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TECHNICAL MANUAL

DEPARTMENT OF THE
AIR FORCE MANUAL

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OPERATING AND MAINTENANCE INSTRUCTIONS

FOR

GRADER, ROAD, MOTORIZED, DIESEL

12-FT. MOLDBOARD

CATERPILLAR MODEL 12

(GRADER SERIAL NUMBERS 9K1 and UP)

DEPARTMENTS OF THE ARMY AND THE AIR FORCE
FEBRUARY 1949

This manual supersedes the Operation and Maintenance Instructions portion of TM 5–1018, 23 March 1944

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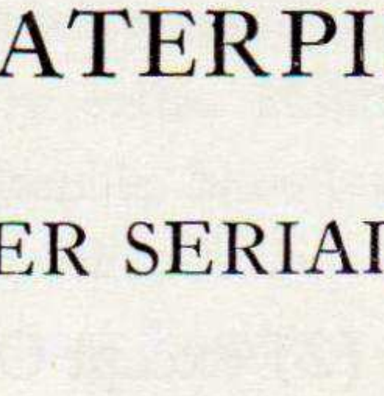
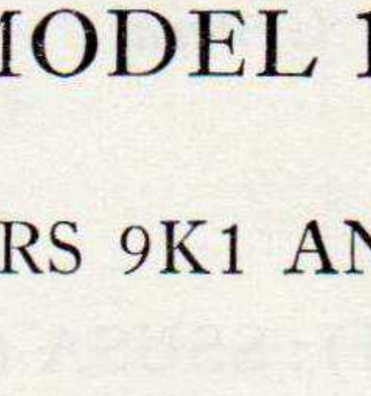
(GRADER SERIAL NUMBERS 9K1 AND UP)





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TM 5–1018—AFM 90–3, Operating and Maintenance Instructions for Grader, Road, Motorized, Diesel, 12-Ft. Moldboard, Caterpillar Model 12 (Grader Serial Numbers 9K1 and up), is published for the information and guidance of all concerned.

[AG 300.7 (26 Jan 48)]

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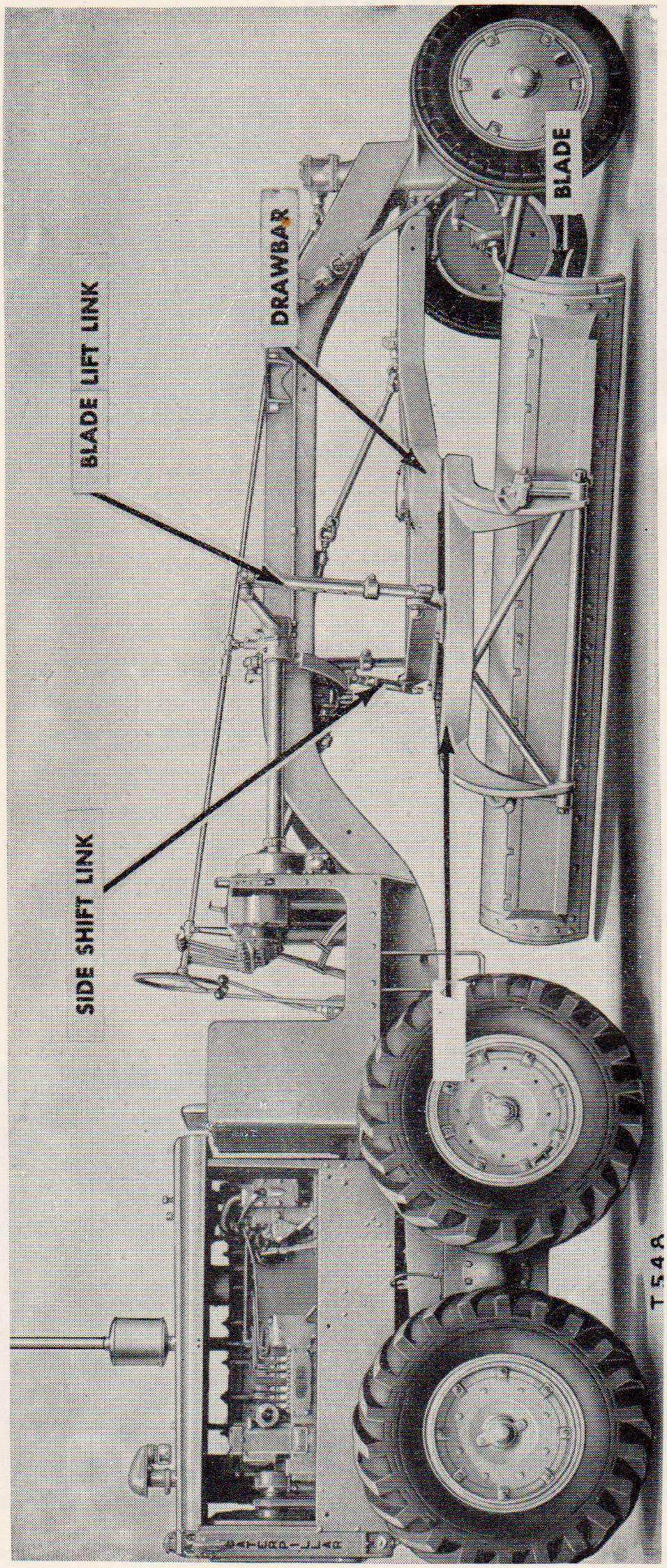


Figure 1. Caterpillar Diesel No. 12 motor grader.

This manual supersedes the Operation and Maintenance Instructions portion of TM 5–1018, 23 March 1944.

PART ONE

INTRODUCTION

Section I. GENERAL

1. Scope

a. This manual is published for the information and guidance of the personnel to whom this equipment is assigned. It contains information on the operation and maintenance of the equipment as well as descriptions of the major units and their functions in relation to the other components of the equipment. It applies only to the Caterpillar Diesel No. 12 Motor Grader, and is arranged in four parts: Part one, Introduction; part two, Operating Instructions; part three, Maintenance Instructions; and part four, Auxiliary Equipment.

b. Repair information for this equipment will be published in a separate technical manual (see FM 21–6 for availability). Parts information will be published in a supply catalog in the ENG 9 series. Pending publication and distribution of this material, existing repair and parts information in TM 5–1018, 23 March 1944, will be used.

c. Technical manuals, supply catalogs, and other publications applicable to the material covered in this manual are listed in appendix II.

2. Records

Maintenance record forms listed and briefly described in the following subparagraphs will be used in the maintenance of this equipment.

a. WD Form No. 48 (Driver's Trip Ticket and Preventive Maintenance Service Record). This form will be used by equipment operators for reporting the accomplishment of daily preventive maintenance services, and for reporting any equipment deficiencies observed during operation.

b. Standard Form No. 91 (Operator's Report of Motor Vehicle Accident). One copy of this form will be kept with the equipment at all times. In case of an accident resulting in injury or property damage, Form 91 should be filled out immediately (or as promptly thereafter as is practical) by the operator.

c. DA AGO Form No. 464 (Work Sheet for Preventive Maintenance and Technical Inspection of Engineer Equipment). This

form is used by personnel of the using organization and higher echelons for reporting the results of preventive maintenance services and technical inspections.

d. WD AGO Form No. 460 (Preventive Maintenance Roster). This form shall be used for maintaining an operating time record of the item of equipment, and for the scheduling of lubrication and preventive maintenance services at proper intervals.

e. WD AGO Form No. 478 (MWO and Major Unit Assembly Replacement Record). Major repairs or rebuilding, the replacement of major unit assemblies, and the accomplishment of equipment modifications shall be recorded on this form.

f. WD AGO Form No. 9-68 (Spot Check Inspection Report for Wheeled and Half-Track Vehicles). This form may be used in lieu of DA AGO Form No. 464 as a check list for applicable items to be inspected during spot-check inspection.

g. WD AGO Form No. 9-69 (Spot Check Inspection Report for All Full-Track and Tank-Like Wheeled Vehicles). This form may be used in lieu of DA AGO Form No. 464 as a check list for applicable items to be inspected during spot-check inspection.

h. WD AGO Form No. 468 (Unsatisfactory Equipment Report). This form shall be used in reporting manufacturing, design, or operational defects in material, with a view to correcting such defects; it shall be used also in recommending modifications of material. Form No. 468 shall not be used for reporting failures, isolated material defects, or malfunctions of material resulting from fair wear and tear or accidental damage. Form No. 468 shall not be used to report the issue of parts and equipment; nor for the reporting of replacements and/or repairs.

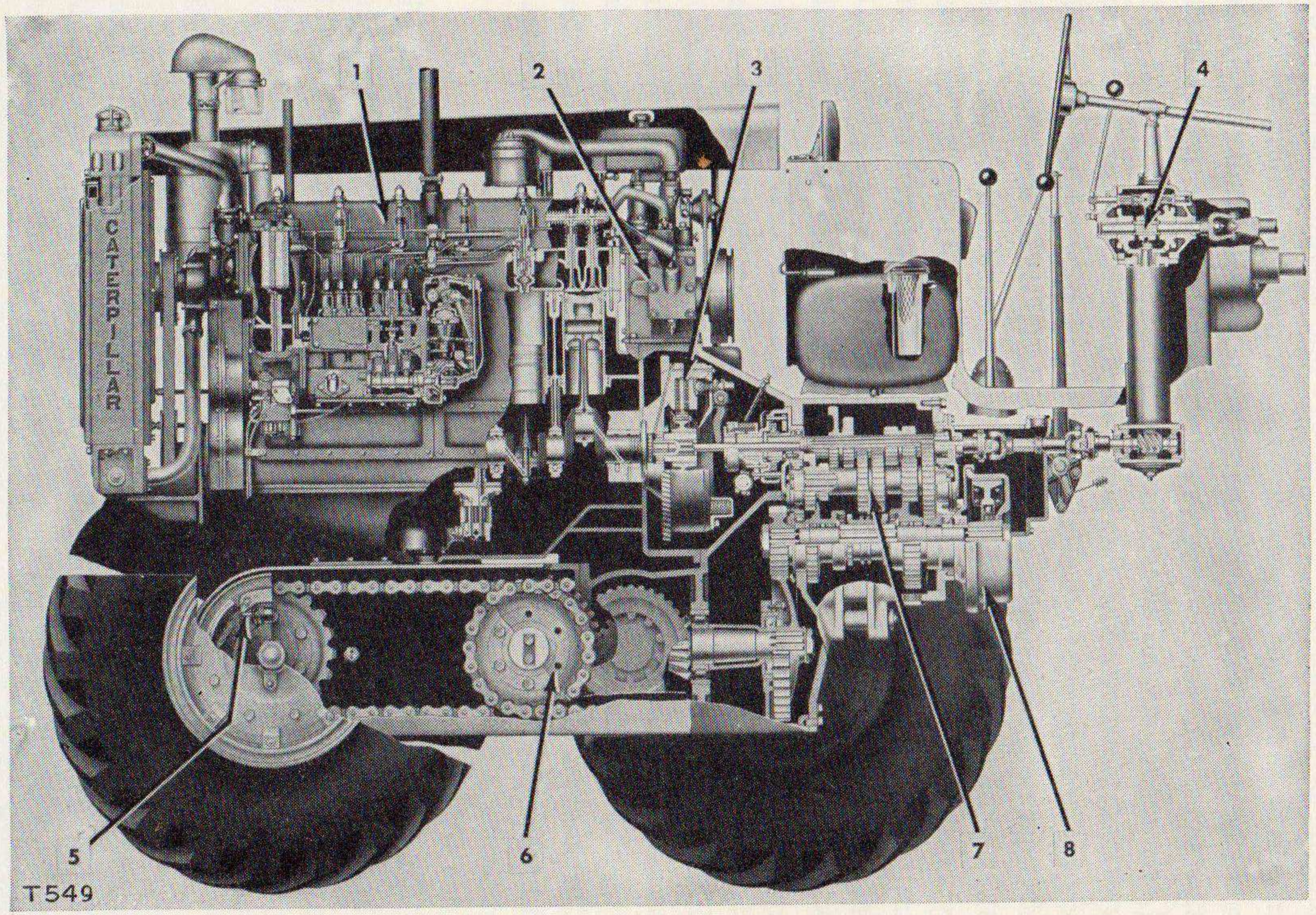
Section II. DESCRIPTION AND DATA

3. Description (See figs. 1 and 2.)

a. General.

(1) The motor grader described in this manual is a rubber tired, six-wheeled "Caterpillar" Diesel No. 12 Motor Grader.

(2) The motor grader is self propelled by a Diesel engine which transmits power to four driving wheels equipped with low pressure rubber tires. The engine also furnishes power for the mechanical power control system. The power control system is manually operated from the operator's seat to operate the blade, auxiliary equipment and to lean the wheels. The engine is back of the operator's seat with the radiator to the rear of the machine.



1. Diesel engine.
2. Starting engine.
3. Flywheel clutch.
4. Power controls.
5. Hydraulic brake.
6. Drive sprocket.
7. Transmission.
8. Hand brake drum.

Figure 2. Motor grader nomenclature.

b. Engine. The engine which powers the No. 12 motor grader is a six-cylinder, four stroke cycle, valve in head, "Caterpillar" Diesel engine. The Diesel engine is quite similar to the spark-ignition engine except that in the Diesel engine, fuel is injected into the cylinders and is ignited by the heat of compression.

c. Starting Engine. An independent two-cylinder, 15-horsepower gasoline engine is used to start the Diesel. The starting engine power is transmitted to the Diesel engine flywheel through a pinion which is manually engaged with the flywheel ring gear. It will crank the Diesel with compression on, for as long as necessary and the pinion automatically releases when the Diesel engine starts.

d. Flywheel Clutch. The flywheel clutch is a dry disc type clutch held in engagement by springs. It is disengaged by pushing on a foot pedal and engages again as soon as pressure is taken off the foot pedal.

e. Transmission. The two gear shift levers enable the operator to select any one of the six forward or two reverse speeds. An interlock mechanism, operated by the flywheel clutch pedal, prevents the gears from being shifted while the clutch is engaged.

f. Tandem Drive Housings. Two chain assemblies which operate in oil are used in each tandem drive housing. They are driven by the two sprockets on the axle shaft and in turn drive the sprocket on each wheel spindle. Each tandem can oscillate independent of the other.

g. Brakes. The motor grader has two complete independent brake systems. One is a hydraulic system controlled by the brake pedal which operates brakes on the rear tandem drive wheels. The other system is a hand brake which operates a brake on the lower transmission shaft. The hand brake is used only for parking or an emergency.

h. Power Controls.

(1) The power controls and their individual clutches are located in the housing on the dash directly in front of the operator's seat. The hand controlled levers engage individual clutches to operate the blade lift, circle reverse, circle centershift, leaning wheel and scarifier mechanism.

(2) A shear pin is provided which will break and prevent damage to the mechanism if the controls are over loaded.

i. Steering Controls. The steering wheel is connected to the front wheels by means of shafts, universal joints and gears. On machines beginning with 9K3521, a snubber arrangement in the steering gear housing prevents shock on the steering wheel when traveling over rough ground.

j. Blade. The blade is attached to a drawbar and is supported by the circle. The blade is controlled from the operator's seat by the power control mechanism for all ordinary work. The blade can be rotated a full 360° and changed from a horizontal, leveling position to the bank sloping position from the operator's seat.

k TIRES. The tires on the rear or driving wheels are the low pressure 13.00 x 24 tires designed to give maximum traction. The tires on the front wheels may be either the high pressure 7.50 x 24 tires or the same size tire that is used on the driving wheels.

4. Identification Plates (See fig. 3.)

a. GENERAL. When parts requisitions and regular reports are made up it is important that the manufacturer's name—capertillar, machine name—Motor Grader, and the registration and serial numbers of the machine involved be placed on the forms.

b. MOTOR GRADER SERIAL NUMBER. The motor grader serial number is stamped on two metal plates. One plate is located on the Diesel engine block, below the starting engine magneto. The other plate is located on the left side of the frame at the front end of the motor grader.

c. MANUFACTURER'S NAME. The manufacturer's name is cast on the radiator top tank and the radiator side plates.

d. DATA PLATES. Cast plates containing dimension, weight and horsepower data and also the serial and registration number, are located on the left side of the seat.

e. DEPARTMENT OF THE ARMY REGISTRATION NUMBER. The Department of the Army registration number is painted on the hood and the original marking is applied by the manufacturer. This number is also stamped on the data plate. The registration number assigned to the machine establishes its permanent identity and under no circumstances will this number, when once assigned, be changed or transferred to another vehicle without the authority of the procuring agency. The

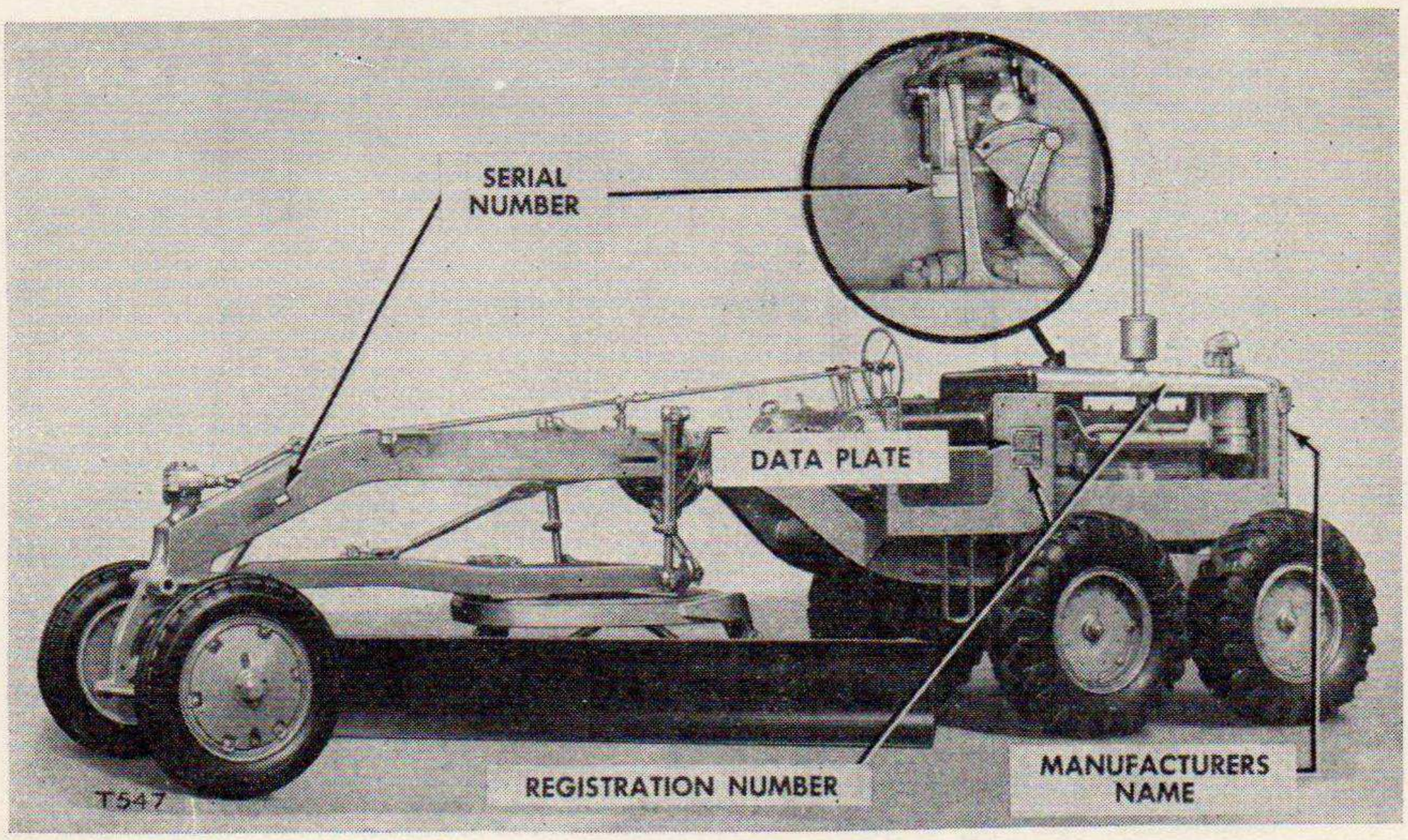


Figure 3. Indentification plates and numbers.

numbers indicate the numerical sequence in which the machine has been added to its type group.

f. DIFFERENCES IN MODELS. This manual covers "caterpillar" No. 12 Motor Grader bearing serial numbers 9K1 and up. The differences in design of machines within this group will be identified with serial numbers.

5. Tabulated Data

a. DIMENSIONS AND WEIGHTS

Diesel No. 12 motor grader

Weight without attachments	21,500 lbs.
Height over-all, with cab	9-ft. 10 in.
Height over-all, without cab	7-ft. 5 in.
Length over-all	25-ft. 0 in.
Width over-all	7-ft. 10 in.
Scarifier	1,200 lbs.
Snow plow	3,250 lbs.

b. PERFORMANCES.

Brake horsepower—maximum—75 at 1400 rpm.

Speed	*Forward*	*Reverse low*	*Reverse high*
First	1.8	2.4	3.8
Second	2.8		
Third	3.4		
Fourth	5.4		
Fifth	9.6		
Sixth	15.2		

c. DIESEL ENGINE.

Model—4 stroke cycle, water cooled.
Number of cylinders—6.
Bore and stroke—4¼-in. x 5½-in.
Firing order—1-5-3-6-2-4.
Weight of engine with radiator—3,400 lbs.

d. STARTING ENGINE.

Model—4 stroke cycle, water cooled spark ignition.
Number of cylinders—2.
Bore and stroke—3⅛-in. x 3½-in.
Brake horsepower—15 at 3,000-rpm.
Weight—340 lbs.

e. CAPACITIES (APPROXIMATELY).

Air cleaner, Diesel engine	2¼-qt.
Air cleaner, starting engine	½-qt.
Blade lift control housing	8½-qt.
Center shift control housing	1-qt.
Circle reverse control shaft housing	¼-qt.
Circle reverse housing	1¾-qt.
Cooling system	15-gal.
Crankcase, Diesel engine	25-qt.
Crankcase, starting engine	1½-qt.
Front wheel lean control housing	2-qt.
Fuel injection pump housing	1-qt.

Fuel tank, Diesel engine	40-gal.
Fuel tank, starting engine	5-qt.
Power control housing	8-qt.
Power control shaft housing	2-qt.
Rear axle housing	60-qt.
Steering gear housing	¾-qt.
Tandem drive housing (each)	30-qt.
Transmission	10-qt.

f. ACCESSORIES.

	Size	*Model*	*Make*
*Battery, lighting and starting system	6-volt	SW–2–116	Willard
*Generator charging	6-volt 90-watt	1101666	Delco Remy
*Generator charging	6-volt 150-watt	GEG–4828–1	Auto-Lite
*Generator lighting	6-volt 130-watt	ARKF	Bosch
*Head lamp, sealed beam unit	6-8-volt	925000	Guide
*Lamp bulb, dash and tail	3-cp	Single contact	Mazda
Magneto, starting engine		RC–2H	Eisemann
*Starter, starting engine	6-volt	1107024	Delco Remy
Spark plug, starting engine	18-MM	15A	Champion
Carburetor		Series TU–4C	Zenith
Fuel injection system	4¼-in. bore	.....	Caterpillar
Air cleaner, Diesel engine		Oil bath A917	Donaldson
Air cleaner, starting engine		Oil bath F600	Donaldson

**Special attachments.*

Section III. TOOLS, PARTS AND ACCESSORIES

6. Tool List

Figure 4 lists and illustrates the tools which accompany each tractor.

7. Parts List

Figure 5 lists and illustrates the spare parts which accompany each tractor.

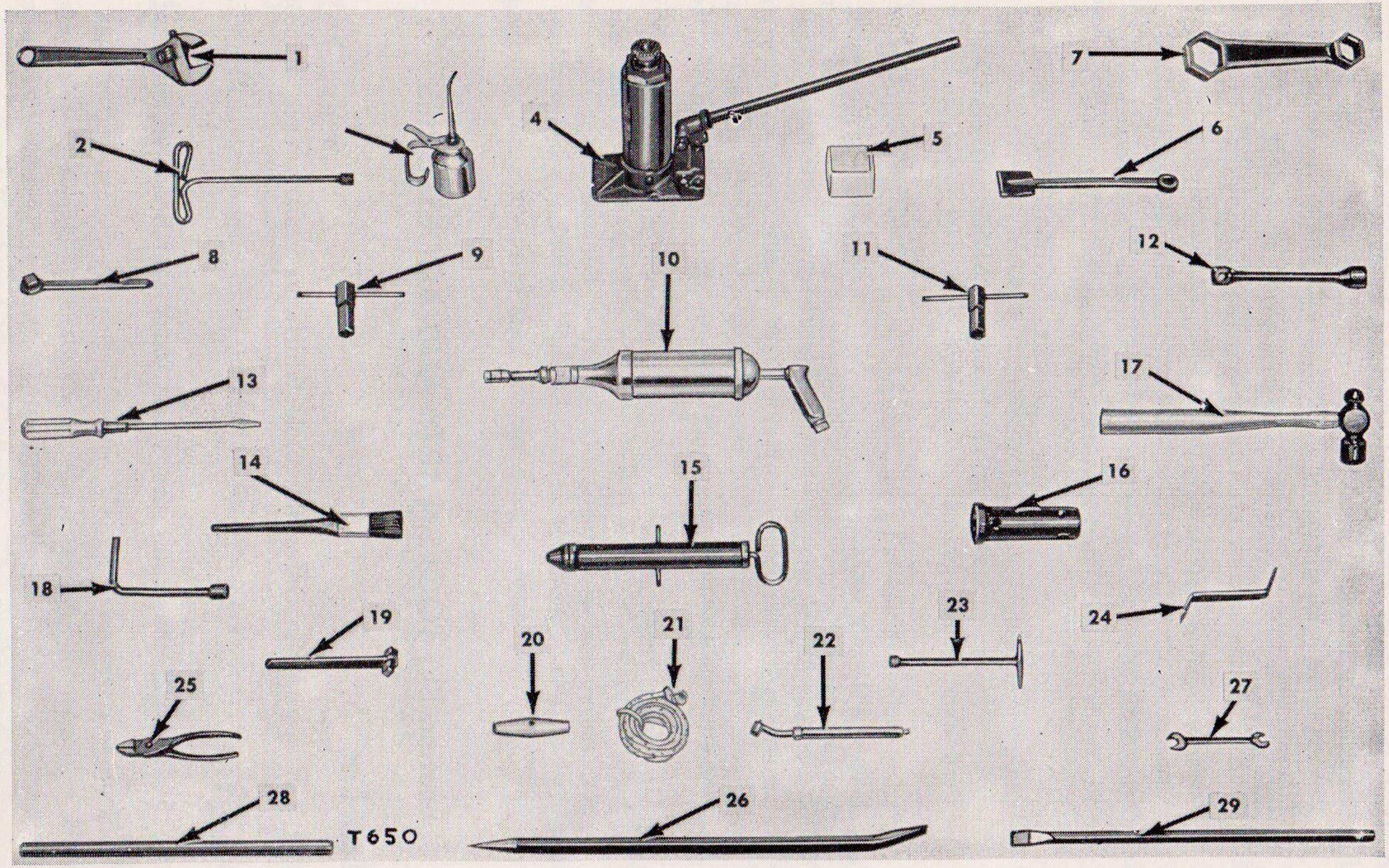


Figure 4. Tools supplied with motor grader.

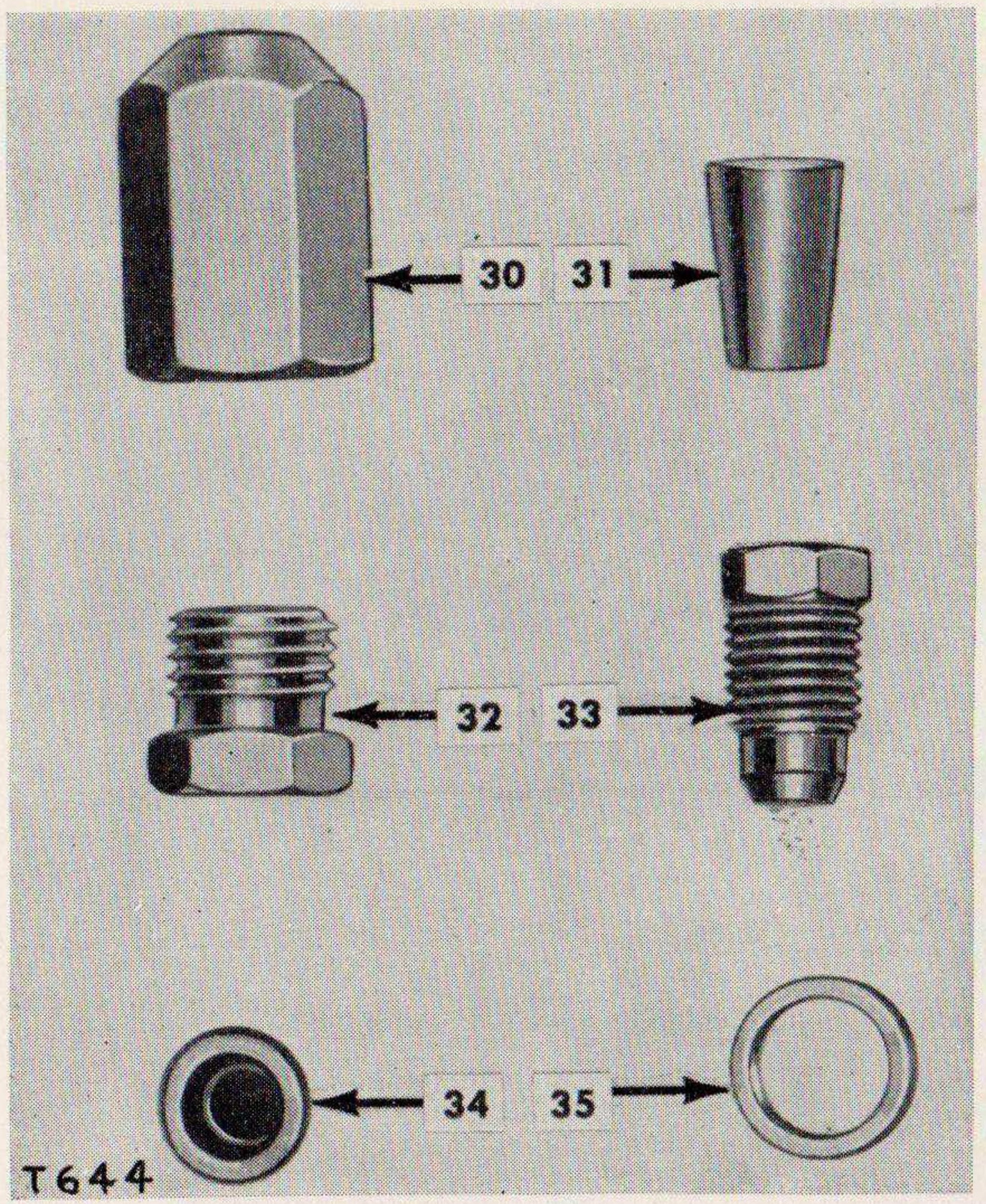


Figure 4.—Continued.

