just contacts the stop on the body; then turn in $1\frac{1}{2}$ additional turns.

f. Assembly and Repair. Reverse procedure in c above. Replace parts with parts in carburetor repair and gasket kits. Refer to figures 26, 27, and 28 for installed views of float, linkage, and internal views of carburetor.

g. Installation. Install and adjust carburetor (TM 10-3930-235-20) .

22. Governor

a. Description. The governor assembly consists of a governor driver and a governor cup, which are mounted to the camshaft gear. See figure 18.

b. Operation (fig. 29). Centrifugal force created by rotation of camshaft gear causes governor drive

ball bearings to move outward in their sockets. Pressure caused by movement of the bearings moves cup away from camshaft gear. This force is then transferred through a lever mounted in the timing gear cover to the governor and carburetor rods. No direct connection is provided between the accelerator pedal and carburetor throttle plate. The throttle opening and engine speed are controlled by means of spring tension applied to the governor rod. Accelerator pedal pressure moves pivot relay lever forward against spring tension on governor rod. Carburetor rod moves forward also allowing carburetor throttle plate to slowly open and increase engine speed. Higher engine speeds increase the governor force until this governor force applied to the governor lever is strong enough to overcome the spring tension on governor rod. When this condition occurs, governor force prevents further move-

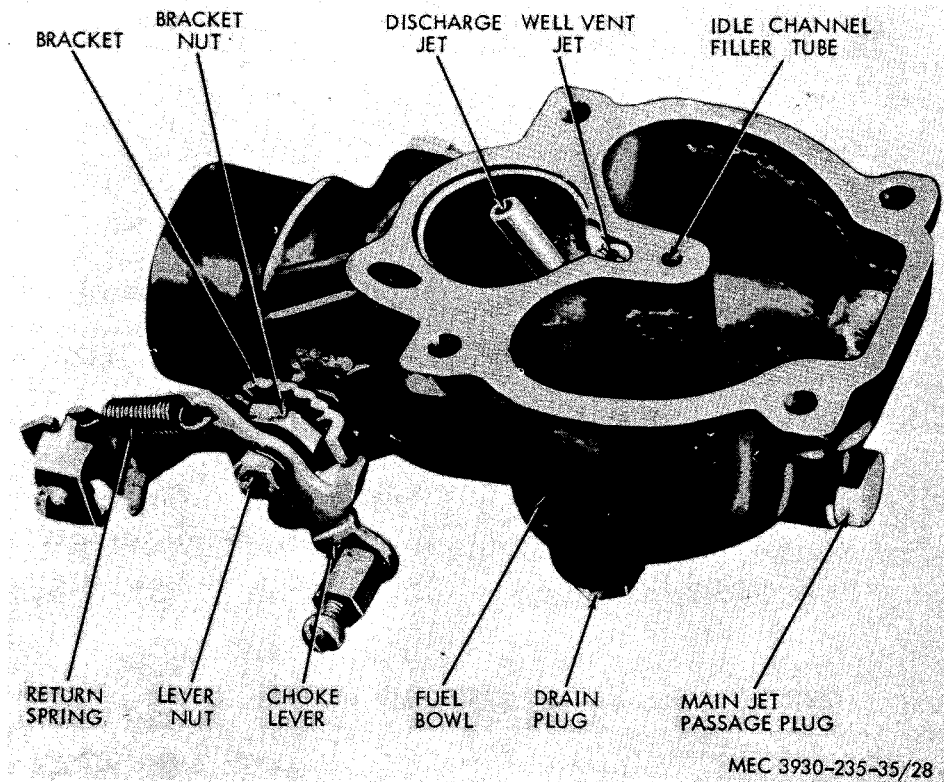


Figure 28. Fuel bowl - internal view.

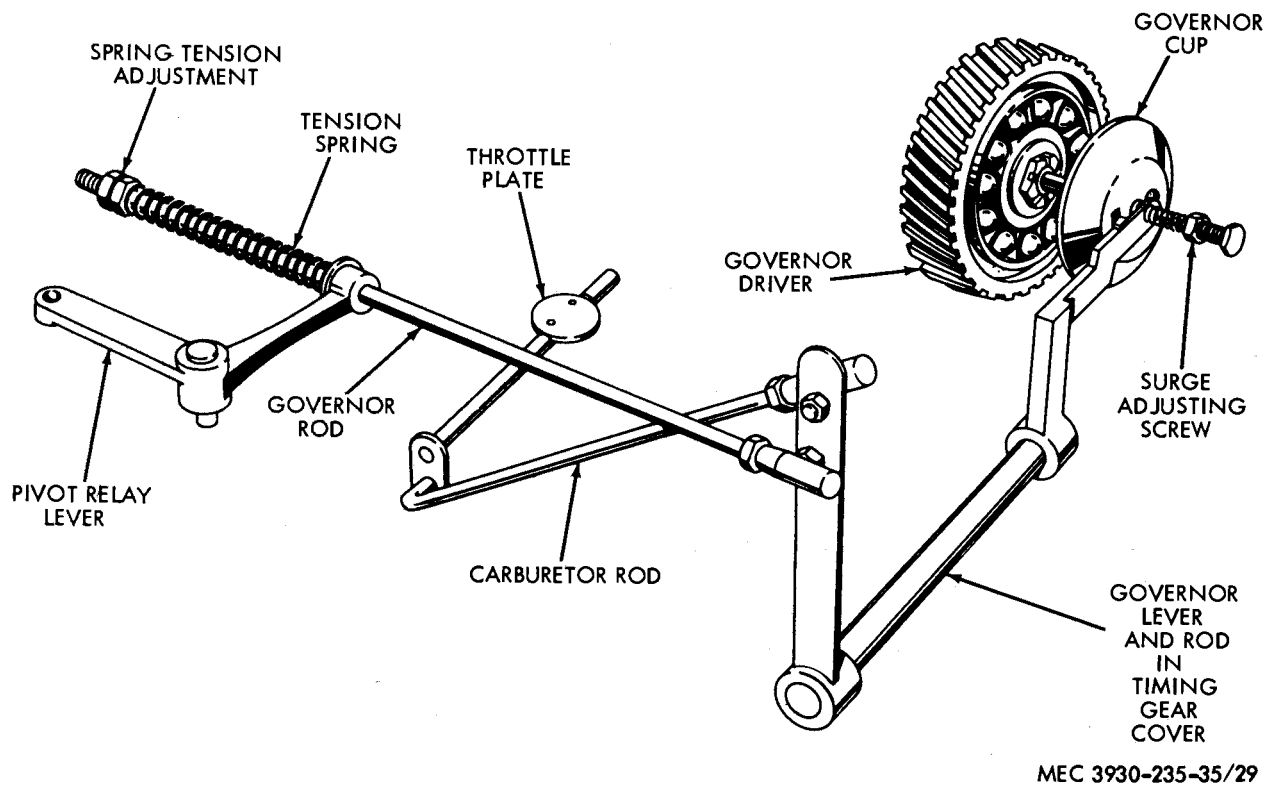


Figure 29. Schematic of governor control.

ment of rods and levers which would open throttle past the maximum governed speed.

c. Removal.

- (1) Remove counterweight and side plates.
- (2) Remove radiator (TM 10-3930-235-20).
- (3) Remove drive belts (TM 10-3930-235-20).
- (4) Remove hydraulic lift pump (para. 50).
- (5) Disconnect linkage at governor lever.
- (6) Remove fan drive and timing gear cover (para. 12)

d. Disassembly. Refer to paragraph 12b.

e. Cleaning. Clean all parts in SD and dry them thoroughly.

f. Inspection and Repair.

- (1) Inspect driver assembly for flat spots on

balls or any binding condition of the balls in the race.

- (2) Inspect cup and shaft for excessive grooving where balls contact level surface. Check for any binding of the shaft in the camshaft. Shaft should move in and out of the camshaft smoothly and without perceptible side play.
- (3) Inspect lever assembly for cracks, damage or wear. Make certain lever moves back and forth without binding in the needle bearings.
- (4) Replace oil seal and felt seal with new parts.
- (5) Replace defective parts as necessary.

g. Assembly. Reverse procedures in *d* above.

h. Installation. Reverse procedures in *c* above.

Section V. COOLING SYSTEM

23. Radiator

a. Removal. Refer to TM 10-3930-235-20.

b. Cleaning. Refer to TM 10-3930-235-20.

c. Testing.

- (1) Plug upper and lower radiator openings with expansion balls and close overflow pipe.
- (2) Submerge radiator in tank of water and

apply 4 to 6 psi air pressure at drain cock opening.

- (3) Watch for air leaks and mark points for soldering.
- (4) Solder leaks and repeat test.
- (5) Test radiator cap. Cap should release under 7 pounds pressure. Replace if defective.

d. Installation. Refer to TM 10-3930-235-20.

Section VI. ELECTRICAL SYSTEM

24. Generator

a. Removal and Installation. Refer to TM 10-3930-235-20.

b. Disassembly (fig. 30).

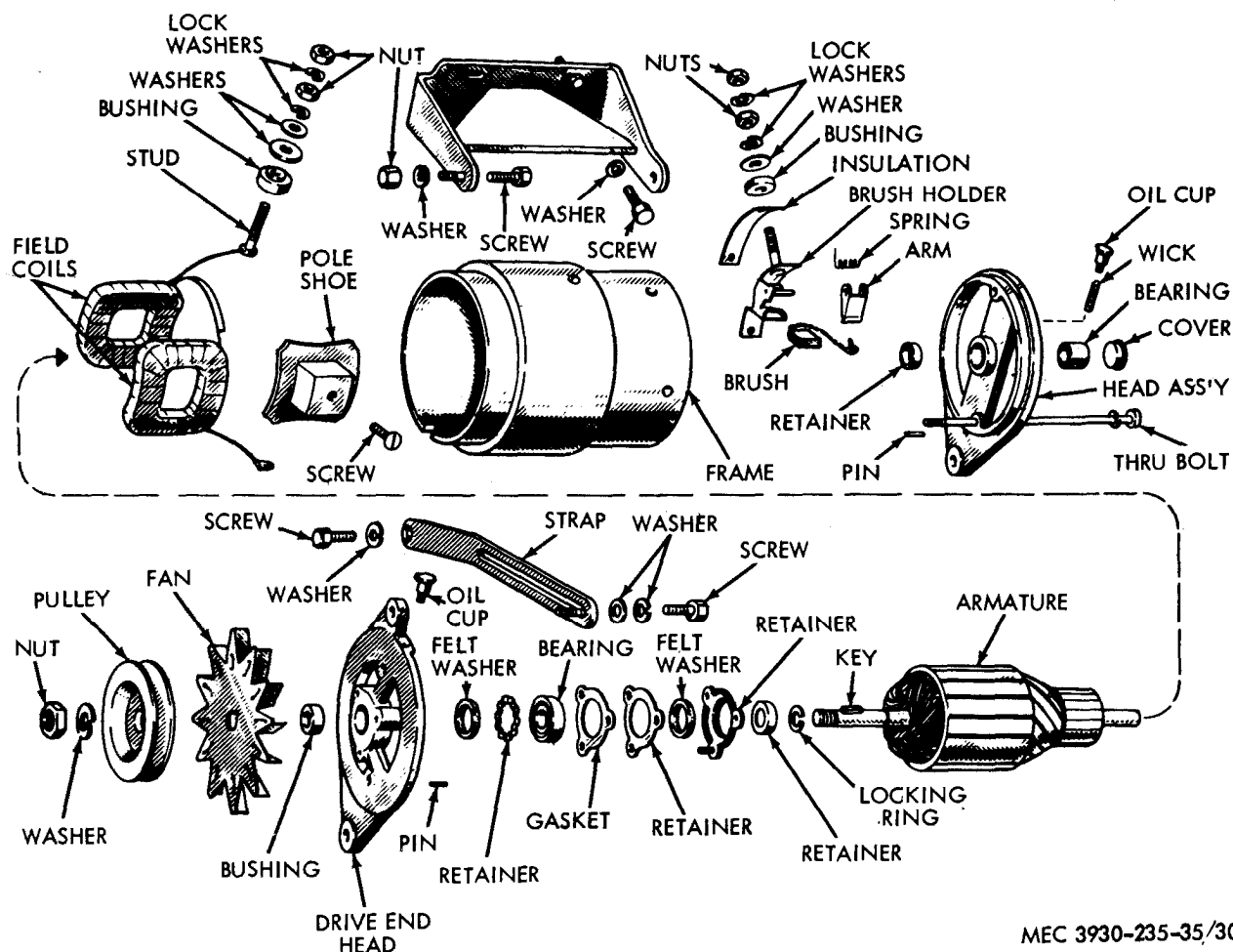
- (1) Remove nut, lockwasher then remove pulley, and fan from armature shaft. Remove key from keyway.
- (2) Remove two thru-bolts and lockwashers, then remove end heads from armature.
- (3) Remove two screws and lockwashers fastening brush leads and pull brushes out of brush holders. Pull brush arm and spring off pins together.
- (4) Lift armature out of frame and field.

(5) Press bearing and cover from commutator end head.

(6) Remove screws and lockwashers attaching retainer to drive end head. Remove retainer, gasket, bearing, retainer, and felt washer from end head.

c. Cleaning and Inspection.

- (1) Clean end heads, pulley and fan with SD.
- (2) Clean frame and field assembly and armature thoroughly with compressed air. Wipe brushes with a clean dry cloth.
- (3) Replace brushes worn to less than half their original length (original length is % inch).



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Figure 30. Generator, exploded view.

- (4) Visually inspect armature commutator for scored, burned, or pitted condition. Repair faulty commutator (para. 25) or replace generator assembly.
- (5) Test armature windings for ground using test lamp. Touch shaft with one test probe and each commutator bar with the other probe. If lamp lights, a ground is indicated. Replace generator assembly if grounded condition is indicated.
- (6) Test armature windings for shorted condition using a growler. Place armature in growler and while holding a thin steel strip on the armature core, rotate armature. If a short is present, the steel strip will become magnetized and vibrate as armature is rotated. Replace generator assembly if a short is indicated.
- (7) Visually inspect field coil windings for burned condition or faulty insulation. Test for grounded condition with test lamp. Touch one test probe on each field coil terminal and ground the other probe to frame. If lamp lights, a ground is indicated. Replace generator assembly, if field coils are grounded.
- (8) Inspect commutator end head for damaged or loosely mounted brush holders. Replace end head assembly if brush holders are loose or faulty.
- (9) Temporarily install commutator end head (with bushing assembled) on armature shaft and inspect for side movement of shaft in bushing. Armature should rotate in bushing without side play. If play is present, replace worn parts.

- (10) With commutator end head positioned on armature shaft, temporarily install brushes. Hook spring scale in brush arm hole. Pull on scale and note reading just as brush leaves commutator. If scale reading (para. 6) is not within specifications, replace springs.

- (11) Inspect ball bearing for binding or looseness. Replace defective bearing.

d. Assembly. Reverse procedure in *b* above. Refer to electrical schematic in TM 10-3930-235-20 for electrical connections.

25. Repair

a. Remove dirt or slight scratches from commutator with No. 000 sandpaper. If rough or deeply scored, turn down in a lathe by taking successive light cuts. Undercut mica to depth of $\frac{1}{32}$ to $\frac{3}{64}$ inch. After cutting commutator, remove burrs with No. 00 to No. 000 sandpaper.

b. If inspection reveals that bushing in commutator end head is worn, replace bushing using an arbor press. If necessary, ream bushing so that armature shaft rotates freely in bushing without perceptible side play.

26. Testing

a. Field Coil Draw Test.

- (1) Measure field coil draw as follows: Connect an ammeter and a variable resistance in series with positive battery post and generator armature terminal "A". Connect negative battery post to generator terminal "F". Connect a voltmeter to generator field terminal "F" and armature terminal "A".
- (2) Adjust variable resistance to obtain 10 volts across field coil. Current draw should be within limits shown in paragraph 6. If current draw is not within specifications, check for incorrect connections. If connections are satisfactory, field coils are shorted, open, or grounded. Replace generator assembly if field coils are faulty.

b. Motoring Draw Test.

- (1) Measure generator motoring draw as follows: Connect a jumper lead between generator terminal "F" and generator frame. Connect an ammeter and a variable resistance in series with the generator armature terminal "A" and positive battery

post. Connect negative battery post to generator frame.

- (2) Adjust variable resistance to obtain 10 volts across generator. Current draw should be within limits shown in paragraph 6 and generator should operate as a motor with the armature turning slowly. If current draw is not within specifications or generator does not operate as a motor, internal electrical units are faulty or armature is not free to rotate. Repair a faulty generator.

27. Starting Motor

a. Removal and Installation. Refer to TM 10-3930-235-20.

b. Disassembly (fig. 31).

- (1) To remove solenoid switch, remove nuts and washers, then remove connector. Remove screws and washers, then lift off solenoid switch assembly, with nut and washer installed.
- (2) Loosen nut and screw, then slide inspection band off frame.
- (3) Raise brush springs, then lift grounded and insulated brushes from brush holders.
- (4) Remove screws, washers, then remove commutator end head assembly from end of armature shaft. Do not remove brush springs, brush holders, rivets, and grounded brushes unless brush replacement is necessary (para. 28). Do not remove bushing from commutator end head.
- (5) Remove screws and washers and pull drive housing assembly off frame. Do not remove bushing from housing unless replacement is necessary. Refer to paragraph 28.
- (6) Remove armature, with starter drive assembled, from frame. Remove thrust washers from commutator end of armature.
- (7) To remove starter drive from armature, pry anchor plate away from intermediate support and remove locating screw. Remove starter drive assembly from armature shaft.
- (8) To disassemble starter drive, remove locking ring, then remove anchor plates and drive spring. Remove retaining ring at bore of pinion and withdraw shaft assembly and meshing spring from pinion. Thread antidrift spring off shaft assembly. Do not disassemble pinion assembly.

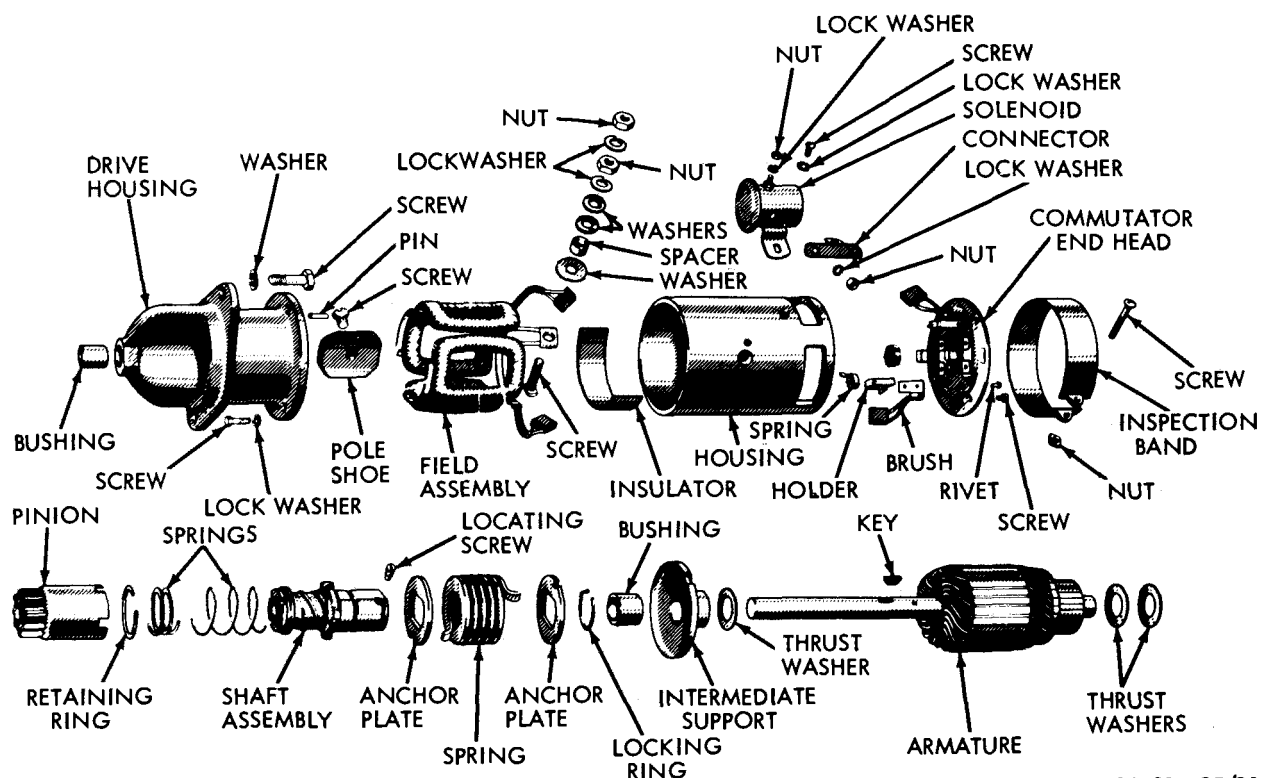


Figure 31. Starting Motor, exploded view.

- (9) Remove key, then remove intermediate support. Do not remove bushing from support unless replacement is necessary. Refer to paragraph 28.
- (10) Remove thrust washer from drive end of armature shaft.
- (11) Do not disassemble frame and field assembly, however, if replacement is necessary, insulated brushes can be replaced. Refer to paragraph 28.

c. Reassembly. Reverse procedures in *b* above. Refer to electrical schematic in TM 10-3930-235-20 for electrical connections.

d. Cleaning and Inspection.

- (1) Clean all parts with SD except armature and frame and field assembly.
- (2) Clean frame and field assembly and armature thoroughly with compressed air. Wipe brushes with a clean dry cloth.
- (3) Replace brushes worn to less than half their original length (original length is $\frac{1}{2}$ inch).

- (4) Visually inspect armature commutator for scored, burned, or pitted condition. Repair faulty commutator (para. 28) or replace starting motor assembly.
- (5) Test armature windings for ground using a test lamp. Touch shaft with one test probe and commutator with other probe. If lamp lights, a ground is indicated. Replace starting motor if test indicates a grounded condition.
- (6) Test armature winding for short-circuits using a growler. Place armature in growler and while holding a thin steel metal strip on armature core, rotate armature. If a short-circuit is present, the steel strip will become magnetized and vibrate as armature is rotated. Replace starting motor if a short-circuit is indicated.
- (7) Visually inspect field coil windings for burned condition. Test for grounded condition with test lamp. Touch one test probe on each field terminal and ground other probe to frame. If lamp lights, a

ground is indicated. Replace starting motor if a ground is indicated.

- (8) Temporarily install commutator end head on armature shaft and inspect fit of bushing on shaft. Armature should rotate freely without excessive side play. If excessive side play is present, replace end head and bushing assembly.
- (9) With commutator end head positioned on armature shaft, temporarily install brushes. Hook a spring scale on brush spring. Pull on scale and note reading just as brush leaves commutator. If scale reading (para. 6) is not within specifications, replace springs.
- (10) Temporarily install intermediate support (with bushing assembled) on armature shaft and check fit of bushing on shaft. Temporarily install drive housing (with bushing installed) on armature shaft and check fit of bushing to shaft. Armature should rotate freely in bushings without excessive side play. If side play is excessive, replace worn parts.
- (11) Inspect starter drive parts for scoring or other indication of wear. Inspect barrel pinion for chipped or broken teeth. Inspect springs for distortion.

28. Repair

a. Clean dirty or slightly scratched commutator with No. 00 to No. 000 sandpaper. If commutator is rough, scored or pitted, turn down in a lathe, taking successive light cuts. Remove burrs with 00 to 000 sandpaper. Undercut mica to a depth of $\frac{1}{32}$ inch and 0.002 inch wider than the mica.

b. If brushes are worn, replace as follows: To remove brushes connected to field coil leads, unsolder terminal and spread connector loop. Install new brush, then clinch loop securely and resolder connection. To remove brushes connected to commutator end head, punch out rivets, then remove brush holder and grounded brush. Install new brush and brush holder, then secure with new attaching parts.

c. If commutator end head bushing is worn, replace end head and bushing assembly.

d. If drive housing or intermediate support bushings are worn, replace bushings using an arbor

press. If necessary, ream bushings so that armature rotates freely in bushing without excessive side play.

e. If fields coils are faulty, replace starting motor.