Reference No.	*Description*	*Quantity*	*Part No.*
1	Wrench (15 in. long)	1	1B7537
2	Wrench (9/16 in. hex)	1	L2303
3	Oil can	1	1B7763
4	Jack	1	2B9886
5	Box (containing items 30–35)	1	2B520
6	Wrench (shiftable blade)	1	7B8975
7	Wrench (front wheel nut)	1	1D3363
8	Wrench (1⅛ in. hex)	1	3B8829
9	Wrench (5/16 in. and 1⅛ in. hex)	1	3563–A
10	Compressor	1	3B8579
11	Wrench (⅞ in. and 5/16 in. hex)	1	3B1285
12	Wrench (rim nut)	1	2B5622
13	Screwdriver	1	4A643
14	Brush	1	2B4317
15	Grease gun	1	3B2301
16	Wrench (injection valve)	1	9B2029
17	Hammer	1	4A642
18	Wrench (magneto mounting nut)	1	5B1218
19	Wrench	1	1B5175
20	Handle (starting rope)	1	3B3809
21	Rope (starting)	1	3B3808
22	Tire pressure gage	1	3B6551
23	Wrench (fuel pump vent screw)	1	4A62
24	Adjusting tool (brake)	1	5B3032
25	Pliers	1	4A644
26	Pinch bar	1	4A645
27	Wrench (7/16 in. and ½ in. opening)	1	5B781
28	Handle (jack)	1	4B9918
29	Rim tool	1	2B5623
30	Cover (injection valve and pump)	12	2F2989
31	Stopper (injection pump)	6	2A4905
32	Plug (injection lines)	12	2F2990
33	Plug (overflow line)	1	1F1559
34	Cap (injection pump housing)	6	2A4716
35	Spacer (injection valve)	6	2F3096

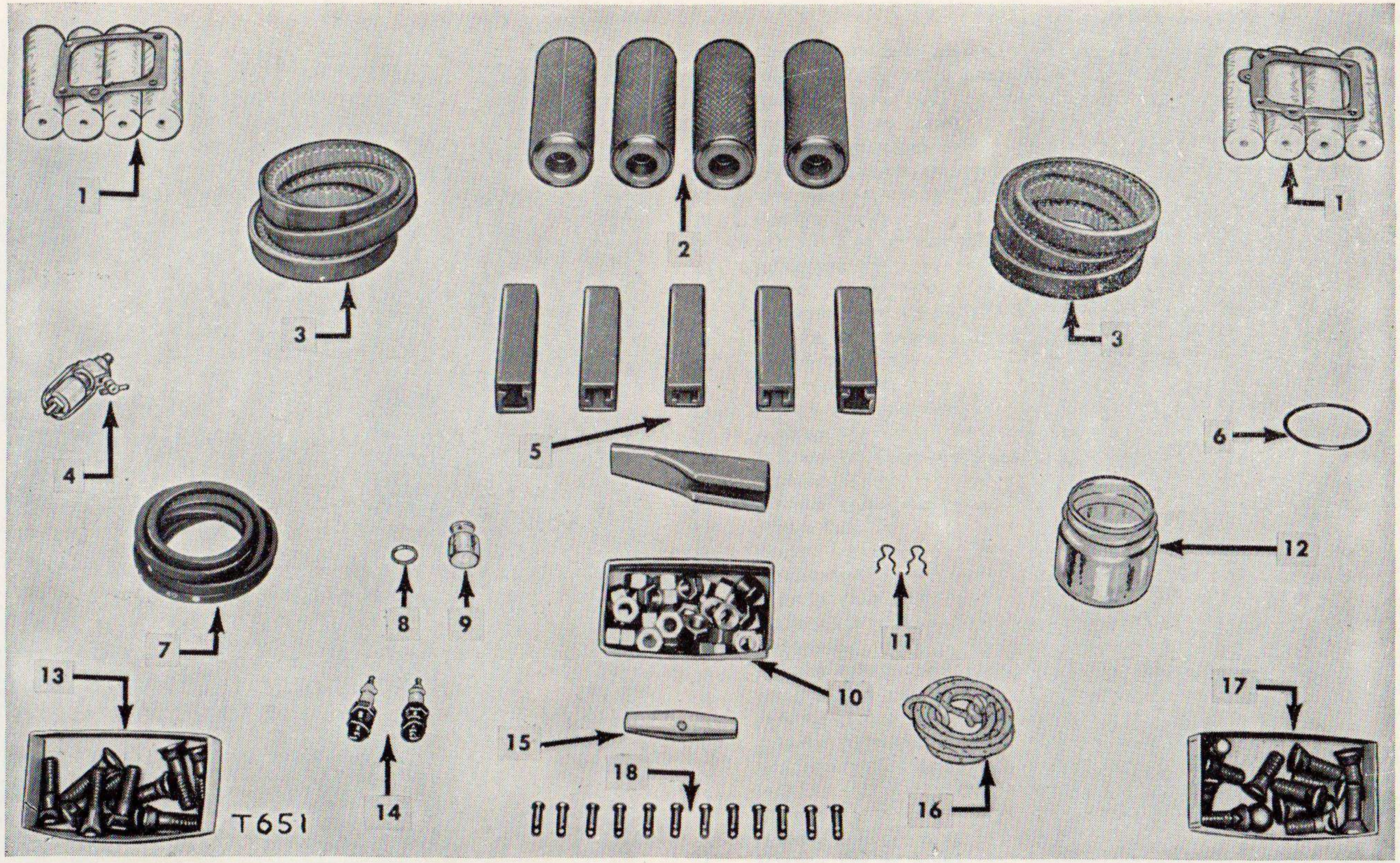


Figure 5. Parts supplied with motor grader.

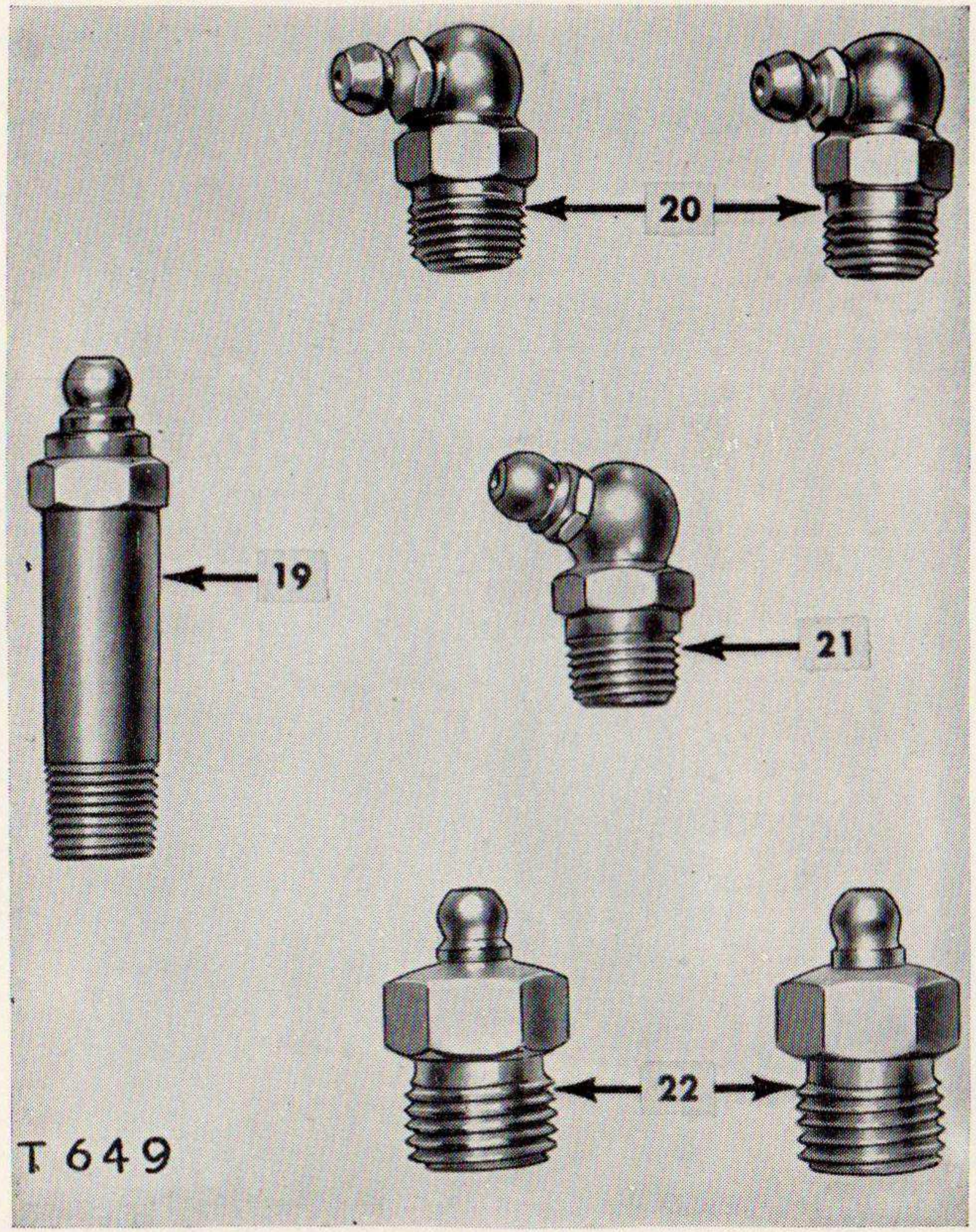
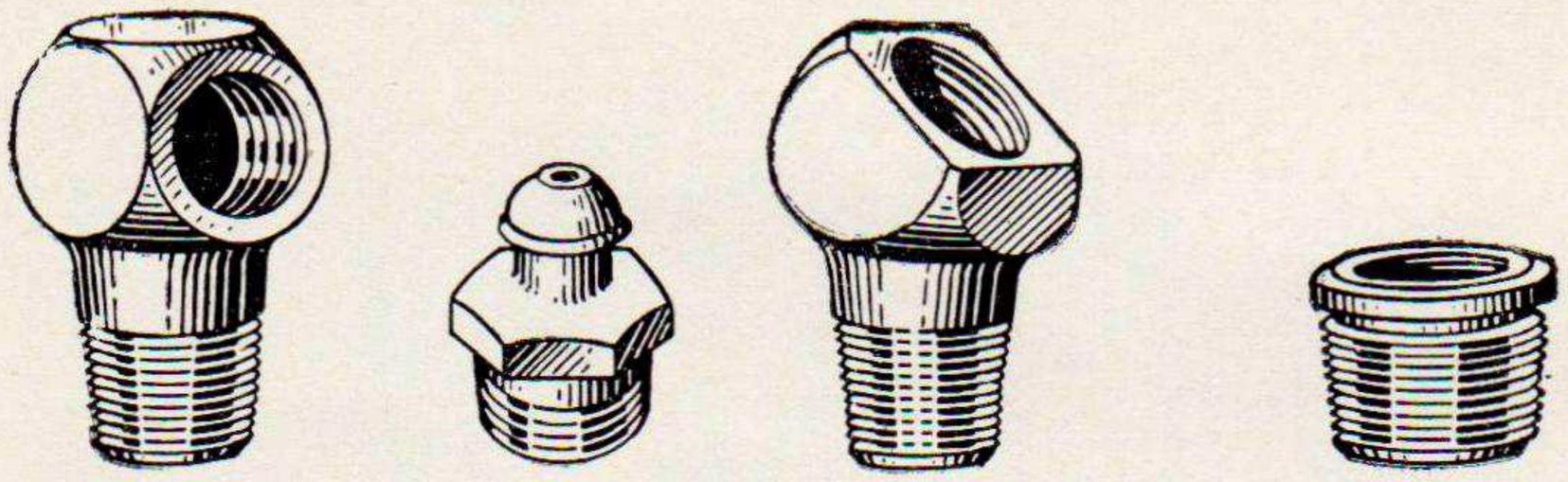


Figure 5.—Continued.

Reference No.	*Description*	*Quantity*	*Part No.*
1	Element assembly (fuel filter)	2	7B8264
2	Element (oil filter)	4	4A332
3	Belt (fan)	2	7B2774
4	Filter (gasoline)	1	3B8830
5	Tooth (scarifier)	11	5B946
6	Ring	1	5B3323
7	Belt (starting engine)	2	4B2544
8	Gasket	1	9B4519
9	Bowl	1	9B4514
10	Nuts	16	1D4720
11	Snap rings	2	6B5454
12	Jar (precleaner)	1	5B2746
13	Bolts	10	1D4659
14	Spark plugs (starting engine)	2	2A3643
15	Handle (starting rope)	1	3B3809
16	Rope (starting)	1	3B3808
17	Bolts	16	1D4657
18	Shear pin	12	1B676
19	Fitting	1	5B651
**20	Fitting	2	3B8488
**21	Fitting	1	3B8486
**22	Fitting	2	3B8490
*	End bit	2	3B4757
*	End bit l. h.	1	5B1856
*	End bit r. h.	1	5B1855
*	Cutting edge l. h.		1D3609
*	Cutting edge r. h.		1D3608

*These items are attached to the motor grader.

**When replacement fittings are required order the standard ordnance fittings, identified in figure 6, sheet 3.



Reference No.		*Part No.*
1.	Elbow—grease fitting, 90°	
	Lincoln Engineering Co.	20029
	"Alemite"	44701
	Caterpillar Tractor Co.	4F2
2.	Fitting—grease	
	Lincoln Engineering Co.	5250
	"Alemite"	1980
	Caterpillar Tractor Co.	3B8489
3.	Elbow—grease fitting, 45°	
	Lincoln Engineering Co.	20028
	"Alemite"	43716
	Caterpillar Tractor Co.	4F3
4.	Bushing—grease fitting	
	Reducing, ¼ inch to ⅛ inch	
	Caterpillar Tractor Co.	4F4

Figure 5. Continued.

PART TWO

OPERATING INSTRUCTIONS

Section IV. GENERAL

8. Scope

Part two contains information for the guidance of the personnel responsible for the operation of this motor grader. It contains information on the operation of the motor grader with the description and location of the controls and instruments.

Section V. SERVICE UPON RECEIPT OF EQUIPMENT

9. New Equipment (Boxed and Processed)

a. GENERAL. New machines and attachments are boxed and processed to meet military requirements for domestic or oversea shipment. To prevent corrosion all vulnerable openings in engines and gear compartments are sealed. Exposed moving parts and unpainted machined surfaces are covered with rust preventive compounds. This preparation makes definite services necessary before a machine can be operated.

b. UNCRATE THE MOTOR GRADER. Remove the sides of the box in which the motor grader was shipped. (See fig. 6.)

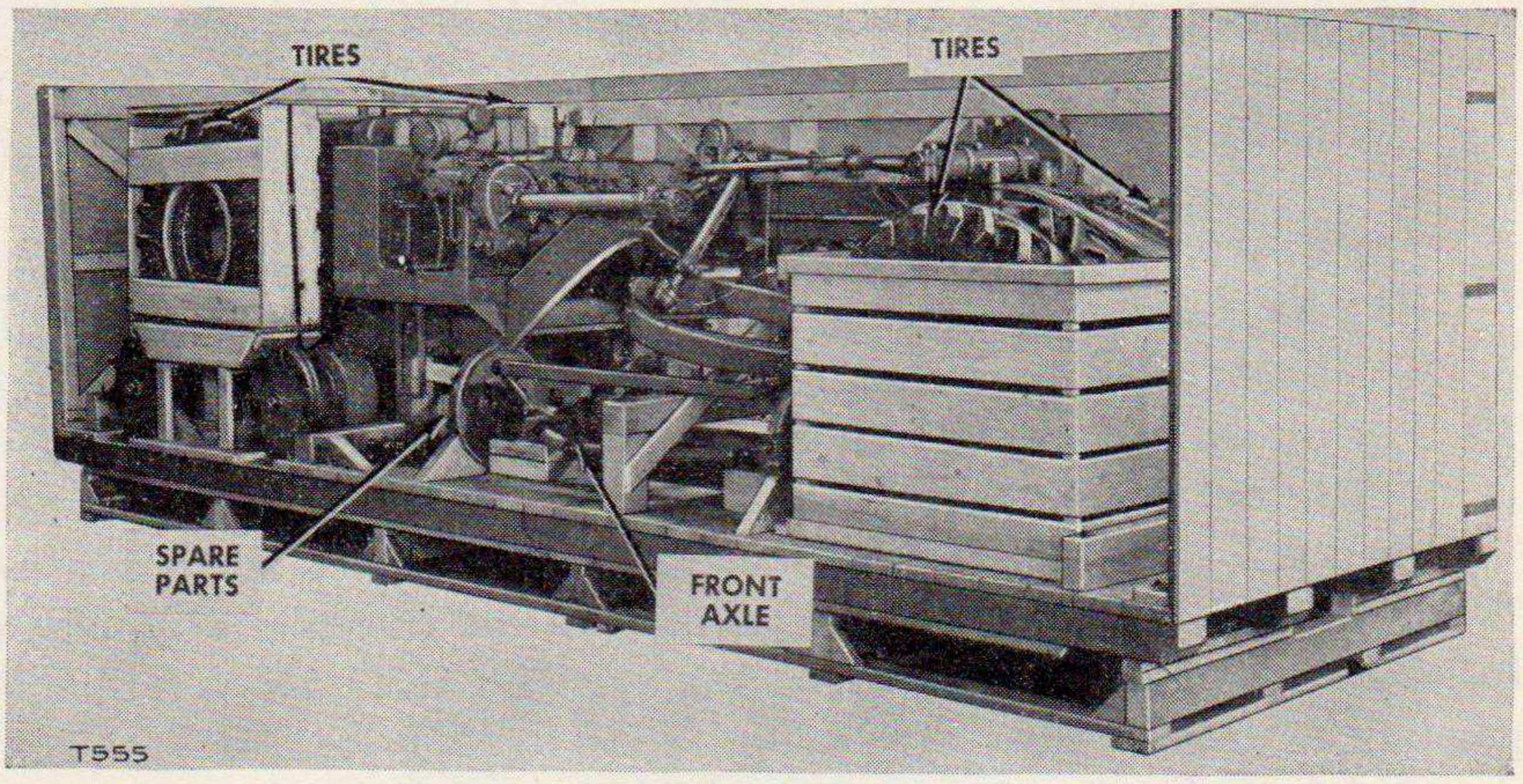


Figure 6. Uncrating motor grader.

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c. Lift Off the Tires. Lift out the crates containing the motor grader tires. (See fig. 6.)

d. Remove Tie Down Devices. Tie bolts at the rear, center, and front secure the motor grader to the box bed. Free the motor grader from these tie bolts.

e. Lift Off the Motor Grader. Lift the motor grader off the bed using the lifting eyes provided on the frame and tandem drive housings. (See fig. 7.)

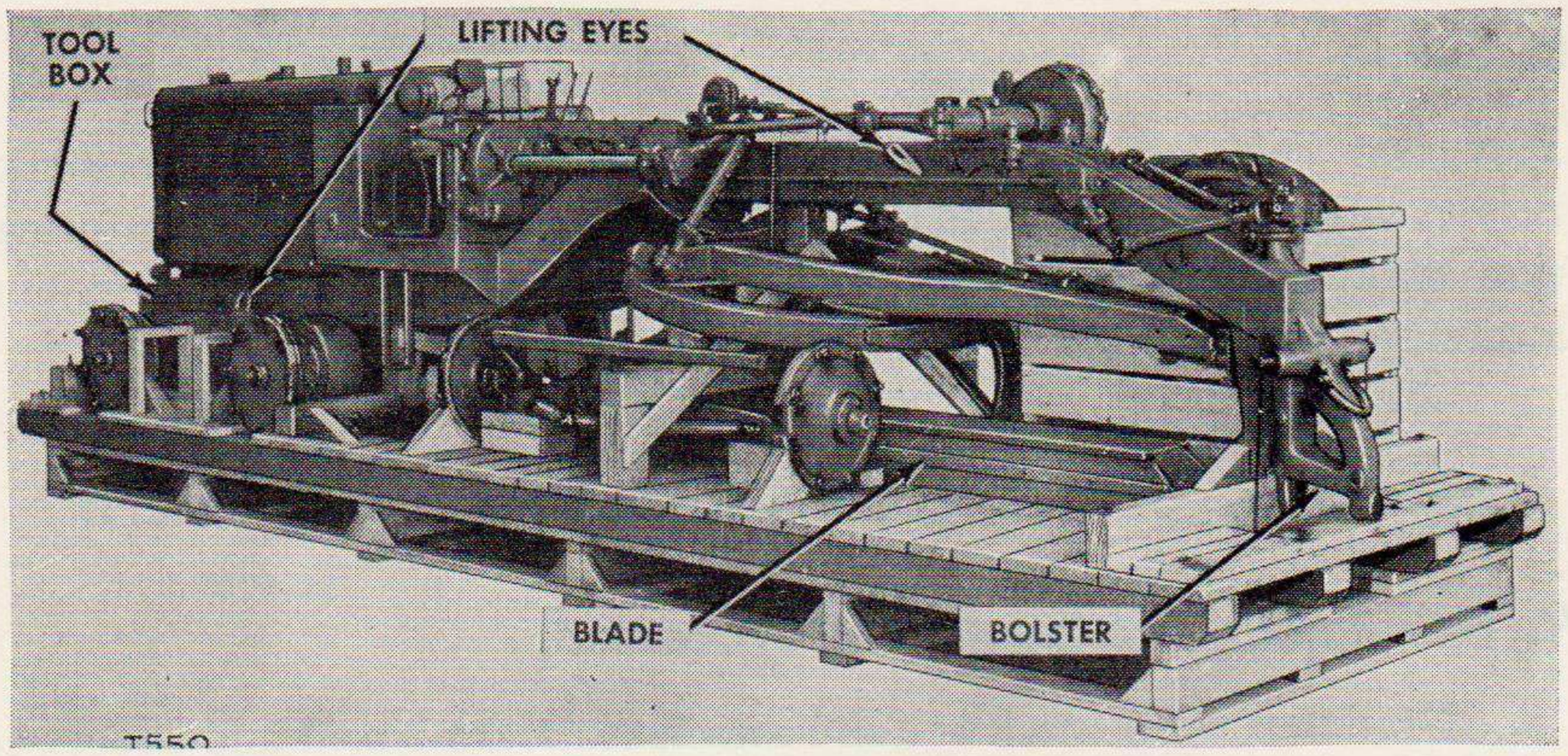

Figure 7. Removing motor grader from box.

f. Tools and Spare Parts. The tools, publications, and fire extinguisher are packed in the tool box. (See fig. 7.) Check the tools using the list in figure 4 as a guide. The spare parts are packed in a box located in the center of the shipping box bed. (See fig. 6.)

g. Attach the Front Axle Assembly. (See fig. 8.)

(1) Lift off the front axle assembly and place it in a position which will permit the motor grader frame to be lowered onto it. Remove the leaning wheel tie bar and replace it after the axle has been attached to the bolster.

(2) Connect the steering arm to the drag link.

(3) Assemble the telescopic leaning wheel control shafts at the universal joint. Be sure the universal joint forks on each end of the telescopic shaft are assembled parallel to each other.

(4) Install the steering wheel and shaft.

h. Install the Tires. Install the front tires with the arrow marked "FREE ROLLING WHEELS" pointing in the direction of rotation. Install the rear tires with the arrow marked "TRACTION WHEELS" pointing in the direction of rotation. (See fig. 9.) If 13.00—24 tires are used both front and rear, inflate all tires to 28 or 30 pounds. If smaller high pressure tires are used in front, inflate them to 70 pounds.

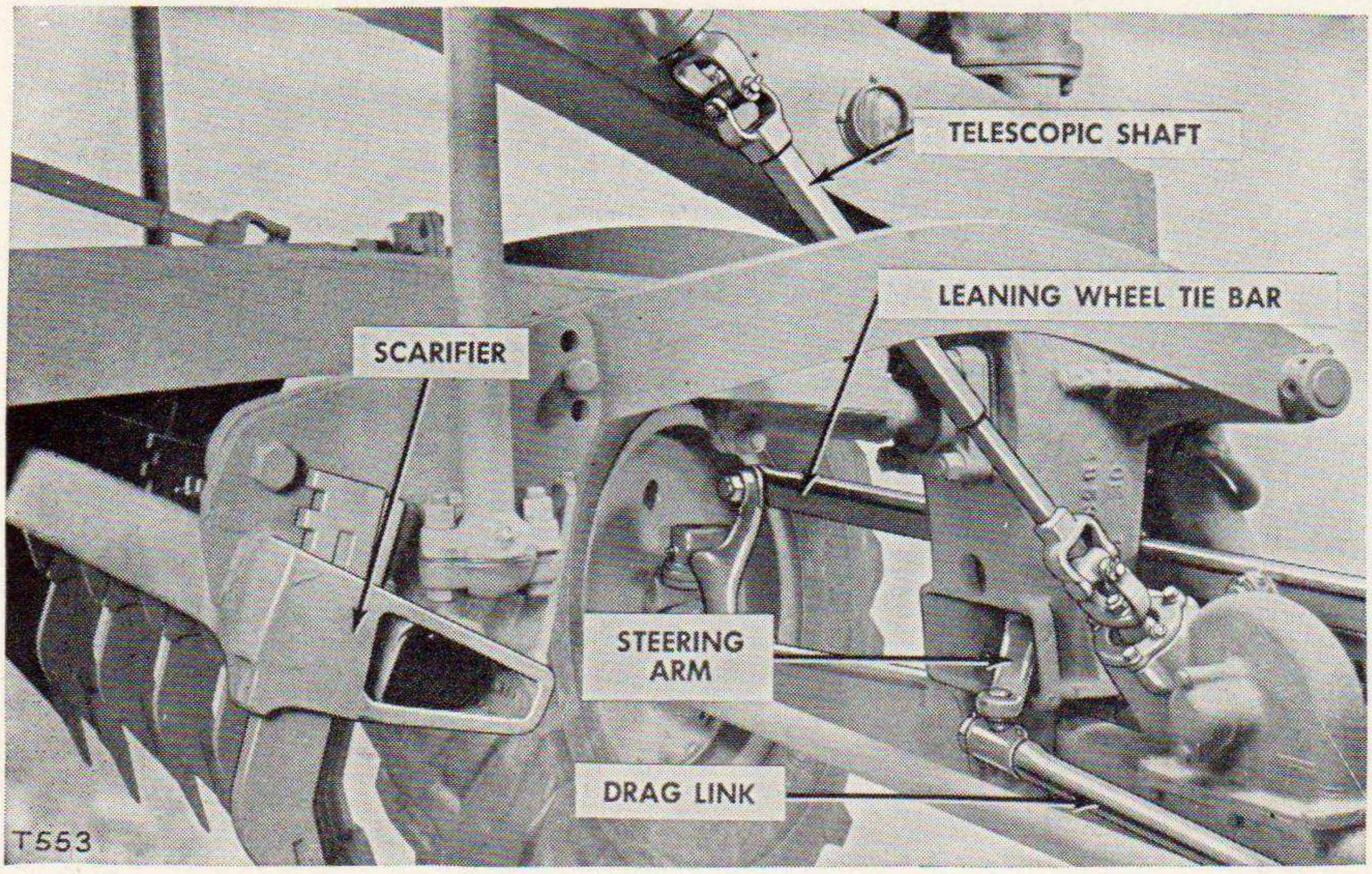

Figure 8. Front axle assembly and scarifier attached.

i. Remove Seals and Corrosion Preventive Compounds.

(1) Remove the seals from the accessories and openings pointed out in figures 10 and 11.

(2) Remove the paper from between the fan belt and fan pulleys and from between the starting engine accessory drive belt and pulleys.

(3) Remove the paper from between the starting engine magneto breaker points. (See fig. 11.)

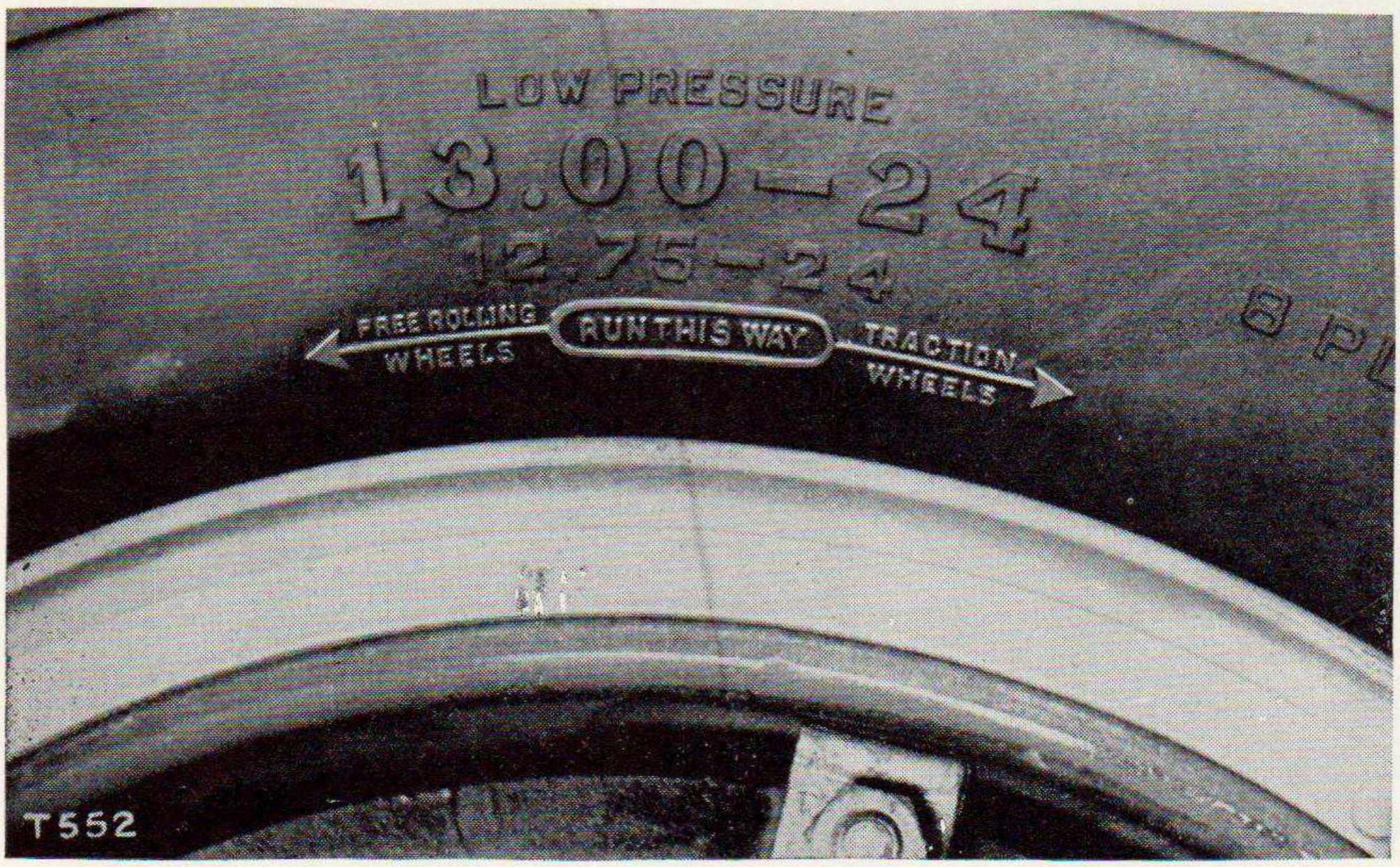

Figure 9. Tire rotation marking.

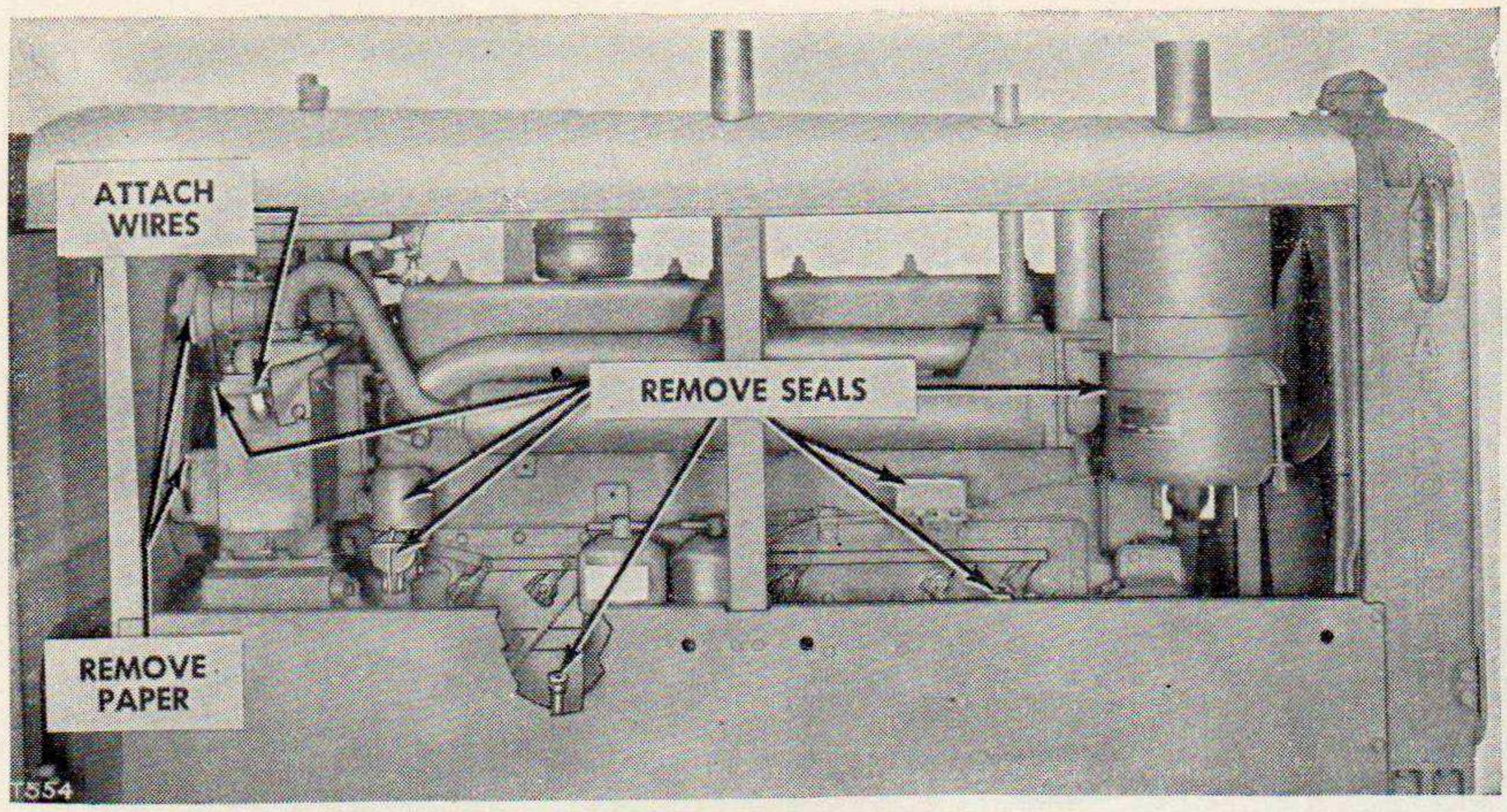

Figure 10. Preparation before operation.

(4) Corrosion preventive compounds can be removed with a steam cleaner. If a steam cleaner is not available dry cleaning solvent can be used.

(5) Drain the rust preventive from the Diesel and starting engine fuel tanks.

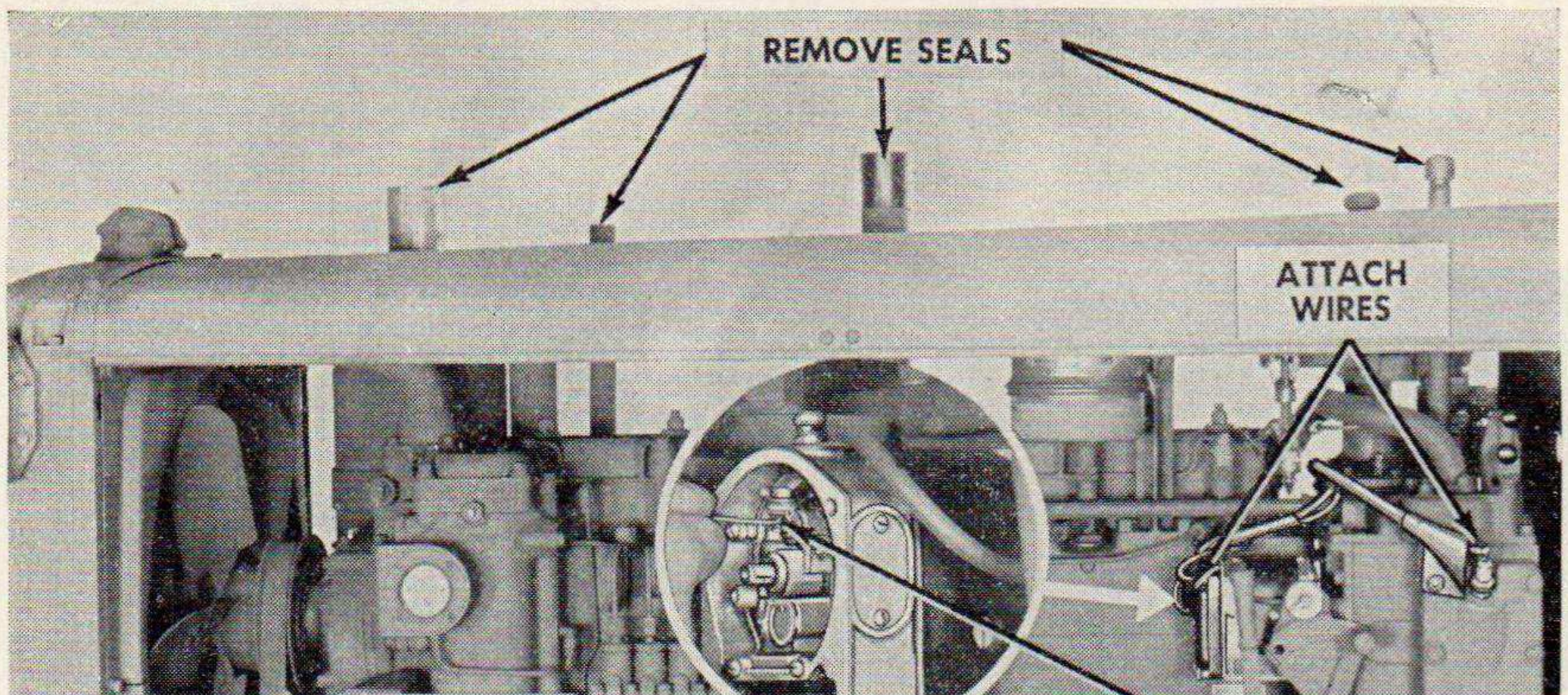

Figure 11. Preparation before operation.

j. Assembly Prior to Starting Engine.

(1) The precleaner is packed with the clamp in the tool box. Install the precleaner on top of the air cleaner inlet pipe.

(2) The Diesel engine block drain plug and the radiator drain valve are in a sack attached to the governor control rod on the right side of the Diesel engine. Screw the plug into the block and the radiator drain valve into the radiator. (See fig. 11.) Add water or antifreeze. Antifreeze proportions are listed in paragraph 25.

(3) The muffler is fastened to the operator's platform. The clamp is located in the tool box. Attach the muffler to the Diesel engine exhaust pipe.

k. Preparing New Batteries for Use.

(1) Batteries shipped with a machine contain dry charged plates but no electrolyte. Vent plugs are screwed in tight and must remain so until the cells are filled with electrolyte.

(2) Make certain the vent holes in all plugs are open.

(3) Fill cells to 3/8 inch above separators with electrolyte not warmer than 70°F. Electrolyte accompanies the motor grader but it is not packed with it.

(4) Do not begin to charge a new battery for several hours after adding electrolyte. Heat will be produced when the electrolyte is added, and the battery should be allowed to cool to atmospheric temperature before connection to the charger.

(5) The charging rate for new batteries should never exceed one ampere per positive plate per cell. Watch the temperature closely; if it exceeds 110°F., reduce the rate at once.

(6) Continue the charge until three readings at hourly intervals show no further rise in specific gravity; then adjust the gravity of the electrolyte if necessary. Never discontinue an initial charge until the maximum specific gravity is obtained.

l. Lubricate the Entire Motor Grader. Check the oil, water, and fuel supply and lubricate the entire motor grader according to the lubrication order. (See par. 35.) If antifreeze is required see paragraph 25.

m. Complete Assembly.

(1) *Install the blade.*

(a) Use the crane or hoist to put the blade in position under the circle and blade beams. Place a block near the center under the reinforcement angle on the back side of the blade to hold the blade upright.

(b) Remove the tilting bracket from the right blade beam. The left bracket is on the crate floor.

(c) Slide the brackets on the slide rails one from each end of the blade.

(d) Operate the controls to put the blade beams in position to connect the tilting brackets to the blade beams.

(2) *Install scarifier.*

(a) Use the hoist or crane to place the scarifier in position in front of the blade. Place blocking under the scarifier block to hold it in an upright position.

(b) Maneuver the machine and controls to put the scarifier lift links and drawbars in position to connect the scarifier links and drawbars. The drawbars are shipped fastened to the floor of the crate under the blade.

(3) *Install the hitch.* The hitch is fastened to the floor of the crate and must be installed on the rear cross-member below the radiator.

n. INSPECTION. Inspect the motor grader for missing or damaged parts. Check the tools, parts, and publications.

10. Used Equipment

a. GENERAL. Perform applicable operations outlined in paragraph 9.

b. INSPECTION. Give a used or reconditioned motor grader a thorough inspection. Check for loose nuts and capscrews, broken or missing parts. Check all adjustments. Check the air pressure of the tires. Try the transmission in all speeds. Be sure the engine is firing on all cylinders.

c. LUBRICATION. Check the oil, water, and fuel supply and lubricate the machine as directed in paragraph 35.

d. OPERATION. If the machine has recently been reconditioned, operate under a medium load for the first 64 hours.

Section VI. CONTROLS AND GAGES

11. General

The controls are described in this section. Actual use of each control under various conditions is explained in section VII.

12. Starting Controls (See fig. 12.)

a. STARTING ENGINE FUEL TANK VALVE. The starting engine fuel tank valve is located directly under the fuel tank between the starting engine and the seat. It shuts off the fuel to the starting engine carburetor.

b. STARTING ENGINE CHOKE CONTROL. The choke operates in a positive manner for three-fourths the choke travel, at which position the valve is fully closed. Pulling the choke rod the last fourth of its travel, trips the positive control and the valve is then held in the closed position

by spring tension. The spring tension allows the choke valve to automatically open when the engine starts which prevents flooding before the choke control knob is returned to the "OFF" position. Pushing the choke all the way in returns the choke to the "OFF" position and re-engages the positive control. For this reason if it is necessary to choke the engine when starting, the choke should always be pulled out all the way.

c. Throttle Control. The throttle control is provided to change the governed speed of the starting engine.

d. Starting Engine Magneto Switch. The starting engine magneto switch grounds the magneto when it is turned to the "OFF" position and stops the starting engine.

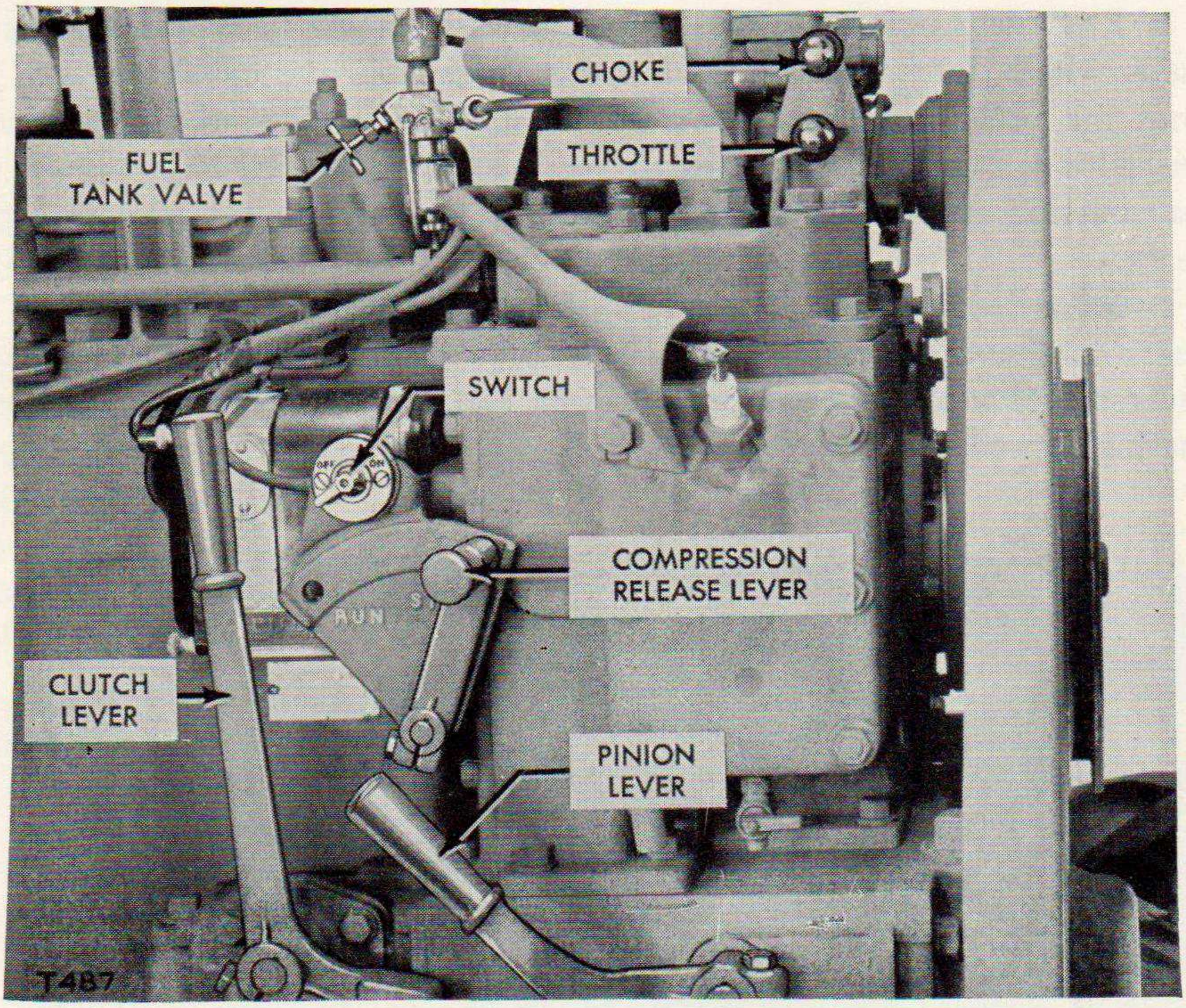

Figure 12. Starting controls.

e. Compression Release Lever. The compression release lever is connected to the inlet valve lifters of the Diesel engine by a cam arrangement. When the lever is moved to the "START" position the inlet valves are lifted off their seats and the compression is released on all cylinders. This is used to reduce the initial effort required to start the Diesel engine.

f. Starting Engine Clutch Control Lever. The starting engine clutch control lever engages the starting engine with the starter pinion

when the lever is pushed toward the radiator and snapped over center. When the lever is pulled toward the seat it disengages the clutch and applies a brake to the starter pinion enabling the operator to engage the starter pinion to the Diesel engine flywheel ring gear without clashing.

g. STARTER PINION LEVER. The starter pinion lever engages the starter pinion with the ring gear on the Diesel engine flywheel.

13. Operating Controls (See fig. 13.)

a. THROTTLE CONTROL LEVER. The throttle lever is used to change the governed speed of the Diesel engine. When the lever is pulled back the speed is increased. When the lever is pushed forward the speed is decreased. When the plunger on the bottom of the lever is pulled out and the lever pushed all the way forward the engine is stopped.

b. FLYWHEEL CLUTCH PEDAL. The flywheel clutch pedal disengages the flywheel clutch. Springs within the clutch hold the clutch engaged until the pedal is pushed down by the operator. When the pedal is pushed down the clutch is released and a brake is applied to the upper transmission shaft which permits gear shifting without clashing the gears.

c. GEAR SHIFT LEVER. The gear shift lever is used to shift the sliding gears in the transmission. This lever selects three forward and one reverse speeds all of which have a high and low speed determined by the high speed shifter lever.

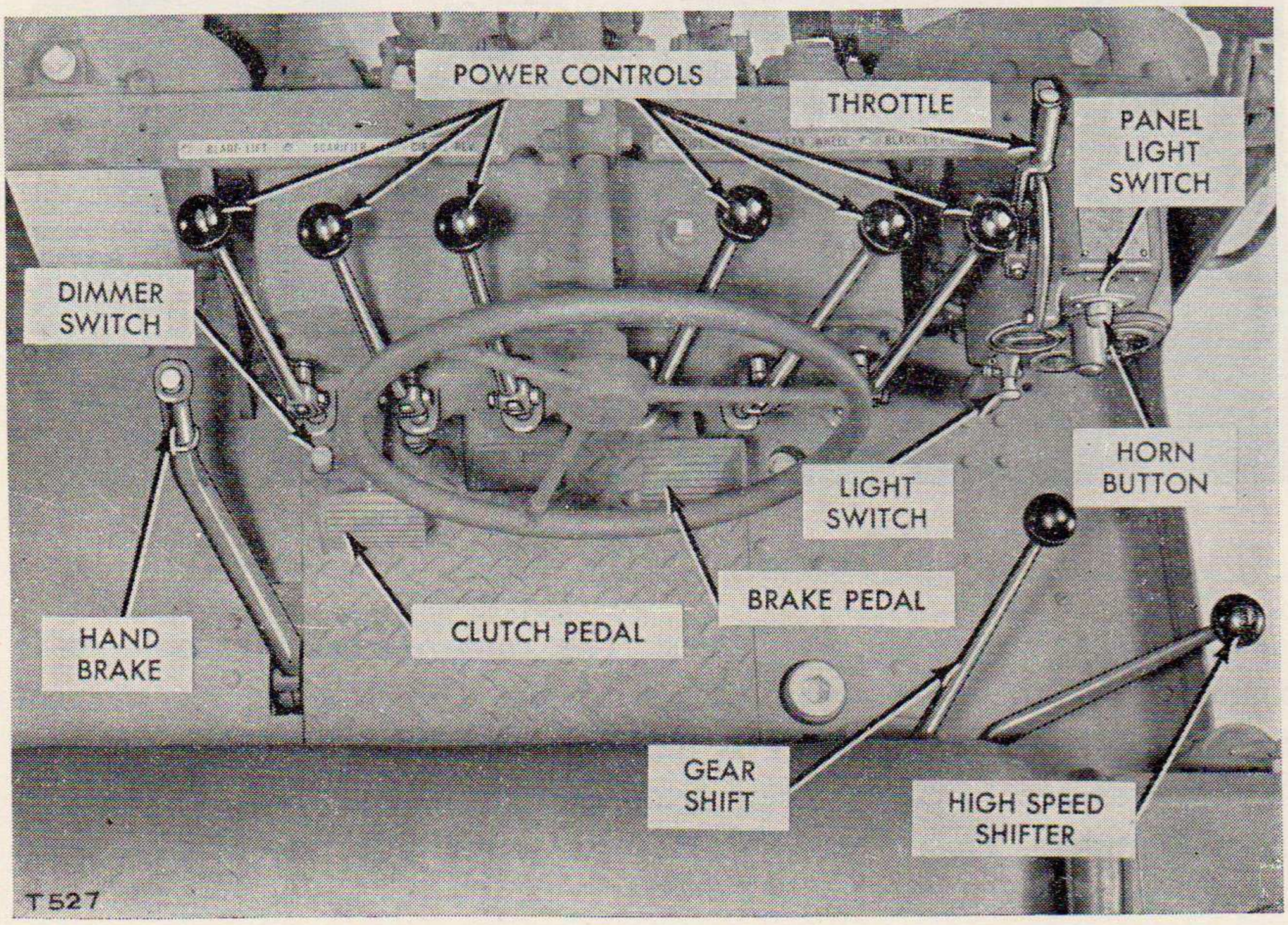

Figure 13. Operating controls.

d. HIGH SPEED SHIFTER LEVER. The high speed shifter lever is to shift the sliding coupling on the lower transmission shaft to obtain the high and low range. This arrangement gives the operator his choice of six forward and two reverse speeds.

e. STEERING WHEEL. Steering is accomplished by the position of the front wheels manually controlled by the steering wheel.

f. BRAKE PEDAL. The brake pedal operates the hydraulic brakes. When the pedal is depressed the brake is applied to the two rear driving wheels.

g. HAND BRAKE LEVER. The hand brake operates the mechanical brake. When the hand brake lever is pulled back the brake is applied to the lower transmission shaft. The hand brake is used primarily for parking.

h. POWER CONTROL LEVERS. The power controls are mechanical, therefore the controls will not operate unless the engine is running. The control levers must be held in engagement by the operator. Each control can be operated independent or more than one can be operated at the same time. When the limit of travel is reached or an abnormal load is encountered on the blade the control lever will "kick back". This is a warning to the operator to release the control lever to prevent shearing the shear pin or damaging any part of the machine. The identification plate directly in front of the control levers identifies each lever.

i. MAIN LIGHT SWITCH. (See fig. 14.) The main light switch, located on the instrument panel, is a four-position push-pull type switch which controls both service and blackout head lights, service and blackout stop and tail lights. The switch is equipped with a circuit breaker type fuse which automatically opens the circuit when a short occurs and automatically closes the circuit when the thermostatic element in the circuit breaker cools off. The switch operates in the following manner.

(1) *Off position.* When the switch control button is pushed completely in, all lights, both service and blackout, are turned off. The blackout and service stop lights cannot be operated with the switch in this position.

(2) *Blackout position.* When the switch button is pulled to first stage, the blackout head lights and blackout stop and tail lights are energized. The button is locked in place with automatic plunger type lock when pulled to this position.

(3) *Service position.* The switch locking button at left of switch body must be depressed before the switch button can be pulled to second stage or service position. When the switch is in the service position, service head lights, service stop and tail lights, and instrument panel lights are energized.

(4) *Service stop light position.* When the switch button is pulled completely out, the service stop lights may be operated for daylight service.

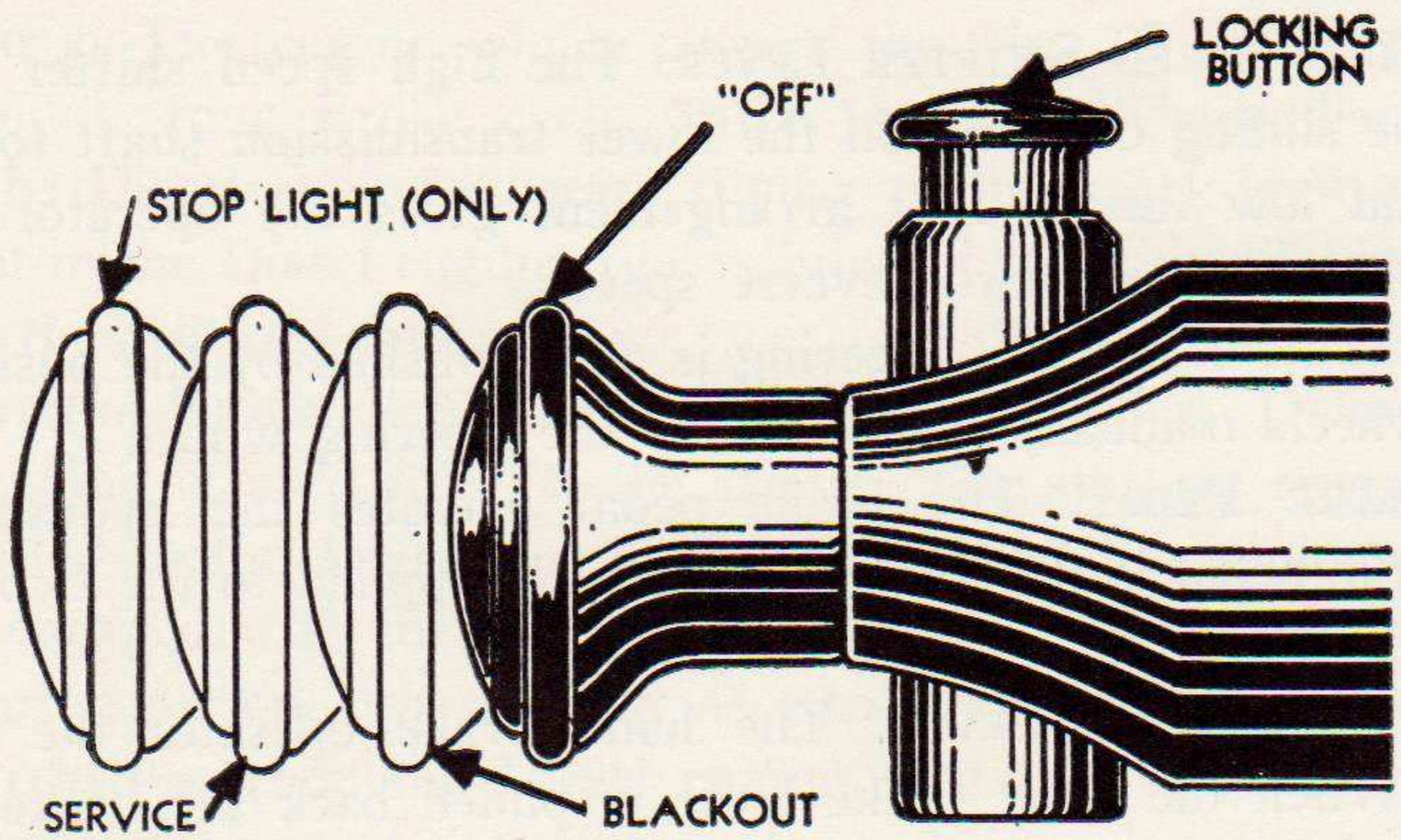

Figure 14. Details of light switch.

j. PANEL LIGHT SWITCH. The panel light switch controls the panel light when the main light switch is in the "Service" position.

k. DIMMER SWITCH. The dimmer switch is located on the floor to the left of the clutch pedal and is used to dim the headlights when the main switch is in the "Service" position.

14. Gages (See fig. 15.)

a. GENERAL. The temperature, oil pressure, and ammeter gages are on an instrument box located to the right of the power controls in front of the operator. The fuel pressure gage is located near the top of the fuel filter housing on the right side of the Diesel engine. The hour meter is located on the right side of the engine near the bottom of the

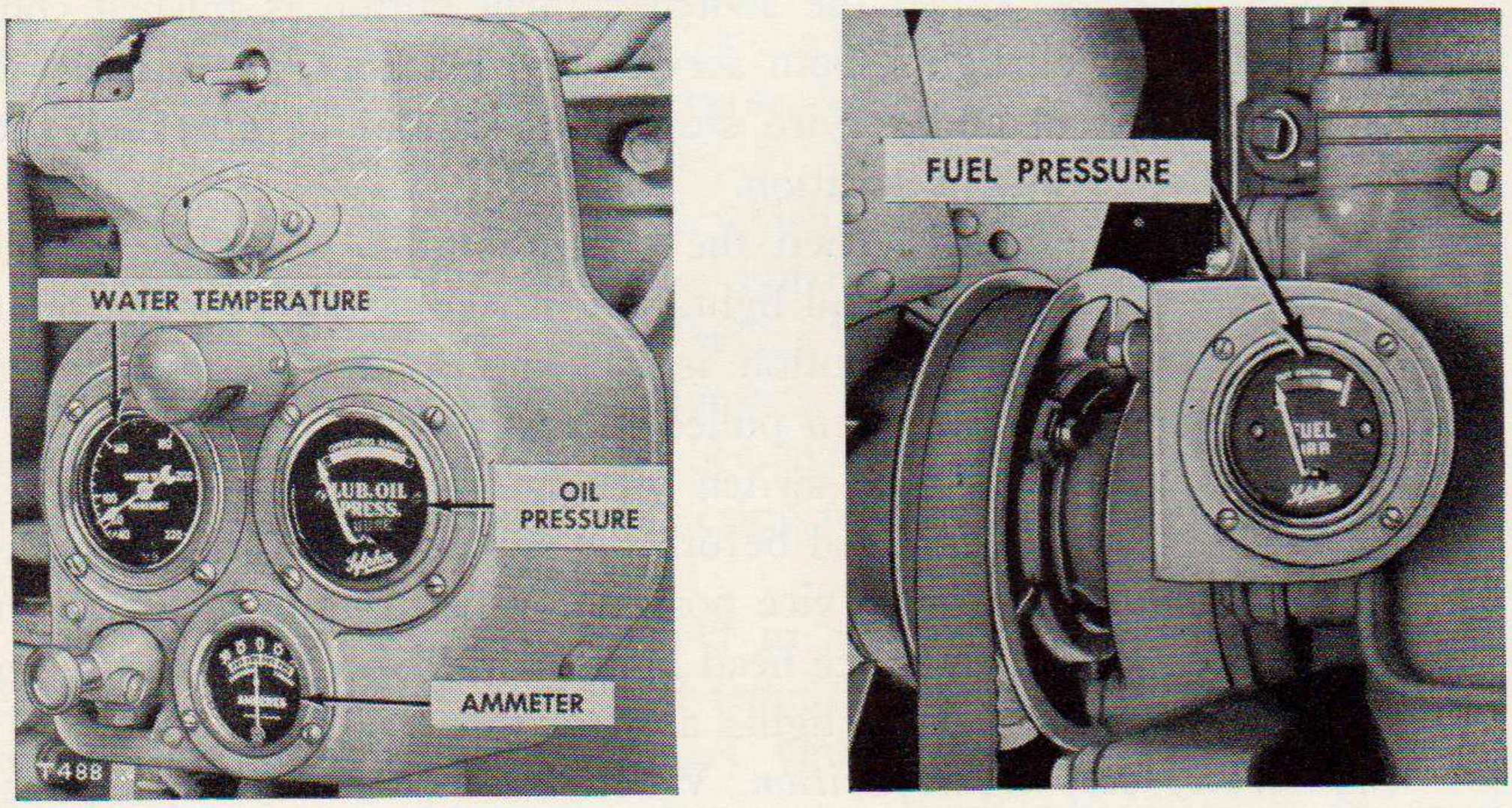

Figure 15. Gages temp., oil, ammeter, fuel.

governor housing below the fuel pressure gage. The odometer is located in the hub of the left front wheel.

b. Temperature Gage. The temperature gage, operated through a capillary tube connected to the engine thermal unit, indicates the temperature of the coolant in the cooling system, not quantity of coolant in the system. The face of the gage is graduated from 50° to 220° F. The normal operating temperature of the engine is between 175° and 185° F.

c. Oil Pressure Gage. The oil pressure gage indicates the pressure of the engine lubricating oil, and does not indicate the amount of oil in the crankcase. When the engine is operating the oil pressure indicator should never fall below the operating "White" range on the gage.

d. Ammeter. The ammeter indicates the amount of electric current being put into the battery by the generator. If the ammeter does not show a high charging rate, it is not an indication that the equipment is at fault unless the battery shows a low reading when checked with a hydrometer.

e. Fuel Pressure Gage. The fuel pressure gage indicates the condition of the fuel filters. As the filters gradually become clogged, the fuel gage indicator will move back from the normal "White" range to the caution "Green" range and later to the out "Red" range (engine operating at normal speed).

f. Hour Meter. (See fig. 16.) The "Hour Meter" does not keep pace with the clock but when the crankshaft turns as many revolutions as are made in an hour at normal operating speed, the dial advances one number.

g. Odometer. (See fig. 17.) The odometer records the number of miles the machine travels but does not indicate the speed it travels.