29. Testing

a. No Load Test.

- (1) Measure no load current and speed of motor as follows: Connect starting motor terminal to battery positive post with a carbon pile rheostat and ammeter in series. Connect voltmeter to starting motor terminal and ground to motor frame. Connect battery negative post to ground motor frame, placing single-pole switch in the lead wire.
- (2) Close switch, operate starting motor and note voltage, current and starting motor speed. Readings should be 55 amperes at 10 volts and 5,200 rpm. If specifications are not as indicated, operate starting motor under no-load conditions for a short period, then recheck readings.
- (3) If current and speed are low, high resistance is indicated. If current is high and speed is low, a binding armature or interference with armature rotation is indicated. If speed and current are far from specified values, a ground, short or open circuit is present in the starting motor. If speed, voltage and current are not within specifications, overhaul starting motor.

b. Stall Torque Test.

- (1) Measure starting motor stall torque as follows: Connect starting motor in test circuit same as indicated for no-load test (a above). Connect torque measuring unit to starter drive.
- (2) Close switch to operate motor. Apply load and note current and voltage. Current should be 235 amperes maximum at 4 volts. If current and torque are both low, high internal resistance is indicated. High current with low torque indicates faulty armature or field coil condition. If performance is not within specification, overhaul starting motor.

Section VII. TRANSMISSION

30. Transmission

a. Description.

(1) General.

- (a)* The transmission is a hydraulic torque converter type and consists of two case assemblies. One case assembly contains a torque converter and an oil pump, and the other houses a directional clutch and gear train. A control valve and shift cylinder are externally mounted on the gear train case for controlling clutch operation. Drive is from the engine flywheel through the torque converter, directional clutch and gear train to a propeller shaft.
- (b)* The hydraulic torque converter (fig. 32) is a combination fluid coupling and torque converter of the single stage, three-element type. The three elements are the impeller which is driven by the engine flywheel, the turbine which drives the clutch, and the stator which provides the means for the converter to multiply torque.
- (c)* A gear type pump (fig. 32) driven by the converter, supplies oil flow to operate the shift cylinder and lubricates the transmission parts. It also circulates oil through the bottom of the engine coolant radiator for cooling purpose.
- (d)* A directional shift lever (fig. 40) and a creeper pedal (fig. 39) controls the position of the control valve plungers. The control valve plunger movement controls oil flow to the shift cylinder. The double-acting shift cylinder incorporates a spring loaded piston and piston rod, which actuate mechanical linkage to engage or disengage the directional clutch.
- (e)* The duplex directional clutch (fig. 33) consists of a clutch flywheel driven by the converter, a double-faced pressure plate, and forward and reverse clutch plates. These parts, plus operating levers and links are enclosed in a cover plate. In operation, the shift cylinder actuates the link, yoke and carrier to move the shifter ring. The shifter ring

actuates the clutch levers to engage either the forward or reverse clutch plate for the desired travel direction.

- (f)* The gear train (fig. 34) is of the drop-down type consisting of spur type gears. The forward gear train includes a forward drive shaft and gear which is connected by splines to the forward clutch plate and an idler gear which is in constant mesh with an output gear, and the forward drive gear. Power flow is from the forward clutch plate through the forward drive shaft and gear, the idler gear, output gear, and to the propeller shaft. The reverse gear train includes a reverse drive shaft and gear which is in constant mesh with the same output gear that meshes with the forward idler gear. Power flow is from the reverse clutch plate through the reverse drive shaft and gear, output gear, and to the propeller shaft.
- (g)* Transmission operation is as follows: With engine operating and creeper pedal in a released position, and with directional shift lever in a neutral position, oil flow from the pump is blocked at the control valve directional plunger. The clutch remains disengaged and the drive line from engine to drive axle wheels is disconnected. When the directional shift lever is moved for forward or reverse travel, oil flow is directed through the control valve to the shift cylinder which in turn engages the clutch for desired travel direction. As the engine is accelerated, torque buildup in the torque converter drives the vehicle. Control of vehicle speed is through movement of the accelerator pedal. For creeping operation, the creeper pedal is depressed and released by the operator. Operation as follows: When the creeper pedal is fully depressed with the vehicle in motion, oil flow to the shift cylinder is blocked by the creeper plunger. The shift cylinder piston is automatically moved to a neutral position and the clutch is disengaged, thus disconnecting the drive line from engine to the axle

wheels. When the creeper pedal is released from a fully depressed position to an approximate halfway position, oil flow to the shift cylinder is partially restricted in such a manner that gradual clutch engagement occurs. With engine accelerated, repeated action of pushing the creeper pedal down quickly and releasing it slowly to an approximate halfway position will cause short period of drive motion to the drive axle wheels and the vehicle will move at a smooth controlled creeping speed. At the same time, the high engine speed will allow efficient operation of the hydraulic lift system.

b. Oil Pressure Check. Normal transmission operating oil pressures are as follows:

Engine speed, rpm	Transmission range	Main oil pressure at pump outlet tee, psi	Shift cylinder inlet pressure, psi	
			Forward	Reverse
500	Neutral . . .	40 min	40 min.	40 min.
2400	Neutral . . .	85-90	70-90	70-90
1050-1100	Forward* . .	60 min	55 min.	0
	Reverse* . .	60 min	0	55 min.
1100-1300	Forward* . .	65 min	60 min.	0
	Reverse* . .	65 min	0	60 min.
1300-1500	Forward* . .	70 min	65 min.	0
	Reverse* . .	70 min	0	65 min.

* Transmission output shaft is to be held stationary as throttle is advanced from idle to full throttle (governor set at 2400 rpm-no-load).

- (1) Main oil pressure at the tee connection may be adjusted by turning the relief valve adjusting screw (fig. 35) at the front side of the valve body. Main pressure should never be adjusted to pressures above 90 psi because of detrimental effects to the converter and clutch linkage.
- (2) The accumulator valve is to be adjusted in the following manner: the adjusting screw on the left side of the valve assembly is to be turned in and bottomed.
- (3) To check oil pressure, proceed as in (4) through (6) below.
- (4) Operate engine and vehicle until transmission is at normal operating temperature.
- (5) Remove pipe plug from pressure line fitting, located in converter case. Install a 150 psi pressure gage in fitting. Install gages and connect hoses at shift cylinder

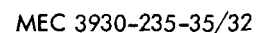
inlet ports to determine pressure reading at these points.

- (6) Operate engine with transmission shift lever in neutral position and with creeper pedal depressed and note pressure reading. If pressures are not as indicated in *b* above, refer to troubleshooting (para. 8) for possible troubles.

c. Removal of Engine and Transmission Assembly. Refer to paragraph 9b and *c*.

d. Disassembly.

- (1) Disconnect and remove hose assemblies.
- (2) Cut lock wire, then remove screws, washers, converter oil pump (fig. 32), remove screws and washers, then remove collector ring and seal rings. If necessary, remove bushing from collector ring (g(5) below). Scribe a mark, for identification purposes during reassembly, then remove pump gears from pump housing. Pump housing includes a matched set of gears. If either gear requires replacement, replace complete pump housing. Remove oil seal from pump housing.
- (3) Disconnect and remove hoses (fig. 38) and unions from shift cylinder. Disconnect and remove tubing, elbow, strainer and elbow. Remove adapter, elbow and plug.
- (4) Remove cotter pin and washer, then lift off upper lever. Remove locking plug from cross shaft, then remove cotter pins, washers, cam plate and creeper control lever. Remove screws and washers then remove upper creeper lever support, control valve assembly and gasket from transmission case.
- (5) Disassemble shifter control valve. Refer to paragraph 32.
- (6) Remove screw assemblies (fig. 32), screw, washer, cover, and gasket from transmission case.
- (7) Cut lock wire and remove screws fastening clutch assembly to clutch flywheel.
- (8) Remove screw assemblies, nuts, washers, and screws, then remove torque converter case, with clutch flywheel and output shaft assembled. Remove seal ring and needle bearing.



- (9) Remove retainer ring (fig. 33), then press flywheel and shaft assembly out of bearing. Cut lock wire and remove screws, then remove output shaft from flywheel. Remove retainer ring and press bearing out of converter case.
- (10) Remove forward clutch plate (fig. 33), then lift out clutch assembly.
- (11) Before disassembling clutch assembly, note match markings, one on the extension lug of the pressure plate and one on the cover adjacent to it. Identify parts so that they may be returned to their original location. Remove cotter pins (fig. 33) and lever anchor pins fastening operating levers

- (12) Remove cotter pins (fig. 33), washers, and pins. Remove link. Remove plug from yoke shaft, then using a brass drift and hammer, drive against yoke shaft until plug is removed and the yoke shaft is exposed. Drive on the exposed yoke shaft, in the opposite direction, until yoke shaft is removed. Remove yoke.
- (13) Remove carrier and bearing (fig. 33) from shifter sleeve. To disassemble car-

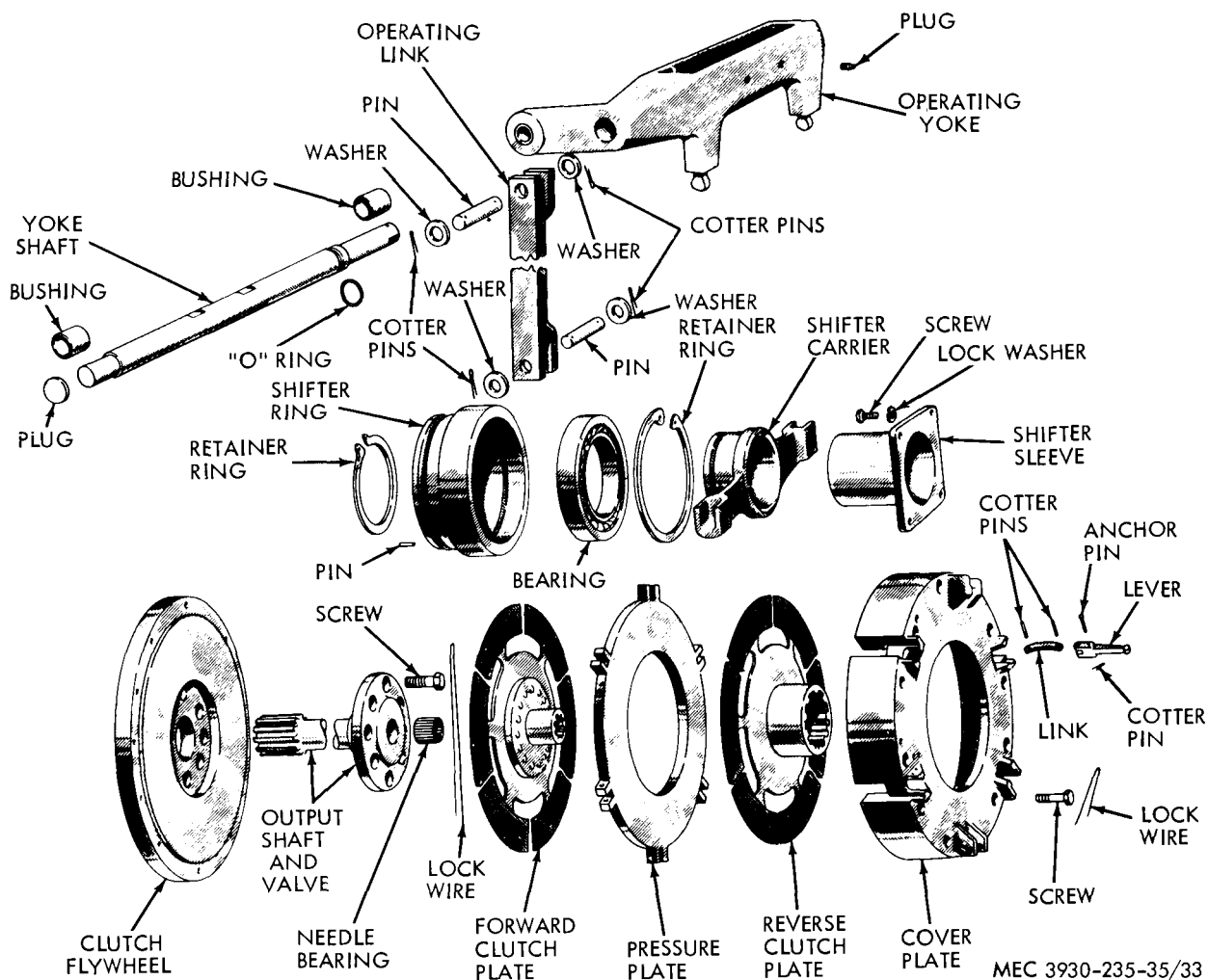


Figure 33. Converter clutch and linkage, exploded view.

- rier and bearing, remove retainer ring and press carrier out of bearing. Remove retainer ring and press bearing out of shifter ring. If necessary, remove pin from shifter ring.
- (14) Remove screw assemblies (fig. 33), then remove shifter sleeve from transmission case.
 - (15) Remove screws and washers, then remove shift operating cylinder and spacers. Remove seal ring from cylinder.
 - (16) Disassemble shift operating cylinder. Refer to paragraph 33.
 - (17) Remove retainer ring (fig. 34), then press forward clutch shaft out of bearing. Slide forward gear off shaft splines, then remove shaft. Remove bearing from transmission case.
 - (18) Remove retainer ring (fig. 34) and press reverse clutch shaft, with bearing assembled, out of transmission case. Lift out reverse gear. Remove key, then press bearing off reverse clutch shaft. Remove retainer ring. If necessary, remove bushing from shaft (g(6) below).
 - (19) Remove screw assemblies (fig. 34), then remove cover and gasket. Remove retainer rings, then press shaft with bearing assembled, out of transmission case. Remove idler gear and spacer. Press shaft out of bearing. Remove key from shaft. Remove bearing from transmission case.

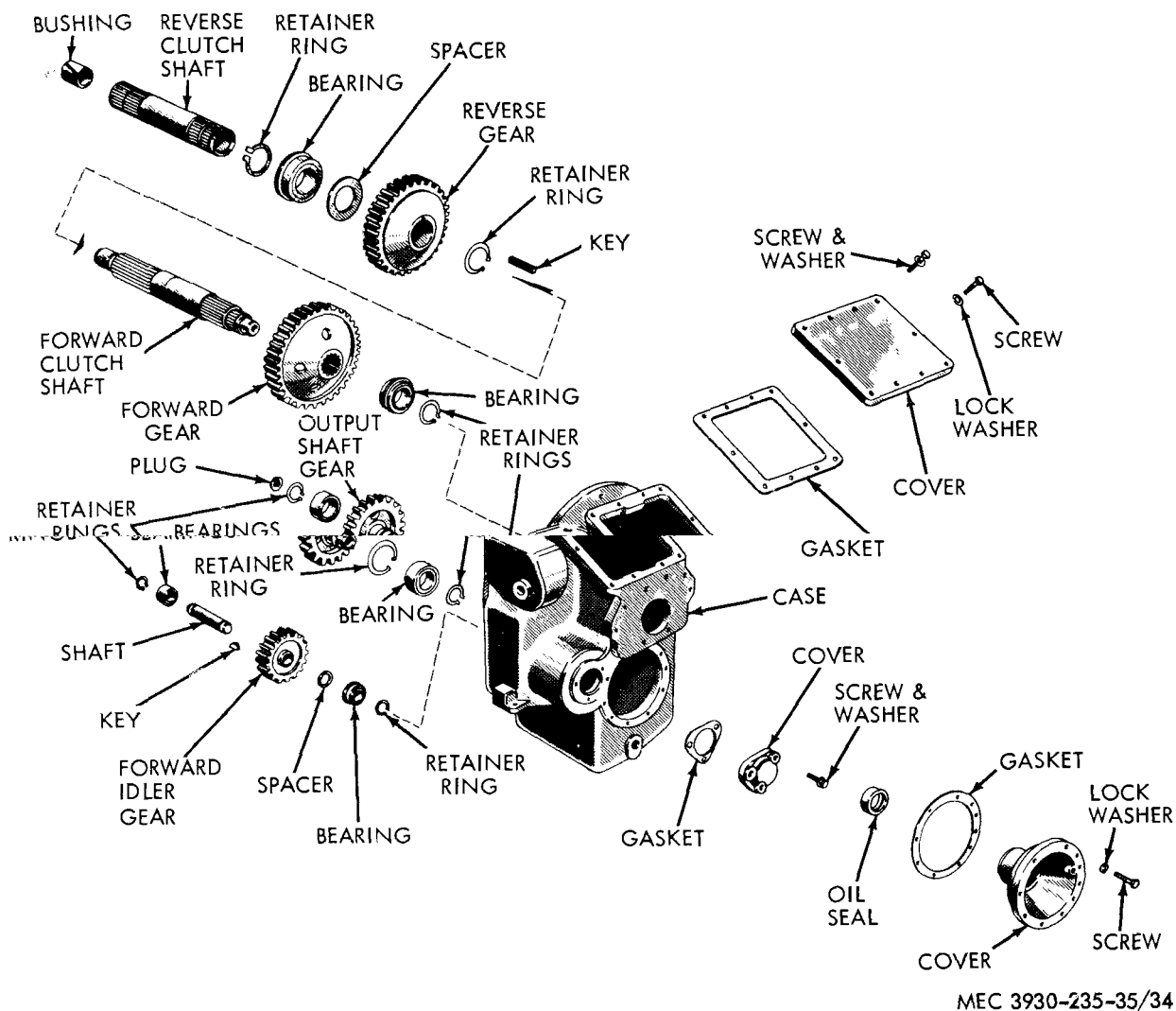


Figure 34. Case, cover, gears, and shafts, exploded view.

- (20) Remove screws (fig. 34) and washers, then remove cover and gear assembly. Remove gasket. Remove oil seal from cover. Remove retainer ring, then press gear assembly out of bearing.
- (21) Remove retainer ring (fig. 34), then press bearing out of cover. If necessary, remove plug from cover.
- (22) Remove retainer ring, then press bearing off output shaft gear. If necessary, remove plug from gear.
- (23) Remove plug, breather cap and drain plug from transmission case.

e. Cleaning. Clean all parts with SD and dry thoroughly with compressed air.

f. Inspection.

- (1) Replace seals and gaskets when transmission has been disassembled.
- (2) Inspect hoses for worn, chafed, or deteriorated condition. Replace defective hoses.
- (3) Inspect converter and transmission cases for cracks or damage. Replace defective cases.
- (4) Visually inspect converter for evidence of oil leakage or damage. Replace converter assembly if faulty.
- (5) Inspect converter for sheared or worn pump drive lugs. Inspect bushing (mounted in pump housing) and converter sleeve bearing surface for scoring or wear. Converter sleeve should rotate freely in bush-

ing without perceptible side play. Replace converter assembly if sleeve is faulty or worn. Replace pump housing assembly if bushing is faulty or worn.

- (6) Inspect oil pump gears for chipped, broken, or worn teeth. Gears and housing are matched parts and should be replaced as an assembly. If gears or housing are faulty, replace housing assembly.
- (7) Inspect bushing (mounted in collector ring) and output shaft for scored or worn condition. If parts are worn beyond limits given in paragraph 6, replace worn parts.
- (8) Inspect bushing (mounted in reverse clutch shaft) and forward clutch shaft for scored or worn condition. If parts are worn beyond limits given in paragraph 6, replace.
- (9) Inspect clutch shift yoke, links and clevis pins for worn pivot or friction points. Replace worn parts. Inspect carrier lugs (at yoke contact points) for wear. Replace worn carrier.
- (10) Inspect carrier and shifter sleeve sliding surfaces for scoring or binding between parts. If binding or excessive looseness is present, replace defective parts.
- (11) Inspect forward and reverse clutch plate facings for scored or worn condition. Inspect clutch plates for loose rivets. Replace clutch plates if faulty or if facing is worn beyond limits given in paragraph 6.
- (12) Inspect faces of clutch plate and flywheel for scoring. Replace defective plates or flywheel.
- (13) Inspect friction and pivot points of clutch links, levers, pivot pins and anchor pins, and clutch plates for grooves, elongated holes, or worn condition. If parts are worn or defective replace clutch assembly.
- (14) Inspect gears for chipped or broken teeth. Replace defective gears.
- (15) Inspect shafts for scoring or worn condition. Replace defective shafts.
- (16) Inspect ball and needle bearings for binding or looseness. Replace defective bearings.
- (17) Inspect output shaft and relief valve as follows: Inspect holes in shaft and valve seat (mounted in splined end of output

shaft) for plugged condition. If valve operation is faulty, replace output shaft and valve assembly.

- (18) Inspect inlet screen for damaged or clogged condition. Clean or replace defective screen.

g. Repair.

- (1) Converter assembly cannot be repaired. If converter is faulty, replace converter assembly.
- (2) Oil pump gears and housing are matched parts. If oil pump gears or housing are faulty, replace oil pump housing assembly.
- (3) Output shaft and relief valve cannot be repaired. If output shaft or relief valve are faulty, replace output shaft and valve assembly.
- (4) The clutch assembly consists of parts that are matched for correct operation. If reverse clutch plate, clutch cover plate, clutch pressure plate, lever, link, anchor pin, or pivot are worn or faulty, replace clutch assembly.
- (5) Replace scored or worn output shaft. Use an arbor press to remove and install bushing in collector ring. Shaft should fit bushing as indicated in paragraph 6.
- (6) Replace scored or worn forward clutch shaft bushing. Use an arbor press to remove and install bushing in reverse clutch shaft. Shaft should fit bushing as indicated in paragraph 6.

h. Reassembly of Transmission.

- (1) Install drain plug (fig. 34), breather cap, and oil level plug in transmission case.
- (2) Press bearing (fig. 34) on gear and install retainer ring. If removed, install plug in gear.
- (3) Press bearing (fig. 34) in cover and install retainer ring.
- (4) Support bearing in arbor press, then press gear with bearing assembled, into bearing. Secure gear with retainer ring.
- (5) Install oil seal and oil level plug in cover. Install gasket and cover and gear assembly on transmission case, then secure with washers and screws.
- (6) Install key (fig. 34) in shaft. Position gear in transmission case, then press shaft

and key into gear. Install spacer on outer end of shaft, then install bearings. Secure bearings with retainer rings. Install gasket, cover, then secure with screw assemblies.

- (7) If bushing was removed from reverse clutch shaft, install new bushing (g(6) above).
- (8) Install rear retainer ring (fig. 34) in reverse clutch shaft groove. Press bearing, with snap ring on bearing facing rear retainer ring, on shaft and against retainer ring. Install key in shaft slot. Install shaft and bearing in transmission case and press until bearing snap ring bottoms against case. Support reverse clutch shaft in press, then install gear and secure with retainer ring.
- (9) Install bearing (fig. 34) in transmission case. Place gear in position and carefully slide forward clutch shaft through hollow shaft and engage splines in gear. Press shaft into bearing, then secure with retainer ring.
- (10) Reassemble shift operating cylinder (para. 32).

Note. During installation of shift operating cylinder, install spacers as necessary to obtain correct clutch neutral setting adjustment. Transmission must be assembled to check adjustment (para. 31).

- (11) To install shift operating cylinder, install seal ring, on cylinder, then install shift operating cylinder and spacers, as necessary, then secure with washers and screws.
- (12) Install shifter sleeve (fig. 33) and secure with screw assemblies.
- (13) If removed, install pins (fig. 33) in shifter ring. Press bearing in shifter ring and secure with retainer ring. Press shifter carrier (fig. 33) in bearing, then secure with retainer ring. Install carrier and bearing assembly on shifter sleeve.
- (14) Place shift operating yoke (fig. 33) in position and install yoke shaft. Threaded end of yoke shaft to be positioned on the side opposite the shift cylinder. Install plug at shift cylinder end of shaft. Install link and secure with pins, washers, and cotter pins.

- (15) With index markings in proper relation on pressure plate and cover, place clutch plate (fig. 33) on face of clutch cover. Assemble links to pressure plate and levers, then secure with pivot pins. Slide pressure plate, with links, pins, and levers attached, in slots provided in clutch cover plate. Align operating levers with holes in clutch cover and install clevis pins and cotter pins.

- (16) Install complete clutch assembly (fig. 33) and make certain that all clutch levers are inserted in shifter ring groove and that reverse clutch plate splines are fully engaged on reverse clutch shaft. Install forward clutch plate and make certain that splines of clutch plate are fully engaged on forward clutch shaft.

- (17) Press bearings (fig. 32) in converter case and secure with retainer ring. Install output shaft in flywheel and secure with screws. Lock wire screw heads. Install flywheel and output shaft in converter case bearing and secure with retainer ring. Install needle bearing in flanged end of output shaft.

- (18) Place new seal ring (fig. 32) in position on transmission case, then install torque converter case assembly. Secure cases together with screws, washers, nuts, and screw assemblies. Align screw holes in clutch cover and clutch flywheel, then install screws. Lock wire screw heads in pairs.

Note. At this point of reassembly, check adjustment of clutch neutral setting (para. 31).

- (19) After adjustment of the clutch neutral setting is satisfactory, install gasket (fig. 34) and cover, then secure with washer, screw and screw assemblies.
- (20) Reassemble shifter control valve (para. 32).
- (21) To install shifter control valve, position gasket (fig. 35) on case, then install shifter control valve and secure with washer, screw and screw assemblies.
- (22) Install plug, elbow, and adapter in converter case. Install elbow, strainer, elbow. Connect tubing. Install unions in shift

cylinder, then connect hoses. See figure 38.

(23) If bushing was removed from collector ring, install new bushing (g(5) above).

(24) Install new oil seal (fig. 32) in pump housing. Install gears in pump housing and align scribe marks. Make sure the side of the internal gear with driving lugs is toward the outside. Place seal rings on collector ring, then install on pump housing. Secure with washers and screws. Place gasket in position, then install pump assembly and secure with washers and screws. Lock wire screw heads.

(25) Install hose assemblies (fig. 38).

i. *Install Transmission on Engine.* Refer to paragraph 9d.

j. *Install Transmission and Engine Assembly.* Refer to paragraph 9e.

31. Clutch Neutral Setting Adjustment

(fig 37)

a. No adjustments are required or provided for

clutch wear. The stroke of the shift cylinder is designed to completely wear out both clutch plates. Adjustment shims located under the shift cylinder mounting flange are factory adjustments for neutral setting. In the event of clutch plate, or shift cylinder replacement, dimensions, for neutral setting must be measured so that correct neutral setting can be obtained through removal or replacement of shift cylinder adjusting spacers.

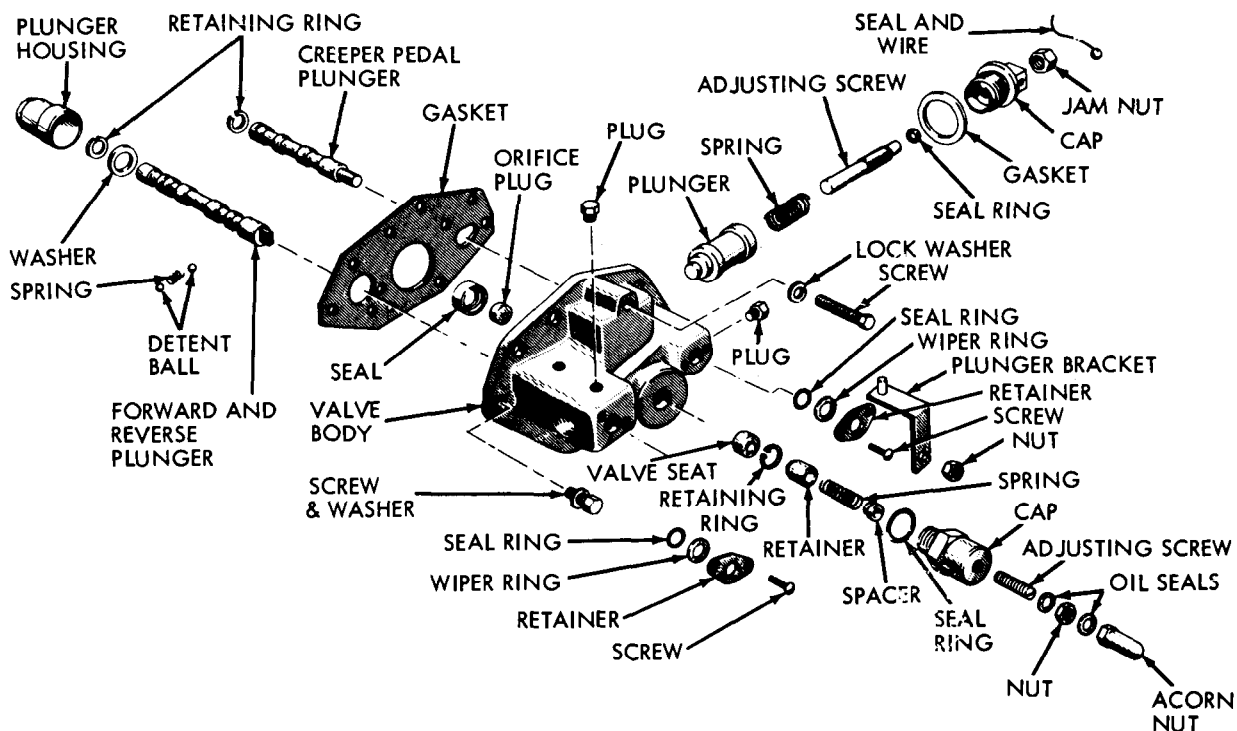
b. Measure the distance between the face of the clutch flywheel and the edge of one or more of the pressure plate driving lugs. Dimensions should be as shown in paragraph 6. Adjust setting by removing or installing spacers (fig. 37) between shift operating cylinder and case.

32. Shifter Control Valve

a. Remove Creeper Pedal Plunger (fig. 35).

(1) Remove retaining ring, then withdraw creeper pedal plunger assembly from valve body. If necessary, remove nut and separate plunger bracket from plunger.

(2) Remove screws, then remove retainer, and wiper ring. Remove seal ring from body.



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Figure 35. Shifter control valve, exploded view.

b. Remove Forward and Reverse Plunger (fig. 35).

- (1) Remove plunger housing.

Note. When removing plunger housing, exercise care as plunger detent balls and spring will fall out. Remove detent balls and spring.

- (2) Remove retaining ring and flat washer from forward and reverse plunger, then withdraw plunger from valve body.
- (3) Remove screws, then remove retainer, and wiper ring. Remove seal ring from body.
- (4) Unscrew and remove safety switch.

c. Remove Relief Valve (fig. 35).

- (1) Unscrew and remove acorn nut, seal, jam-nut, seal, and adjusting screw from relief valve cap.
- (2) Unscrew and remove relief valve cap with seal ring assembled. Remove seal ring from cap.
- (3) Remove guide spacer, spring, and retainer and ball assembly from valve body.
- (4) Remove retaining ring and relief valve seat from valve body.
- (5) Remove oil seal and orifice plug from valve body.

d. Remove Accumulator Valve (fig. 35).

- (1) Unscrew and remove accumulator valve cap assembly. Remove cap gasket. To disassemble cap, cut seal wire and remove seal. Hold adjusting screw then remove jamnut. Unscrew and remove adjusting screw from cap. Remove seal ring from cap bore.
- (2) Remove compression spring and accumulator valve from valve body.

e. Cleaning. Clean all parts with SD and dry thoroughly with compressed air.

f. Inspection.

- (1) Inspect accumulator valve plunger for binding or sticking in control valve body bore. Inspect for broken or distorted spring. Replace faulty parts.
- (2) Inspect retainer and ball assembly, and relief valve seat surfaces for nicks, scratches, or other defects that may cause poor seating. Inspect for broken or distorted spring. Replace faulty parts.

- (3) Inspect fit of creeper plunger and shift plunger in control valve body. Plungers should slide freely in control valve body without perceptible side play. Replace faulty parts.

- (4) Inspect detent balls for flat spots. Inspect for broken or distorted spring. Replace faulty parts.

- (5) Replace seals, wiper rings and gasket when valve has been disassembled.

g. Repair. Replace parts as necessary if found to be faulty.

h. Reassembly. Reverse procedures given in *d*, *c*, *b*, and *a* above. Adjust relief valve setting and accumulator valve (para. 30b).

i. Test Control Valve. Control valve should be tested after transmission has been installed and is in operating condition. Test under actual driving conditions to see how vehicle functions.

33. Shift Operating Cylinder

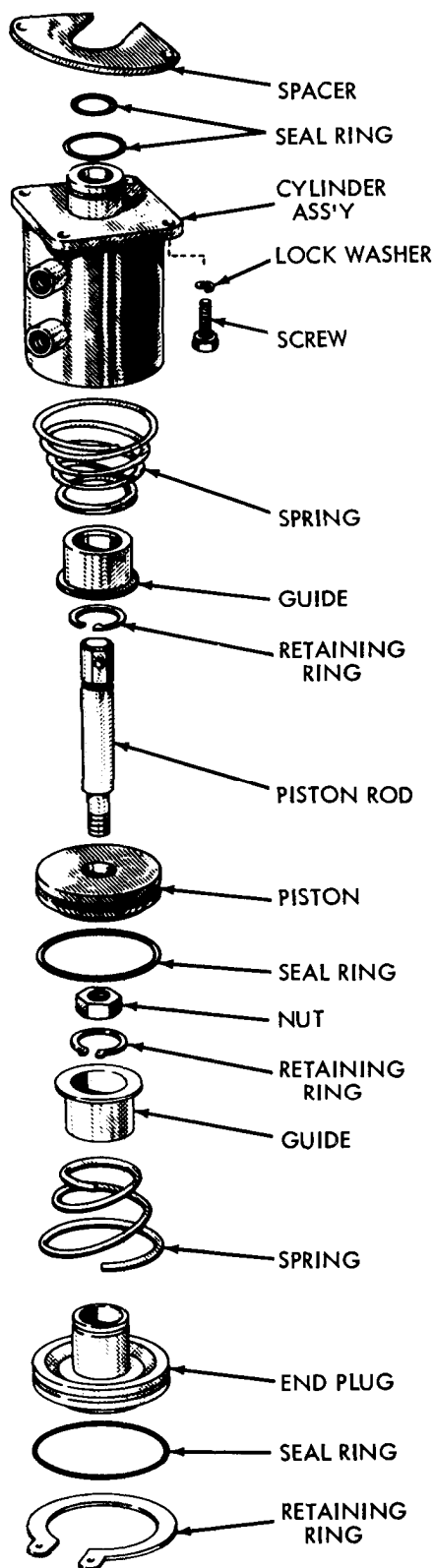
a. Disassembly (fig. 36).

- (1) Remove retainer ring from body. Screw a $\frac{3}{8}$ -16 NC bolt in tapped hole of end plug and remove plug assembly, using screw as a puller. To disassemble end plug assembly, use a vise or arbor press and compress against spring guide, then remove retainer ring. Release vise or press slowly, to relieve tension, then remove spring guide and spring from end plug. Remove seal ring.
- (2) Remove piston rod assembly from body, then remove seal ring. Remove nut, then separate piston from piston rod.
- (3) Insert body in press and press against spring guide, then remove retaining ring. Release press slowly, to relieve tension, then remove spring guide and spring.
- (4) Remove seal ring from body.

b. Cleaning. Clean all parts with SD and dry thoroughly with compressed air.

c. Inspection and repair.

- (1) Inspect cylinder bore for scratches or grooves which would cause cutting or scratching of seal ring and cause leakage.
- (2) Inspect piston rod surface where it slides back and forth in end plug for scoring or binding condition. Replace faulty parts.



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Figure 36. Shift operating cylinder, exploded view.

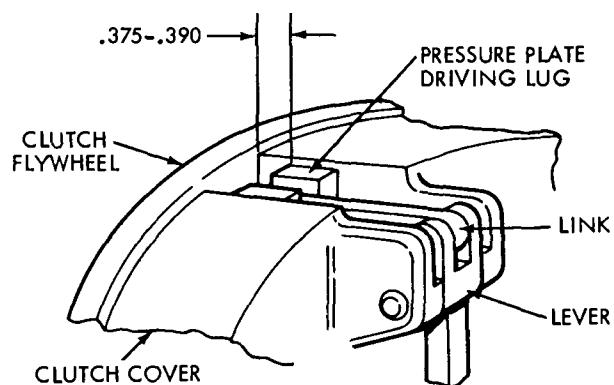


Figure 37. Adjustment of clutch neutral setting.

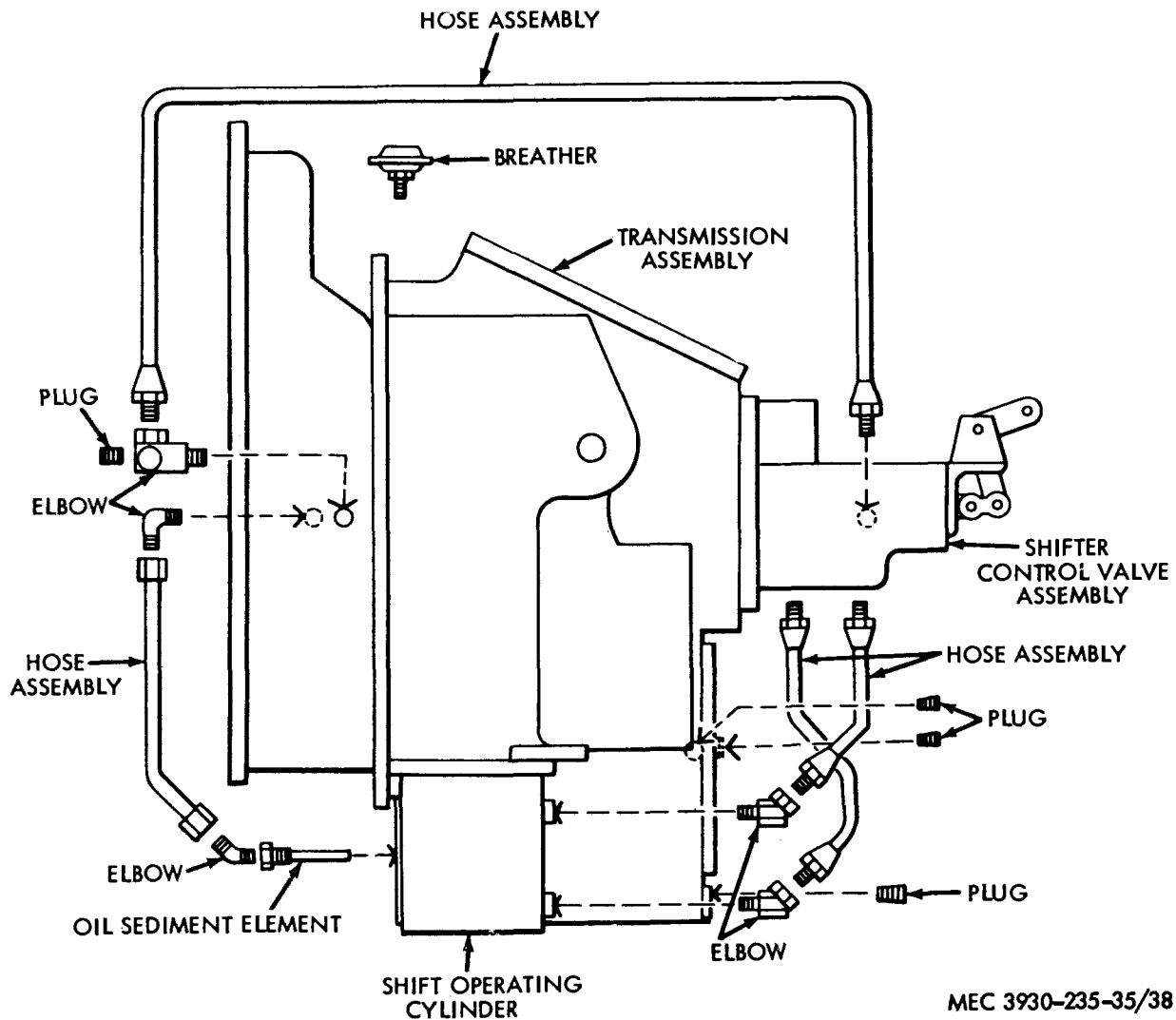
- (3) Inspect piston for scoring on surface which contacts cylinder bore. Replace faulty piston.
- (4) Replace all seals when cylinder has been disassembled.

d. *Reassembly.* Reverse procedures given in a above.

34. Creeper Pedal and Linkage

a. *Removal and Disassembly* (fig. 39).

- (1) Unhook all return springs.
- (2) Unscrew and remove ball joint nut and lockwasher at pedal lever, then separate ball joint from lever.
- (3) Remove cotter pin and clevis pin then disconnect cable yoke from lever.
- (4) Loosen clamping screw, then slide lever off creeper pedal shaft. Remove key from pedal shaft.
- (5) Cut lock wire then remove setscrew from creeper control arm. Slide creeper pedal out of bracket and at same time remove control arm, from between bracket up-rights. If necessary remove pedal shaft bushings from bracket up-rights.
- (6) Unscrew and remove ball joint nut and lockwasher at upper lever, then separate rod assembly from lever.
- (7) Remove cotter pin and flat washer, then lift off upper support lever.
- (8) Remove screws and washers, then remove upper support assembly from control valve body.



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Figure 38. Converter lines and fittings.

- (9) Remove cotter pin and flat washer then lift off lever support lever from plunger bracket. Remove cotter pins, and flat washer then remove lower support lever from control lever.

- (10) Remove locking plug from cross shaft. Remove cotter pins, washers, spacer washers, and cam plate. Remove bushings from control lever pins.

b. Cleaning and Inspection. Clean all parts with SD and dry thoroughly with compressed air. Inspect parts for worn pins, oblong holes, broken welds or damaged parts.

c. Repair. Replace parts as necessary to maintain smooth linkage operation.

d. Reassembly. Reverse procedures in a above.

e. Adjust Creeper Pedal and Linkage. Refer to T M 10-3930-235-20.

35. Transmission Shift lever and Linkage

a. Removal and Disassembly (fig. 40).

- (1) Remove steering wheel (para. 45).
- (2) Remove cotter pin and clevis pin then disconnect shift rod from shift lever lower lever.

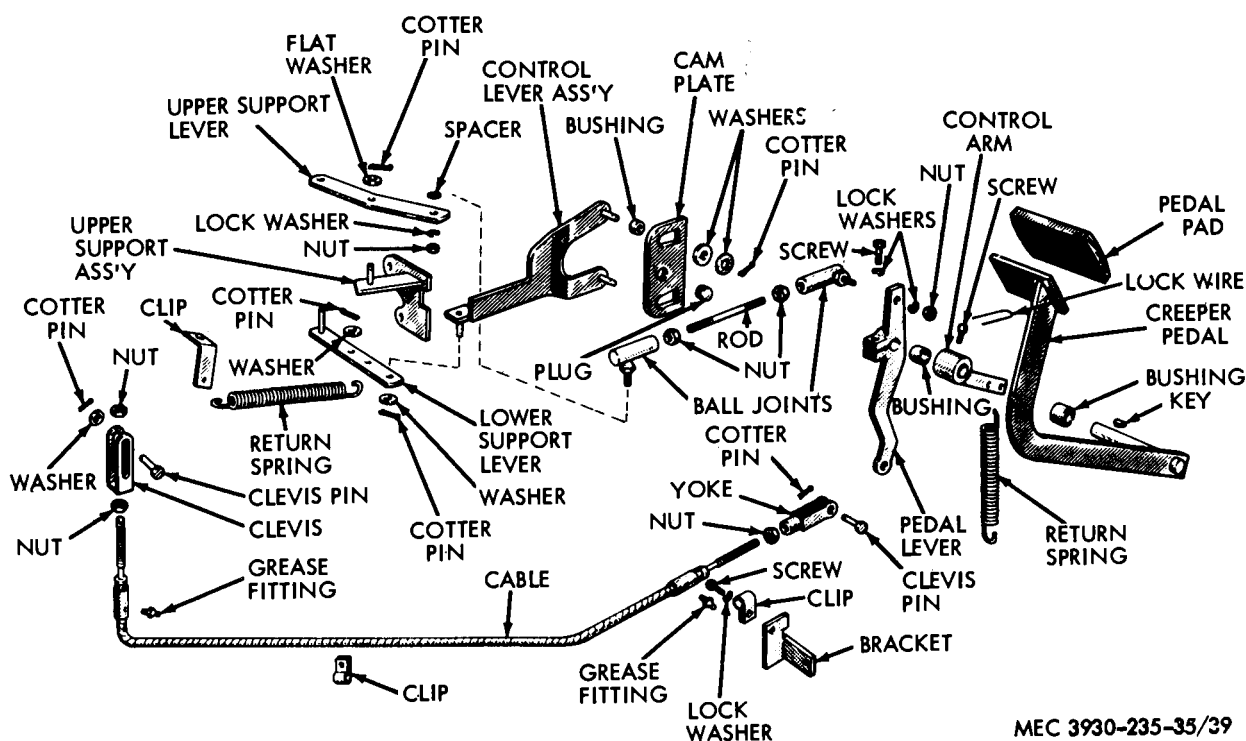


Figure 39. Creeper pedal and linkage, exploded view.

- (3) Loosen lower lever clamping nut, then remove lower lever from shift lever.
- (4) Knock out groove pin in collar, then remove shift lever by raising up and out of upper bracket.

Note. When shift lever is raised, the spring plunger will fall out.