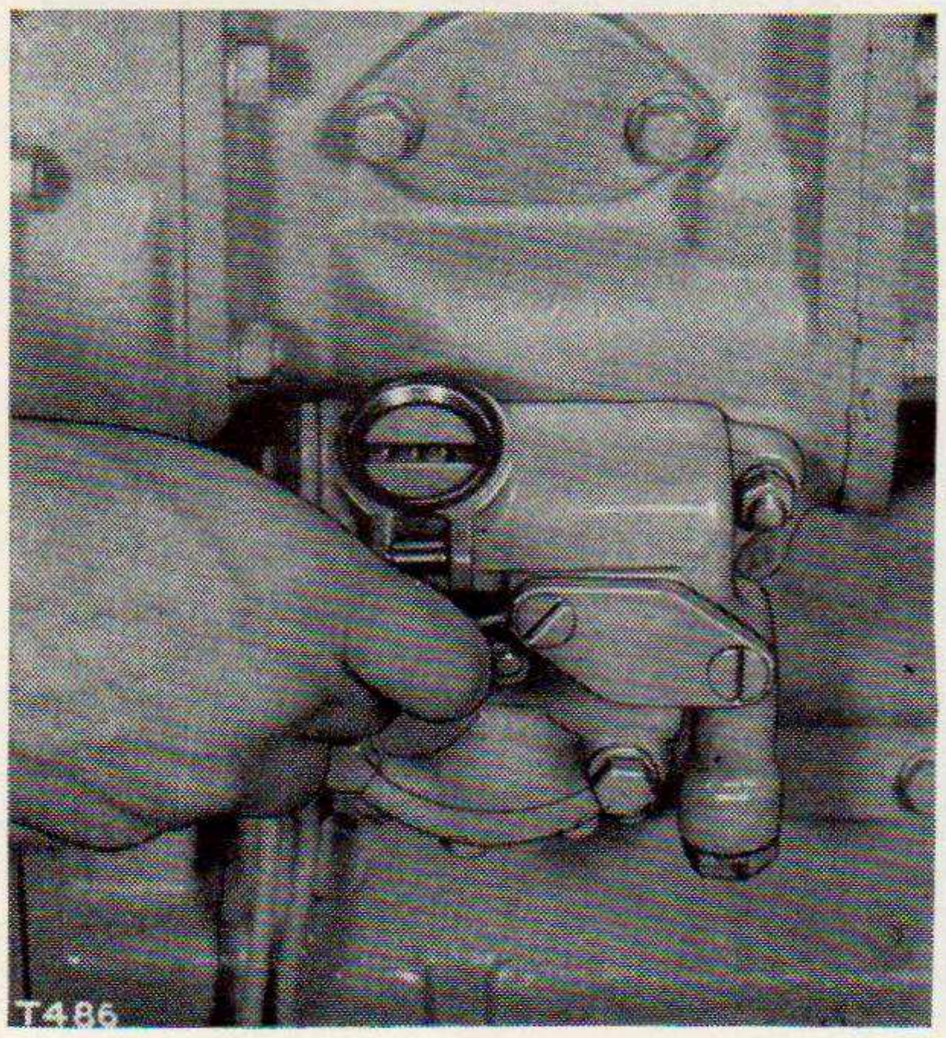

Figure 16. Hour meter.

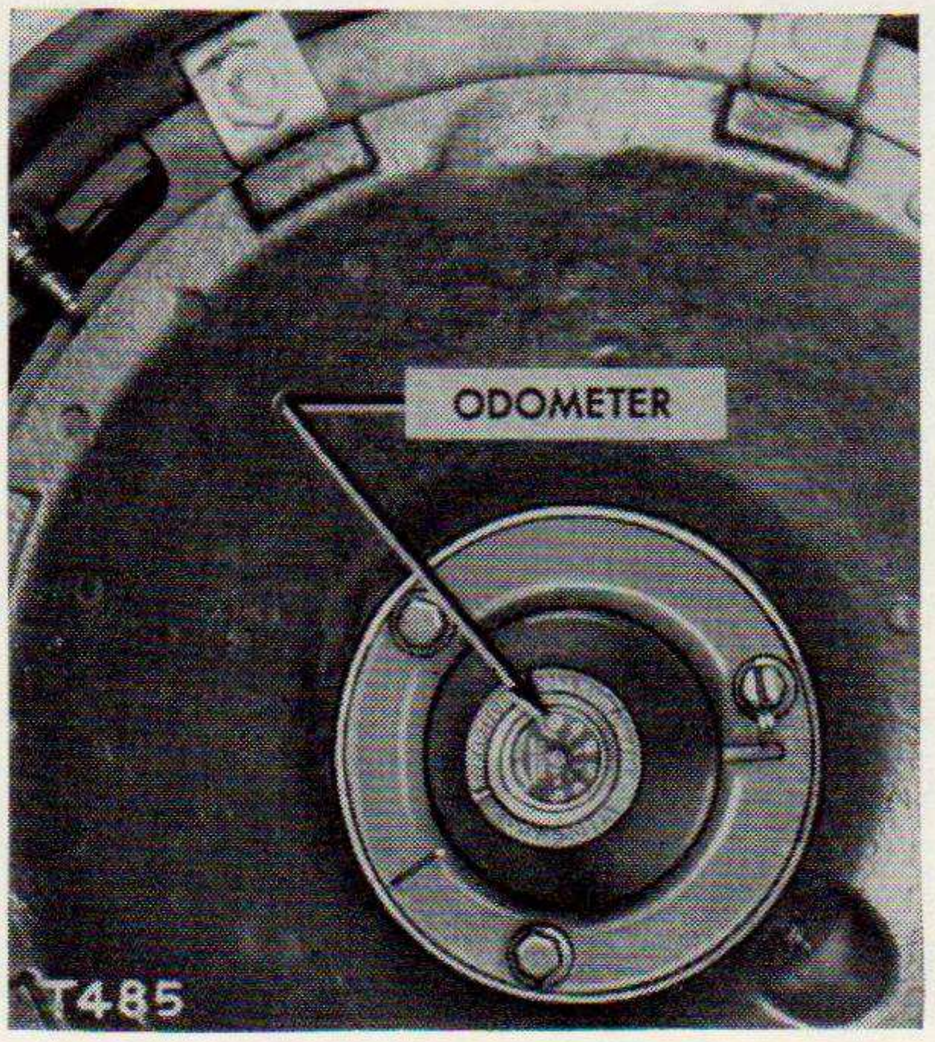

Figure 17. Odometer.

Section VII. OPERATION UNDER USUAL CONDITIONS

15. General Operation

a. SAFETY PRECAUTION. The complete observance of one simple rule would prevent many serious injuries. That rule is: Never attempt to clean, oil, or adjust a machine while it is in motion.

b. PREPARATION FOR STARTING. (See fig. 18.)

(1) *Check oil and water.* Check oil, water, and fuel and add if necessary in both the starting and Diesel engines.

(2) *Gear shift lever.* Place the gear shift lever in neutral. In the neutral position this lever can be moved sideways to the right or left.

(3) *Throttle control.* Lock the throttle in the extreme forward or "STOP" position.

(4) *Compression release lever.* Move the compression release lever to the "START" position.

(5) *Starting engine clutch.* Disengage the starting engine clutch.

c. STARTING THE STARTING ENGINE. (See fig. 18.)

(1) *Fuel tank valve.* Open the starting engine fuel tank valve. If the motor grader is equipped with hood side doors remove left door while starting.

(2) *Choke.* If the starting engine is cold pull the choke rod out in the choke "ON" position. If the engine is warm do not choke.

(3) *Throttle control rod.* Pull the throttle control rod out to the idling position.

(4) *Switch.* Turn the magneto switch "ON".

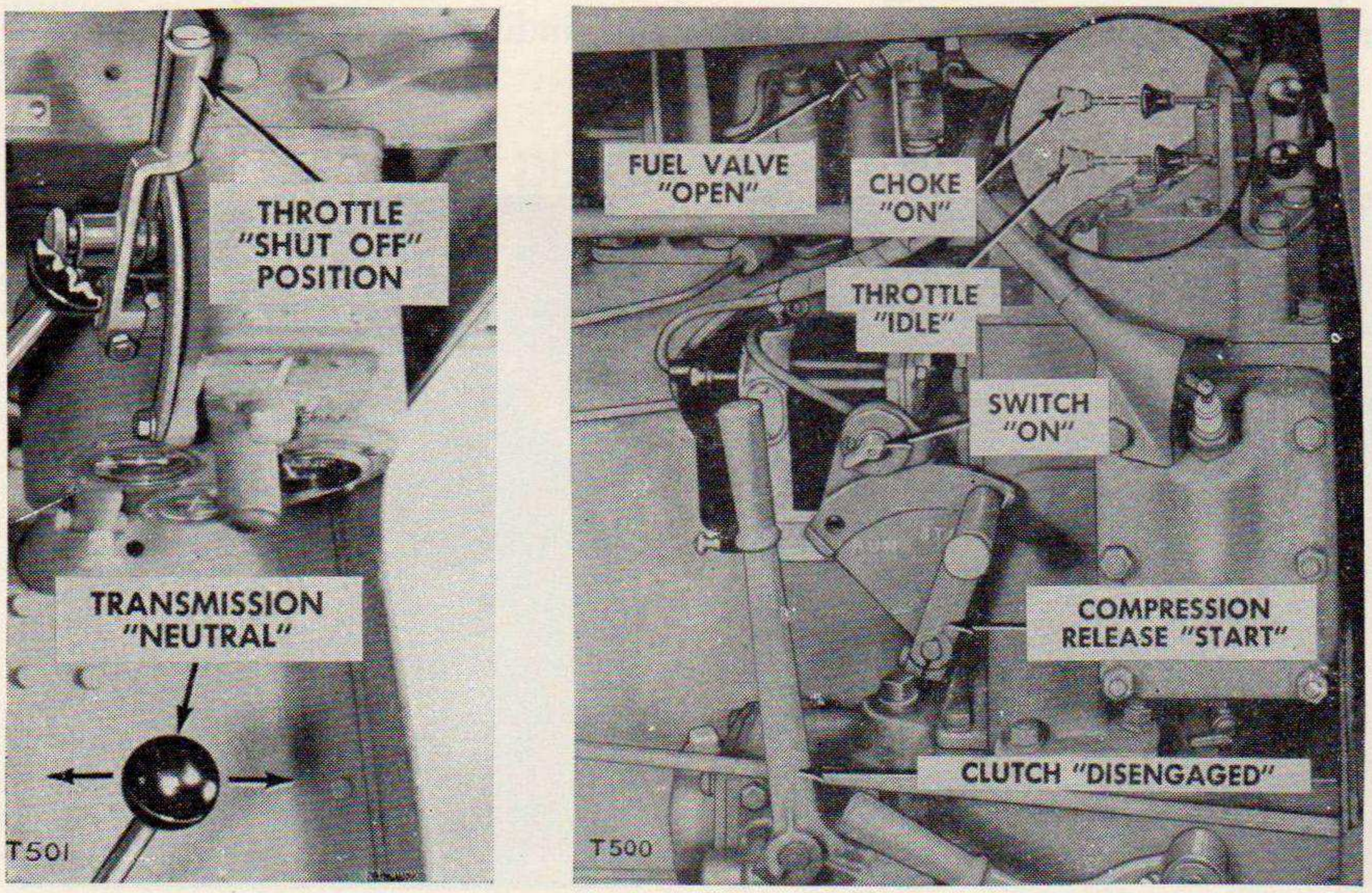

Figure 18. Controls in start position.

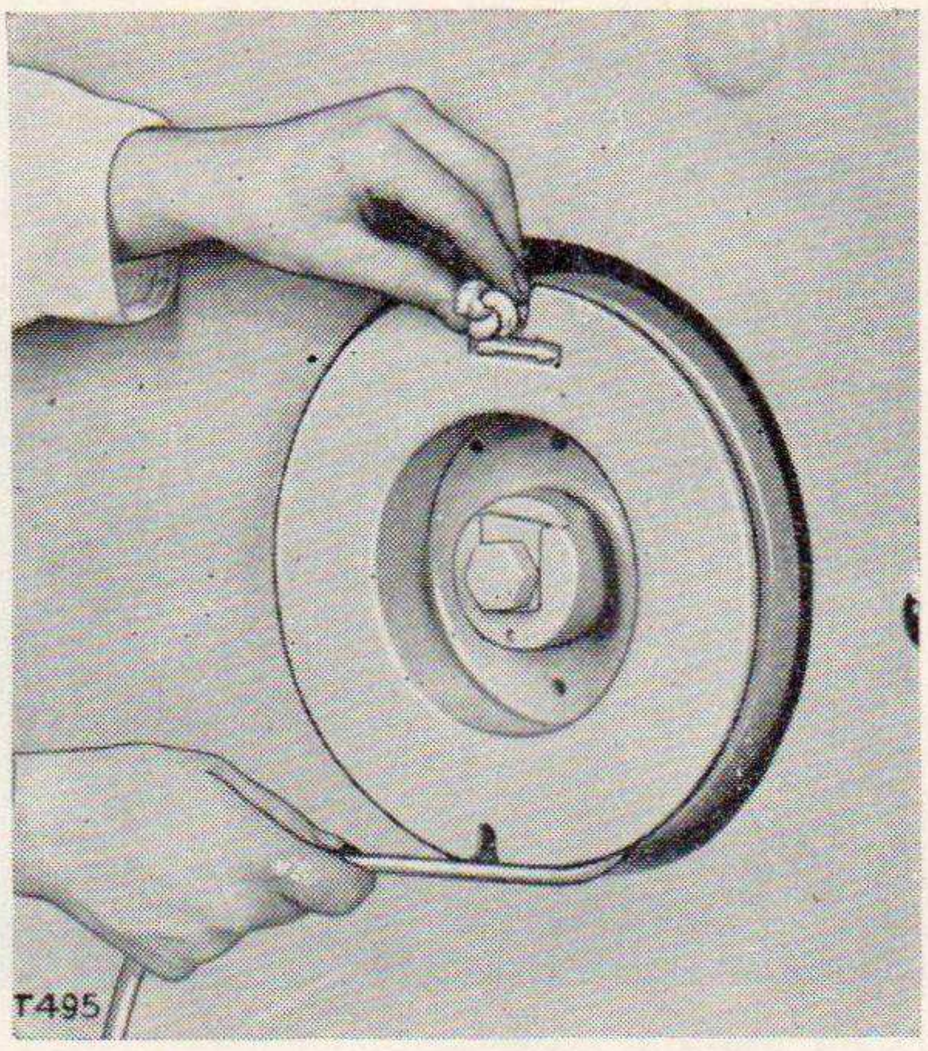

Figure 19. Cranking with a rope.

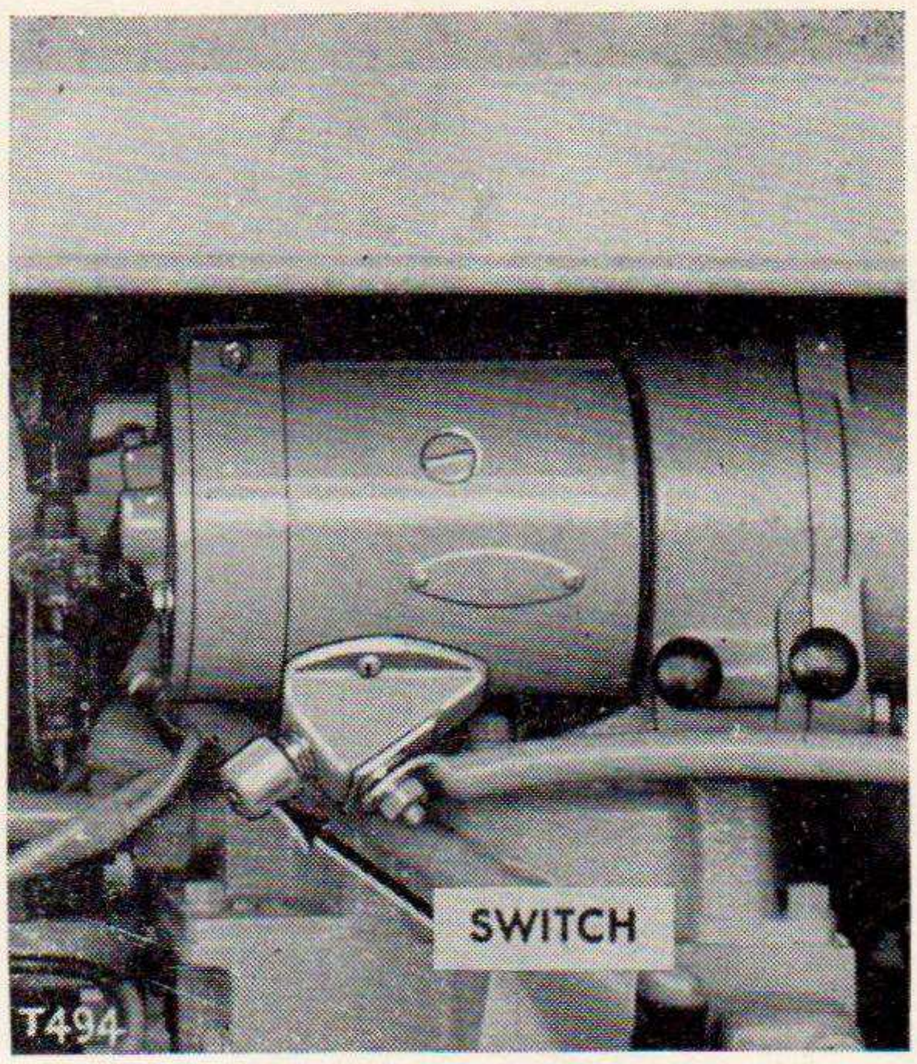

Figure 20. Electric starter (special attachment).

(5) *Crank.* (See fig. 19.) Place the knotted end of the starting rope in one of the two notches on the starting engine flywheel flange with the knot to the outside, and wind the rope around the groove in such a manner that when the rope is pulled the flywheel will turn in the direction indicated by the arrow on the flywheel. Grasp the starting rope handle with the right hand and spin the flywheel with a quick pull on the rope.

(6) *Trouble shooting.* If the engine will not start refer to the trouble shooting guide in paragraph 41.

(7) *After the starting engine starts.*

(a) Push the choke in to the "OFF" position.

(b) Permit the engine to warm up at idling speed before using it to start the Diesel engine.

(8) *Electric starter.* If the starting engine is equipped with an electric starter, place the starting engine controls in the same position as described above, then crank the engine with the electric starter by pressing on the electric starter switch. (See fig. 20.)

d. Starting the Diesel Engine.

(1) Engage the starter pinion. (See fig. 21.) Pull the starting engine clutch control lever back (toward the flywheel) to stop the pinion from rotating and prevent it from clashing with the Diesel engine flywheel ring gear. At the same time pull up on the starter pinion control lever as far as possible. This engages the starter pinion with the ring gear.

(2) Push in on the starting engine throttle control. This puts it in the high idle position and the starting engine will run at full governed speed.

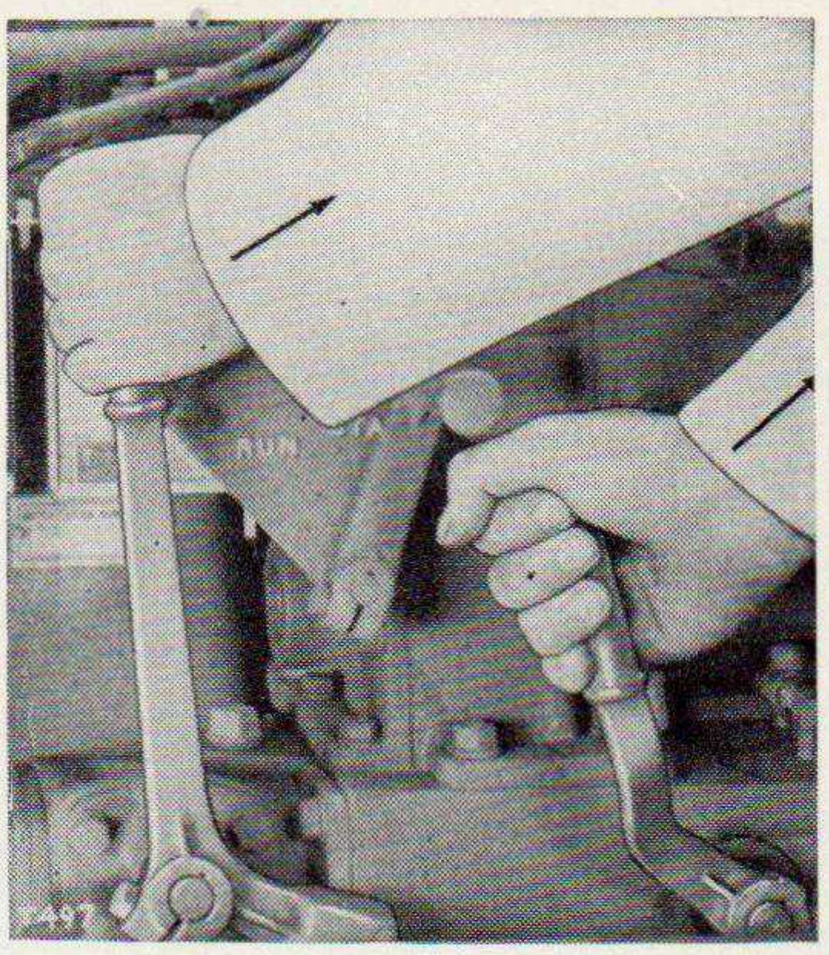

Figure 21. Engaging starter pinion.

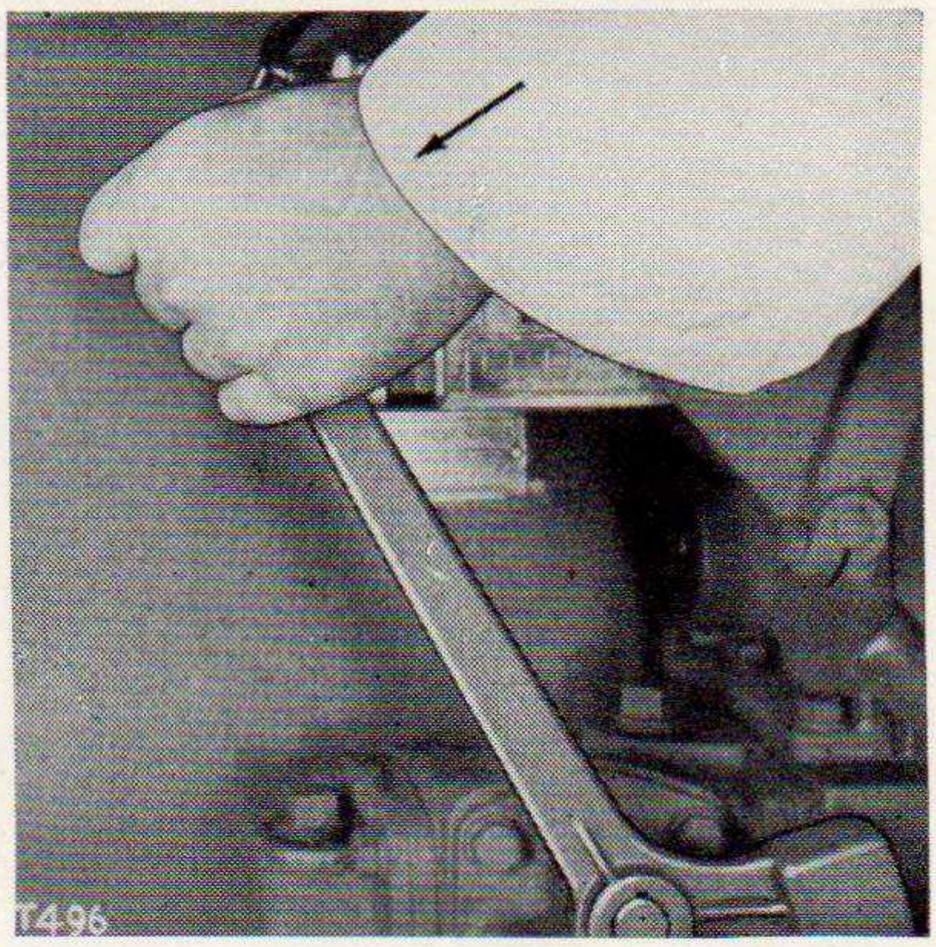

Figure 22. Engaging clutch.

(3) Engage the starting engine clutch. (See fig. 22.)

(4) Move the compression release lever to the "RUN" position as soon as the starting engine will turn the Diesel engine at normal cranking speed. (See fig. 23.)

(5) Allow the Diesel engine to warm up. When the starting engine is cranking the Diesel engine against compression (with the compression release in the "RUN" position) the heat of compression and the circulation of the starting engine exhaust gases around the Diesel engine inlet manifold warms the cylinders, pistons and combustion chambers to the temperature necessary for starting.

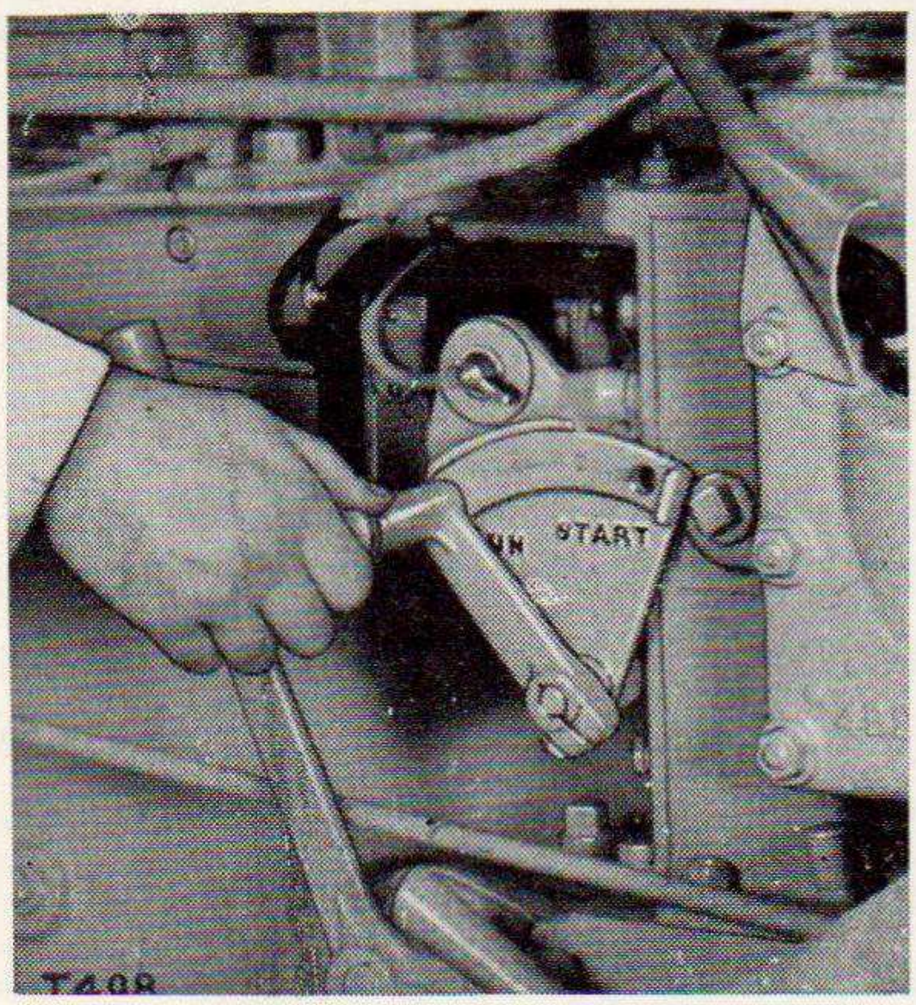

Figure 23. Compression release in 'run" position.

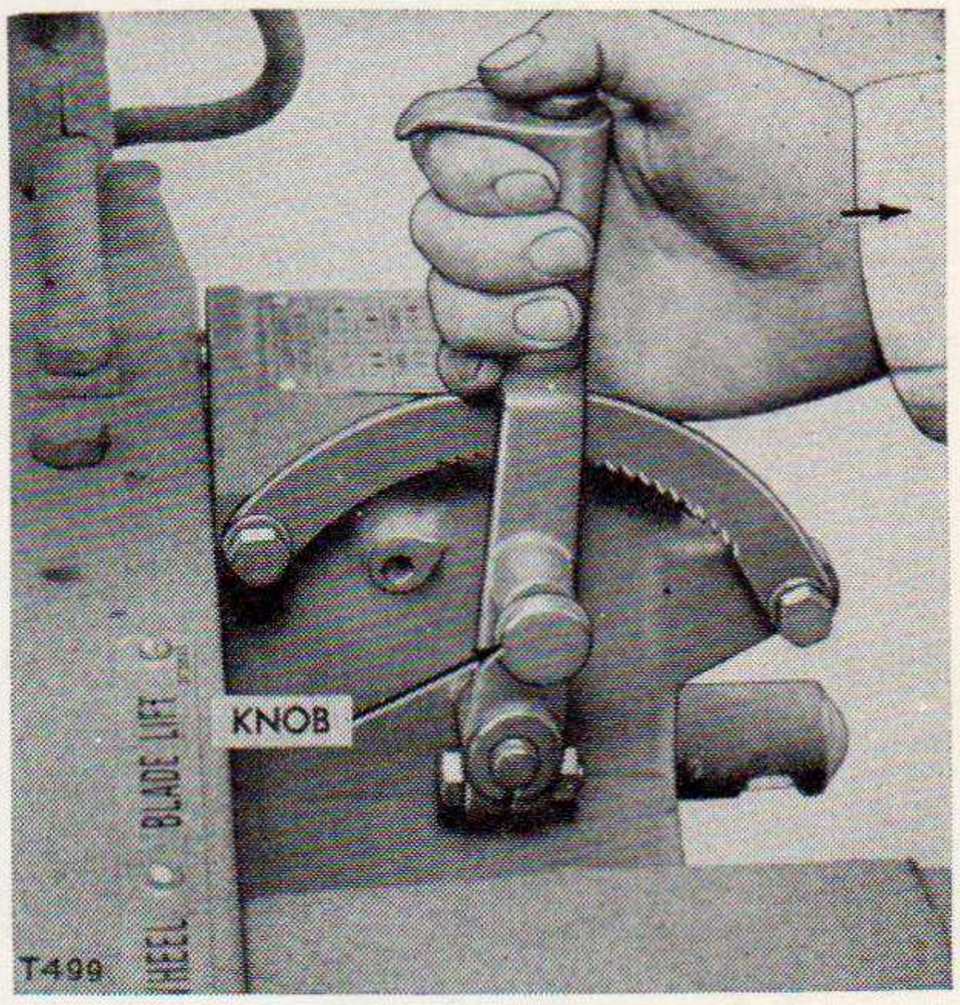

Figure 24. Pulling back the throttle to start the Diesel engine.