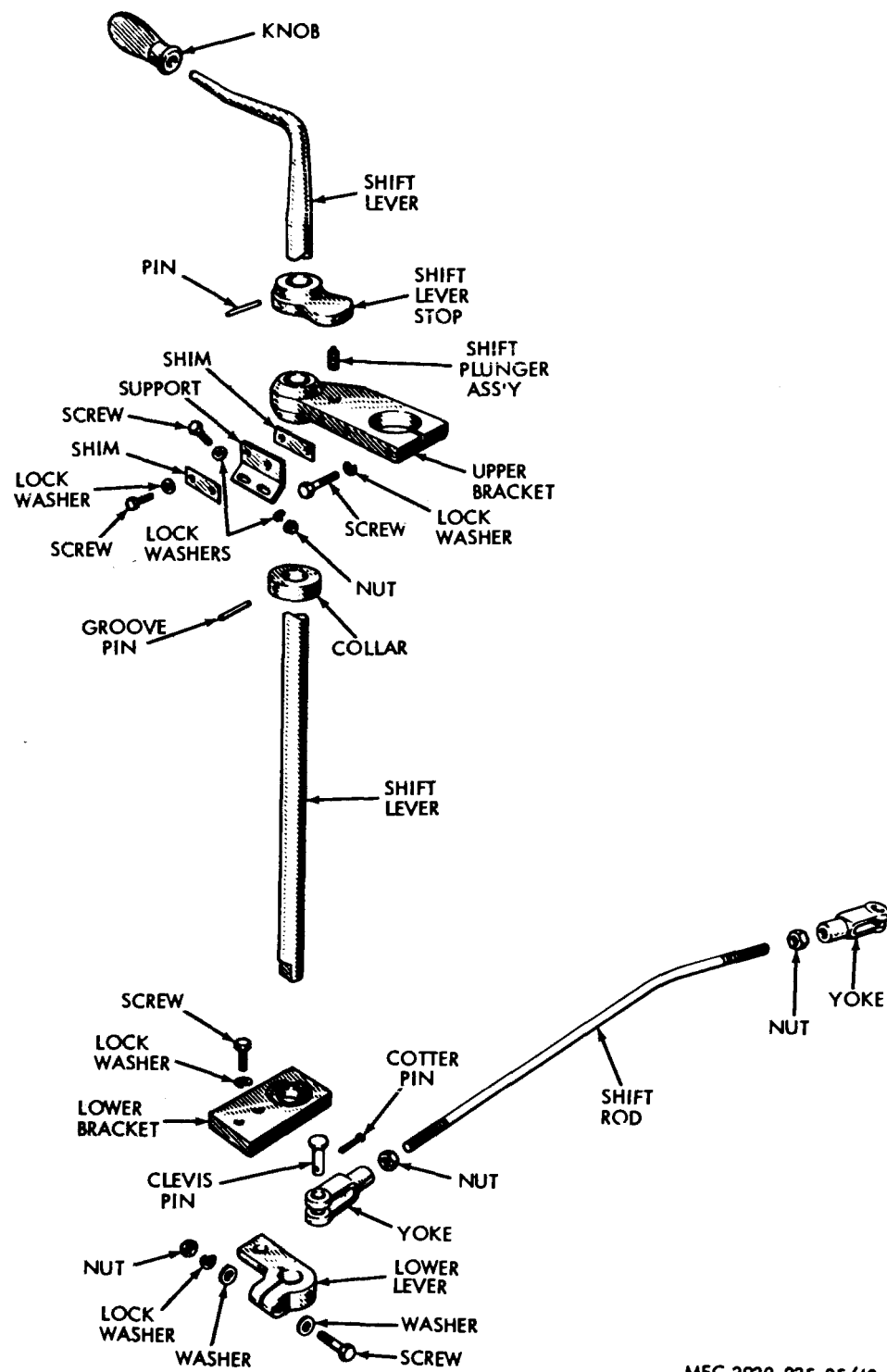
- (5) If necessary, remove pin and shift lever stop from shift lever.

b. Cleaning and Inspection. Clean all parts with SD and dry thoroughly with compressed air. Inspect parts for damage and wear.

c. Repair. Replace parts as necessary to maintain smooth shift lever operation.

d. Reassembly. Reverse procedures in *a* above.

e. Shift Lever and Linkage Adjustment. Refer to TM 10-3930-235-20.



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Figure 40. Transmission shift lever and linkage.

Section VIII. UNIVERSAL JOINT

36. Universal Joint

a. Removal and Disassembly (fig. 41).

- (1) Remove lock wires and screws fastening four bearings to the coupling plate. Carefully pry bearings out of coupling plate retaining lugs and slide bearings off spider journals. Remove coupling plate.
- (2) To remove spider, remove screws fastening bearings to yoke or brake flange. Pry bearing out of retaining lugs and remove spider and bearing assembly.

b. *Cleaning and Inspection.* Clean all parts with SD and thoroughly dry with compressed air. Inspect bearings and spider journal for wear or scoring caused by lack of lubrication. Replace spider and bearing as an assembly if parts are worn.

c. *Repair.* Do not repair universal joint bearings or spiders. If bearings or spiders are faulty, replace spider and bearing assemblies.

d. Reassembly and Installation.

- (1) Lubricate bearings during reassembly (LO 10-3930-235-20) and place them temporarily on spider journals to remove excess lubricant.
- (2) Remove the bearings and install new cork gaskets.
- (3) Slide drilled bearings on spider journals and install assemblies on yoke and brake flange. Insert coupling plate between the two spiders. Slide two drilled bearings on spider adjacent to transmission and two tapped bearings on spider adjacent to drive axle. Install screws through drilled bearings and coupling plate and into tapped bearings. After tightening retaining screws, secure with lock wires.

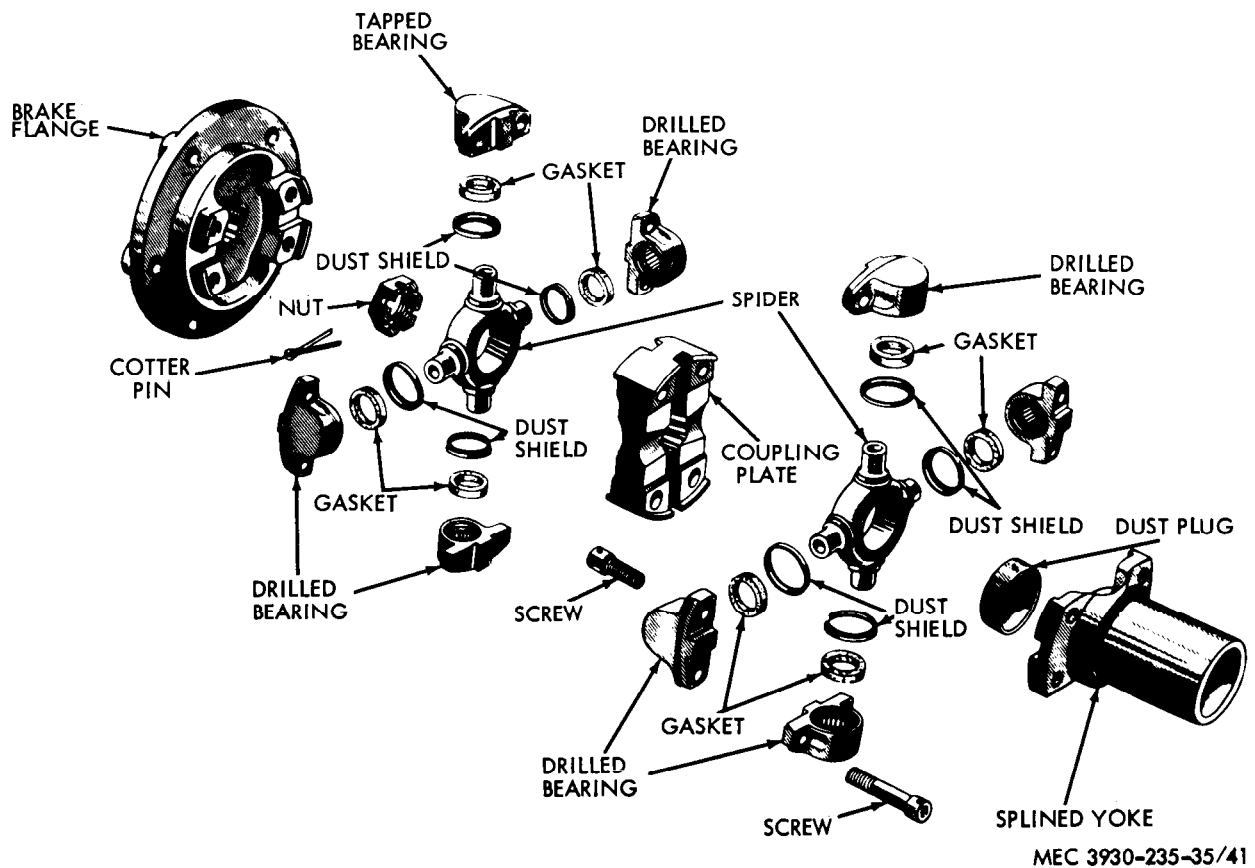


Figure 41. Universal joint, exploded view.

Section iX. DRIVE AXLE

37. Drive Axle

a. Removal.

- (1) Disconnect brake pedal and creeper pedal return springs.
- (2) Disconnect hydraulic brake tubing at tee mounted on axle housing.
- (3) Disconnect parking brake cable from brake pivot lever by removing return spring, cotter pin, washer, and pin.
- (4) Raise vehicle, then remove nuts, washers, bolts, power steering cylinder mounting plate, and washer fastening drive axle to frame. Pull drive axle assembly toward front of vehicle, disengaging universal

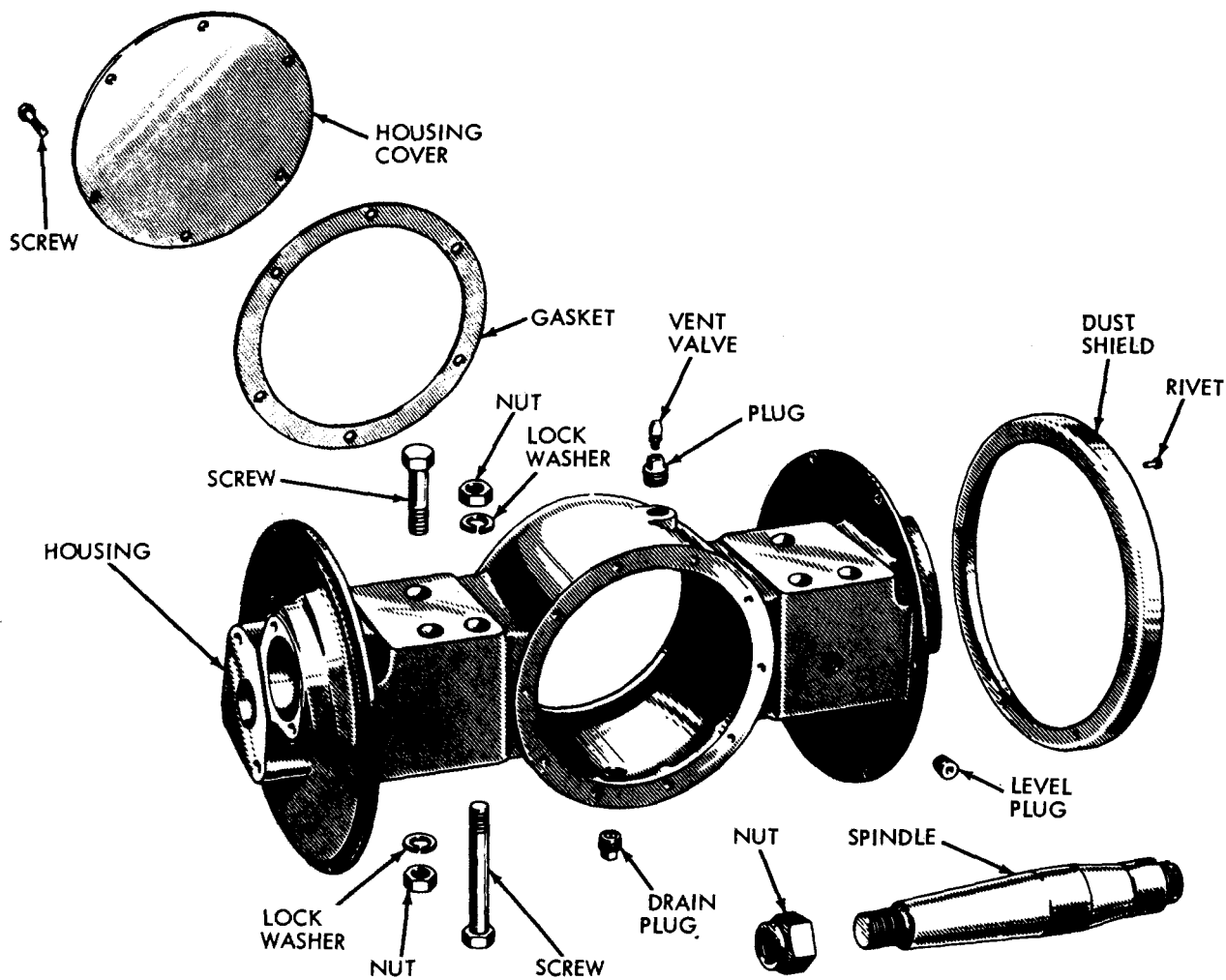
joint splined yoke from transmission, then remove axle assembly.

- (5) Drain lubricant.

b. Disassembly.

- (1) *Disassembly of drive axle.*

- (a) Remove drive wheels (TM 10-3930-235-20).
- (b) Remove service brake shoes (TM 10-3930-235-20).
- (c) Remove drive axle shaft (TM 10-3930-235-20).
- (d) Remove parking brake (para. 43).
- (e) Remove universal joint (para. 36).
- (f) Remove screws and washers fastening



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Figure 42. Drive axle housing, exploded view.

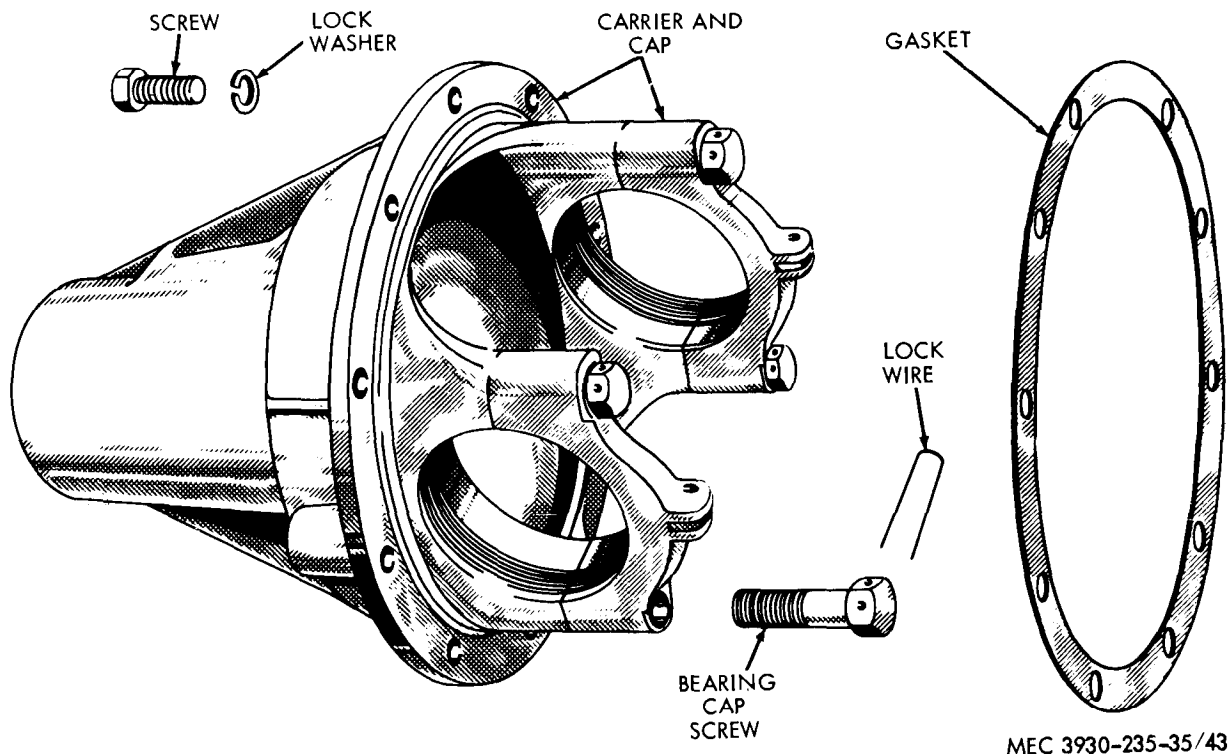


Figure 43. Differential carrier.

differential carrier to axle housing (fig. 42), then remove differential carrier assembly and gasket.

- (9) If replacement is necessary, remove rivets, and dust shield (fig. 42) from axle housing. Remove nut, then remove spindle from axle housing. Remove vent plug, drain plug, and level plug from axle housing.
- (h) On Model MHE-191, remove screws, housing cover, and gasket from axle housing.
- (2) *Disassembly of differential* (fig. 44).
 - (a) Mark position of bearing adjusters for identification in reassembly. Remove cotter pins and locks. Cut lock wire, loosen carrier cap screws, then remove adjusters. Remove bolts and bearing caps, then remove differential subassembly and bearing cups from carrier. (fig. 43)
 - (b) Mark the two case halves (fig. 44) for identification then separate case halves. Remove thrust washers, pinions and spider, side gears and thrust washers

from case halves. If replacement is necessary, pull bearing cones off case halves.

- (c) Do not remove bevel gear from case unless replacement is necessary (d below).
- (d) Remove cotter pin (fig. 44) and nut, then pull brake flange off bevel pinion. Drive out pinion using a brass drift and hammer. Remove shims, spacer, and inner bearing cone from bevel pinion. Remove oil seal, and outer bearing cone from differential carrier by carefully tapping cone from inside of carrier.

Note. During removal of drive pinion, note size and number of shims at spacer, and between inner cup and carrier. To facilitate adjustment, use same size and number of shims during reassembly.

- (e) Remove inner bearing cup (fig. 44) from carrier, using a puller. Remove outer cup by tapping from inside of carrier, driving through slots in carrier.
- (f) If necessary, remove parking brake anchor pin from carrier.

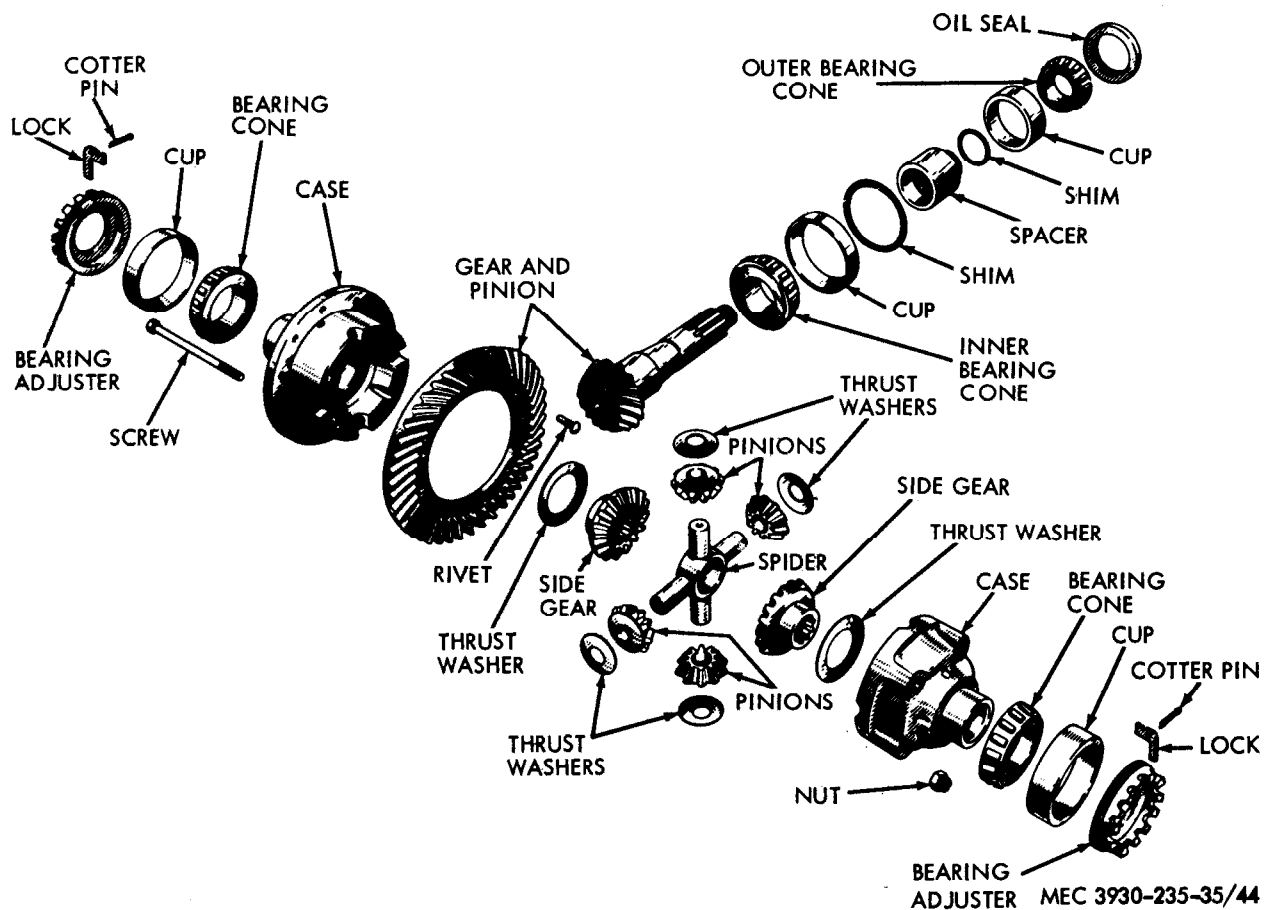


Figure 44. Differential, exploded view.

c. Cleaning and Inspection.

- (1) Clean all parts with SD and dry thoroughly with compressed air.
- (2) Inspect tapered roller bearing cups and cones for scoring, nicks, or flat spots. Replace faulty bearings.
- (3) Inspect bevel gear and pinion for worn, chipped, or broken teeth. Replace faulty gear or pinion. Refer to 7d below for instructions covering removal and installation of bevel gear.
- (4) Inspect differential side gears and pinions for chipped, broken, or worn teeth. Replace faulty gears or pinions. Inspect friction surfaces of thrust washers, side gears, pinion, and differential case for scoring or wear. Replace faulty parts.
- (5) Replace all oil seals and gaskets when drive axle has been disassembled.

d. Repair.

- (1) Replace faulty bevel gear as follows: Heat rivets, then drive them out of gear and differential case. Install new gear on case and secure with new rivets. Peen rivets cold.
- (2) Replace faulty parts as necessary.

e. Reassembly of Differential (fig. 44).

- (1) Install same size and number of shims that were removed during disassembly in carrier, then install inner bearing cup.
- (2) Install outer bearing cup using a brass drift and hammer.
- (3) Install inner bearing cone on bevel pinion, then install pinion assembly in carrier. Place bearing spacer, original number of shims and outer bearing cone on pinion.

Note. Do not install oil seal until differential is completely adjusted.

- (4) Install brake flange and nut. Tighten nut and inspect for proper adjustment. Refer to *f* below for pinion bearing adjustment. Install oil seal after correct adjustment is obtained.
- (5) Place thrust washers and side gear in flanged half of differential case. Place pinions and thrust washers on journals of spider, then place this assembly on flanged half of differential case. Place the other side gear and thrust washer on pinion assembly. Position plain half of differential case on flanged half, aligning identification marks made in disassembly, then install bolts and nuts. Lock wire nuts.
- (6) If bearing cones were removed from differential case, install new bearing cones using an arbor press.
- (7) Place bearing cups on cones, then position differential case assembly in carrier and install caps and screws. Do not tighten screws completely. Install bearing adjusters and tighten until marks previously made during disassembly are aligned.
- (8) Adjust differential bearings as described in *g* below. Adjust drive gear to pinion backlash as described in *h* below.
- (9) After differential is correctly adjusted, tighten screws and install locks and cotter pins. Remove nut and brake flange from bevel pinion, then install oil seal. Reinstall brake flange and secure with nut and cotter pin.

f. Adjustment of Bevel Pinion Bearings.

- (1) Adjust pinion outer bearing assembly to obtain a preload of 0.000- to 0.002-inch-tight clearance. Adjust by removing or installing shims between outer bearing cone and bearing spacer.

- (2) Inspect adjustment by measuring pinion end play with a dial indicator or by rotation of pinion by hand. Correct adjustment is indicated if a slight drag (with oil seal removed) is felt when rotating pinion. Install shims if pinion cannot be rotated. Remove shims if pinion is too loose.
- (3) If a dial indicator is used, measure pinion end play and install or remove shims as necessary to obtain correct adjustment. *For example:* If end play is 0.008 inch, remove shim or shims totaling 0.010 inch. This will remove end play and create a 0.002-inch preload on bearings.

g. Adjustment of Differential Bearings.

- (1) Adjust bevel gear and pinion backlash to approximately 0.006 to 0.010 inch. Make final backlash adjustment (*h* below) after differential bearings are adjusted.
- (2) Tighten bearing adjusters as much as possible to seat bearing cones in cups. Loosen adjusters until a slight drag is felt when turning bevel gear by hand. This slight drag should indicate a bearing adjustment of 0.000 to 0.005 inch tight.

h. Adjustment of Bevel Gear to Pinion Backlash.

Adjust bevel gear to pinion backlash by turning bearing adjusters equal distances in opposite directions, to remove ring gear toward or away from pinion and still retain correct differential bearing adjustment made in *g* above. To adjust, loosen bearing cap screws, then turn one bearing adjuster counterclockwise and turn the opposite bearing adjuster clockwise. Each time adjustment is made, tighten bearing cap screws and reinspect gear backlash. Backlash should be 0.006 to 0.010 inch.

i. Reassembly of Drive Axle. Reverse procedures in *b*(1) above.

j. Installation. Reverse procedure in *a* above.

Section X. STEERING AXLE

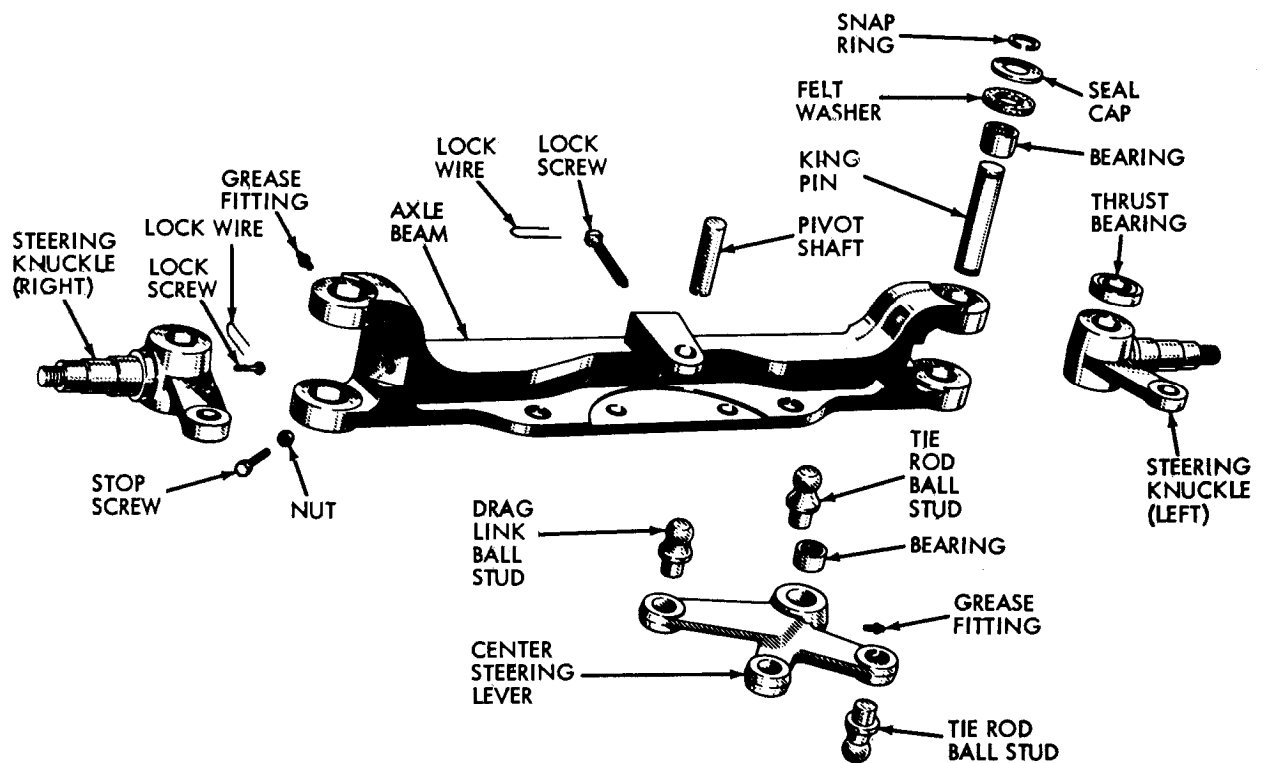
38. Steering Axle (MHE-191)

a. Removal of Axle and Spring Assembly.

- (1) Raise vehicle until wheels just rest on floor. Disconnect rear drag link from center steering lever ball stud by removing cotter pin and unscrewing end plug.

- (2) Remove nuts and washers then drive out shackle bolts to disconnect springs from frame hanger brackets. Remove axle assembly.
- (3) Remove springs from axle (para. 47).

b. Disassembly of Steering Axle (fig. 45).



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Figure 45. Steering axle, exploded view (MHE-191).

- (1) Remove steering wheels (TM 10-3930-235-20).
- (2) Remove tie rods (TM 10-3930-235-20).
- (3) Cut lock wire, then remove lock screw and pivot shaft. Remove steering lever assembly from axle beam. If necessary, remove needle bearings from steering level using an arbor press.
- (4) Remove snap rings, seal caps, felt washers, lock screws, and king pins, then remove steering knuckles and thrust bearings from axle beam. Press needle bearings from axle beam. Remove opposite steering knuckle in the same manner.
- (5) If necessary, remove stop screws and nuts. Remove lubricant fittings.

c. Cleaning and Inspection.

- (1) Clean all parts in SD and dry thoroughly with compressed air.
- (2) Inspect king pin for scoring or grooves. Inspect king pin bearings for scored, pitted, or damaged condition. Inspect steering knuckle thrust bearing for binding condi-

tion. Inspect steering knuckles for fractures or damage.

- (3) Inspect center steering pivot shaft and bearings for scored or worn condition. Shaft should rotate freely in bearings without perceptible side play.
- (4) Inspect ball studs for scored condition.

d. Repair. Replace faulty parts as necessary.

e. Reassembly. Reverse procedures in *b* above.

f. Installation. Reverse procedures in *a* above.

g. Adjust Toe-In. Refer to TM 10-3930-235-20.

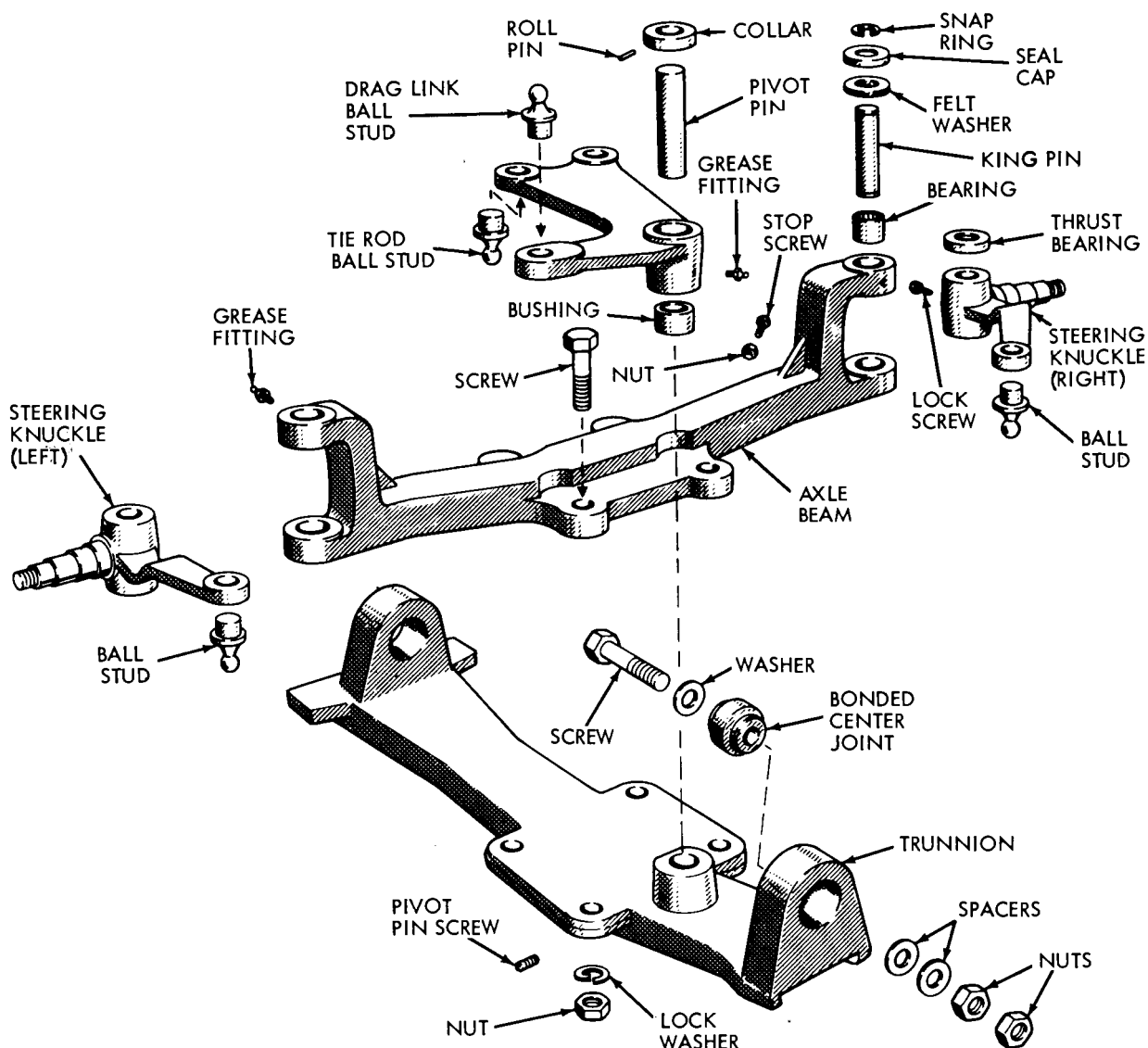
39. Steering Axle (MHE-190)

a. Removal of Axle Assembly.

- (1) Raise vehicle until wheels just rest on floor. Disconnect rear drag link from center steering level ball stud by removing cotter pin and unscrewing end plug.
- (2) Remove nuts, spacers, and bolts fastening trunnion frame brackets. Remove axle assembly.

b. Disassembly of Steering Wheels.

- (1) Remove steering wheels (TM 10-3930-235-20).



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Figure 46. Steering axle, exploded view (MHE-190).

- (2) Remove tie rods (TM 10-3930-235-20).
- (3) Remove pivot pin setscrew, then drive out pivot pin, with collar and roll pin assembled, from trunnion. If necessary, remove bushings from steering lever (*d* below).
- (4) Remove snap rings, seal caps, felt washers, lock screws, and king pins, then remove steering knuckles and thrust bearings from axle beam. Press needle bearings out of axle beam.
- (5) If necessary, remove stop screws and nuts. Remove lubricant fittings.
- (6) Remove bolts, nuts, and washers, then separate axle beam from trunnion.
- (7) If necessary press bonded center joint out of trunnion.

c. Cleaning and Inspection. Same as paragraph 38c, except inspect center bonded joint for oil-soaked condition. Replace bonded joint if rubber is oil-soaked and gummy.

d. Repair. Same as for paragraph 38d, except replace scored or worn bushings in center steering lever using an arbor press. If necessary, ream bush-

ings so that shaft rotates freely in bushing without perceptible side play.

e. Reassembly. Reverse procedures in *b* above.

f. Installation. Reverse procedures in *a* above.

g. Adjust Toe-in. Refer to TM 10-3930-235-20.

Section Xi. BRAKES

40. Brake Pedal and Master Cylinder

a. Removal.

- (1) Remove floor plates. Disconnect return spring from spring clip. Remove cotter pin and clevis pin to disconnect yoke from lever.
- (2) To remove pedal (fig. 47), loosen screw,

nut, and washer, then remove lever and key. Remove pedal and pad. If necessary, remove pedal shaft bushings from frame.

- (3) To remove master cylinder, disconnect stoplight switch wires. Disconnect brake tubing at master cylinder fitting. Remove bolts (fig. 48), nuts, and lockwashers

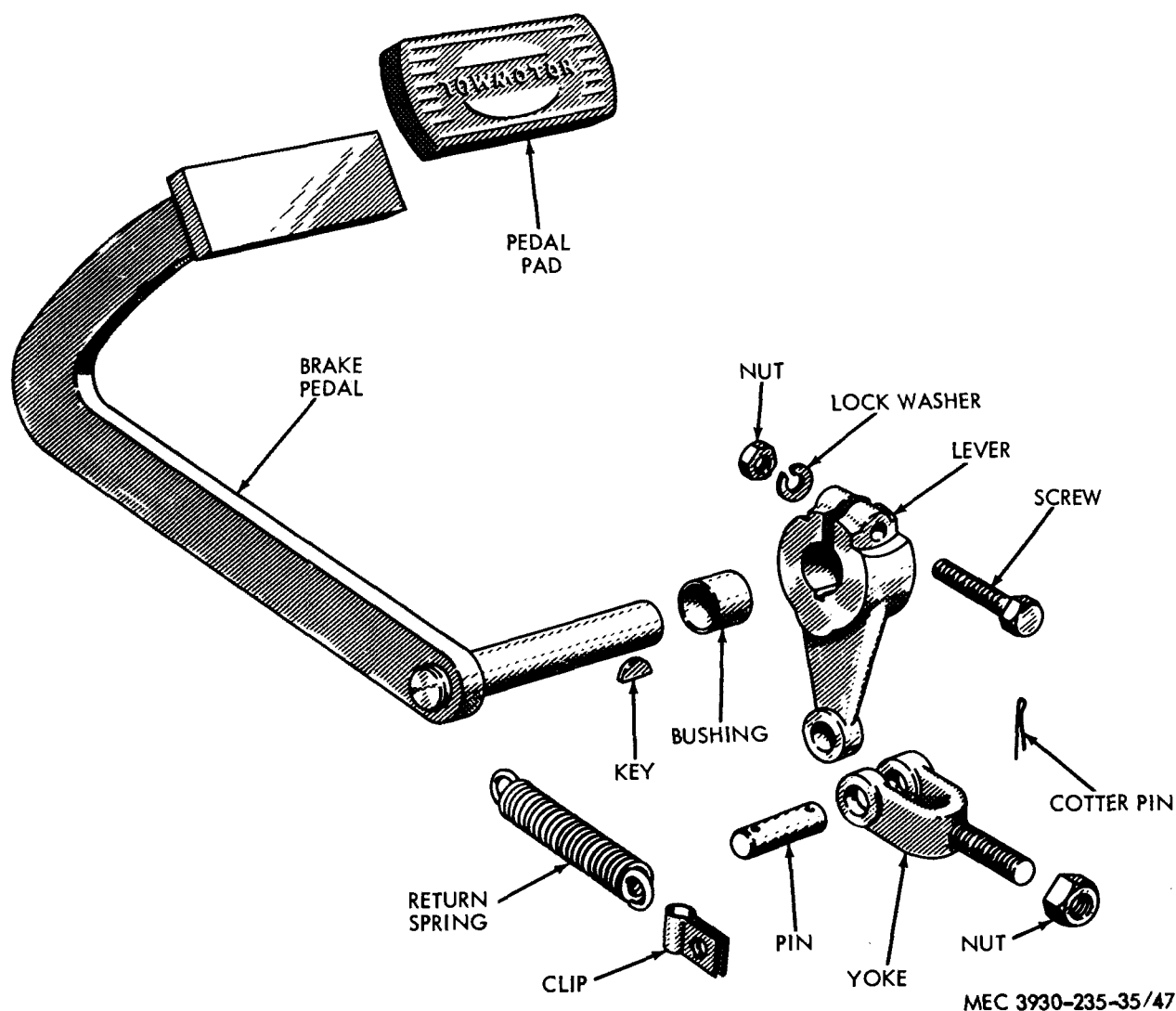
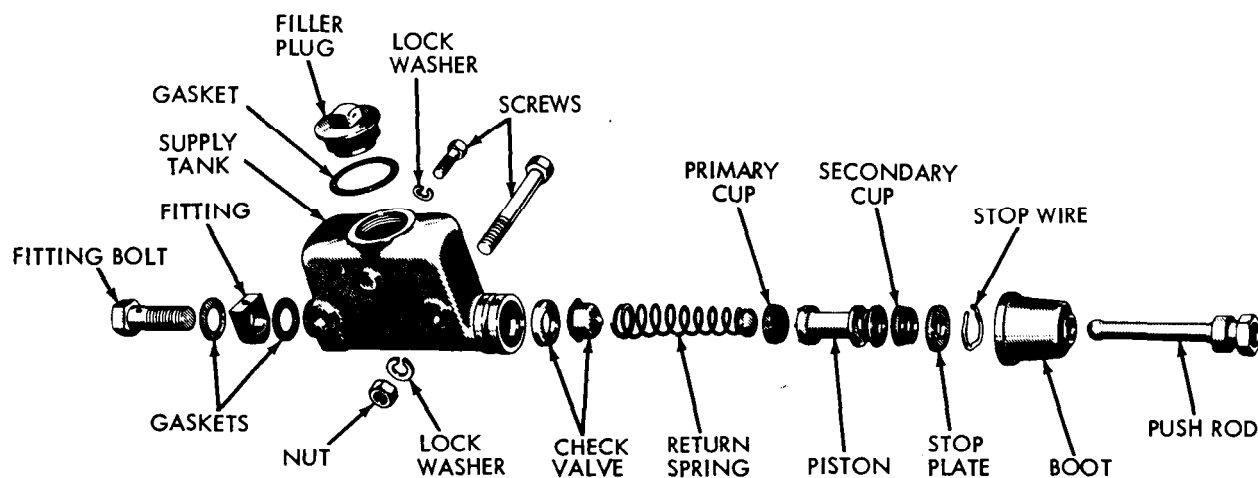


Figure 47. Brake pedal, exploded view.



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Figure 48. Master cylinder, exploded view.

fastening master cylinder to frame, then remove master cylinder assembly.

b. Disassembly of Master Cylinder (fig. 48).

- (1) Loosen nut and remove yoke from push rod.
- (2) Remove filler cap and gasket. Remove push rod and boot.
- (3) Remove piston stop wire, stop plate, secondary cup, piston, primary cup, return spring, and valve from supply tank. If necessary, remove fittings from supply tank.

c. Inspection.

- (1) Inspect pedal to master cylinder yoke, lever, and pins for wear or elongated holes at linkage connecting points. Replace faulty or worn parts.
- (2) Inspect supply tank bore, piston, and cups for nicks, scratches, or scoring. Replace faulty parts. When cylinder has been disassembled for repair, it is recommended that parts contained in repair kit be replaced.

d. Repair. When master cylinder has been disassembled and supply tank bore is in satisfactory condition, it is recommended that parts contained in repair kit be replaced.

e. Reassembly of Master Cylinder. Reverse procedures in *b* above, except coat internal parts with brake fluid.

f. Installation. Reverse procedures in *a* above.

g. Bleed Brake System. Refer to paragraph 42.

h. Adjust Brake Pedal Free Travel. Refer to TM 10-3930-235-20.

41. Brakeshoes and Wheel Cylinders

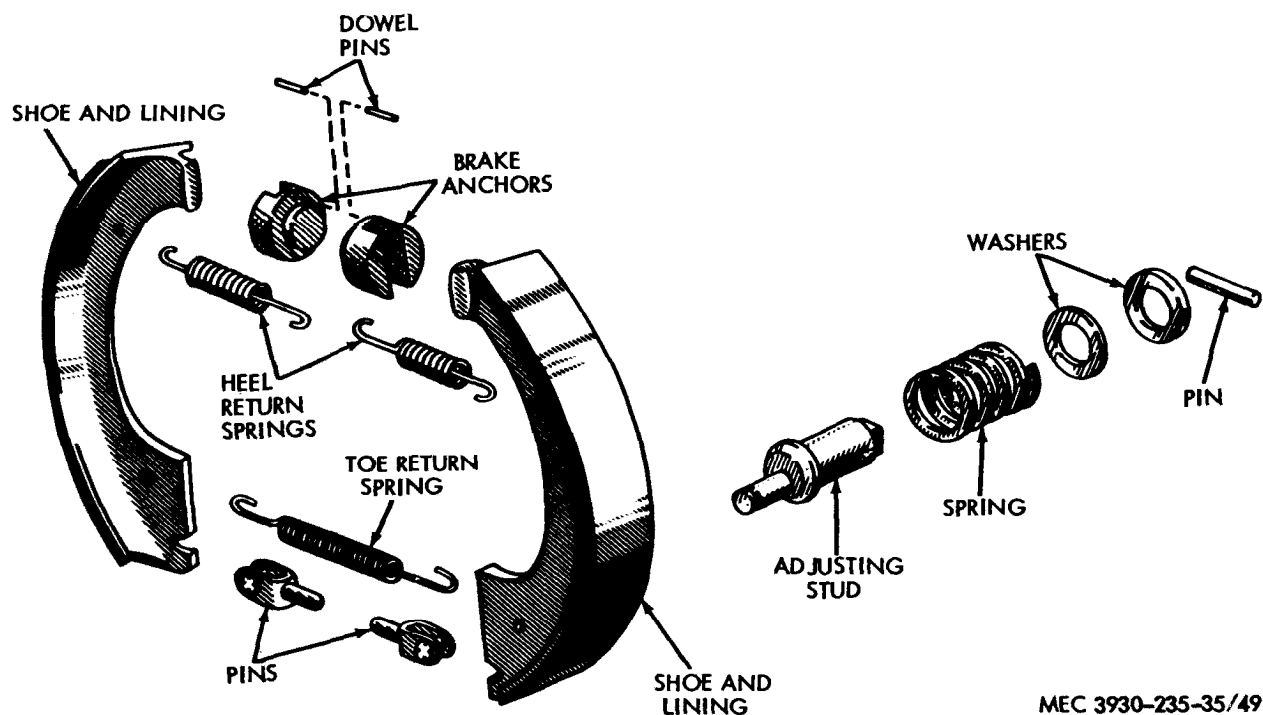
a. Removal (fig. 49).

- (1) Remove wheels (TM 10-3930-235-20).
- (2) Cut lock wire, then remove cap screws and grease shield.
- (3) Using proper tool, disconnect heel return spring and toe return spring.
- (4) Lift off brakeshoes.
- (5) Disconnect brake line at wheel cylinder.
- (6) Remove screws and washers, then remove wheel cylinder from backing plate.

b. Disassembly of Wheel Cylinder (fig. 50). Remove pins, boots, pistons, cups, and spring from body. Remove bleeder screw.

c. Inspection.

- (1) Inspect brakeshoe lining for grease-soaked or worn condition. If linings are grease-soaked or worn to less than $\frac{1}{8}$ -inch thick, replace brakeshoe assembly.
- (2) Inspect pistons, piston cups, and cylinder bore for nicks, scratches, or scoring. Replace faulty parts. When cylinder has been disassembled for repair, it is recommended that parts contained in the repair kit be replaced.



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Figure 49. Brakeshoes, exploded view.

d. Repair.

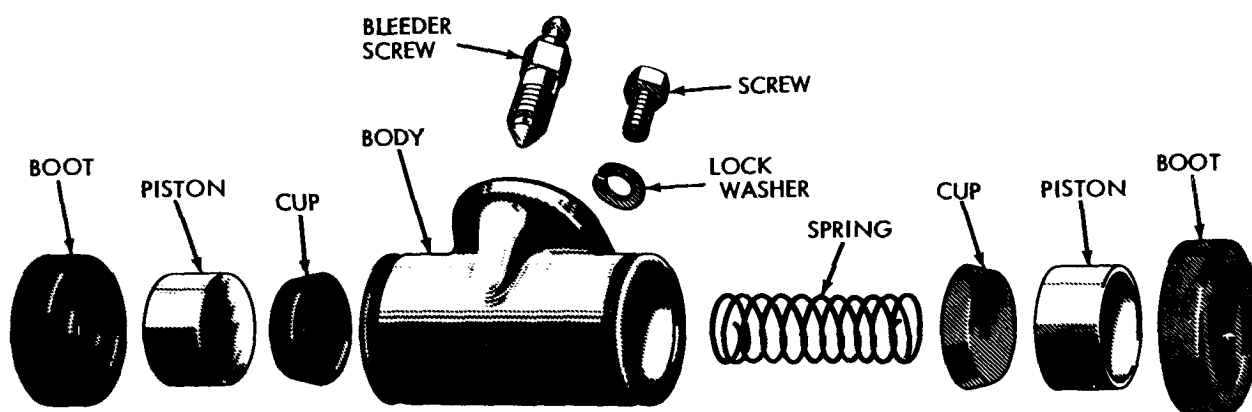
- (1) Linings are bonded to brakeshoes. If linings are faulty or worn, replace shoe assembly.
- (2) When wheel cylinder has been disassembled and cylinder bore is satisfactory, it is recommended that parts contained in repair kit be replaced.

e. Reassembly of Wheel Cylinder. Reverse procedures in *b* above, except coat internal parts with brake fluid.

f. Installation. Reverse procedures in *a* above.

g. Adjust Brake Shoes. Refer to TM 10-3930-235-20.

h. Bleed Brake System. Refer to paragraph 42.