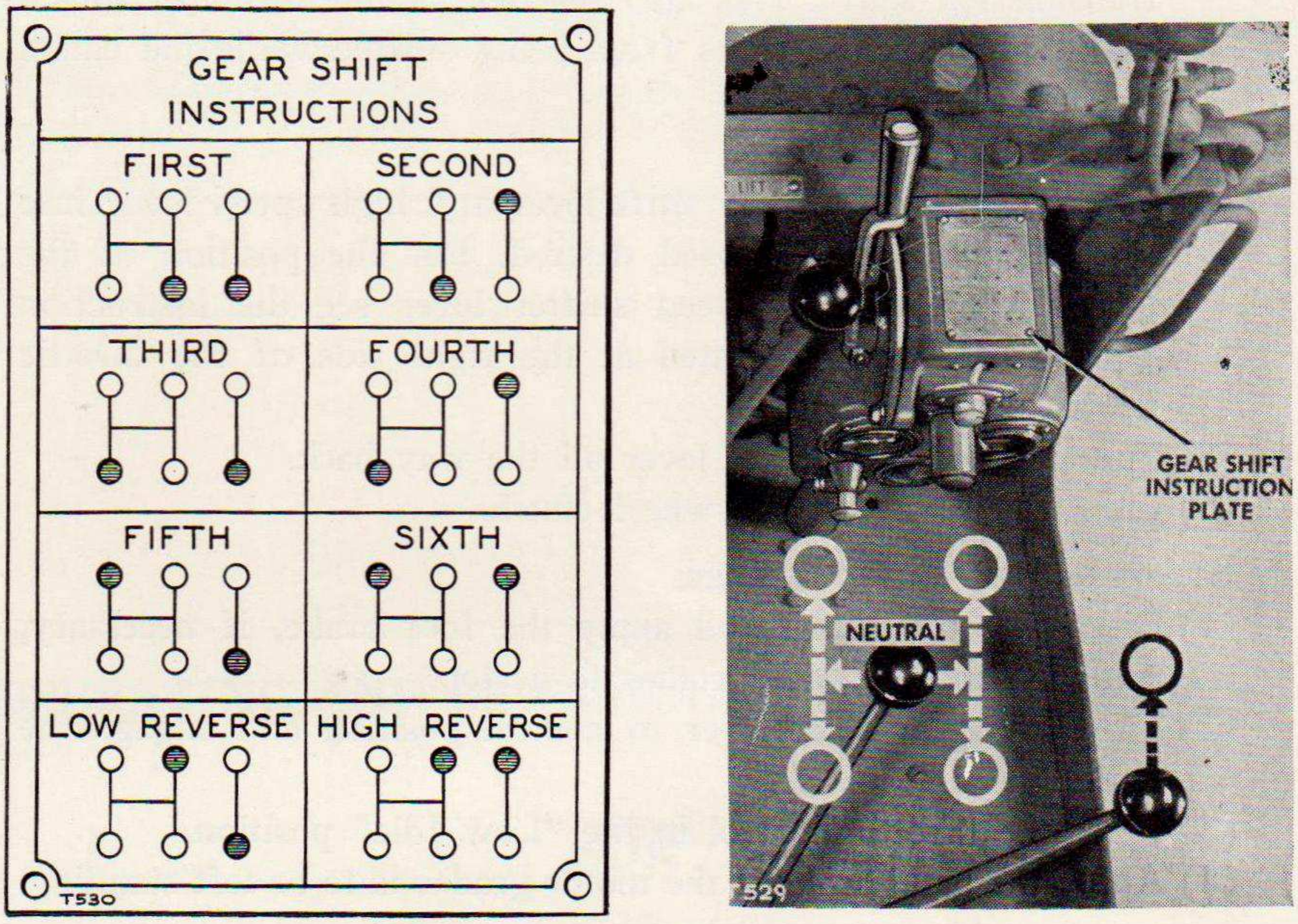

Figure 25. Gear shift lever positions.

(6) After the starting engine has cranked the Diesel engine against compression until it is sufficiently warm, and the lubricating oil pressure gage indicator is registering in the "Operating Range," unlock the throttle lever by pulling out on the knob and pull the throttle control lever back about half way. (See fig. 24.)

(7) If the engine does not start refer to the trouble shooting guide in paragraph 42. Cold weather starting directions are given in paragraph 25.

(8) When the Diesel begins to fire the starter pinion disengages automatically.

(9) Disengage the starting engine clutch.

(10) Pull the starting engine throttle control out to the idling position.

(11) Stop the starting engine by closing the valve under the starting engine fuel tank, allow the engine to burn all the fuel in the carburetor.

(12) Allow the Diesel engine to idle 5 minutes with the throttle at least half open and 5 minutes at full speed before applying the load.

e. DRIVING THE MOTOR GRADER.

(1) Move the throttle control lever to the idling position.

(2) Disengage the flywheel clutch. Press down on the clutch pedal to disengage the flywheel clutch and apply a brake to the upper

transmission shaft. This also releases an interlock mechanism which prevents the gears from being shifted while the clutch is engaged.

(3) Release the hand brake.

(4) Carefully move the gear shift lever and high speed lever into the position for the speed desired. For the position of the gear shift and high speed shifter lever see the instruction plate (see fig. 25) located at the right side of the throttle control lever.

(5) Pull the throttle control lever all the way back.

(6) Carefully engage the flywheel clutch.

f. STOPPING THE MOTOR GRADER.

(1) Disengage the clutch and apply the foot brake, if necessary, until the motor grader comes to a stop.

(2) Move the gear shift lever to neutral position and engage the clutch.

(3) Place the throttle control in the "Low Idle" position.

(4) Apply the hand brake if the motor grader is to be left standing.

g. STOPPING THE DIESEL ENGINE.

(1) After normal operation allow the engine to idle five minutes with the throttle half open before stopping the engine.

(2) Move the throttle control lever to the extreme forward "Shut Off" position and drop the plunger into the hole on the throttle control bracket.

(3) Place compression release lever in "START" position.

(4) If machine is to be left exposed to the weather cover the exhaust pipes to exclude rain or snow.

h. OPERATING THE POWER CONTROLS. (See fig. 26.)

(1) *General.* The power controls are driven directly by the engine independent of the flywheel clutch. The control levers must be held in engagement by the operator.

(2) *Shear pin.* On late motor graders the power control shaft drive is equipped with a shear pin. This shear pin has sufficient strength to withstand normal expected operation but will shear when abnormal shock occurs, thus preventing damage to the controls. To install a new pin, stop the engine, raise the cover in the housing, rotate the shaft until the pin hole in the shaft flange is accessible, remove the broken pin, and drop a new pin in place.

Caution: The control levers should be released immediately when the limit of travel is reached to prevent shearing the pin.

(3) *Blade lift control.* The blade lift control levers can either be operated independent of one another or they can be operated together. Push the control lever forward to lower the end of

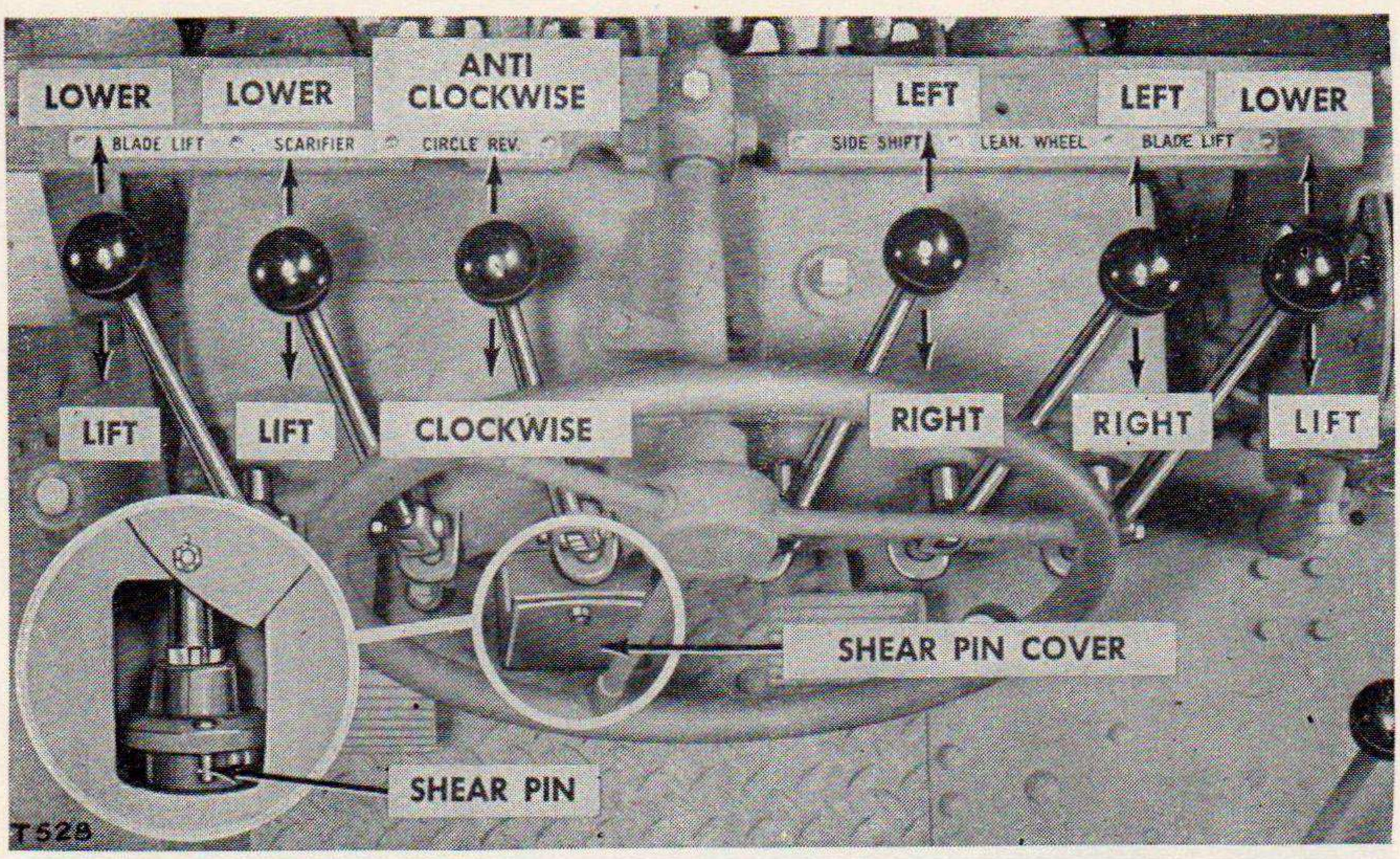

Figure 26. Power control levers.

the blade. Pull back to raise the blade. The control lever will automatically return to the hold position.

(4) *Sideshift control.* The sideshift enables the operator to shift the circle and the blade sideways for different operating conditions. Push the control lever forward to shift the circle to the left. Pull back the control lever to shift the circle to the right. The control lever will automatically return to the hold position.

(5) *Circle reverse control.* The circle reverse enables the operator to rotate the circle and blade to any desired angle. The circle can be rotated a full 360°. Pull the control lever back to rotate the circle clockwise. Push the control lever forward to rotate the circle counterclockwise. The control lever will automatically return to the hold position. Grading and maintaining may be accomplished in reverse gears by reversing the blade. On machines equipped with a scarifier the scarifier teeth must be removed. To reverse the blade lower it to within a few inches of the ground with the circle level and centered with the frame. It is important that the circle be centered with the frame to avoid striking and damaging the tires with the end of the blade. In this position the blade can be rotated either clockwise or counterclockwise to any desired angle.

(6) *Front wheel lean control.* The front wheel lean mechanism enables the operator to lean the wheels to brace them against the sidedraft set up by the machine operating with the blade at an angle. This also aids in making short turns.

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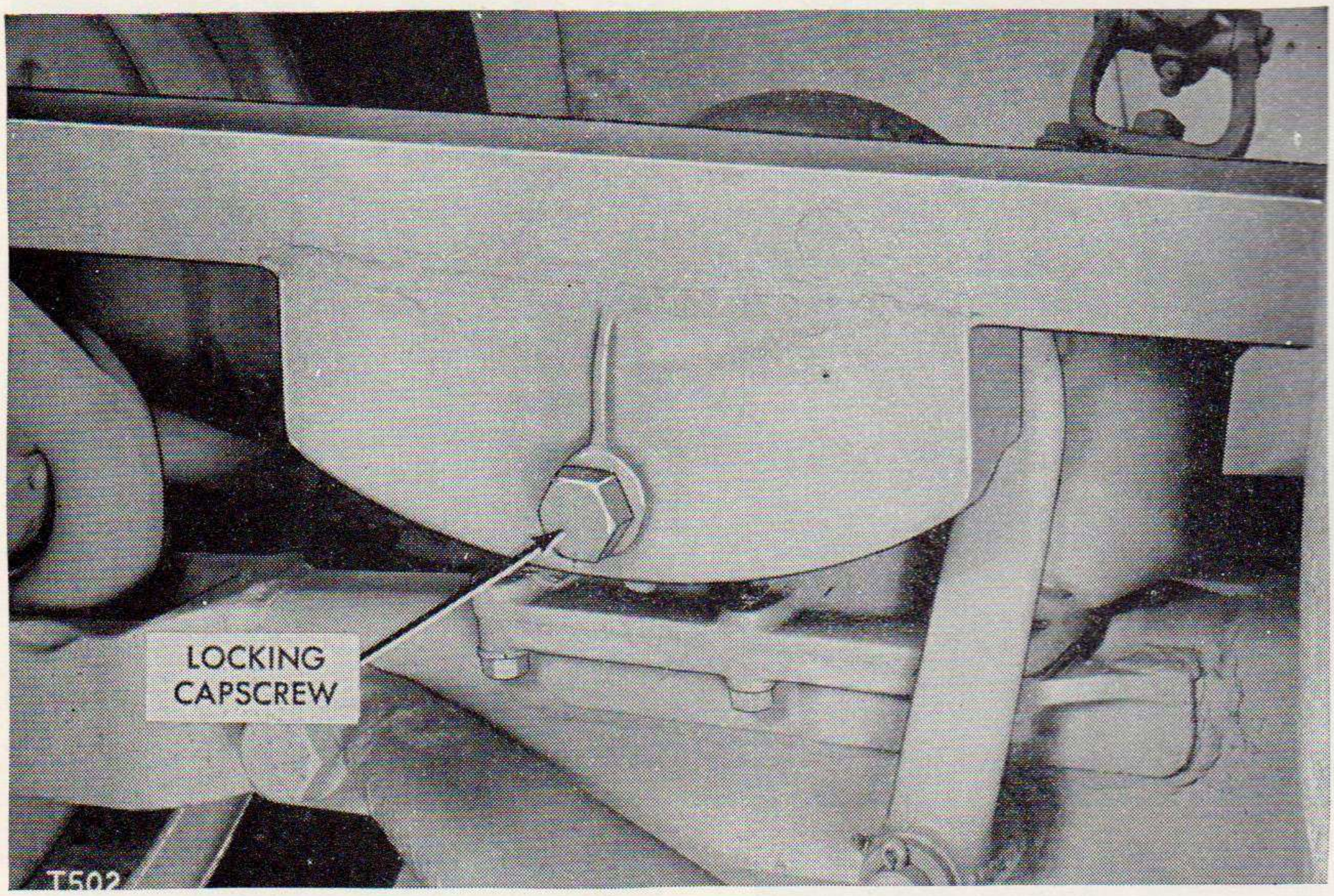

Figure 27. Front wheel tie bar locking capscrew.

Caution: Always remove the locking capscrew before operating the front wheel lean control lever. (See fig. 27.) The capscrew is provided to lock the front wheel tie bar to the front wheel lean control housing; thus keeping the front wheels in a vertical position. Unless there is considerable side draft, the front wheels should be operated in a vertical position to get the most service from the tires.

Pull the control lever back to lean the wheels to the right. Push the control lever forward to lean the wheels to the left. The control lever will automatically return to the "hold" position. The wheels should be leaned so that the machine is held against the load and in turning the wheels should be leaned to the side in which the turn is to be made.

(7) *Scarifier control lever.* The scarifier control lever enables the operator to raise and lower the scarifier. Pull the control lever back to raise the scarifier. Push the control lever forward to lower the scarifier. The control lever will automatically return to the "hold" position. When the motor grader is equipped with a snow plow the scarifier control lever is used to operate it also.

(8) *Power control speed change.* A power control speed change on motor graders before 9K2911 enables the operator to shift the power control in high speed for fast control operation or to shift the power control in low speed for finer control for finishing work. The forward position gives a high speed, the

rear position a low speed. The lock pin must be in the lock pin hole before the controls are put into operation. The speed change lever on these motor graders is located on the steering wheel support post.

16. Manual Adjustments of Blade, Lift and Center Shift Links

a. General. All normal work including ordinary back sloping can be done without making any manual blade adjustments. However, some types of work make manual blade adjustments necessary.

b. Blade Shift.

(1) *General.* In ordinary operation the blade should be mounted in center position of the blade beams. To obtain more extreme blade positions for greater reach on banks or shoulders the blade may be shifted to the right or left on the blade beams.

(2) *To offset the blade on motor graders after 9K2911.*

(a) Clean dirt from slide rails and from around the tiltable blade supporting brackets, using the opposite end of the wrench No. 7B8975.

(b) Turn the cam using wrench No. 7B8975 to release the plungers in each of the tiltable supporting brackets. (See fig. 28.)

(c) Place the end of the blade in the ground behind the front wheel; have the other end of the blade slightly elevated.

(d) Drive the machine forward with the front wheels leaned and steered in such a manner that the line of travel parallels that of the blade. (See fig. 29.)

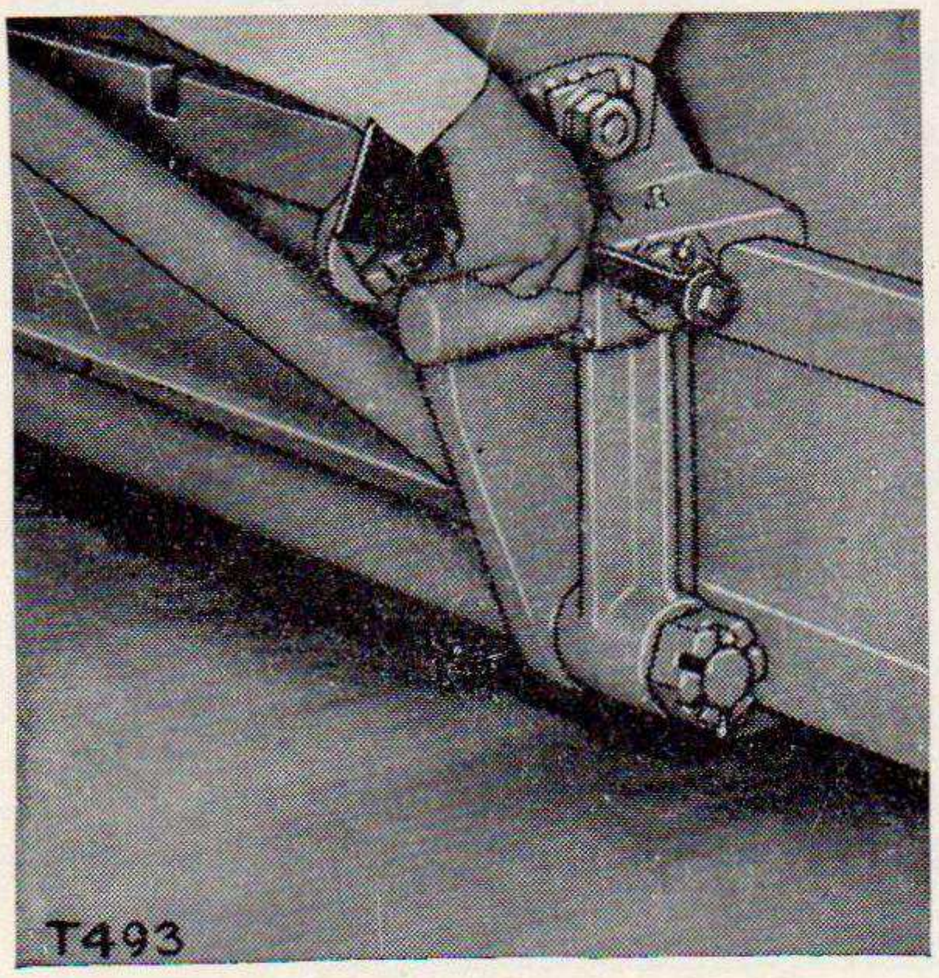

Figure 28. Turning cam to release plungers.

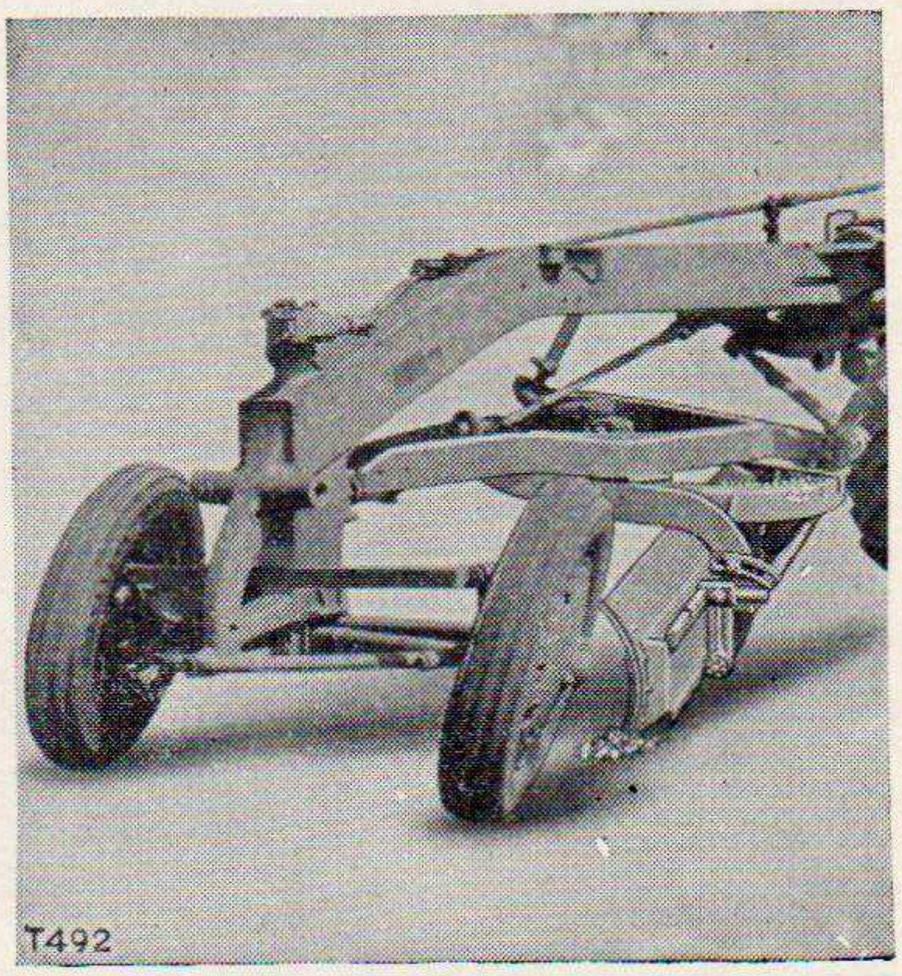

Figure 29. Shifting blade by driving forward.

(e) Turn the cam so the plungers will automatically engage in the desired notches. The cam should be turned to release the plungers as soon as the blade has slid past the last notches before the ones desired. The plungers will automatically engage into the notches as the blade is slid into position.

(3) *To offset the blade on motor graders before 9K2911.*

(a) Shift the blade to the extreme right or left as desired and lower it to the ground.

(b) Place blocks under the reinforcement angle to hold the blade upright.

(c) Remove the pins from the blade beams and tilting straps.

(d) With the power controls, raise the blade beams clear of the blade and shift the circle so the beams may be lowered into the desired set of brackets.

(e) Lower the beams into place and replace the pins in the blade beams and tilting straps.

c. BLADE PITCH.

(1) *General.* For more efficient operation the blade pitch must be different for cutting and dragging. For cutting, tilt the blade back until the top and bottom blade edges are on a line approximately perpendicular to the ground. (See fig. 30.) For dragging tilt the blade forward until the cutting edge is approximately perpendicular with the ground. (See fig. 31.)

(2) *Blade tilting procedure.*

(a) Loosen the bolts through the blade beams and the tilting straps.

(b) Lower blade until the cutting edge rests on the ground.

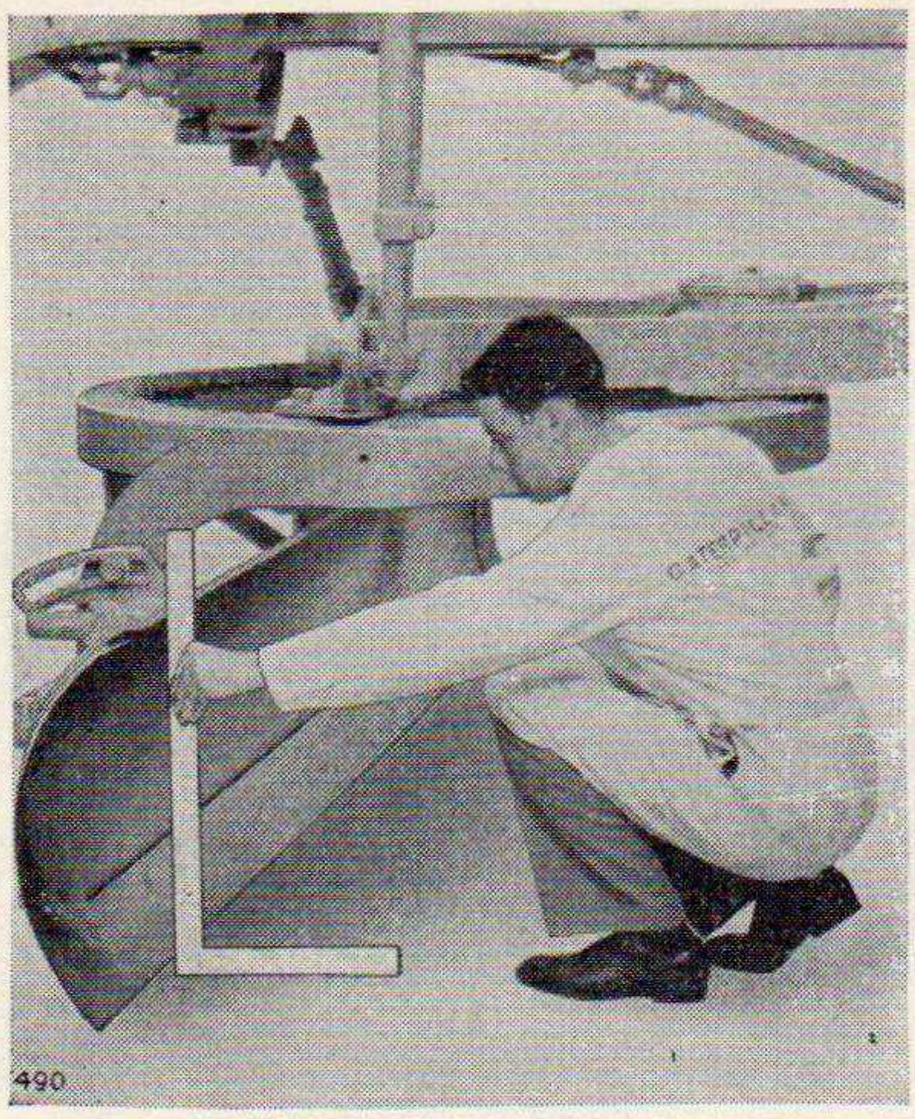

Figure 30. Blade pitch for cutting.

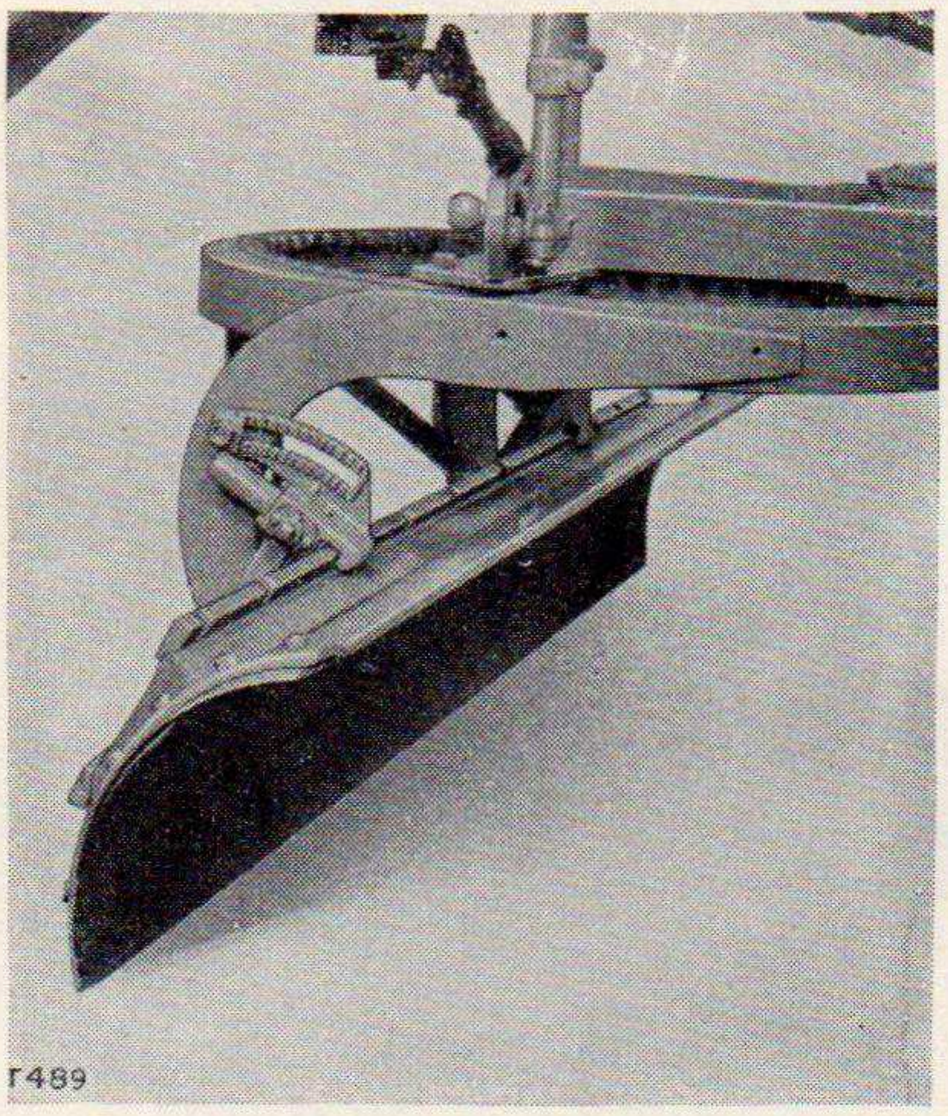

Figure 31. Blade pitch for dragging.