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Figure 50. Wheel cylinder, exploded view.

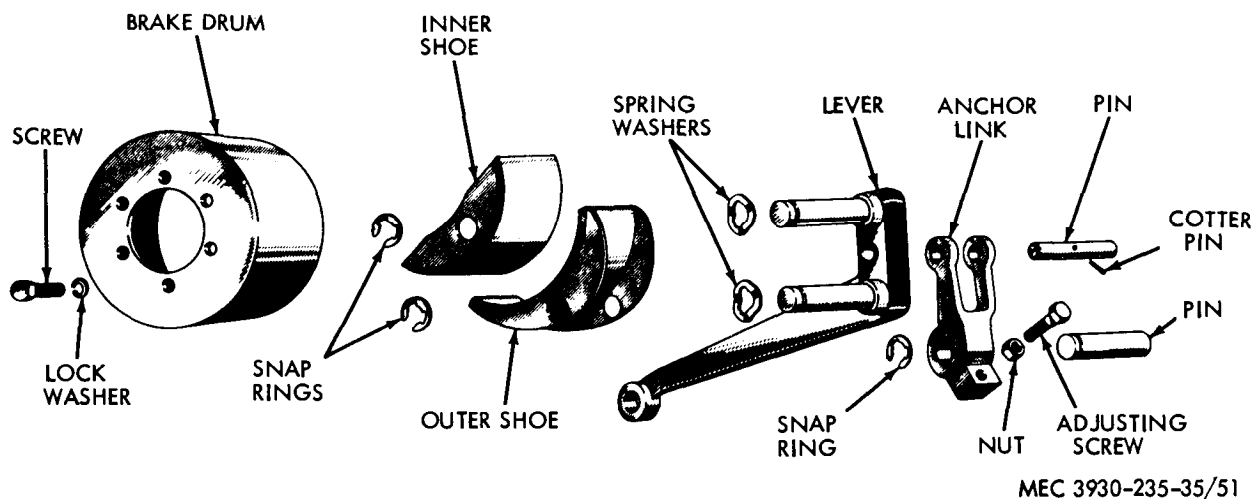


Figure 61. Parking brakeshoes, exploded view.

42. Bleeding Hydraulic Brake System

a. Fill master cylinder. Attach a rubber hose to the end of the wheel cylinder bleeder screw and extend the open end of the hose in a receptacle containing hydraulic brake fluid.

b. Loosen the bleeder screw one-half turn. Then slowly depress and release the brake pedal until fluid runs out of the hose in a steady stream without bubbles. Tighten bleeder screw.

43. Parking Brakeshoes

a. *Removal and Disassembly* (fig. 51).

- (1) Disconnect spring and remove cotter pin, washer, and pin to disconnect cable from pivot lever.
- (2) Remove screws and washers fastening brakedrum to brake flange, then slide drum over propeller shaft toward transmission.
- (3) Loosen nut and adjusting screw. Remove snap ring fastening brakeshoe assembly to

pin mounted in drive axle differential carrier. Remove brakeshoe assembly.

- (4) Remove snap rings, inner and outer brakeshoes, and friction washers from mounting pins in pivot lever.

b. *Inspection.*

- (1) Inspect lining for grease-soaked or worn condition. Replace linings if they are grease-soaked or worn.
- (2) Inspect brakedrum for scoring. Replace scored drum.

c. *Repair.* Replace grease-soaked or worn brakeshoe linings by replacing brakeshoe assembly. Linings are bonded to shoe. Keep new linings free of oil or grease during installation.

d. *Reassembly and Installation.* Reverse procedures in a above.

e. *Adjust Parking Brakeshoes.* Refer to TM 10-3930-235-20.

Section Xii. STEERING SYSTEM

44. Power Steering Pump

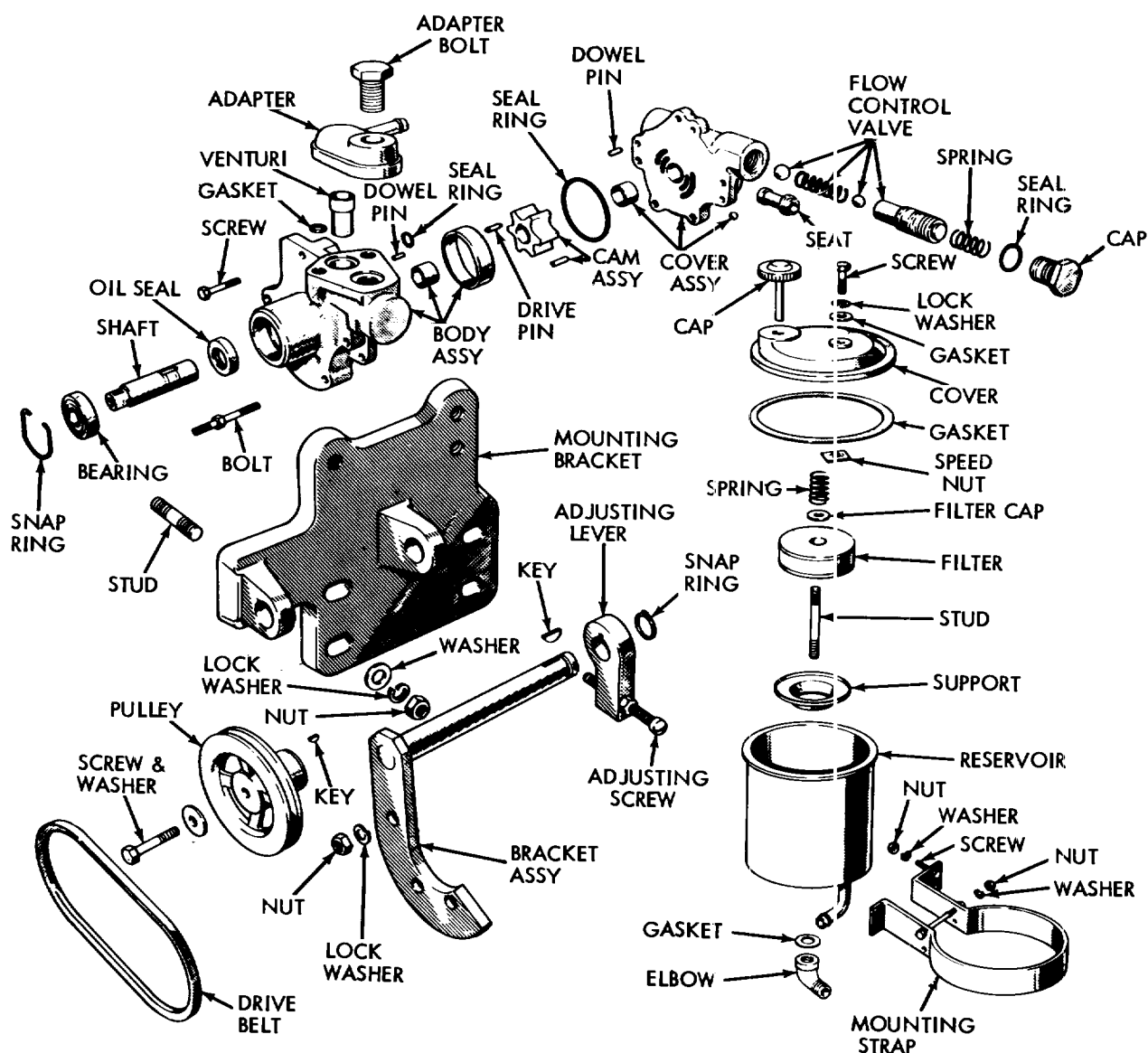
a. *Removal.* Refer to TM 10-3930-235-20.

b. *Disassembly* (fig. 52).

- (1) Remove screw, washer, pulley, and key from pump drive shaft.
- (2) Remove adapter bolt, adapter, and adapter gasket from pump body.

- (3) Remove cap, seal ring, spring, and valve assembly from pump cover. With valve assembly removed, ball spring and ball will drop out of cover.

- (4) Remove screws and mounting studs, then lift cover vertically from body. Remove seal rings from grooves in body.



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Figure 52. Power steering pump and reservoir, exploded view.

- (5) Remove cam assembly by lifting cam carrier, rollers and insert from body.
- (6) Remove key from shaft and snap ring from body, then remove shaft assembly from body. Remove bearing from shaft.
- (7) Remove oil seal from body.
- (8) Do not remove dowel pins, venturi, bushings, tube seat, or ball from body unless replacement is necessary.

c. Inspection.

- (1) Inspect shaft friction surface and bushings in body and cover for scoring or wear.

Shaft should rotate freely in bushings without perceptible side play. Replace faulty shaft. If bushings are faulty, replace cover or body assembly.

- (2) Inspect shaft ball bearing for binding or looseness. Replace faulty bearing.
- (3) Inspect shaft seal surface for scratches, scoring, or other defects that may cause leakage. Replace faulty shaft. Replace oil seal when pump has been disassembled.
- (4) Inspect end of cam rollers for scoring or wear. Measure cam assembly and clear-

ance with cam assembly and drive shaft installed in body. Use straight edge and feeler gage. If end clearance exceeds 0.002 inch, replace cam assembly. If end of cam rollers are scored, replace cam assembly.

- (5) Inspect flow control valve body for nicks or defects that may cause sticking. If any of the flow control valve parts are faulty, replace valve assembly.
- (6) Install new element, oil seals, and gaskets when pump has been disassembled.

d. Repair.

- (1) If drive shaft bushings in pump body or cover are faulty, replace pump body assembly or cover assembly.
- (2) If cam carrier, rollers, or insert are faulty, replace cam assembly.

e. Reassembly. Reverse procedures in *b* above, except use new oil seal, gaskets, and seal rings.

f. Testing Power Steering Pump Oil Pressure.

- (1) Check reservoir for correct oil level (fig. 52).
- (2) With engine stopped, disconnect pressure hose at pump and install a tee in the pump discharge port. Install a 1,500 psi gage in tee. Connect shutoff valve to tee, then connect pressure hose to valve.
- (3) Turn shutoff valve to a fully-opened position. Start engine and idle until oil has reached operating temperature.

Caution: To prevent damage to pump parts, do not allow valve to remain closed for more than 3 to 4 seconds during the following tests.

- (4) Close shutoff valve and note pressure reading, then quickly open the valve.
- (5) If pressure reading is less than 750 psi, the pump is faulty.
- (6) If pressure reading is between 750 psi and 900 psi, the pump is delivering sufficient pressure and test should be continued to determine if there is a loss of pressure in the hydraulic cylinder.

Caution: To prevent damage to power steering system units, do not maintain full pressure in the system for longer than 10 seconds during the following test.

- (7) With shutoff valve open, turn the wheels against a curb or suitable object and maintain sufficient force on the steering wheel to apply full pressure in the hydraulic cylinder. Note pressure reading, then release wheel.
- (8) If the pressure reading is 750 psi or above, the hydraulic cylinder is operating correctly. If reading is less than 750 psi, the hydraulic cylinder is faulty.

45. Steering Gear

a. General.

- (1) The action of the steering gear is both manual and hydraulic in effect. When the cam is turned to the left or right, by the driver's effort on the steering wheel, the levershaft stud is moved through the groove of the cam (worm), thus rotating the levershaft and providing angular movement of the steering gear pitman arm. Whenever the driver's effort at the steering wheel exceeds the preload of the actuator centering springs, the control valve is actuated and the hydraulic system comes into operation automatically; thus providing the driver with power steering.
- (2) The valve spool is moved axially as the cam is moved. However, movement is restricted by the actuator centering springs. The effect of these springs is to center the spool. When the valve spool is in the center position, oil pressure to the two cylinder ports is equal and results in no effective forces in the cylinder.
- (3) Operation is as follows: When the driver's effort at steering wheel overcomes effect of the centering spring, the actuator and valve spool move axially. Movement of the valve spool restricts one of the valve return passages to the valve outlet port, thus causing an immediate increase in pressure at one end of the hydraulic cylinder. At the same time, the other valve return passage is enlarged, allowing the oil, from the opposite end of cylinder, to return to the reservoir. The immediate effect is increased pressure in one end of the cylinder which actuates the cylinder piston and causes hydraulic power to be applied to steering linkage. Full hydraulic pressure is applied

with a spool travel of approximately 0.050 inch. Slightest movement of valve spool results in a pressure differential.

- (4) When effort at steering wheel is released, the valve spool is returned to the center or neutral position.
- (5) If the steering axle wheels are subjected to shock loads, the pittman arm, acting through the lever shaft, shifts the cam and control valve spool axially in the appropriate direction, to direct hydraulic pressure to the correct side of the cylinder piston to resist the shock forces. This action prevents kickbacks at the steering wheel.

b. Adjustments.

(1) *Adjust thrust bearing.*

It is recommended that the steering gear be removed to adjust thrust bearings. If it is desirable to make the adjustment with the steering gear installed, the shift lever must be removed and jacket tube bracket must be disconnected from the support strap. Then proceed to remove upper cover as described below.

- (b) To adjust bearings with steering wheel installed and gear removed from vehicle, proceed as follows.
- (c) Remove horn button, contact cup, spring, contact cap, base plate, nut, and steering wheel. Remove screws fastening upper cover and actuator housing. Slide assembly, consisting of jacket tube and upper cover, off cam and wheel tube.

Note. Take care not to damage contact ring (mounted on cam and wheel tube) when removing upper cover.

- (d) Reassemble screws fastening actuator housing, using 3/8-inch-thick spacers under screw heads. This will keep actuator intact while making the adjustment. Remove contact ring from cam and wheel tube.
- (e) Before adjusting bearings, check nut for binding. Straighten lug of lockwasher, then remove adjusting nut, lockwasher, tongued washer, upper thrust washer, and upper thrust bearing. Make sure that nut turns freely (finger torque) on cam and wheel tube threads. Then reassemble upper thrust bearing, upper

thrust washer, tongue washer, lockwasher, and adjusting nut.

- (f) To adjust bearings, turn gear off mid-position to free stud in cam groove. Then tighten adjusting nut to obtain a light preload of thrust bearings without lash or heavy drag. Adjust as follows: Tighten nut to 10 foot-pounds torque. Back off nut 10° to 20° or move nut back a distance equal to 1½ times the width of a lockwasher lug. Bend lockwasher lug to secure nut position.
- (g) After adjustment is made, install contact ring on cam and wheel tube. Remove screws and temporary spacers from actuator housing. Install gasket, upper cover, and jacket tube, then fasten actuator housing and upper cover with washers and screws. Assemble contact brush to jacket tube. Install steering wheel, nut, base plate, contact cap, spring, contact cup, and horn button.

(2) *Adjust levershaft backlash.*

- (a) Backlash is determined by the position of the stud to the cam groove. To adjust levershaft backlash, place steering gear in mid-position. Loosen locknut and tighten adjusting screw until a slight drag (high spot) is felt when turning gear back and forth through midposition. When adjustment is made to a positive high spot, back off nut one-sixteenth of a turn and tighten locknut.

Note. A shim pack (consisting of 0.003-, 0.010-, and 0.020-inch shims between two washers), mounted on levershaft, prevents stud from being pulled into cam groove. When shim pack is correct, it should be of sufficient thickness to hold stud out of cam groove but but still not prevent adjusting to the high spot.

- (b) If the high spot cannot be felt when adjusting levershaft screw, remove levershaft then remove shims from pack until the high spot can be noticed.

Note. Remove only enough shims to permit feel of high spot.

- (c) If the high spot can be felt when adjusting levershaft screw, it is not an indication that the shim pack is correctly adjusted. The only positive method of knowing is to add shims until high spot cannot be felt, then remove shims and adjust as described above.

- (d) After correct adjustment is obtained, turn gear through full travel to check adjustment.
- (3) *Adjust stud roller bearing unit.*
 - (a) In nearly every instance, the levershaft and thrust bearing adjustments are sufficient to bring the steering gear up to serviceable standards. However, in some cases it may be necessary to remove levershaft and adjust the stud roller bearing unit.
 - (b) The stud roller bearing unit should be adjusted to obtain a preload on the bearings at all times. Adjust as follows: Straighten lockwasher lug and tighten adjusting nut to obtain noticeable drag (3 inch-pounds torque to rotate stud). Rotate stud several times, then recheck adjustment. Lock adjustment by bending lockwasher lug over nut.

Removal of Steering Gear.

- (1) Remove floor plates. Disconnect hydraulic hoses to aid in reconnecting hoses during gear installation. Disconnect linkage at pittman arm. Disconnect horn cable at contact brush.
- (2) Remove horn button, contact cup, spring, contact cap, and base plate. Remove nut and steering wheel.
- (3) Disconnect shift lever linkage at lower shift lever. Remove screws and lower shift lever. Loosen setscrews in lever collars and remove collars. Then, remove shift lever and stop assembly from bearing in jacket tube bracket.
- (4) Disconnect strap from jacket bracket to cowl. Remove nuts, screws, and washers fastening steering gear to frame. Remove steering gear assembly.

d. Disassembly of Steering Gear (fig. 53).

- (1) *Remove levershaft.* Drain lubricant. Remove nut, lockwasher, and pittman arm. Loosen locknut and adjusting screw in gear housing side cover. Remove screws, washers, side cover, and gasket. Turn cam and wheel tube until levershaft engages center of cam, then remove levershaft.

Note. Keep shim pack intact to aid in reassembly.

- (2) *Remove and disassemble control valve.*

Remove screws fastening control valve to actuator housing, then remove control valve assembly and gasket. If control valve operation is suspected of being faulty, disassemble as follows: Remove retaining ring, cover plate and seal ring from valve body. Remove screws, washers, and end cover from valve body. Remove two small seal rings from valve body. Remove nut and washer from flexure rod, then withdraw rod from valve spool. Push spool out of valve body in same direction that rod is removed, then remove three centering washers, seal ring, and spring. Remove seal ring from spool. If it is desirable, remove bypass valve plug, seal ring, spring, and ball from valve body.

- (3) *Remove jacket tube and upper cover.* Remove screws and contact brush from jacket tube. Remove screws fastening upper cover and actuator housing to gear housing. Slide assembly consisting of jacket tube and upper cover off cam and wheel tube.

Note. Take care not to damage contact ring (mounted on cam and wheel tube) when removing cover and jacket tube. Remove contact ring from tube.

- (4) *Remove and disassemble cam and wheel tube and actuator assembly.* Loosen actuator screw and washer. Remove complete assembly of cam and wheel tube and actuator from gear housing. If it is desirable to disassemble these parts, proceed as follows: Straighten lugs of lockwasher, then remove adjusting nut, lockwasher, tongued spacer washer, upper thrust washer, upper thrust bearing, and another upper thrust washer from cam and wheel tube. Remove upper centering washer from actuator, then remove actuator and housing.

Note. Take care not to lose centering rings (mounted in actuator). Remove lower centering washer, lower thrust washer and lower thrust bearing from cam and wheel tube.

e. Inspection and Repair.

- (1) Inspect and replace levershaft oil seal and bushings. Visually inspect bushings for scoring or pitted condition. Check condition of oil seal. To restore parts, pry old oil seal out of housing. Press bushings out of housing using an arbor press. Press new

bushings in housing and check fit of levershaft in bushings. Line ream if necessary until levershaft rotates freely and clearance between bushing and levershaft does not exceed .002 inch. After levershaft and bushings are fitted correctly, press new oil seal in housing.

(2) *Inspect and replace levershaft and stud roller bearing unit.*

- (a) Check levershaft for twisted or damaged splines and wear on bushing surface. Replace faulty levershaft. Inspect roller bearing unit stud for nicks, flat spots, or spalling. Replace faulty bearing unit.
- (b) To replace roller bearing unit, straighten lug of lockwasher, then unscrew nut and remove lockwasher, spring washer, flat washer, and conical washer. Remove bearing rollers and stud will drop out.
- (c) Inspect rollers for flat spots or pit marks. Replace all rollers if one or more are faulty.
- (d) To install roller bearing unit, position rollers on stud and hold in position with heavy grease. Install stud in levershaft. Install rollers on opposite side, holding them in position with heavy grease. Install conical washer (cupped side toward rollers), flat washer, spring washer (CUP end toward rollers), lockwasher, and nut. Tighten nut as required, then revolve stud several turns and check adjustment b(3) above. After correct adjustment is obtained, bend lug of lockwasher over nut to secure nut position. Wash heavy grease from rollers and lubricate with correct lubricant.

- (3) Inspect and replace cam bearings. Visually inspect cam bearings for binding, pit marks, or scoring. Replace faulty bearings. Replace bearings with an arbor press.

Note. Take care not to exert excessive pressure on bearing and retaining ring when installing bearings. However, make sure bearings are seated against retaining rings.

- (4) Inspect cam and wheel tube. Inspect cam groove for chipping, scoring or brinelling (cam is copper plated). Normal operation of stud in groove will wear away the plating. (This is a normal condition and does not necessarily indicate abnormal wear.) Inspect condition of bearing surface on

cam. Replace cam and wheel tube assembly if cam is faulty.

- (5) Inspect control valve parts. It is impractical to measure spool and body for wear in the field. Spool is lubricated by circulating oil and should not wear appreciably. Check for free fit of spool in body. Visually inspect spool and body contact surfaces for scoring or other faulty conditions. If spool or body are faulty, replace valve assembly. Replace all seal rings when valve has been disassembled.

f. Reassembly of Steering Gear.

- (1) Assemble and install actuator, cam and wheel tube, and jacket tube. Lubricate internal parts as they are assembled.
- (2) Preassemble and adjust actuator on cam and wheel tube.

Note. Make sure adjusting nut turns freely (finger torque) on tube threads before assembling parts.

- (3) Place lower thrust bearing on cam and wheel tube, then install lower thrust washer, lower centering washer, actuator, springs (in actuator), upper centering washer, upper thrust washer, upper thrust bearing, a second upper thrust washer, tongued washer, lockwasher, and adjusting nut. Adjust nut to obtain a light preload of thrust bearings without lash or heavy drag (b(1) above).
- (4) Insert cam into gear housing and check for free rotation. Install gasket and actuator housing, positioning housing for correct location of valve mounting. Install washer and retaining screw in actuator housing.
- (5) Install contact ring on cam and wheel tube. Install gasket, upper cover, and jacket tube, then fasten actuator housing and upper cover to gear housing with washers and screws. Assemble contact brush to jacket tube.
- (6) *Install levershaft.* Assemble shim pack (0.003-, 0.010-, 0.020-inch shims between two washers) to levershaft and install levershaft in gear housing. Prior to installing side cover, pack housing with grease specified in LO 10-3930-235-20. Use approximately 2½ pounds. Install gasket and side cover on gear housing and fasten

with screws and washers. Install adjusting screw and locknut. Tighten adjusting screw until a very slight drag (or high spot) is felt when turning gear through mid-position (b(2) above). Install pittman arm, lockwasher, and nut.

- (7) Assemble and install control valve. Install seal ring on spool, then install spool in valve body.

Note. Use a twisting motion for easier installation of spool in body. At end cover side of valve body, install centering washer, spring, a second centering washer, seal ring, and a third centering washer. Insert flexure rod through opposite end of spool and fasten rod with washer and nut. Tighten nut to 125 to 150 inch-pounds torque.

- (8) If bypass valve was removed, install seal ring on plug, then install ball, spring, and plug in valve body.
- (9) Install actuator lever in actuator housing.