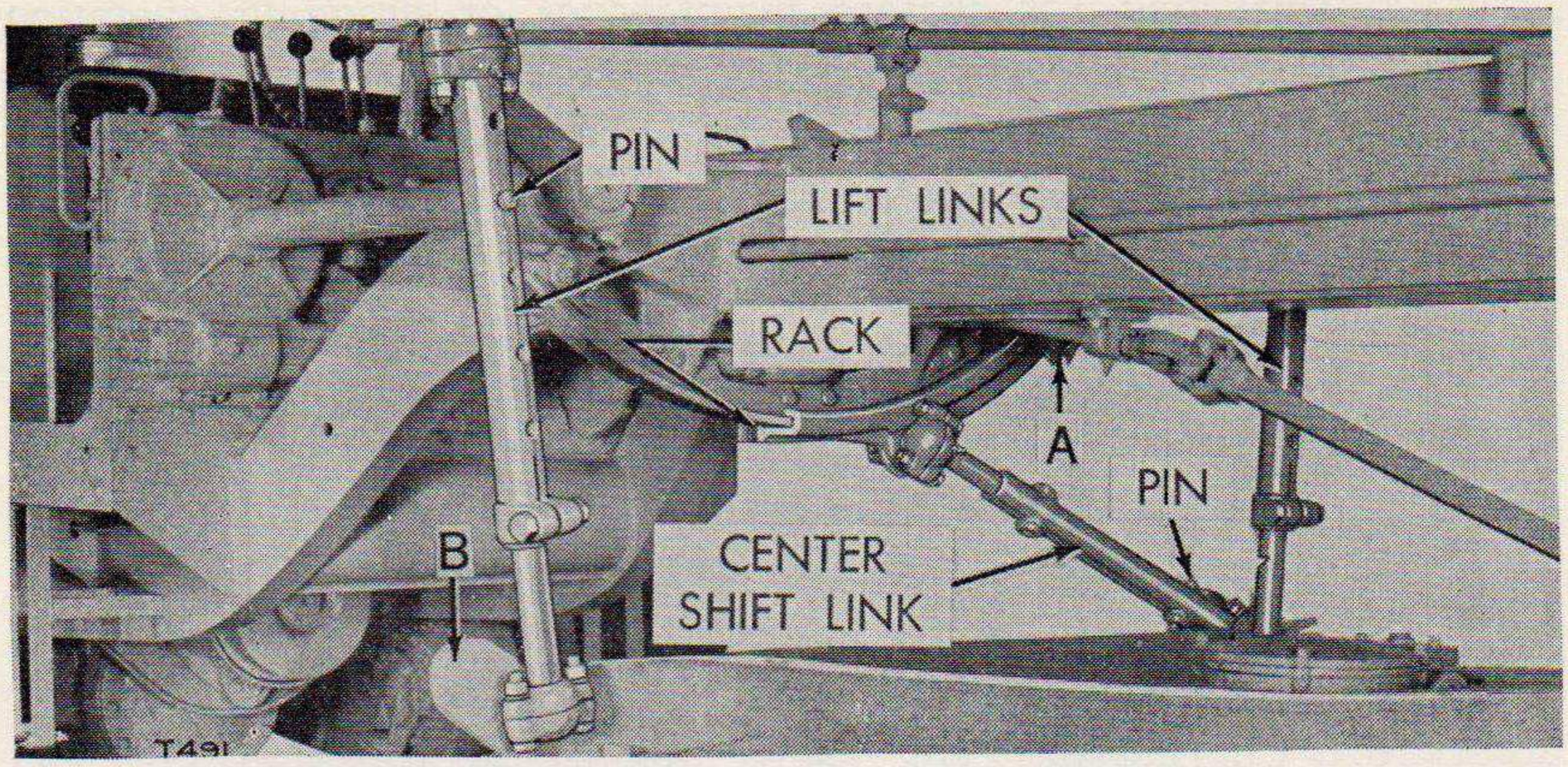

Figure 32. Blade lift and side shift link setting.

(c) Move the motor grader forward to tilt the blade forward to dragging position or backward to tilt the blade back to cutting position.

(d) Tighten the bolts through blade beams and tilting straps.

d. Lift and Center Shift Links Setting. (See fig. 32.)

(1) *Lift links.*

(a) *General.* The lift links for normal operation are set with both links extended one hole from the top. For more extreme bank cuts, it is necessary to extend further the left lift link. For lower slopes and wide side reach the right lift link must also be extended.

(b) *Lift link setting.*

1. Lower the blade until it rests on the ground.

2. Remove cotter pin and pin from the lift link to be set.

3. Raise or lower the blade lift arm with the power control until the desired holes line up in the lift link.

4. Replace pin and cotter pin.

(2) *Center shift links.*

(a) *General.* The center shift link should always be attached to the center shift gear rack on the opposite side from which it is attached to the circle drawbar. The center shift link is connected to the center shift gear rack on the right side and to the circle drawbar on the left for normal operation. For left bank work these connections should be changed on both the circle and the rack. The center shift link has three length adjustments. The intermediate position for normal operation, the shortest position to aid in bank cutting and greater side reach and the longest position for greater side shift to the left. It is also advisable to extend the center

shift link for surface maintenance or dragging operation as this gives greater rigidity to the blade.

(b) *Shifting center shift link for left bank cuts.* (See fig. 32.)

1. Lower blade until it rests on the ground.
2. Clean the ball stud (B) to which center shift link is to be connected.
3. Remove cap from end of link on circle.
4. Remove ball stud with link attached from gear rack and place it in hole (A) on other side of rack.
5. Shift center shift with power control until center shift is in position to connect the link to the opposite ball stud (B).
6. Connect the center shift link to the ball stud (B) and replace the cap.

(c) *Making center shift link length adjustment.* (See fig. 32.)

1. Lower blade until it rests on the ground.
2. Remove cotter pin and remove the pin from center shift link.
3. Shift the center shift with power controls until the desired holes line up in the center shift link.
4. Replace pin and cotter pin.

Section VIII. SPECIFIC OPERATION

17. General

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

b. It is essential that the operator knows how to get every useful blade position and when to use each position. Nearly every job presents a different problem, therefore the procedure must be varied to fit each individual job. In the following outline of grading a road an attempt is made to help the operator in obtaining the desired positions.

Note. All references to right and left hand blade settings or operations, forward or reverse, are intended to mean right hand or left hand, when looking from the operator's platform toward the front end of the machine where steerable wheels are located.

18. General Instructions

a. TURNING THE MOTOR GRADER AROUND. (See fig. 33.) The motor grader should be turned around by backing across the ditch, keeping the front wheels on the road, rather than by driving the front wheels across the ditch. The traction and crawling action of the oscillating

Figure 33. Turning the motor grader around.

tandem drive enables the rear end of the machine to cross ditches readily and the front wheels are left on the road surface where they are easily steered. Leaning the front wheels aids in turning if leaned in the proper direction. When turning the motor grader around, lean the front wheels all the way over in the direction turn is being made, and leave them in this same position for both forward and reverse movements until turn is completed.

b. Working Speeds.

(1) Ordinary ditching and scarifying is usually done in the second speed. First speed is used for exceptionally heavy or slow speed finishing work. Higher speeds are used to cast windrows and surface maintenance.

(2) "Bouncing" of motor graders on surface maintenance is usually due to too high speed for the condition of the surface being worked. If surfaces are kept smooth by frequent maintenance, higher speeds can be used, but rough, pitted or corrugated surfaces must be worked at a slower speed for satisfactory results.

c. Controlling Side Draft.

(1) Side draft is controlled by properly setting the blade to keep the load as well balanced as possible. A little more pressure on the heel of the blade will correct any tendency for the front of the machine motor grader to skid away from the load.

(2) On heavy maintenance work, the circle should be side shifted to bring the forward end of the blade toward the motor grader to better balance the load.

19. Grading a Road

a. General. The grading job outlined in the following paragraph is the recommended procedure to follow to cut new ditches, slope the banks, and finish the road bed.

b. Blade Setting. All of the blade positions unless otherwise stated in this outline are with the blade tilted for cutting and in the center position on the blade beams. Both of the blade lift links are extended one hole from the top and the center shift is in the intermediate position. (See par. 16.)

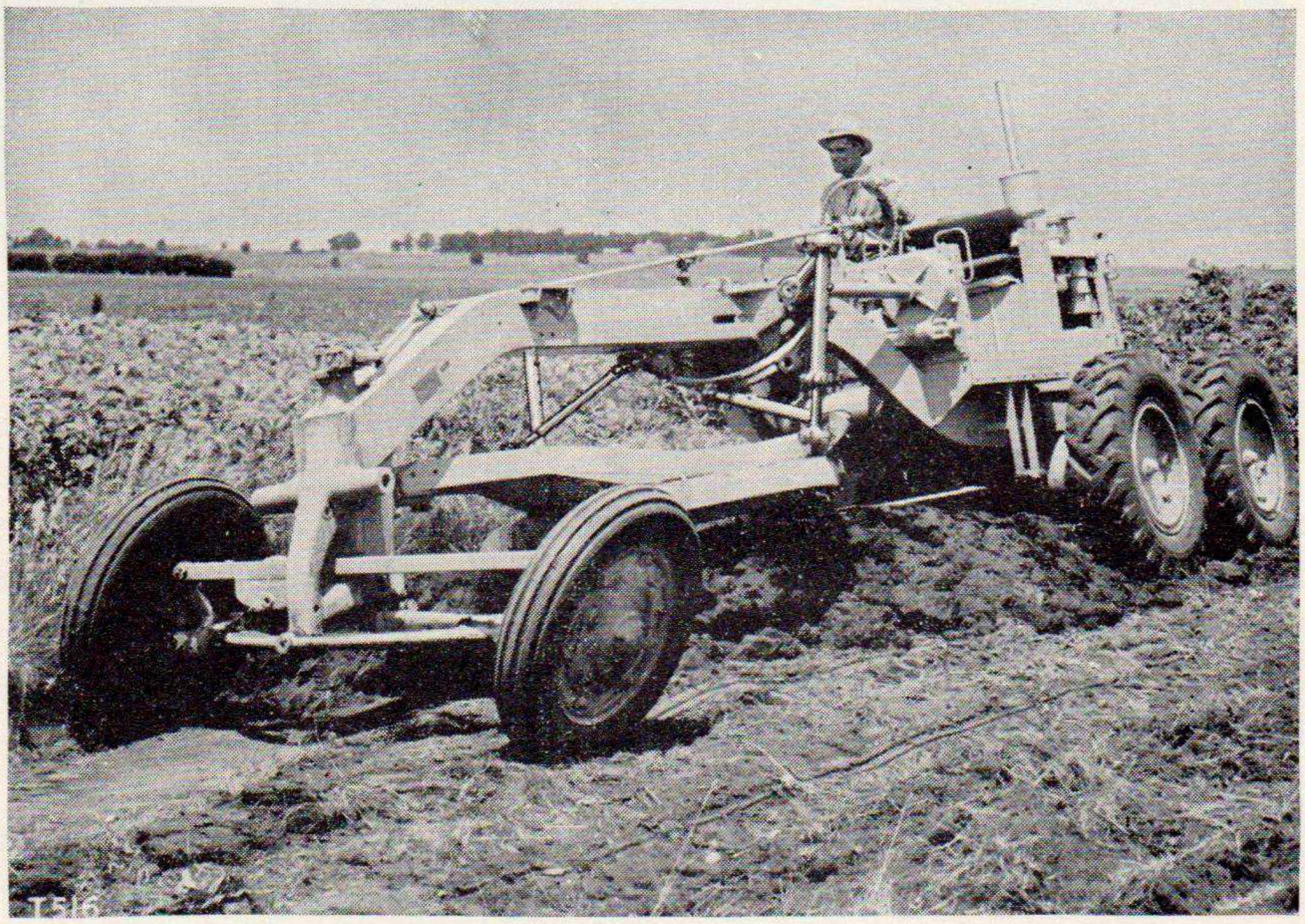

Figure 34. Starting the ditch.

c. Starting the Ditch. (See fig. 34.)

(1) To obtain right hand ditching position do the following:

(a) Operate the side shift to almost extreme left.

(b) Rotate the circle until point of blade is directly behind the right front wheel.

(c) Raise the left blade lift crank to the high position.

(d) Lower the right blade lift crank to set the point of the blade for the desired depth of cut.

(e) Lean the front wheels sufficiently to the left to counteract the side draft of the blade.

(2) Make one cut with the blade in this position, cutting just deep enough to mark out the ditch line. If both sides of the road are to be worked, make one complete round in this manner.

(3) Make the second cut with the blade in the same position except that the point of the blade is lowered for a deeper cut. A heavier ditch cut can be made after the first, as the front wheels are held in line by the ditch bank.

(4) Make the third cut. Normally three ditch cuts are made before it is necessary to remove the windrow from the shoulder line.

d. Moving the Windrow. (See fig. 35.)

(1) Change the blade from right hand ditching to a side reach position. The windrow should be moved on the right hand side because, with normal setting, the blade reach to the right is greater than to the left.

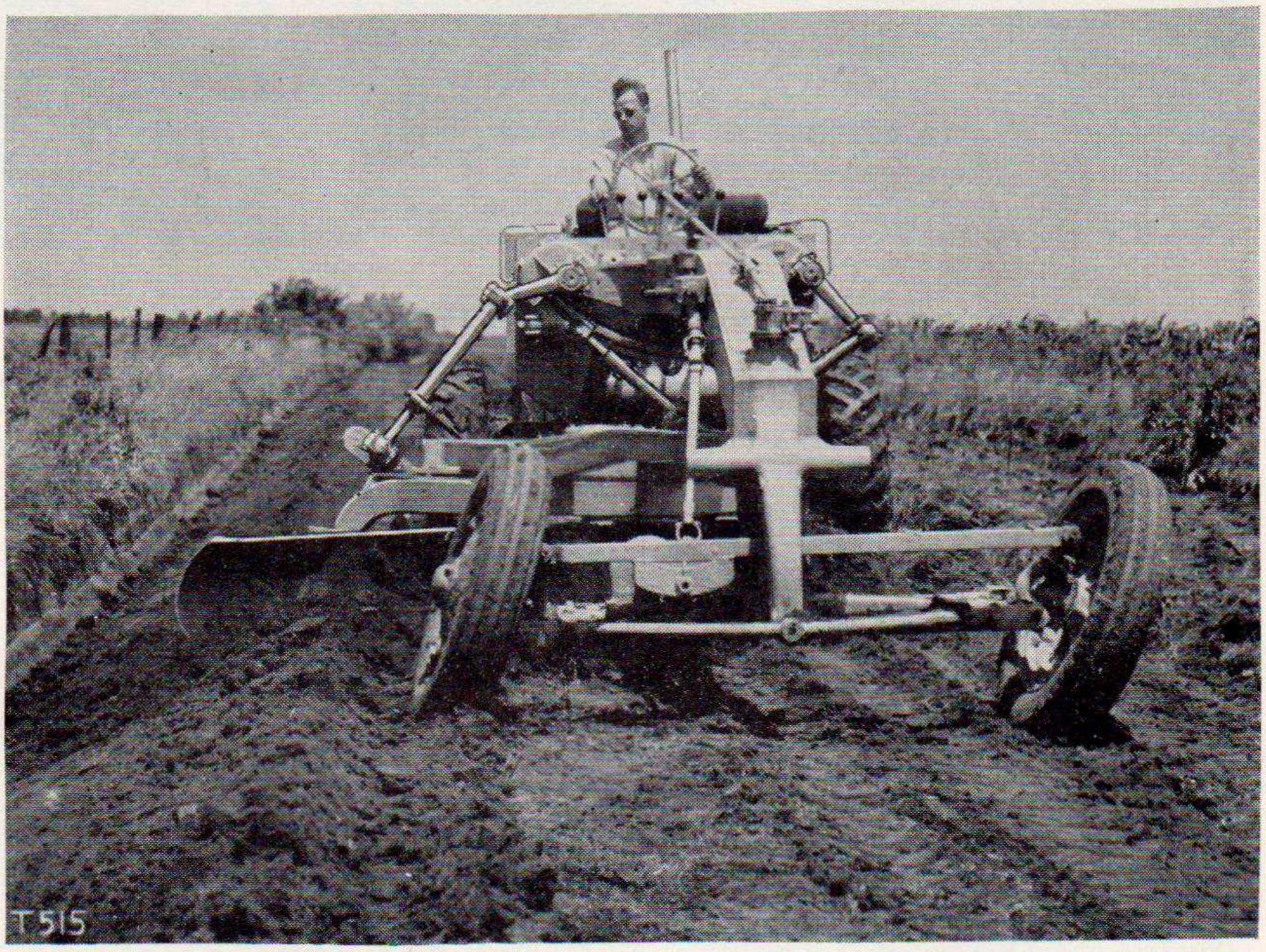

Figure 35. Moving the windrow.

(a) Set the right and left blade lift cranks so that the blade is horizontal and clears the ground.

(b) Rotate the circle until the point of the blade is approximately two feet back of the right front wheel.

(c) Operate the center shift to the right until the right end of the rack is visible above the blade lift shaft.

(d) Lower the right and left blade lift cranks until the blade is horizontal and rests on the ground.

(e) The front wheels are left leaning to the left.

(2) Make one trip with the blade in this position. Keep the front wheels to the left of the windrow and reach out with the blade.

Figure 36. Ditching in reverse.

e. CUTTING THE DITCH TO THE DESIRED DEPTH.

(1) Make as many ditch cuts as are necessary to obtain the desired depth.

(2) The windrow will have to be moved after every ditch cut as the ditch is deeper and a heavier ditch cut can be made.

(3) Distribute the windrows over the entire road bed.

f. DITCHING IN REVERSE. (See fig. 36.)

(1) *General.* Ditching in reverse can be accomplished after the second or third ditch cuts are made. This saves time when only one side of the road is to be worked, in that the machine does not have to be turned around at each end. On machines equipped with a scarifier, the scarifier teeth must be removed before the circle can be rotated 360°.

(2) *The blade position for reverse ditching.*

(a) Center shift to almost the extreme left.

(b) Blade rotated until the end is on a line with the outer edge of the right rear wheels.

(c) Left blade lift crank in the high position.

(d) Right blade lift crank lowered to set the point of the blade to the desired cutting depth.

(e) Front wheels leaned to the left.

g. SLOPING THE BANK. (See fig. 37.)

(1) *General.* After the ditch is to the desired depth and the windrows are distributed over the road bed, the bank must be sloped. This not only adds to the appearance of the road but also prevents the bank from crumbling and filling the ditch. For ordinary bank sloping the blade remains in the center

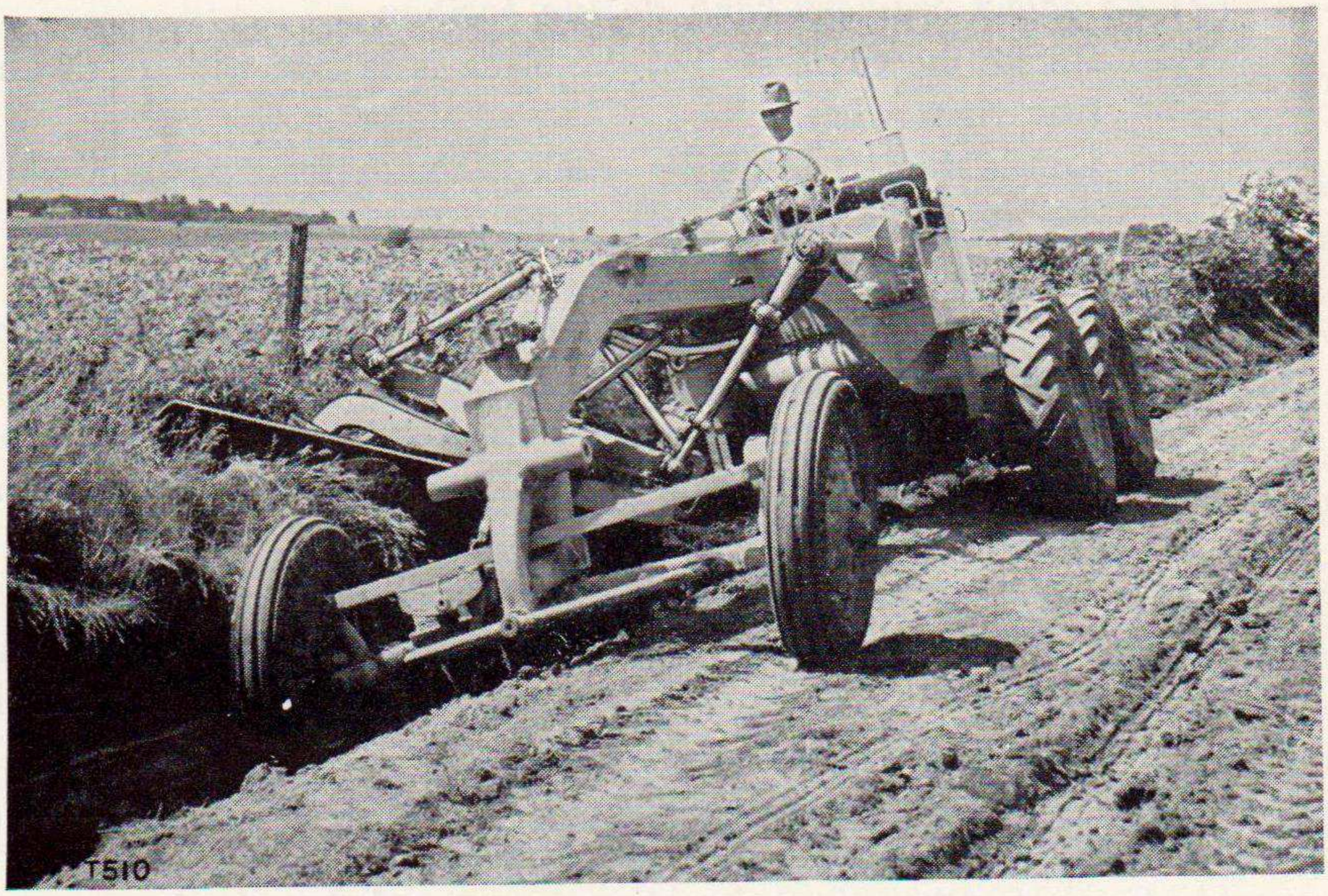

Figure 37. The first bank cut.

position on the blade beams and the blade lift links remain extended one hole from the top. However, in some cases the blade must be shifted on the blade beams, and the blade lift links must be either lengthened or shortened.

Figure 38. Removing dirt brought into ditch by bank sloping.

(2) *To obtain ordinary bank sloping position.*

(a) Rotate the circle so that the blade is in line with front and rear right wheels.

(b) Lower the left blade lift crank to the extreme position while operating the center shift to the extreme right.

(c) Raise the right blade lift crank.

(d) Rotate the circle so that the heel of the blade will travel in the bottom of the ditch.

(e) Lower or raise the right blade crank to fit the bank to be cut.

(f) Lean the front wheels to the left as required to hold machine against the load.

(g) Make one cut with the blade in this position.

(3) *Remove dirt.* Remove the dirt brought into the ditch by bank sloping. (See fig. 38.) The position of the blade for this is the same as for ditch cutting.

(4) *Finish slope.* Finish the slope by repeating this procedure.

h. CUTTING THE INSIDE SLOPE. (See fig. 39.)

(1) *General.* After the bank slope is cut and the dirt is removed from the ditch, next establish the inside slope. Inside slopes are usually long enough that they must be cut left handed, because with normal setting the circle and blade can be side shifted farther to the right than to the left.

Figure 39. Cutting the inside slope.

(2) *Obtaining blade position for left hand cut on inside slope.*

(a) Rotate the circle until the point of the blade is behind the left front wheel.

(b) Operate the center shift to the right until the blade is in position to cut desired length inside slope, keeping the point behind the left front wheel.

(c) Set the heel of the blade to carry dirt over the shoulder.

(d) Lean the front wheels to the right until they are in a vertical position when the motor grader is in the ditch.

(3) *Make one cut.* Make one cut with the blade in this position. Care should be taken not to lower the grade of the ditch.

(4) *Remove windrow.* Remove the windrow from the shoulder line.

(5) *Finish slope.* Finish the inside slope by repeating this procedure.

MAKING A FLAT BOTTOM DITCH.

(1) *General.* In some localities flat bottom ditches are desirable to provide greater drainage capacity. If a flat bottom ditch is to be made, and the preceding operations are completed the work should continue as follows, in advance of finishing operations. The first step in preparing the ditch for a flat bottom is to make a trenching cut on the inside slope approximately the same distance from the ditch line, as the desired width of the flat bottom. (See fig. 40.) In order to have enough side shift

Figure 40. Cutting a trench on the inside slope is the first step in making a flat bottom ditch.

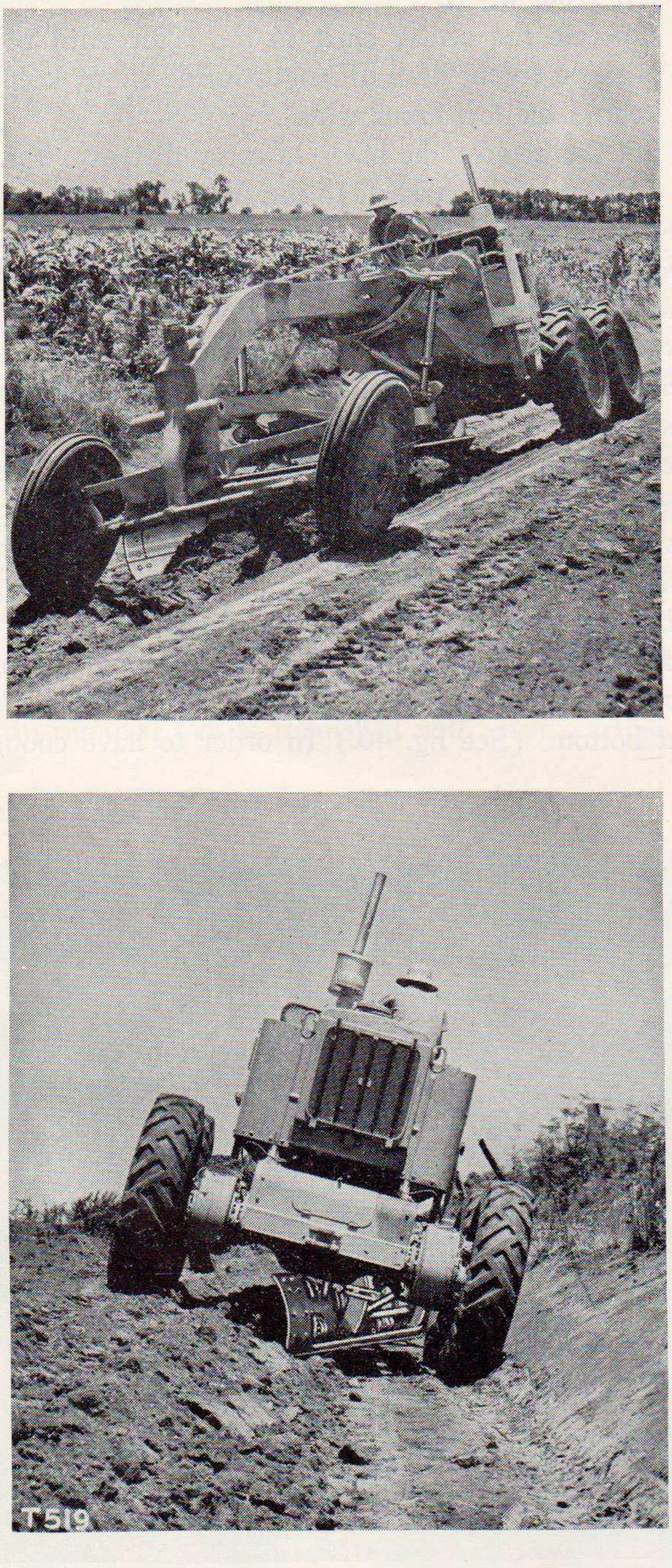

Figure 41. Cutting the flat bottom.

to get the proper blade position for this trenching cut, it should be made left handed.

(2) *To obtain blade position for trenching cut.*

(a) Set the right and left blade lift cranks so that the blade clears the ground.

(b) Operate the center shift to the extreme right and rotate the circle until the point of the blade is the correct distance to the right (inside) of the left front wheel (same distance as width of the flat bottom).

(c) Lower the blade lift cranks to position blade for the desired cut.

(d) Lean front wheels to the right to a vertical position.

(3) *Cut trench to same depth as ditch.* Make as many cuts as necessary with the blade in this position to cut this trench as deep as the ditch.

(4) *Remove the windrows.* Remove the windrow from the shoulder line after each cut.

(5) *Re-establish the slopes.* After the trench has been cut re-establish the bank and inside slope.

(6) *Cut the flat bottom.* (See fig. 41.)

(a) Place the entire length of the blade in the ditch bottom. The point of the blade at the toe of the bank slope and the heel is set to give the desired width to the ditch bottom.

(b) Make one cut with the blade nearly level on the bottom of the ditch. In a flat bottom ditch the bottom should incline slightly toward the bank slope.

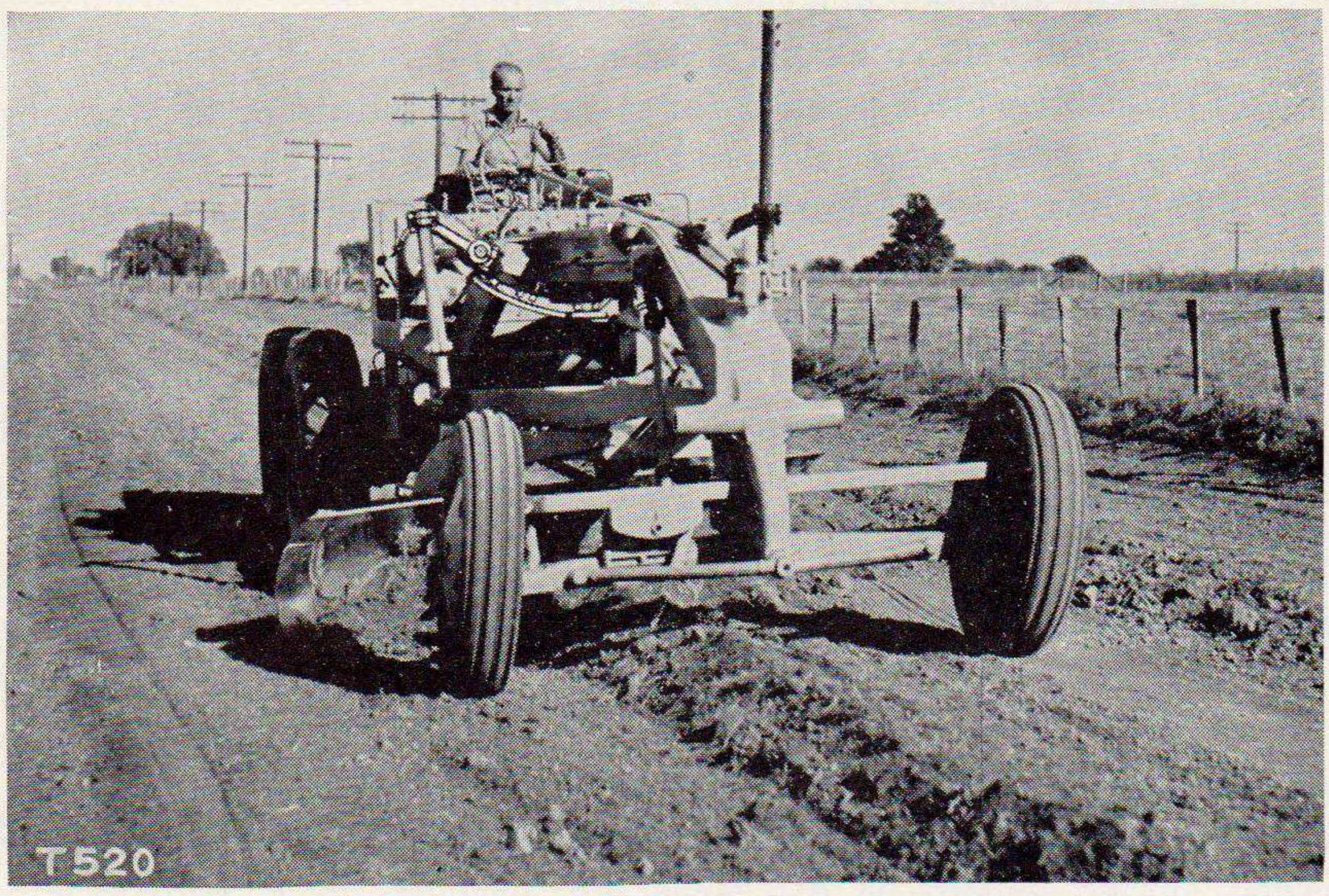

Figure 42. Finishing the surface.

Figure 43. Sloping extremely high banks.

(c) Carry the dirt from the ditch up the inside slope with the blade at a sharp angle to avoid dirt from spilling around the front end of the blade.

j. Establishing the Shoulder Line. In removing the last windrow from the shoulder line with the blade in position as previously described, the permanent shoulder line can be established.

k. Finishing the Surface. (See fig. 42.)

(1) Establish blade position for casting the windrow or for finishing.

(a) Operate center shift to almost extreme left.

(b) Rotate circle until heel of blade will carry dirt outside of the rear wheels.

(c) Lean front wheels slightly to counteract side draft.

(2) Blade the material from one shoulder line to the other to fill the low spots and get an even, level surface. Only a small windrow should be carried, and on the last trip the windrow is feathered out under the blade.

20. Conditions Which Require Manual Blade Adjustments

a. Sloping Extremely High Banks. (See fig. 43.)

(1) Offset the blade to the right on the blade beams.

(2) The right lift link is shortened as required by the degree of slope.

b. Low Flat Back Slopes. (See fig. 44.)

Figure 44. Cutting low back slope.

(1) Extend both blade lift links to maximum length.
(2) Offset the blade on the blade beams.

21. Leveling and Surfacing Maintenance (See fig. 45.)

a. Ordinary leveling and surface maintenance is usually done by working the material across the road or runway, from one side to the other, with the blade set at an angle 20° to 30° from right angle with the motor grader.

b. The blade is titled forward on the tilting straps until the top of the blade is somewhat ahead of the bottom. (See par. 16*c*.) In general the forward tilt is increased with higher speeds. If the motor grader is to be used for leveling or surface maintenance only, extend the center shift link to the long position. The circle should be shifted well to the side toward which the material is being delivered, to properly balance the load. Lean the front wheels slightly to counteract any side draft, and hold the motor grader in a straight course.

c. Rough or badly pitted surfaces must be planed smooth by cutting action, and the surface material respread over the smooth base. This job is usually worked from the center to each side. Cut a smooth base, blading the surface material to the outside, then respread this material back over the planed surface.

d. Leveling and surface maintaining can be done in reverse to save time in turning. With the motor grader not equipped with a scarifier or with scarifier teeth removed, the blade can be rotated by the power controls to a reverse position.

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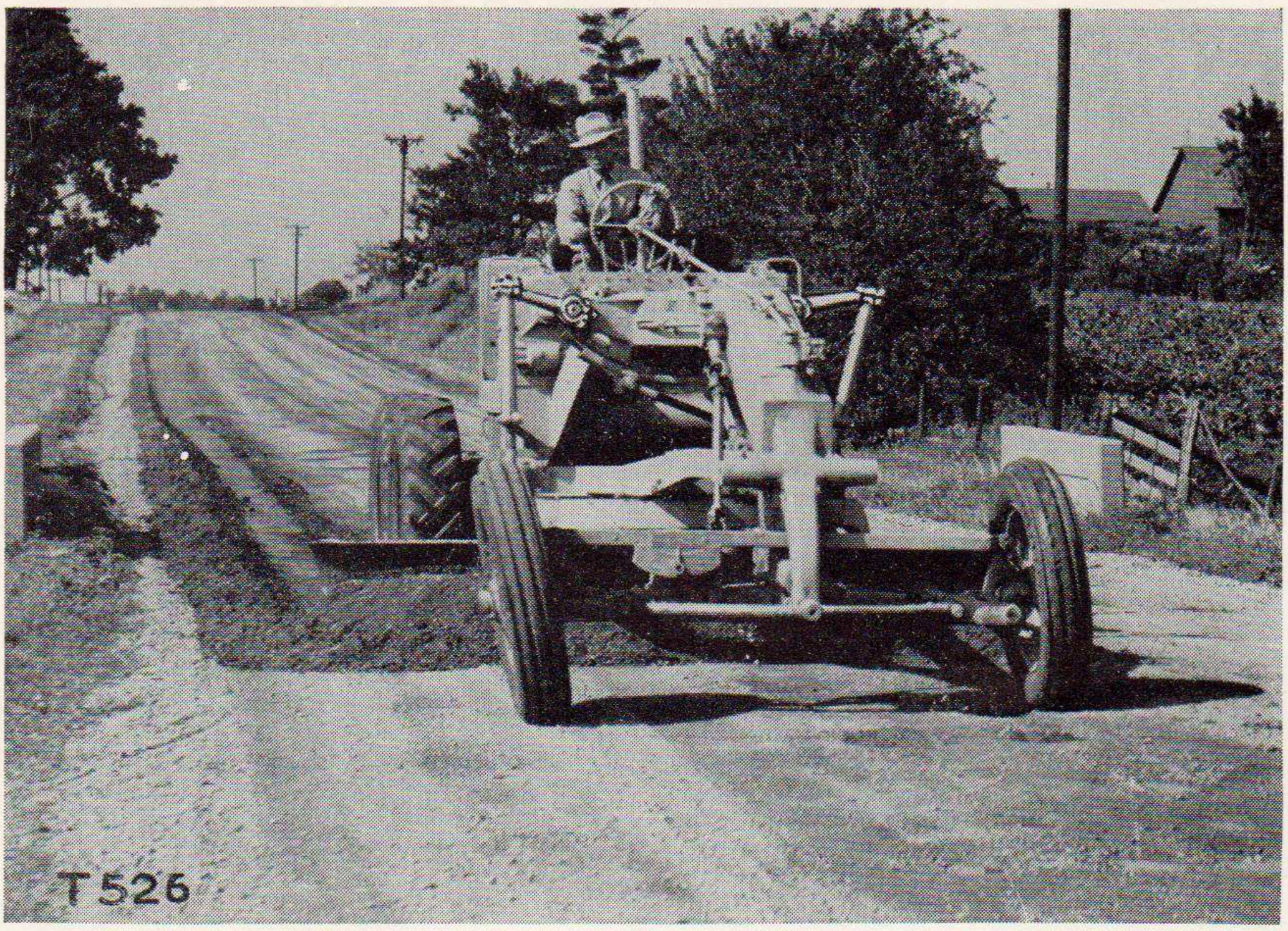


Figure 45. Leveling and surface maintenance.

Section IX. OPERATION OF AUXILIARY EQUIPMENT

22. General

This section will guide the using personnel in the operation of the auxiliary equipment used on the No. 12 motor grader.

23. Scarifier (See fig. 46.)

a. GENERAL. The scarifier is used to tear up material too hard to cut with the blade.

b. OPERATING INSTRUCTIONS.

(1) The teeth should always penetrate the material and not be allowed to drag along the top surface as this causes undue wear on the scarifier points. Get a firm grip in the material to be torn up and work the teeth as deep as permitted by the job and by the available power.

(2) Extremely hard surfaces require the use of fewer teeth. However, greater care must be exercised when part of the teeth are removed, as this concentrates all of the load on the remaining teeth and greatly increases the danger of breakage. Less than six teeth in extremely heavy work is not advised.

(3) It is not necessary to remove the scarifier block for ordinary ditch or bank work. It is desirable, however, in ditching to

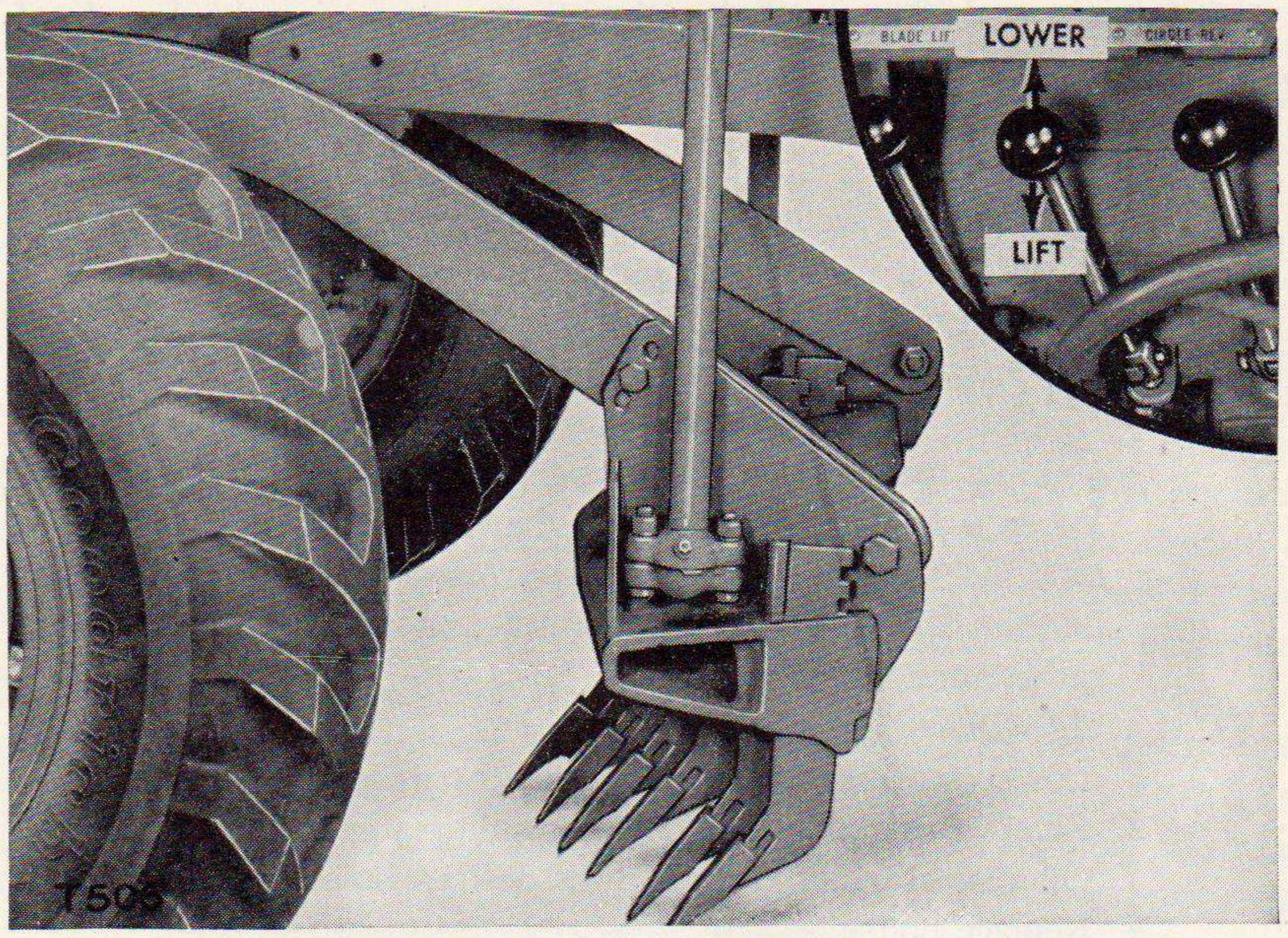


Figure 46. Scarifier.

remove two or more of the teeth nearest to the point of the blade. If the reverse blade position is to be used it is necessary to remove all teeth. This will allow the end of the blade to pass under the block.

SCARIFIER TOOTH ADJUSTMENT.

(1) *Tooth length adjustment.* (See fig. 47.)

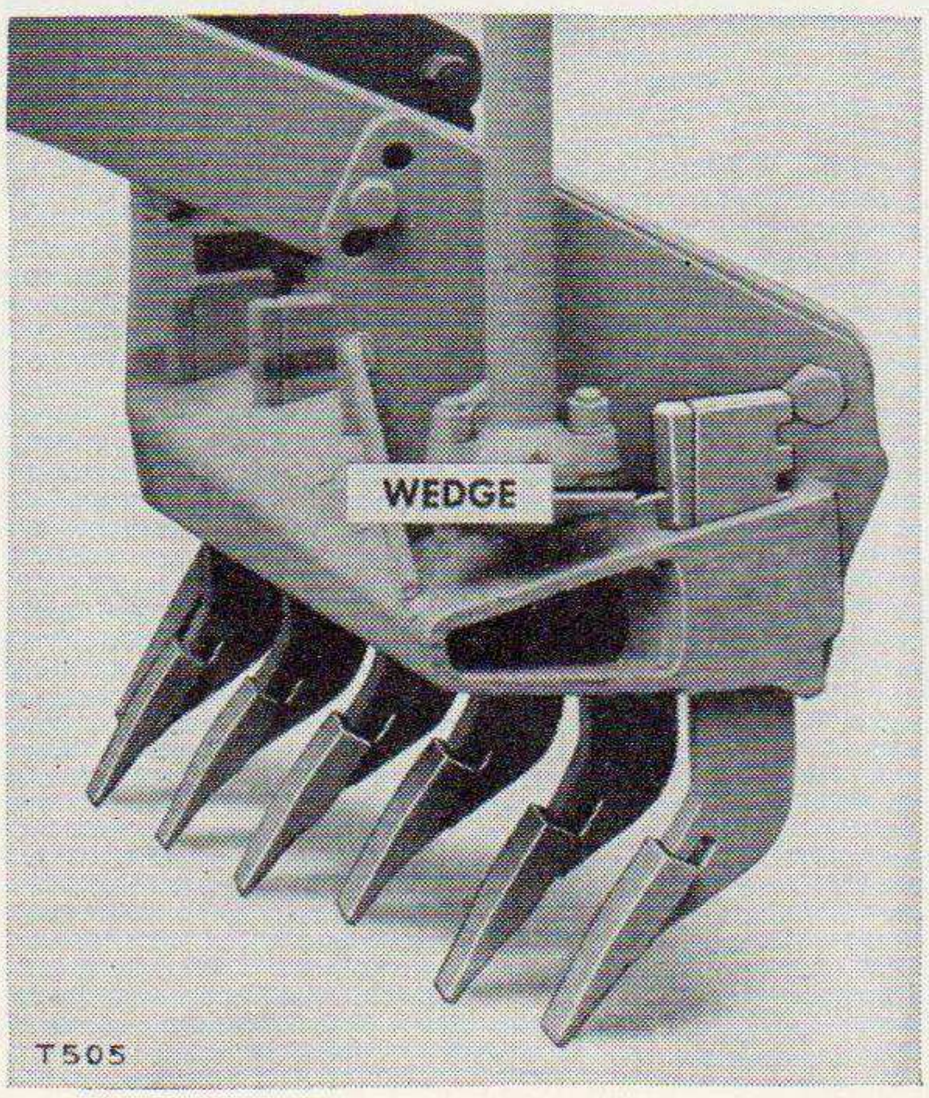


Figure 47. Tooth length adjustment.

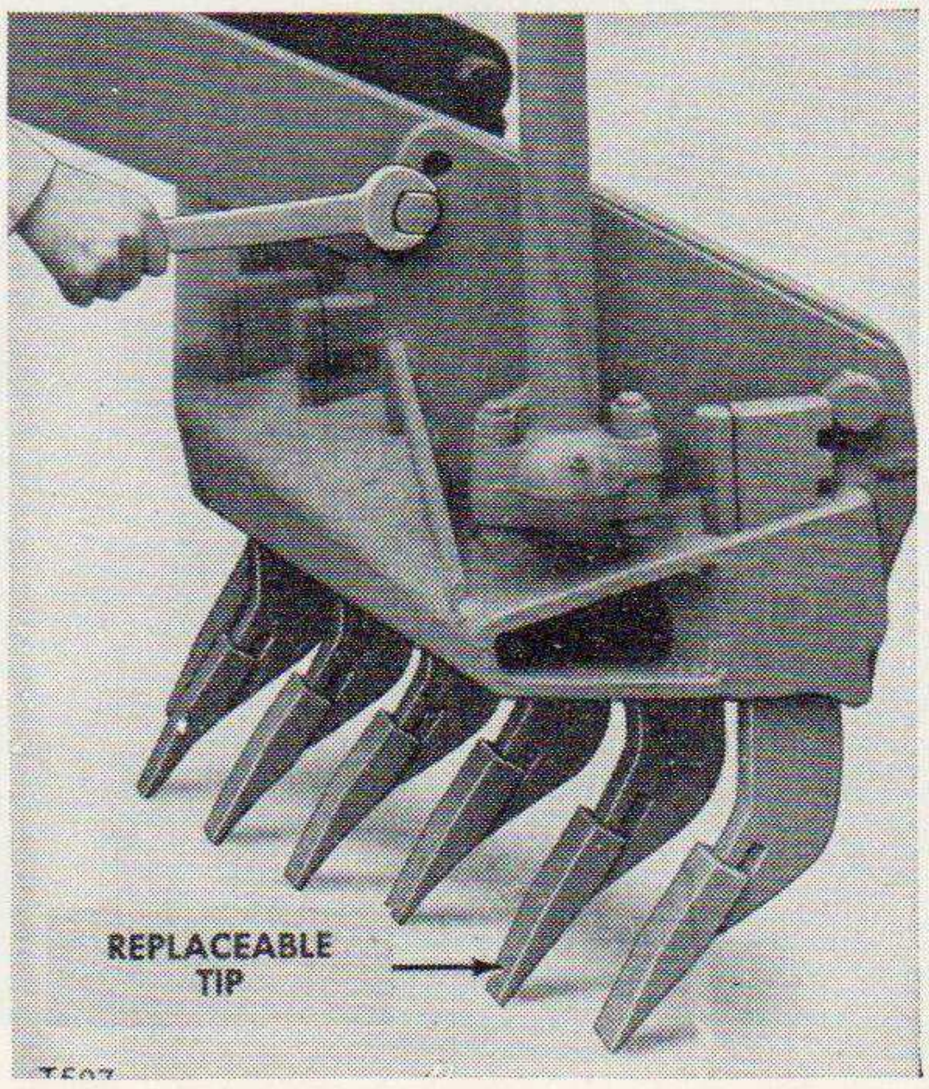


Figure 48. Tooth pitch adjustment.

(a) *General.* The tooth length adjustment varies the length of tooth below the scarifier block to suit the type of material being worked.

(b) *Procedure.*

1. Remove the wedge that holds the tooth in place.

2. Place tooth in desired notch.

3. Replace wedge.

(2) *Tooth pitch adjustment.* (See fig. 48.)

(a) *General.* The tooth pitch can be varied to secure the best possible penetration for type of material being worked. When scarifying exceptionally hard surfaces, it is important that the teeth be tilted at the greatest possible angle. This permits the teeth to slide under and tear up the material rather than cut through it.

(b) *Adjustment procedure.*

1. Lower scarifier until it rests on the ground.

2. Remove the bolts that hold the side plates to the drawbar.

3. Operate scarifier control until desired holes line up.

4. Replace bolts.

d. SCARIFIER TEETH. The scarifier teeth have replaceable tips. When the tips become unserviceable they may be driven off and new ones installed. A tip removal tool is furnished with each scarifier group.

24. Tire Pump (See fig. 49.)

a. GENERAL. The tire pump is a small air compressor mounted on the left side of the transmission in the space between the transmission case and the motor grader frame. It is driven by the motor grader transmission and is equipped with a lever to control its engagement.

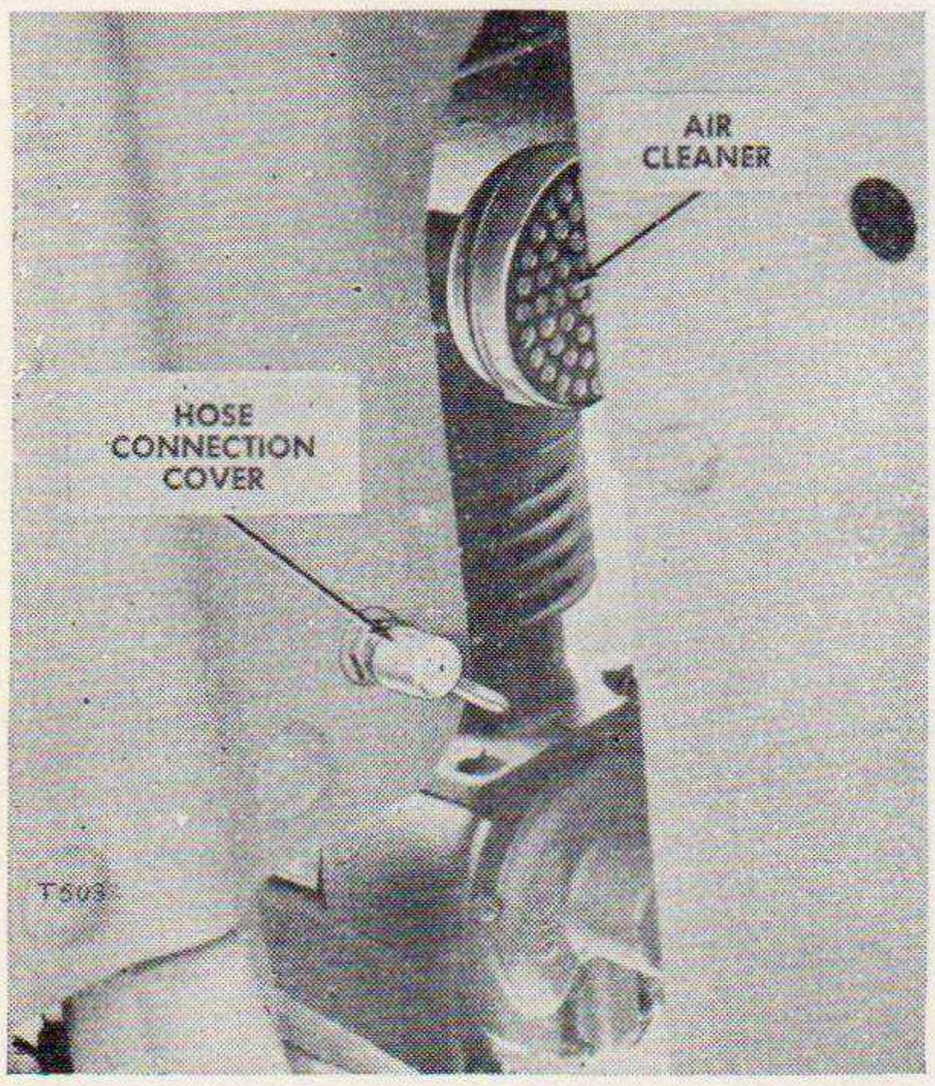


Figure 49. Tire pump.

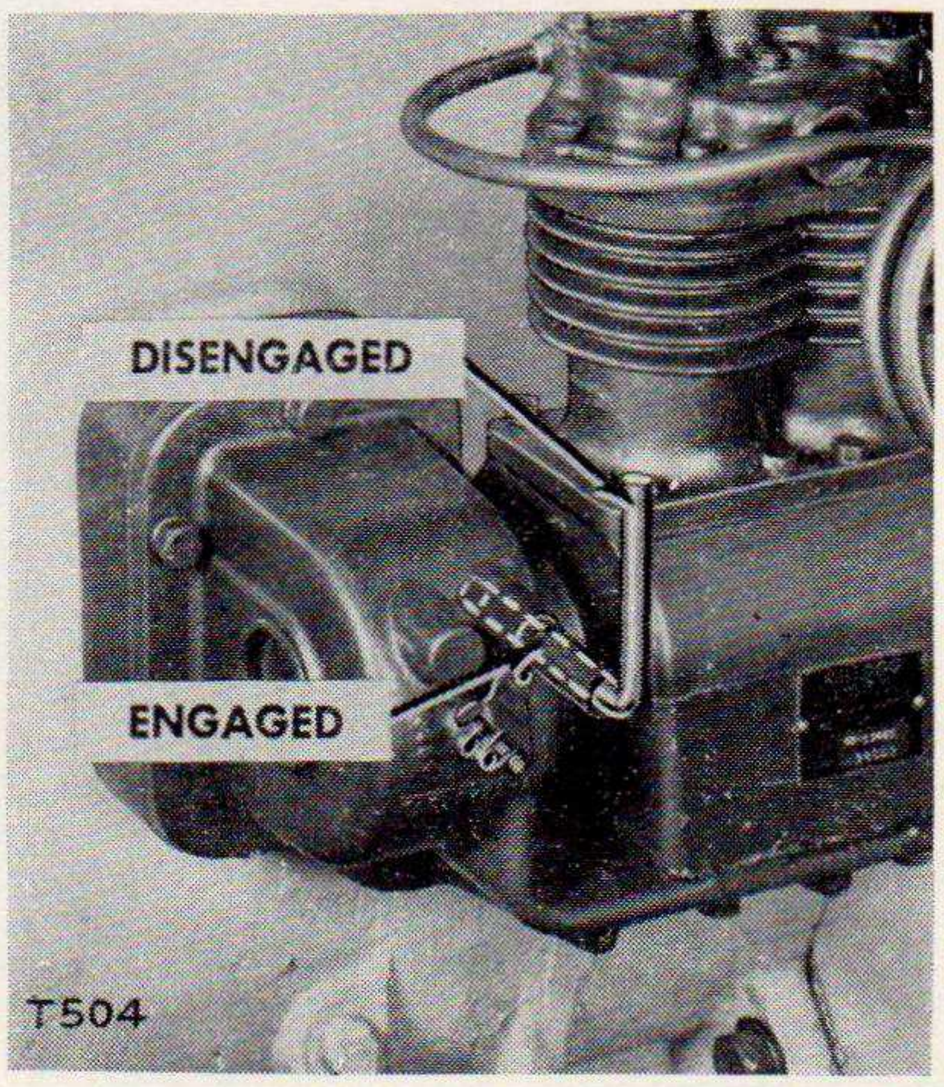


Figure 50. Tire pump control lever.

b. Operating Instructions.

(1) Be sure the motor grader transmission shift levers are in neutral.

(2) Remove the air pressure connection cover and connect the hose.

(3) Using the control lever on the side of the tire pump, shift the pump drive gear into mesh with the reverse idler gear. (See fig. 50.)

(4) Shift the motor grader gear shift lever into "LOW" gear position, place the throttle in the lowest idle speed position and engage the flywheel clutch. Use only "LOW" idle engine speed to operate the pump.

c. Maintenance. Inspect the felt pad in the air cleaner occasionally, by removing the retaining cap. If dust in quantity is evident wash the pad in dry cleaning solvent. Lubricate the pump as directed in figure 52.

Section X. OPERATION UNDER UNUSUAL CONDITIONS

25. Cold Weather Operation

a. General. Low temperatures make additional preparation and maintenance necessary to assure starting and prevent damage to the tractor.

b. Protection of the Cooling System.

(1) Antifreeze ethylene glycol is prescribed for use as an antifreeze solution. The following table gives the quantity required to protect the cooling system of this motor grader at the indicated temperatures.

10°F.	15 -Qt
0°F.	18¾-Qt
—10°F.	22½-Qt
—20°F.	26¼-Qt
—30°F.	30 -Qt
—40°F.	33¾-Qt
—50°F.	33¾-Qt
—60°F.	37½-Qt

(2) The following precautions should be taken before installing the antifreeze compound.

(a) Flush the cooling system thoroughly. If necessary remove the scale as described in paragraph 63.

(b) Check and repair any leaks found in the cooling system.

(c) Inspect the fan belt. Adjust or replace if necessary.

c. Lubrication Below 0°F. Lubrication below 0°F. is covered in LO 5–1018. (See fig. 52 and par. 35.)

d. Fuel System.

(1) In subzero weather use Grade X Diesel fuel.

(2) The following precautions should be taken to avoid the formation of ice in the fuel system.

(a) Always keep the fuel tank as full as possible. This will reduce condensation of water from the free air space above the fuel.

(b) Use precaution when handling fuel to prevent the entrance of snow or ice.

(c) Open the fuel tank drain cock and remove the filter housing drain plug regularly to drain off accumulated water. (See pars. 67 and 69.)

e. BATTERY. The battery should be tested with a hydrometer and kept within a margin of safety to a specific gravity of 1.270 to 1.300. A dangerously low point of charge is indicated by a hydrometer reading of 1.150 which will permit the battery to freeze. A specific gravity of 1.250 will permit the battery to withstand temperatures as low as —30°F., without freezing.

Caution: In subzero weather, water should not be added to the battery until just before the tractor is operated. Operation is necessary to charge the battery and mix the water with the electrolyte to prevent it from freezing.

f. STARTING THE STARTING ENGINE. The following instructions are intended to supplement the starting procedure covered in paragraph 15.

(1) Fill the fuel tank with fresh gasoline.

(2) Before every start, see that there is no ice on the spark plugs, wiring or magneto.

(3) Sometimes moisture will collect on the starting engine spark plugs. Dry the plugs by pouring gasoline over the electrodes and igniting it.

(4) Pouring a small amount of gasoline on spark plug electrodes before they are replaced is more effective in promoting combustion than priming the cylinders with raw gasoline.

26. Hot Weather Operation

a. COOLING SYSTEM.

(1) In extremely high temperatures the water in the cooling system should be checked more frequently than under normal conditions.

(2) Inspect the fan belt adjustment at frequent intervals.

(3) Keep trash out of the fins in the oil cooler and water radiator cores.

(4) Use only clean water. Avoid the use of water that contains alkali or other substances which may cause scale formation.

(5) If the engine overheats have the water temperature regulator and water pump checked.

b. LUBRICATION. Special attention should be given to lubrication. Consult LO 5–1018 (see fig. 52) and the instructions in paragraph 36.

c. BATTERY. In torrid zones, cell water level should be checked daily and replenished if necessary with pure distilled water.

27. Operating in Mud, Snow or Sand

a. Lower the pressure in the rear, drive tires to 22 pounds pressure for greater traction.

b. Install chains on the rear wheels for added traction.

c. Making lighter cuts will permit the use of higher speeds which will prevent the machine from miring.

d. Special attention should be given to lubrication. Consult LO 5–1018 (see fig. 52) and instructions in paragraph 36.

28. Operating in or Near Salt Water

Operating in or near salt water makes the following steps after operation necessary.

a. If fresh water is available wash the entire machine.

b. Lubricate the entire machine before and after operation.

c. Inspect gear compartments and drain, flush and refill with fresh oil if water is detected.