Note. Seat stud end of lever in actuator groove and position rod so that lever slot will engage flexure rod clevis pin when valve assembly is mounted.

- (10) Install gasket and valve assembly, then carefully install and tighten screws.

Note. Tighten all four screws evenly and lightly, then tighten to 10 to 15 foot-pounds torque. Careful tightening will prevent pulling spool off center.

- (11) Before proceeding with further assembly, make sure that spool moves properly in both directions. Temporarily install steering wheel. Turn steering wheel to move pittman arm against a stop. Apply sufficient effort at steering wheel to actuate spool. Reverse pittman arm against an opposite stop to move spool in opposite direction.
- (12) If spool is operating properly, install small seal rings on valve body, then install end cover, washers, and screws. Assemble seal ring, cover plate, and retaining ring at opposite end of valve body.

g. Install Steering Gear.

- (1) Position steering gear for mounting. Install mounting screws, washers, and nuts. Do not tighten mounting screws until jacket tube bracket is correctly adjusted. With jacket tube bracket clamp screw loose, fasten strap to bracket with shims, screws,

and washers. Use shims (between strap and bracket) as necessary to provide correct gear alignment without strain on jacket or cam and wheel tubes. When gear is correctly aligned, tighten all mounting screws.

- (2) With bearing positioned in jacket tube mounting bracket, install shift lever and stop assembly in bearing. Slide collars on shift lever. Install lower shift lever. Place detent spring and ball between shift lever stop and jacket tube bracket. Adjust position of collars on shift lever to provide free movement of lever with minimum end play. Tighten collar setscrews. Connect lower shift lever to linkage.
- (3) Install steering wheel and nut, base plate, contact cap, spring, contact cup, and horn button. Connect horn cable to contact brush.
- (4) Connect steering linkage to pittman arm. Connect hydraulic hoses to control valve. Install floor plates.

46. Power Steering Cylinder

a. Description. The power steering cylinder is of the double acting type and is interconnected in the steering linkage. Its function is to assist the operator in steering the vehicle through the use of hydraulic pressure.

b. Operation. In operation, the steering gear control valve directs hydraulic pressure to the appropriate cylinder port for right or left steering. Hydraulic pressure applied to the cylinder piston extends or compresses the double acting cylinder. This action, in turn, is transmitted to the steering linkage to assist manual steering effort.

c. Removal. Refer to TM 10-3930-235-20.

d. Disassembly of Cylinder (fig. 54).

- (1) Remove screws, washers, and end plate from cylinder.
- (2) Remove retaining ring from bore of cylinder, then withdraw gland and rod and piston assembly from cylinder.
- (3) Remove gland from piston rod.
- (4) To remove seals from gland, remove retaining ring, spacer washer, oil seal, spacer washer, retaining ring, backup ring, and seal ring.

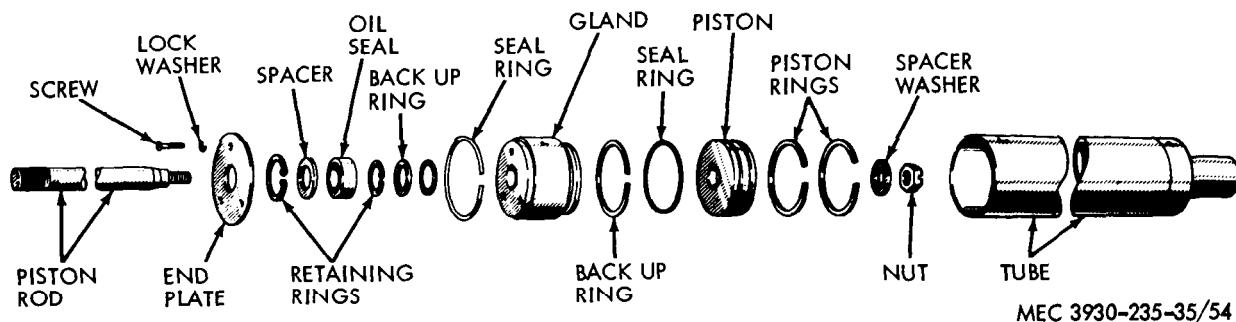


Figure 54. Power steering cylinder, exploded view.

- (5) To disassemble piston and rod, remove nut, spacer washer, and piston from piston rod. Remove piston rings from piston.

e. Inspection.

- (1) Inspect for scored piston or rings which would cause pressure leak or binding in cylinder. Replace faulty rings. If piston is faulty, replace cylinder assembly.
- (2) Inspect piston rod surface for scoring or defects that would cause damage to a new oil seal. Replace cylinder assembly, if piston rod is faulty. Replace seal rings

and oil seal each time cylinder is disassembled.

f. Repair. Replace faulty parts as necessary. Always use new seals and gaskets when reassembling.

g. Reassembly. Reverse procedures in *d* above.

h. Installation. Refer to TM 10-3930-235-20.

47. Power Steering Control Valve

This valve is a component of the steering gear assembly and instructions for removal, inspection, repair, and reassembly will be found under "Disassembly of Steering Gear" (para. 45d). See figure 53.

Section Xiii. SPRINGS

48. Rear Springs (MHE-191)

a. Removal. Refer to paragraph 38a for removal of steering axle and spring assembly.

b. Remove Spring from Axle. Remove locknuts, nuts, and U-bolts, then remove spring assemblies from axle beam.

c. Disassembly (fig. 55).

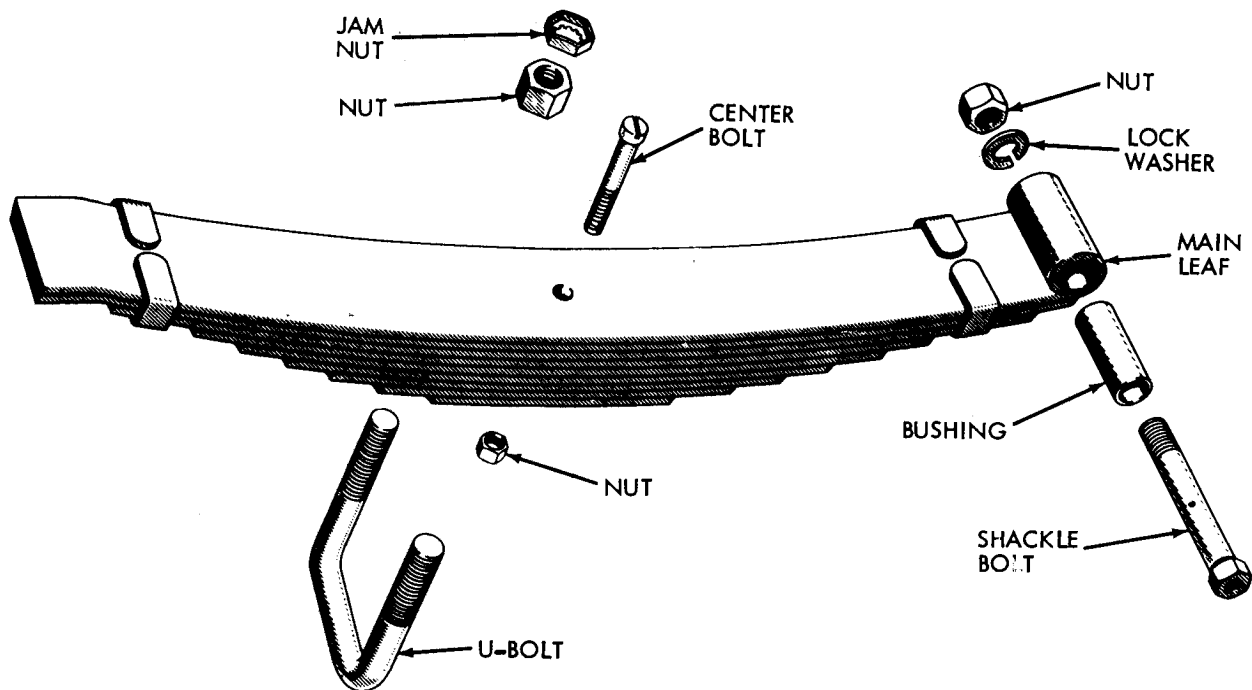
- (1) Press shackle bushing out of spring main leaf if necessary.
- (2) Clamp spring in an arbor press and remove nut and center bolt. Spread spring clips enough to clear width of main leaf. Release press slowly and remove leaves.

d. Inspection and Repair. Inspect spring assemblies for broken leaves. Replace broken main leaf or replace spring assembly if other leaves are broken. Inspect shackle bolt and main leaf bushing, for wear or damage. If new main leaf bushing is installed, shackle bolt should fit without binding. Ream bushing as necessary.

e. Reassembly. Reverse procedures in *c* above.

f. Install Spring on Axle. Reverse procedures in *b* above.

g. Installation. Reverse procedures in paragraph 38a.



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Figure 55. Spring (MHE-191).

Section XIV. BODY

49. Seat and Backrest Cushions

a. *Removal and Installation.* Refer to TM 10-3930-235-20.

b. *Inspection and Repair.*

- (1) Inspect cushion and backrest for wear, rips, and other visible damage. If it is possible

to do so, install new covers on cushions.

- (2) Inspect seat frame for bends, breaks, and distortion. If it is possible to do so, straighten bends and distortions. Repair breaks by welding.
- (3) Replace faulty parts as necessary.

Section XV. HYDRAULIC LIFT

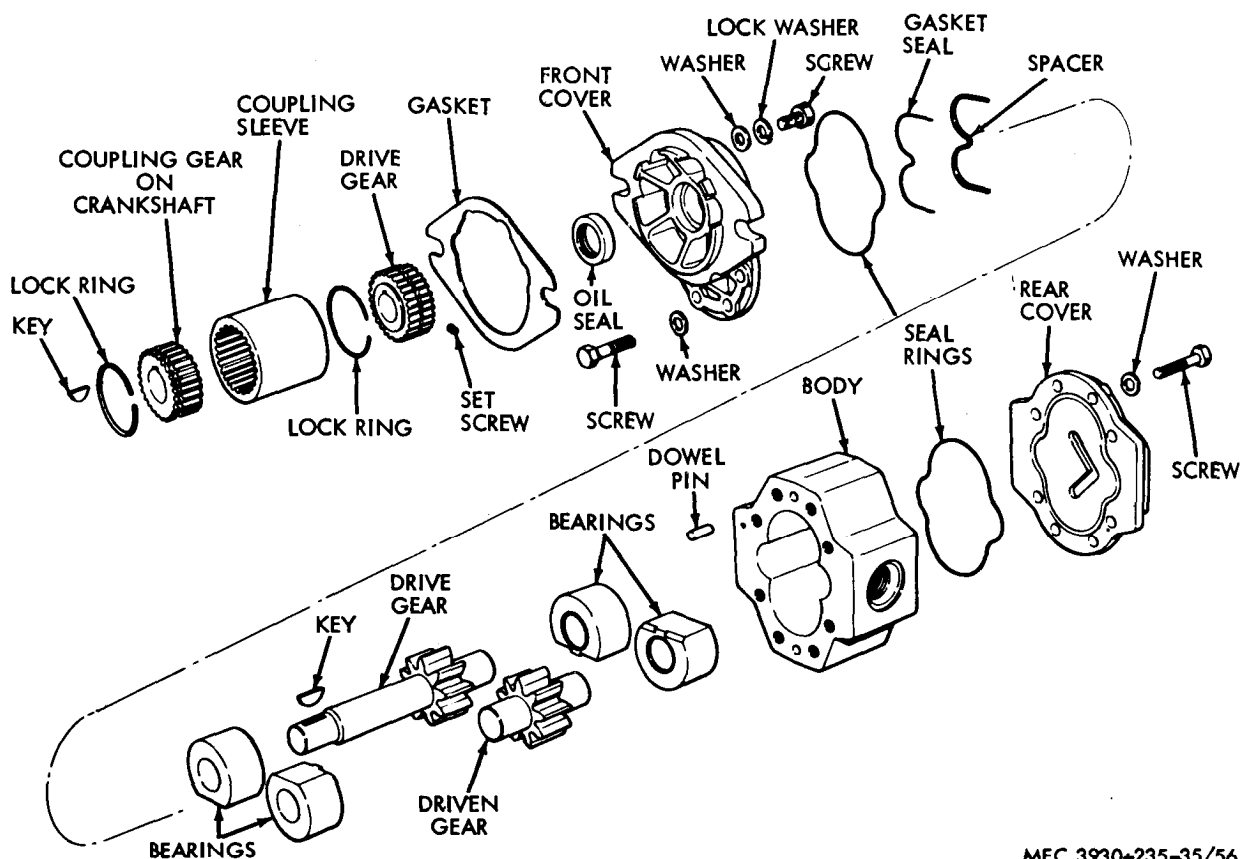
50. Hydraulic Pump

a. *Removal.*

- (1) Raise and block up vehicle to a suitable working height.
- (2) Disconnect and cap hydraulic lines at pump.
- (3) Remove cap screws and washers, then remove pump and gasket from timing gear cover. Discard gasket. Remove fittings from pump as necessary.

b. *Disassembly* (fig. 56).

- (1) Scribe a mark across covers and body. Remove retaining ring and loosen set screw, then remove coupling gear from pump shaft. Remove key.
- (2) Remove screws and washers, then separate front cover from body. Remove oil seal from cover.
- (3) Remove seal ring, gasket seal, and spacer from front cover groove.
- (4) Remove front cover drive and driven bearings, drive gear and shaft, driven gear and shaft, and body drive and driven bearings.



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Figure 56. Hydraulic pump, exploded view.

Note. Mark bearings to facilitate identification if they are used in reassembly.

- (5) Remove screws and washers, then separate rear cover from body. Remove seal ring from cover groove.
- (6) Do not remove dowel pins from body unless replacement is necessary.

c. *Cleaning.* Clean all parts with SD and dry thoroughly with compressed air.

d. *Inspection and Repair.*

- (1) Inspect bearings for nicks, grooves, or deep scoring. Inspect gears for chipped or broken teeth. Inspect covers and body for cracks, stripped threads, or damage.
- (2) If original bearings are to be reused, nicks, scratches, or scoring can be removed by dressing bearing faces on a piece of crocus cloth placed on a flat surface plate. Dress bearings by rubbing lightly over the cloth in a circular motion until a smooth finish

is obtained. Bearing diameters and surfaces must be parallel, square, and concentric with each other.

e. *Reassembly.* Reverse procedures in b above except, if new bearings are to be installed, it may be necessary to dress the flats to facilitate installation. To dress the flats, place both bearings of a set end to end on a shaft that accurately fits the bearing bores. Hold flats squarely against a piece of crocus cloth placed on a flat surface plate. Move bearings lightly over cloth in a circular motion. Check for correct fit of bearings in bore after each stroke. Bearings must not bind or wedge when installing.

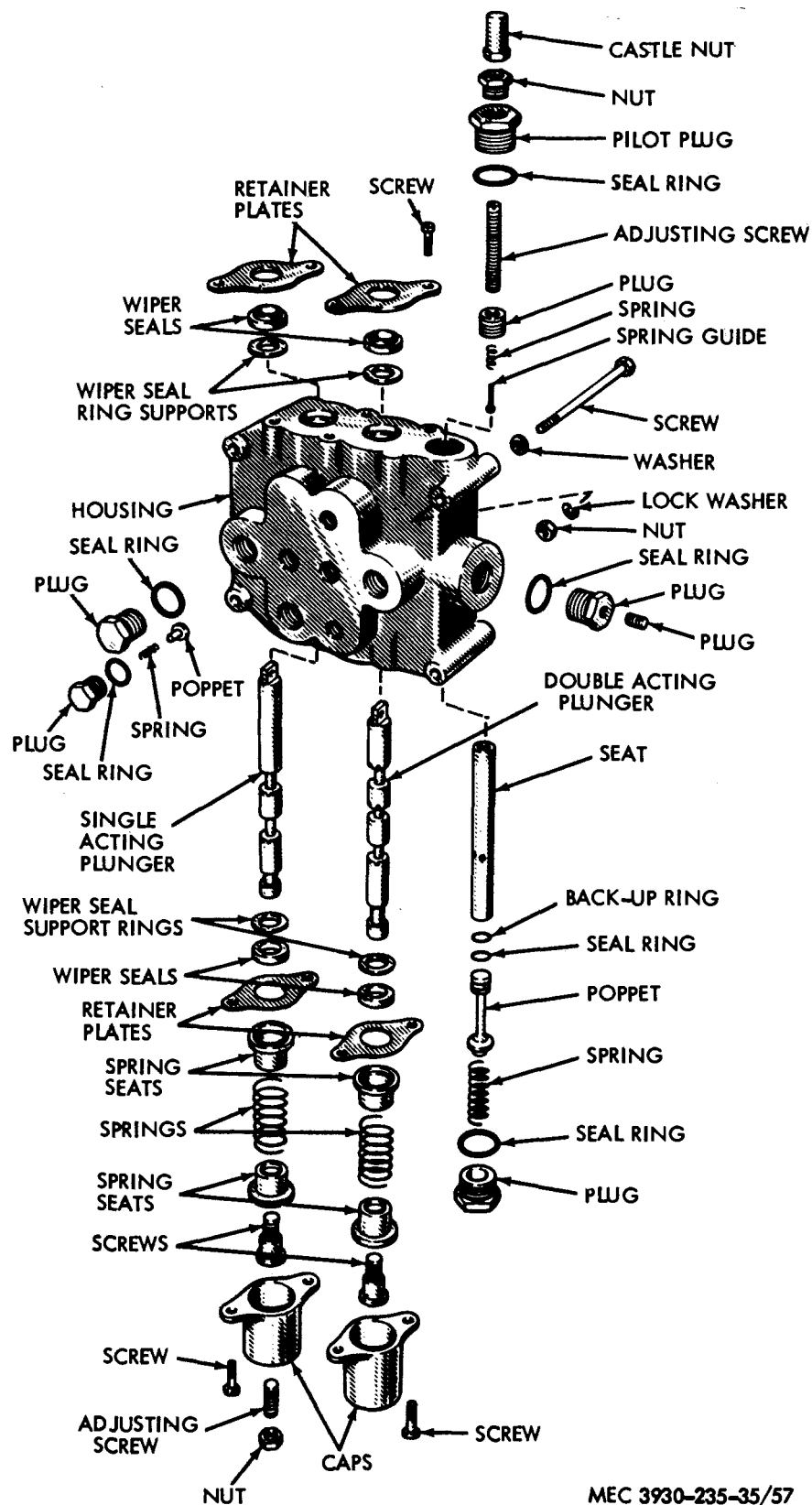
f. *Installation.* Reverse procedures in a above.

g. *Test Pump.* Refer to paragraph 52.

51. Hydraulic Control Valve

a. *Removal.*

- (1) Remove screws and washers, then remove control valve hood.



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Figure 57. Hydraulic control valve, exploded view.

- (2) Remove cotter pins and clevis pins to disconnect links at control valve plungers.
- (3) Disconnect hydraulic lines at valve and catch oil in a receptacle.
- (4) Remove bolts, nuts, and washers, then remove control valve from mounting plate.
- (5) Remove fittings from valve if necessary.

b. Disassembly (fig. 57).

- (1) Remove screws fastening plunger caps, then remove plunger caps and withdraw plungers by grasping spring end. Mark plungers for identification in reassembly. Clamp plunger assembly in a soft-jawed vise. Compress plunger spring, then remove cap screws and outer spring seats. Release spring tension slowly, then remove spring and inner spring seats.
- (2) Remove wiper seal retainer plates, wiper seals, and wiper seal support rings from each end of the housing.
- (3) Remove relief valve plug, seal ring, relief valve spring, and relief valve poppet.
- (4) Unscrew and remove castle nut. Loosen adjusting screwnut, then unscrew adjusting screw with nut assembled. Unscrew and remove relief valve adjusting plug. Remove relief valve pilot plug and seal ring. Remove relief valve pilot spring and spring guide from bore of relief valve seat.
- (5) Unscrew and remove check valve plug and seal ring. Remove check valve spring and poppet from housing bores.

c. Inspection and Repair.

- (1) Wash all parts in SD and dry thoroughly with compressed air.
- (2) Blow out all passages in body with compressed air.
- (3) Replace all broken or distorted springs.
- (4) Inspect plungers for grooves or wear. See that plungers fit in body with a slight hand pressure. There should not be any perceptible side clearance. If plunger is faulty or if body bore is scored, replace entire valve.
- (5) Inspect relief valve poppet seat and its mating seat in housing for nicks or scratches.
- (6) Replace faulty parts as necessary.

d. Reassembly. Reverse procedures in b above

except do not attempt to adjust relief valve to its proper setting at this point. Refer to paragraph 52 to adjust relief valve and paragraph 53 to adjust lowering speed.

e. Installation. Reverse procedures in a above.

52. Adjust Relief Valve

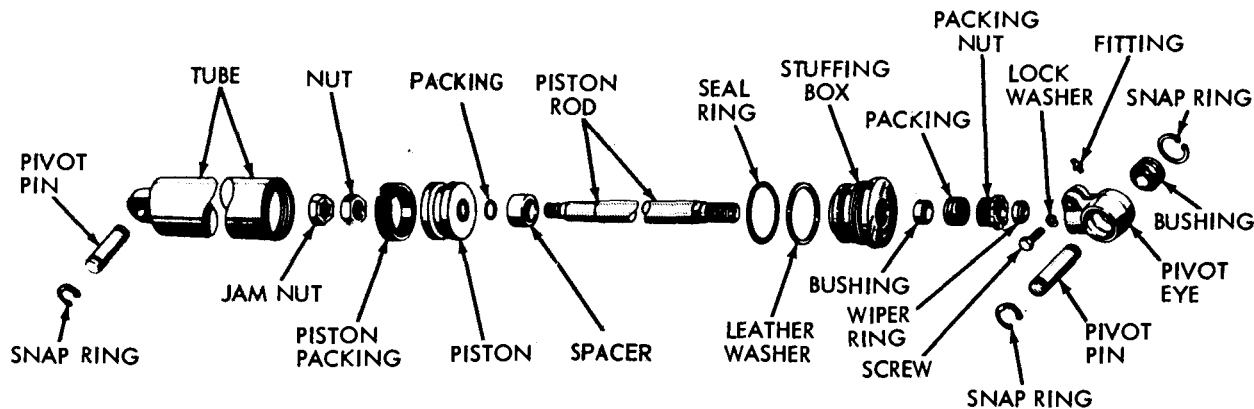
a. Description. The relief valve “blows off” or unloads pressure when operating cylinders have reached their maximum extent of operation. When the oil pressure is above the predetermined maximum value, the valve plunger is forced off its seat and the oil is bypassed back to the supply tank. When the pressure is lowered to its correct maximum value, the spring overcomes the oil pressure, forces the valve plunger on its seat, closes the valve, and stops further decrease in pressure.

b. Adjustment. The relief valve is adjusted and set at the factory and should only require adjustment after overhaul. To test hydraulic pump output after overhaul and to regulate the hydraulic system pressure after overhaul of control valve, proceed with the following steps:

- (1) Remove 1¼-inch pipe plug from fitting in control valve, and install a 0-3000-psi gage.
- (2) Remove acorn nut from relief valve. Hold jamnut and back off adjusting screw until no tension is felt on relief valve.
- (3) Start engine and operate at 2,250 rpm.
- (4) Operate tilt cylinder in either direction and hold until (5) below is completed.
- (5) Turn adjusting screw clockwise until gage registers 1950 psi. Hold screw and tighten jamnut. Secure with acorn nut.
- (6) To make certain hydraulic pump is producing sufficient volume after overhaul, operate control valve and check rate of lifting speed. Lifting speed should be 85 feet per minute. If speed is within this limit, pump is producing sufficient volume and the system is regulated correctly.

53. Adjust lowering Speed

The single acting plunger cap (fig. 57) is equipped with an adjusting screw and a locknut for controlling the “lowering speed” of the load. If this adjustment was disturbed during valve repair, it will be necessary to readjust the “lowering speed”. Trucks shipped from the factory have been set for



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Figure 58 Tilt cylinder, exploded view.

maximum "lowering speed," loosen locknut and turn the adjusting screw "in". Tighten locknut when proper "lowering speed" has been determined.

54. Tilt Cylinder

a. *Removal.* Refer to TM 10-3930-235-20.

b. *Disassembly* (fig. 58).

- (1) Loosen screw and washer, then remove pivot eye from piston rod. If replacement of bushing is necessary, remove snap rings, then remove bushing using an arbor press.
- (2) Unscrew packing nut from stuffing box, then remove wiper ring and packing.
- (3) Using a spanner wrench or equivalent tool, unscrew stuffing box from tube. Remove seal ring and leather washer from box.
- (4) Pull piston rod assembly from tube. To disassemble piston rod, remove locknut, nut, and piston from piston rod. Remove packing and seal ring from piston. Remove spacer from piston rod.

c. *Inspection and Repair.*

- (1) Inspect bushings in pivot eye for scored or worn condition. Inspect pivot pins for worn or scored condition. Replace faulty parts.
- (2) Inspect the piston rod surface that contacts packing for scoring or defects that will wear or damage packing. Replace faulty piston rod.
- (3) Replace seals, packings, and wiper rings when reassembling cylinder.

d. *Reassembly.* Reverse procedures in b above

except when installing piston rod packing in stuffing box, make certain that the ring lip is worked in smoothly and that ring is not twisted or distorted. Use a small screwdriver to start rings into stuffing box, then use a blunt end tool to push the rings to the bottom of the stuffing box. First install the molded forming ring (flat side down), then install four leather rings, one rubber ring, one leather ring, one rubber ring, in that sequence and repack the remaining area in the stuffing box with leather rings until there is 0- to 1/6-inch compression after gland nut is tightened.

Note. For correct adjustment of packing rings, there should be $\frac{1}{16}$ - to $\frac{3}{32}$ -inch gap between packing gland and stuffing box. This gap provides space for future adjustment of packing nut. Add or subtract leather rings, as necessary, to adjust the gap.

c. *Installation.* Refer to TM 10-3930-235-20.

55. Lift Cylinder

a. *General.* Before removing or disassembling lift cylinder for repairs, it is suggested that a thorough inspection of the cylinder be performed as indicated in b below.

b. *Inspection and Repair* (fig. 59).

Note. The two top packings of the lift cylinder can be replaced, if necessary, with the lift cylinder installed. To replace the packing at the bottom of the cylinder, it is necessary to remove the cylinder from the mast column.

- (1) If oil is seeping past any of the packing nuts, tighten nuts. If leak does not stop or if leak is excessive, continue inspection of cylinder.
- (2) Raise carriage high enough to expose all polished surfaces of the cylinder plungers.

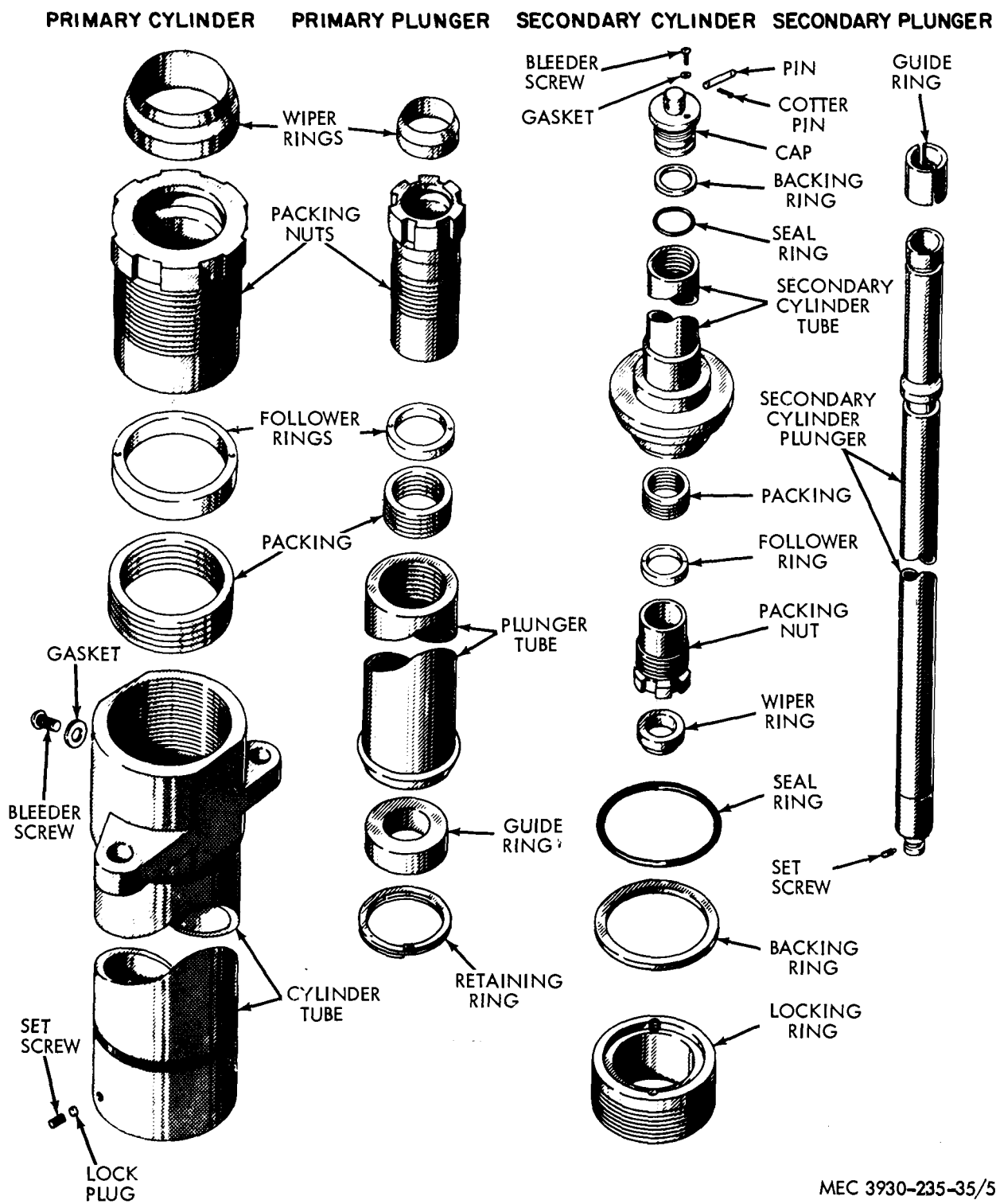


Figure 59. Lift cylinder, exploded view.

Carefully inspect these exposed surfaces for scratches or scored condition. Remove scratches or score marks, using an india stone. If plungers will not clean up to a smooth finish, it is recommended that the cylinder be replaced.

Note. If a cylinder, with a scratched or scored plunger is repacked, the new packing will soon be cut and will leak oil.

- (3) If plungers are in good condition, repack cylinder as follows: Unscrew and remove packing nut using a spanner wrench to prevent damaging nut. Pull out old packing rings, using a sharp pointed tool. Make certain all old packing material is removed from stuffing box, then proceed to install new packing. When installing rings, make certain that the ring lip is worked in smoothly and that ring is not twisted or distorted. Use a small screwdriver to start rings into stuffing box. Then use a blunt-end tool to push the rings to the bottom of the stuffing box. First, install the molded forming ring (flat side down). This ring provides a seat for the succeeding rings. Then install four leather rings, one rubber ring, one leather ring, one rubber ring, in that sequence and repack the remaining area in the stuffing box with leather rings until there is 0- to 1/16-inch compression after gland nut is tightened.

Note 1. For correct adjustment of packing rings, there should be ~~1/8-~~ to ~~3/16-~~ ^{1/4-} ^{3/8-} inch gap between packing gland nut and cylinder. This gap provides space for future adjustment of packing nut. Add or subtract leather rings as required to adjust the gap.

Note 2. After a few days operation the cylinder packing may tend to swell, resulting in a growling noise when hoist is operated. If this condition occurs, loosen the cylinder packing nut one-quarter turn until the plunger operates smoothly without noise.

c. Removal (fig. 59).

- (1) Remove screws and washers, then lift backrest off carriage.
- (2) Remove forks.
- (3) Raise carriage until mast inner column is lifted about 10 inches. Block carriage and inner slide in this position.
- (4) Remove cotter pins, then drive out pin fastening lift cylinder to mast inner col-

umn. Lower the lift cylinder plunger to disconnect from the inner column.

- (5) Disconnect hydraulic line and catch oil in a receptacle.
- (6) Disconnect chains at lift cylinder, then lift off crosshead and rollers.
- (7) Remove setscrew fastening lift cylinder at bottom of stationary mast column.
- (8) Raise cylinder up and out of mast column.

d. Installation. Reverse procedures in c above.

e. Disassembly.

- (1) Remove secondary cylinder packing nut, follower ring, and packing from secondary cylinder tube. Remove wiper ring from packing nut.
- (2) Unscrew and remove secondary cylinder cap from secondary cylinder tube. Remove backing ring and seal ring from cap. Do not remove bleeder screw and gasket unless replacement is necessary.
- (3) Push secondary cylinder plunger out of secondary cylinder tube. Remove guide rings from plunger.
- (4) Remove primary cylinder plunger packing nut, follower ring, and packing from primary cylinder plunger tube. Remove wiper ring.
- (5) Remove setscrew and lock plug from primary cylinder tube. Unscrew and remove locking ring. Remove secondary cylinder tube. Remove backing ring and seal ring from secondary cylinder tube.
- (6) Remove primary cylinder tube packing nut, follower ring, and packing from primary cylinder tube. Remove primary cylinder plunger tube from primary cylinder tube. If necessary, remove retaining ring and guide ring from primary cylinder plunger tube. Remove bleeder screw and gasket from primary cylinder tube, if necessary.

f. Reassembly. Follow procedures in e above, except as follows:

- (1) Secondary cylinder plunger is fitted with two guide rings which ride in the inside diameter of the secondary cylinder tube.
- (2) When a new secondary cylinder tube is required during overhaul, it will be necessary to measure the inside diameter to

determine selection of the proper guide rings to be used. Select the proper guide ring from the following chart.

Secondary cylinder tube (inside diameter)	I	Guiding required, part number
2.485		22325-C1
2.490		22325-C2
2.495		22325-C3
2.500		22325-C4

56. Mast Assembly

a. Removal.

- (1) Remove carriage backrest.
- (2) Remove forks.
- (3) Remove carriage (para. 57).
- (4) Remove lift cylinder (para. 54).
- (5) Support mast column with a chain hoist, then remove snap rings and pivot pins at tilt cylinder pivot eye.
- (6) Remove nuts, screws, blocks, and bushings, then lift mast column off mast tilt shaft, using chain hoist or equivalent mechanism.

b. Disassembly (fig. 60).

- (1) To separate inner and outer mast column, slide columns apart.
- (2) With columns separated remove wear strip shims and wear plates.

c. Cleaning and Inspection.

- (1) Clean parts thoroughly with SD and dry with compressed air.
- (2) Inspect both columns for fractures or breaks in welds.

d. Repair. No repairs are feasible except that, if broken, they can be rewelded. Care should be taken to avoid excessive heat which could cause distortion of the columns.

e. Reassembly. Reverse procedure in *b* above except that wear strips are provided at eight places in the mast inner column. When reassembling and shimming for the required clearance of 0.015 to 0.025 inch, add wear strip shims to the rear wear strips only.

f. Installation. Reverse procedures in *a* above.

57. Mast Carriage

a. Removal.

- (1) Remove forks.
- (2) Remove backrest.
- (3) Raise carriage about 2 feet above floor level and block in this position. Disconnect chains at carriage.
- (4) Remove carriage stop screws and washers at top of outer mast column. Raise carriage up and out of mast column.

b. Disassembly (fig. 60).

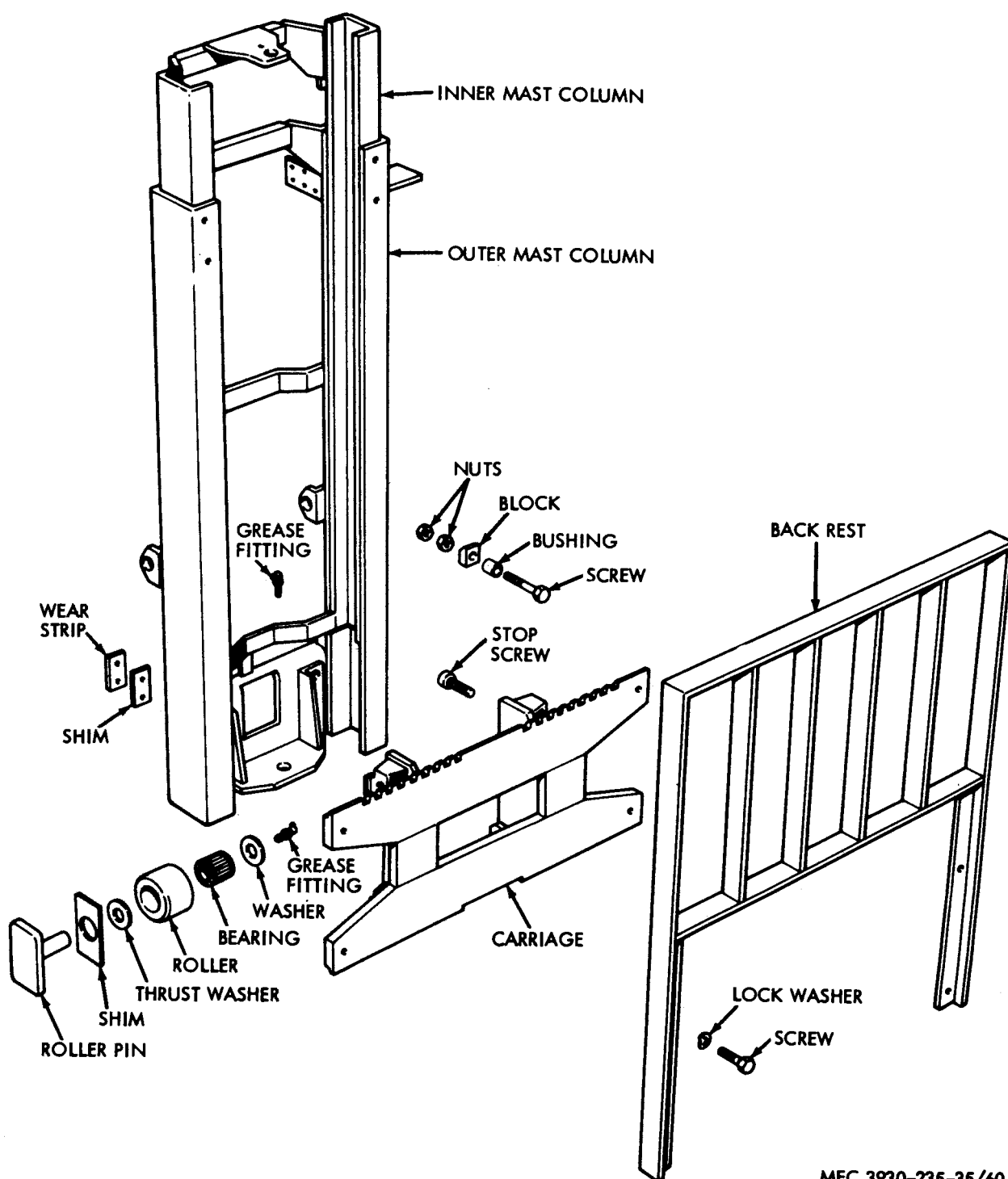
- (1) Remove roller pin and shims from outside of carriage bracket.
- (2) Remove roller assembly from side of carriage bracket. Remove thrust washers and bearing from roller.

c. Inspection and Repair. Inspect roller and bearing for scoring or flat spots. Temporarily install bearing on roller pin and check for free rotation. Inspect carriage for broken welds and reweld if necessary.

d. Reassembly.

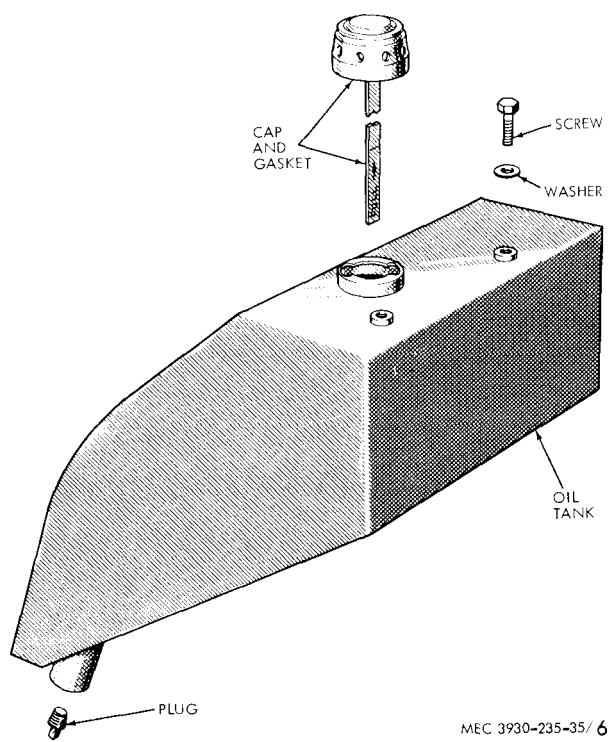
- (1) Before installing carriage rollers, determine quantity of shims necessary to provide 0.020-inch clearance between roller pin and narrowest sliding width of inner mast column.
- (2) To assemble rollers, place bearing in roller and one thrust washer on each side of roller.
- (3) Place necessary shims on roller pin, then position roller assembly in carriage bracket and insert roller pin assembly from the outside of the carriage bracket and through the roller assembly. Roller pins are held in place when the carriage is installed in the inner mast column.

e. Installation. Reverse procedures in *b* above.



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Figure 60. Mast column and carriage, exploded view.



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Figure 61. Hydraulic oil tank, exploded view.

58. Hydraulic Oil Tank

a. Removal (fig. 61).

- (1) Drain oil from tank by removing drain plug.
- (2) Disconnect hydraulic lines and catch any remaining oil from the lines.
- (3) Remove screws and washers fastening tank to cowl. Remove oil tank.

b. Installation. Reverse procedures in *a* above. Fill tank to proper level. Start engine and inspect for leaks.

APPENDIX I

REFERENCES

AR 310-1	General Policies.
AR 320-5	Dictionary of United States Army Terms.
AR 320-50	Authorized Abbreviations and Brevity Codes.
AR 600-55	Motor Vehicle Driver Selection, Testing, and Licensing.
AR 750-5	Organization, Policies, and Responsibilities for Maintenance Operation.
AR 700-58	Report of Damaged or Improper Shipment.
AR 700-3900-5	Registration of Materials Handling Equipment and Special Purpose Vehicles.
AR 743-505	Limited Storage of Engineers Mechanical Equipment.
AR 746-5	Color and Marking of Army Materiel.
AR 750-5	Organization, Policies, and Responsibilities for Maintenance Operations.
AR 750-3900-1	Materials Handling Equipment.
AR 754-9130-1	Utilization of Automotive Gasoline.
FSC 9100-IL	Fuels, Lubricants, Oils, and Waxes.
DA Pam 108-1	Index of Army Motion Pictures, Filmstrips, Slides, Tapes, and Phono-Recordings.
DA Pam 310-1	Index of Administrative Publications.
DA Pam 310-2	Index of Blank Forms.
DA Pam 310-3	Index of Doctrinal, Training, and Organizational Publications.
DA Pam 310-4	Index of Technical Manuals, Technical Bulletins, Supply Manuals (types 4, 6, 7, 8, and 9), Supply Catalogs (type CL) Supply Bulletins, Lubrication Orders, and Modification Work Orders.
DA Pam 310-5	Index of Graphic Training Aids and Devices.
DA Pam 310-25	Index of Supply Manuals - Engineers Type Items.
FM 5-25	Explosive and Demolition.
FM 21-5	Military Training.
FM 21-6	Techniques of Military Instruction.
FM 21-30	Military Symbols.
TB ENG 60	Preservation and Painting of Serviceable Corps of Engineers Equipment.
TB ENG 347	Winterization Techniques for Engineer Equipment.
TM 5-687	Repair and Utilities: Fire Protection Equipment and Applications: Inspection, Operations, and Preventive Maintenance.
TM 5-764	Electric Motor and Generator Repair.
TM 9-200	General Packaging Instructions for Ordnance General Supplies.
TM 9-6140-200-15	Operation and Organizational, Field and Depot Maintenance: Storage Batteries, Lead-Acid Type.

TM 10-3930-235-10	Operator's Manual: Truck, Lift, Fork, Gasoline, Solid and Pneumatic Tired Wheels, 4,000 Lbs. Capacity, Towmotor Models 462SG4024-100 (Solid Tire), 462SG4024-144 (Solid Tire), 502PG4024-144 (Pneumatic Tire), FSN'S 3930-781-3856, 3930-781-3855 and 3930-073-9222 respectively. Army Model MHE-191 (462SG4024-100 and 462SG4024-144), MHE-190 (502PG4024-144).
TM 10-3930-235-20	Organizational Maintenance Manual; Truck, Lift, Fork, Gasoline, Solid and Pneumatic Tired Wheels, 4,000Lbs Capacity, Towmotor Models 462SG4024-100 (Solid Tire), 462SG4024-144 (Solid Tire), 502PG4024-144 (Pneumatic Tire), FSN'S 3930-781-3856, 3930-781-3855 and 3930-073-9222 respectively. Army Model MHE-191 (462SG4024-100 and 462SG4024-144), MHE-190 (502PG4024-144).
TM 10-3930-235-20P	Organizational Maintenance Manual; Repair Parts and Special Tools List; Truck, Lift, Fork, Gasoline, Solid and Pneumatic Tired Wheels, 4,000 Lbs Capacity, Towmotor Models 462SG4024-100 (Solid Tire), 462SG4024-144 (Solid Tire), 502PG4024-144 (Pneumatic Tire), FSN'S 3930-781-3856, 3930-781-3855 and 3930-073-9222 respectively. Army Model MHE-191 (462SG4024-100 and 462SG4024-144), MHE-190 (502PG4024-144).
TM 10-3930-235-35P	Direct and General Support, and Depot Maintenance Repair Parts and Special Tools List; Truck, Lift, Fork, Gasoline, Solid and Pneumatic Tired Wheels, 4,000 Lbs Capacity, Towmotor Models 462SG4024-100 (Solid Tire), 462SG-4024-144 (Solid Tire), 502PG4024-144 (Pneumatic Tire), FSN'S 3930-781-3856, 3930-781-3855 and 3930-073-9222 respectively. Army Model MHE-191 (462SG4024-100 and 462SG4024-144), MHE-190 (502PG4024-144).
TM 11-483	Radio Interference Suppression.
TM 21-300	Driver Selection and Training (Wheeled Vehicles).
TM 38-230	Preservation, Packaging, and Packing of Military Supplies and Equipment.
TM 38-750	Army Equipment Record Procedures.
MIL-STD-162A	Preparation for Delivery of Warehouse Materials Handling Equipment for Domestic and Oversea Shipment and Storage.
LO 10-3930-235-20	Lubrication Order; Truck, Lift, Fork, Gasoline, Solid and Pneumatic Tired Wheels, 4,000 Lbs Capacity, Towmotor Models 462SG4024-100 (Solid Tire), 462SG4024-144 (Solid Tire), 502PG4024-144 (Pneumatic Tire), FSN'S 3930-781-3856,3930-781-3855 and 3930-073-9222 respectively. Army Model MHE-191 (462SG4024-100 and 462SG4024-144), MHE-190 (502PG4024-144).

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USAR: None.

For explanation of abbreviations used, see AR 320-50.

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