29. Operating in High Altitude

a. GENERAL. As altitude increases the density of air decreases and therefore the weight of oxygen in a given volume of air decreases. The

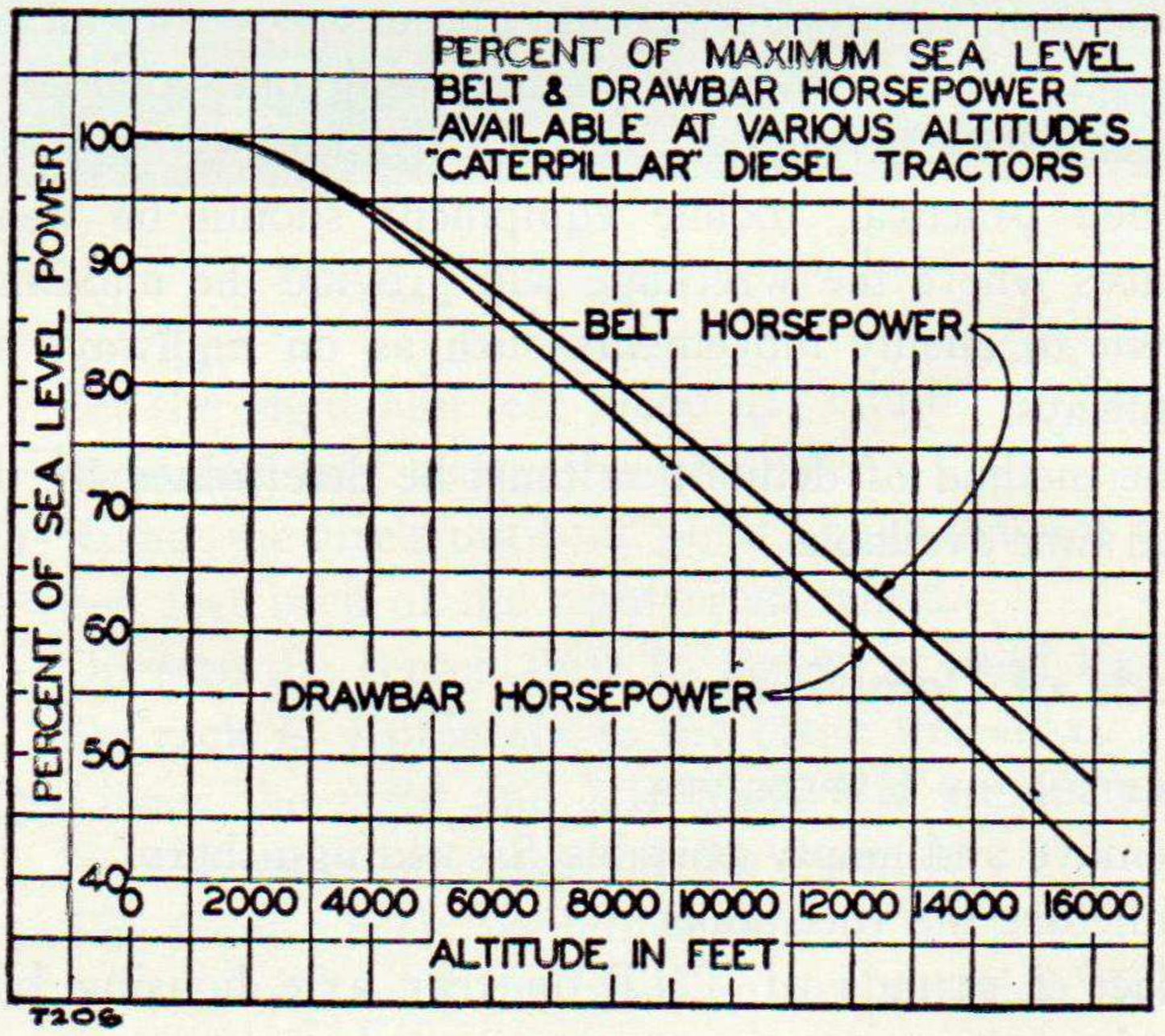


Figure 51. Altitude horsepower loss curve.

volume of fuel that can be burned and the horsepower developed within the cylinders will likewise decrease.

b. GRAPH. The power consumed between the engine and the load will vary slightly with the speed and tractive conditions, but the accompanying graph may be considered sufficiently accurate for estimating purposes. (See fig. 51.)

Section XI. DEMOLITION OF EQUIPMENT

30. General

a. NECESSITY FOR DEMOLITION. Tactical situations may arise when, owing to limitations of time or transportation it will become impossible to evacuate all equipment. In such situations it is imperative that every machine which cannot be evacuated be destroyed to prevent its capture intact by the enemy.

b. PRINCIPLES OF DEMOLITION.

(1) The destruction of machines subject to capture or abandonment in the combat zone, will be undertaken only when in the judgment of the military commander concerned, such action is necessary.

(2) Rubber is such a critical item that an attempt to destroy pneumatic tires must always be made, even if time will not permit destruction of the remainder of the machine. With adequate training, the destruction of tires may be accomplished in conjunction with the destruction of the machine without increasing the time necessary.

(3) The same essential parts must be destroyed on all like units to prevent the enemy from constructing one complete unit from several damaged ones, by cannibalization.

(4) When practical, mobile equipment should be demolished in places where the wreckage will provide the maximum impediment to enemy movements such as on highways and airfield runways.

(5) The method of demolition must be determined by the material and time available.

31. Methods of Demolition

a. DEMOLITION BY EXPLOSIVES.

(1) Remove and empty portable fire extinguishers.

(2) Puncture the fuel tanks.

(3) Place 2 pounds of TNT on rear axle housing below Diesel engine.

(4) Place 2 pounds of TNT on left side of flywheel housing under starting engine.
(5) Place 1 pound of TNT on left side of transmission case adjacent to tire pump.
(6) Place 1 pound of TNT on under side of power control housing.
(7) Place 1 pound of TNT in cavity below circle reverse housing.
(8) Insert tetryl nonelectric caps with at least 6 feet of safety fuse in each charge placed.
(9) Ignite an M14 incendiary grenade under each tire. To insure the best results when this method is used, be certain that the incendiary fires are well started before detonating the TNT.
(10) Ignite fuses and take cover.
(11) Elapsed time of 2 or 3 minutes if charges are prepared before hand.

b. Demolition by Gunfire or Grenades.

(1) Remove and empty fire extinguishers.
(2) Puncture the fuel tanks.
(3) Fire on the equipment with artillery, rockets, 50 cal. machine guns, tanks or grenades, first at the engine and radiator, second at the rear drive tires and tandem drives, then at the controls and last at the front tires.
(4) About 3 to 5 minutes of concentrated fire on this equipment should destroy it beyond use.

c. Demolition by Sledge Hammer, Axes, Pick Axes, Crowbars, or Other Heavy Tools Available.

(1) Remove and empty fire extinguishers.
(2) Puncture the fuel tanks.
(3) Smash the engine cylinder heads, cylinders, crankcase, carburetor, generator, magneto, air filters, oil filters, injection equipment, batteries, radiator, power controls, power control gear housings and tire pump.
(4) Damage tires (deflate them before starting the destruction if possible).
(5) Cut all cables and electric wiring.
(6) Douse gasoline and fuel over the tires (entire machine if possible) and ignite.
(7) The time required will depend upon tools available.

PART THREE

MAINTENANCE INSTRUCTIONS

Section XII. GENERAL

32. Scope

Part three contains information for the guidance of the using organizations responsible for the organizational maintenance (1st and 2d echelon) of this equipment. It contains information needed for the performance of the scheduled lubrication and preventive maintenance services as well as description of the major systems and units and their functions in relation to other components of the equipment.

Section XIII. Special Organizational Tools and Equipment

33. Tools Accompanying Motor Grader

A list of special tools accompanying the motor grader is given in figure 4.

34. Special Service Tools

No special Caterpillar tools are issued to organizational mechanics.

Section XIV. LUBRICATION

35. Introduction

Lubrication is a highly essential part of preventive maintenance, determining to a great extent the serviceability of parts and assemblies. Lubrication instructions for this tractor are consolidated in LO 5–1018 (see fig. 52) which specifies the points to be lubricated, the periods of lubrication and the lubricant to be used. The circled reference numbers in the reproduction of LO 5–1018 are keyed to detailed illustrations of the lubrication points which follow figure 52. Paragraph 36 gives detailed instructions for some of the more complex lubrication operations.

LUBRICATION ORDER

LO 5-1018

30 March 1948 (Supersedes LO 5-1018, 3 May 1945)

GRADER, ROAD, MOTORIZED, DIESEL ENGINE-DRIVEN, 12-FT MOLDBOARD, (CATERPILLAR, MODEL 12)

Reference: TM 5-1018, TB 5-1018-1, Mfr's Serial No located on left front side of frame.

Intervals given are maximums for normal 8-hour day operation. For abnormal conditions or activities, intervals should be shortened to compensate.

Clean fittings before lubricating.

Relubricate after washing or fording.

Clean parts with SOLVENT, dry-cleaning, or with OIL, fuel, Diesel. Dry before lubricating.

Lubricate points indicated by dotted arrow shafts on both sides of the equipment.

Drain crank and gear cases only when hot after operation; check level and replenish when cool.

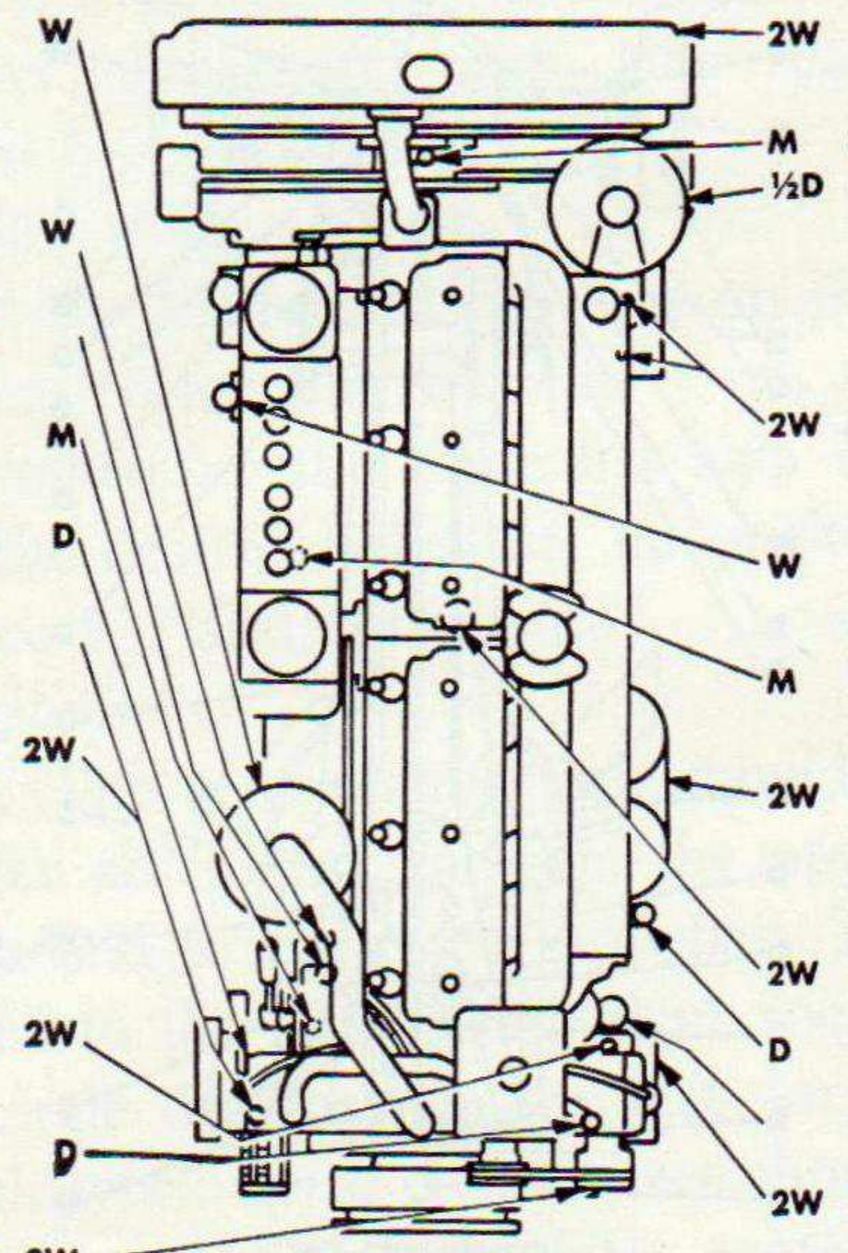
— KEY —

LUBRICANT	CAPACITY	EXPECTED TEMPERATURE			INTERVALS
		Above +32°F	+32°F to 0°F	Below 0°F	
OE—OIL, engine					½D—Twice Daily D—Daily W—Weekly 2W—Two Weeks M—Monthly S—Semiannually
Starting Engine Crankcase	1½ qts.	OE 30 or N. S. 9250	OE 10 or N. S. 9110	See Note 1	
Diesel Engine Crankcase	25 qts.				
Tire Pump	¼ qt.	OE 30 or N. S. 9250	OE 10 or N. S. 9110	OE 10 or N. S. 9110	
Clutch	½ qt.				
Fuel Injection Pump Housing	1 qt.				
Other Points					
Starting Engine Air Cleaner	½ qt.	OE 30 or N. S. 9250	OE 10 or N. S. 9110	OH or SAL	
Diesel Engine Air Cleaner	2¼ qts.				
GO—LUBRICANT, gear, universal Transmissions and Housings		GO 90	GO 90	GO 75	
CG—GREASE, general purpose		CG 1 or N. S. 14L9	CG 0	CG 0	
HB—FLUID, brake, hydraulic. All temperatures.					
OH—OIL, hydraulic or N. S. OS 2943					
SAL—FLUID, shock absorber, light					

STARTING ENGINE

Lubricant • Interval

1. Air Cleaner — OE — W — (See Key) (Clean and refill oil cup. Every month remove filter section and wash)
2. Clutch Level Plug — W — (Check level)
   Clutch Fill Plug — OE — (See Key)
   Clutch Drain Plug — M — (Drain and refill)
   Starter Pinion — OE — D — (Oil Cup)
3. Crankcase Fill — OE — (See Key)
   Crankcase Breather — OE — 2W — (Before 9K2123, remove and wash breather assembly. Pour ¼ pint of OE through breather. After 9K2123, no service required)
4. Crankcase Drain Plug — 2W — (Drain and refill)
3. Crankcase Level Gage — D — (Check level)
5. Water Pump Drive Shaft — CG — 2W



DIESEL ENGINE

Interval • Lubricant

6. Oil Cooler Vent Plug — 2W — (Remove when draining crankcase)
7. Fan — M — CG
8. Air Cleaner — ½D — OE — (See Key) (Clean and refill oil cup. Every week remove and clean screens. Install screens with cross arms facing each other. Keep precleaner clean)
9. Generator — 2W — OE — (Sparingly. Some generators have packed bearings. No lubrication necessary.)
10. Fuel Injection Pump Housing Fill and Level — W — OE — (See Key) (Check level)
    Fuel Injection Pump Housing Drain Plug — M — (Drain and refill)
11. Oil Filters — 2W — (Drain sludge compartment. Wash metallic element and housing. Replace inner filter element)
6. Crankcase Drain Plug — 2W — (Drain and refill)
12. Crankcase Level Gage — D — (Check level)
    Crankcase Fill — 2W — OE — (See Key)
    Crankcase Breather — 2W — OE — (Clean element) (Pour ¼ pt. OE through filter)

CONTINUED ON FOLLOWING PAGE

Figure 52. Lubrication order.

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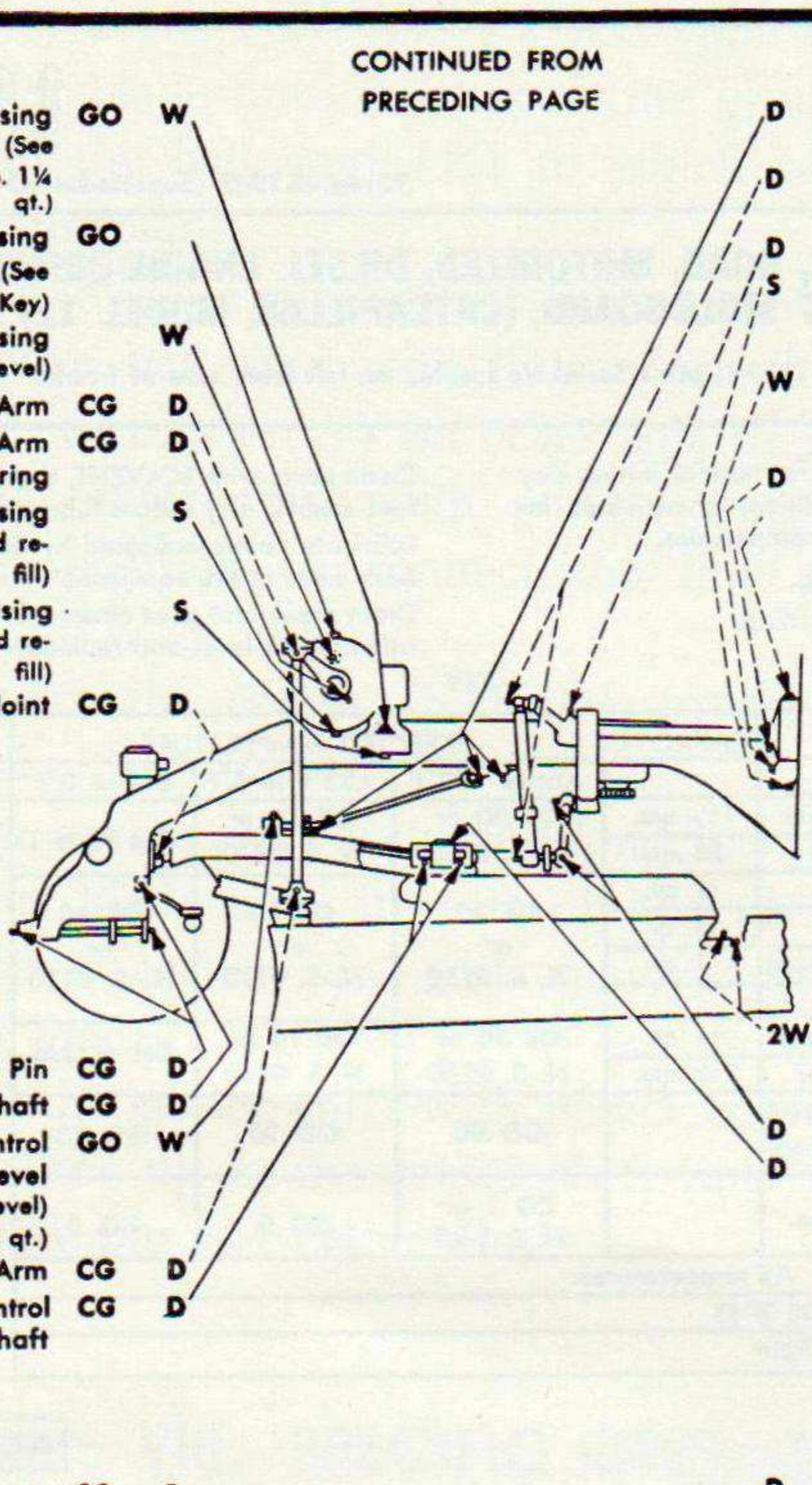


35	Scarifier Drive Housing Fill and Level Plug (See Key) (Check Level) (Cap. 1¼ qt.)	GO	W	D	CG	Universal Joints and Shaft Bearings — 34
30	Scarifier Control Housing Fill Plug (Cap. 7 qts.) (See Key)	GO		D	CG	Circle and Blade Control Arm
	Scarifier Control Housing Level Plug (Check level)		W	D	CG	Lift Arm Shaft Bearing — 38
31	Scarifier Control Arm	CG	D	S		Blade Lift Control Housing Drain Plugs (Drain and refill)
	Scarifier Control Arm Shaft Bearing	CG	D	W		Blade Lift Control Housing Level Plug (Check level) — 36
30	Scarifier Control Housing Drain Plug (Drain and refill)		S	D	CG	Lift Arm Control Shaft
35	Scarifier Drive Housing Drain Plug (Drain and refill)		S		GO	Blade Lift Control Housing Fill Plug (See Key) (Cap. 8½ qts.) — 36
33	Circle Draft Ball Joint	CG	D			
33	Front Axle Pivot Pin	CG	D	2W	CG	Blade Locking Mechanism (On machines after 9K2911) — 37
	Steering Gear Shaft	CG	D			
32	Circle Reverse Control Housing Fill and Level Plug (See Key) (Check level) (Cap. ¼ qt.)	GO	W	D	CG	Circle Center Shift Link — 38
31	Scarifier Control Arm	CG	D	D	GO	Circle Reverse Housing Fill and Level Plug (See Key) (Check Level) (Cap. 1¾ qt.) (On machines before 9K1703, lubricate housing and bearing at base with CG) — 34
34	Circle Reverse Control Shaft	CG	D			
40	Front Wheel Lean Upper Bearings	CG	D	D	CG	Front Wheel Lean Control Arm
	Front Wheel Lean Lower Bearings	CG	D	W	GO	Front Wheel Lean Control Housing Fill and Level Plug (See Key) (Check level) (Cap. 2 qts.) — 45
41	Front Wheel Bearings (Every 6 months remove wheel, clean inspect all parts, replace damaged or worn parts, repack bearings and reassemble)	CG	D	D	CG	Front Wheel Lean Control Housing Bearing
42	Spindle Rod	CG	D	D	CG	Drag Link — 42
	Tie Rod	CG	D	D	CG	Tie Rod — 42
39	Steering Gear Housing Fill Plug (See Key) (Cap. ¾ qt.)	GO		D	CG	Front Wheel Lean Control Shaft Universal Joints — 46
	Steering Gear Housing Level Plug (Check level)		W	D	CG	Front Wheel Lean Control Shaft Housing and Bearings
42	Drag Link	CG	D	D	CG	Scarifier Control Arm Shaft Bearing — 31
46	Steering Control Shaft Universal Joints and Bearings	CG	D	D	CG	Front Wheel Lean Control Shaft Bearing — 46
31	Steering Control Shaft Bearing	CG	D	S		Center Shitt Control Housing Drain Plug (Drain and refill) — 47
43	Center Shift Housing Bearing	CG	D	W	GO	Center Shift Control Housing Fill and Level Plug (See Key) (Check level) (Cap. 1 qt.) — 47
31	Scarifier Control Shaft Bearing	CG	D	D	CG	Front Wheel Lean Control Shaft Bearing — 46
44	Control Shaft Universal Joints	CG	D	D	CG	Control Shaft Universal Joints — 44
38	Blade Lift Control Shaft Bearing	CG	D			

CONTINUED ON FOLLOWING PAGE

Figure 52.—Continued.

CONTINUED FROM PRECEDING PAGE

	Lubricant	Interval
20 Drawbar Hook Mechanism	CG	W
13 Tandem Drive Housing Fill Cover (See Key) (Cap. 30 qts.)	GO	S
14 Tandem Drive Housing Drain Plug (Drain and refill)		M
14 Tandem Drive Housing Breather (Clean and reoil)		D
16 Throttle Control Bearing	OE	W
13 Tandem Drive Housing Level Plug (Check level)		D
15 Power Unit Cradle Bearing	CG	D
15 Power Control Shaft Universal Joint	CG	D
16 Throttle Control Bearing	CG	D
16 Gear Shift Lever Bearing	CG	M
17 Brake Master Cylinder Fill and Level (See Key) (Maintain level ½ in. to filler plug) (Cap. ¾ qt.)	HB	W
18 Power Control Housing Level Plug (Check level)		D
18 Power Control Housing Fill Plug (See Key) (Cap. 8 qts.)	GO	S
16 Throttle Control Bearing	OE	W
18 Power Control Housing Drain Plug (Drain and refill)		D
28 Power Control Shaft Housing Fill and Level Plug (See Key) (Maintain Level to Filler Elbow) (Cap. 2 qts.)	GO	W
29 Steering Control Shaft Bearing	CG	D

Interval	Lubricant	
S		Rear Axle Housing Drain Plug (Drain and refill)
W	GO	Rear Axle Housing Fill and Level Plug (See Key) (Check level) (Cap. 60 qts.)
M		Rear Alxe Housing Breather (Clean and reoil)
D	CG	Axle Housing Bracket Cap
D	CG	Tandem Drive Pivot
M	CG	Flywheel Clutch Pilot Bearing (Remove cover, turn flywheel until fitting is visible. After 9K7649, remove cover under crankcase filler, turn flywheel until fitting is visible)
D	OE	Flywheel Clutch Release Bearing (Fill immediately before operation)
S		Tire Pump Drain Plug (Drain and refill)
2W	OE	Tire Pump Fill and Level (See Key) (Check level) (Fill to top of filler cup)
S		Transmission Drain Plug (Drain and refill)
W		Transmission Level Plug (Check level; early models right side, late models left side)
	GO	Transmission Fill Plug (See Key) (Cap. 10 qts.)
D	CG	Brake Control Shaft Bearings
D	CG	Power Control Shaft Universal Joint
S		Power Control Shaft Housing Drain Plug (Drain and refill)

19 20 21 22 23 24 25 26 15 27

NOTES:

1. COLD WEATHER (When winterization kit is not available) (Diesel Engine Crankcase)——Every 3 days drain crankcase, refill to "Full" mark with OE 10. Add 7½ qts. of gasoline. Run engine 5 minutes to mix. Mark the new level on the gage for future reference. (Caution) Every ½ day check level and fill to "Full" mark with OE 10. Then, if engine is to be shut down for ½ day or more, add 7½ qts. of gasoline to reach new level mark. Operate engine for 5 minutes to mix.

(Starting Engine Crankcase) Every 3 days drain crankcase, refill to "Full" mark with OE 10. Add ½ qt. gasoline, run the engine 5 minutes to mix. Mark the new level on the gage for future reference. (Caution) Every ½ day check level and fill to "Full" mark with OE 10. Add ½ qt. gasoline, to reach new level mark. Run the engine 5 minutes to mix. NOTE: Diesel Fuel may be used as a temporary diluent, but ONLY when sufficient gasoline is not available.

(Fuel Injection Pump) Every 3 days drain injection pump, refill and maintain to level with mixture of 3 parts OE 10 to 1 part OIL, fuel, diesel.

2. OIL CAN POINTS—Every week lubricate brake and clutch linkage, throttle control rods, and starting engine governor linkage with OE.

3. POINTS REQUIRING NO LUBRICATION—Diesel Engine Water Pump, Starting Engine Magneto, Circle Gear and Pinion, Front Wheel Lean Rack and Pinion, and Center Shift Rack and Pinion.

Copy of this lubrication Order will remain with the equipment at all times; instructions contained herein are mandatory and supersede all conflicting lubrication instructions dated prior to 30 March 1948.

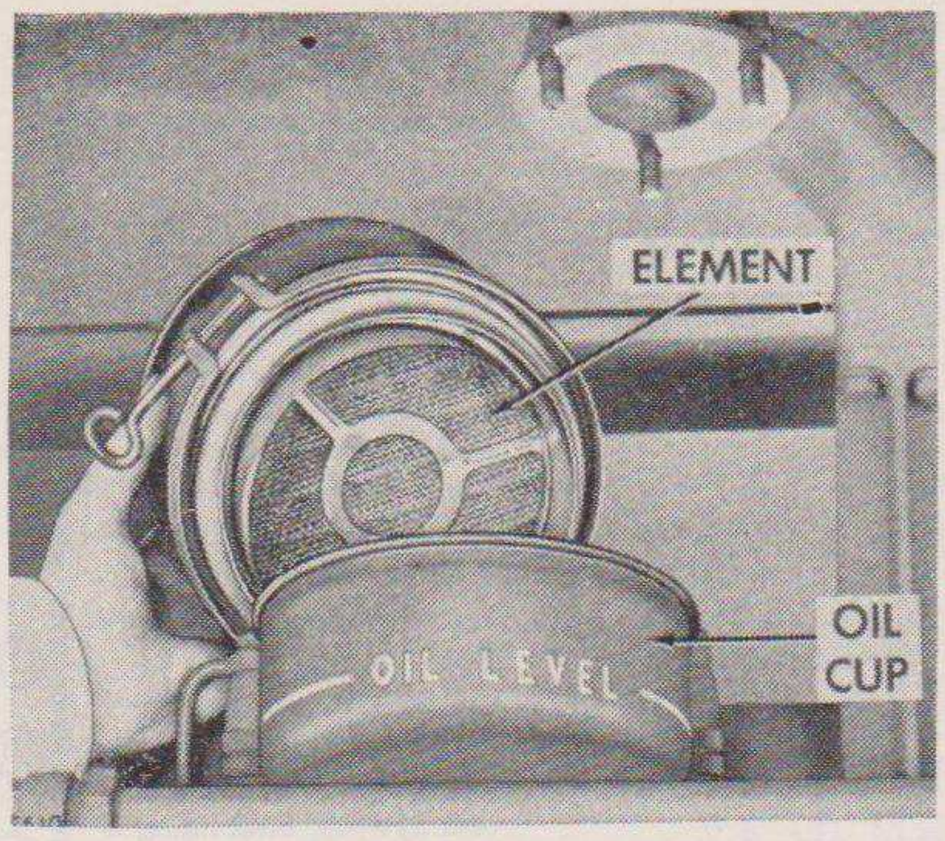
By order of the Secretary of the Army

OMAR N. BRADLEY
Chief of Staff,
United States Army

OFFICIAL:

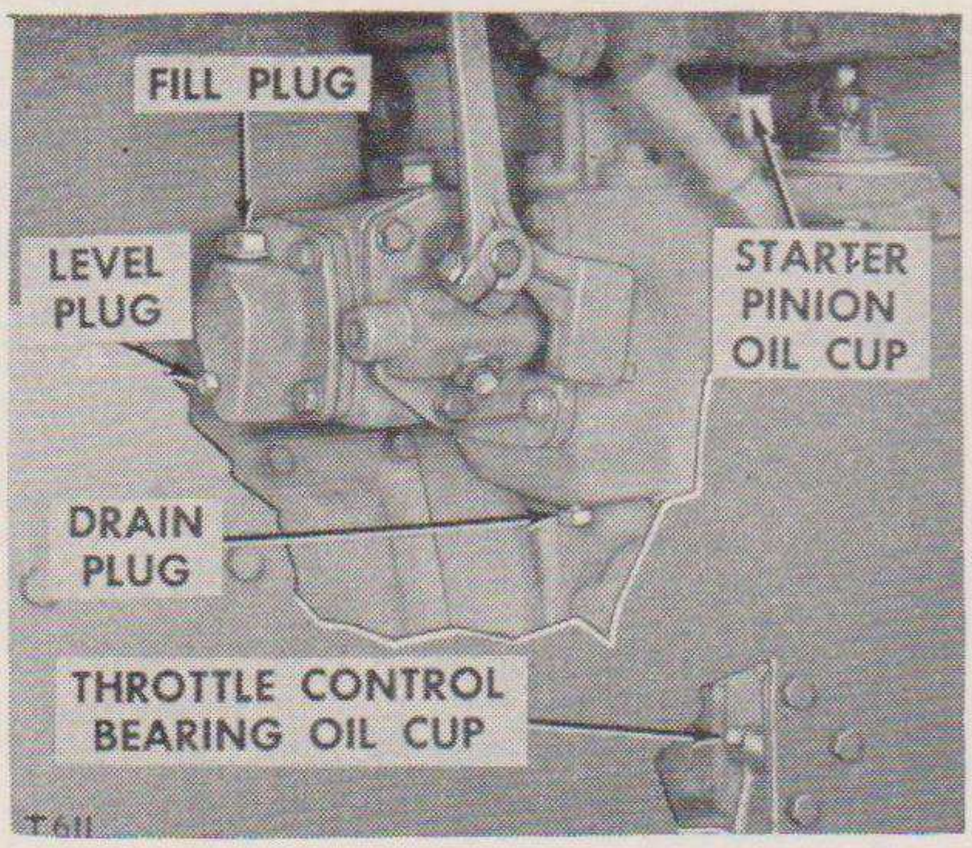
EDWARD F. WITSELL,
Major General,
The Adjutant General.

Figure 52.—Continued.



REF. 1—STARTING ENGINE AIR CLEANER

Remove and clean oil cup, refill to level of bead. Remove filter section and wash in dry cleaning solvent.

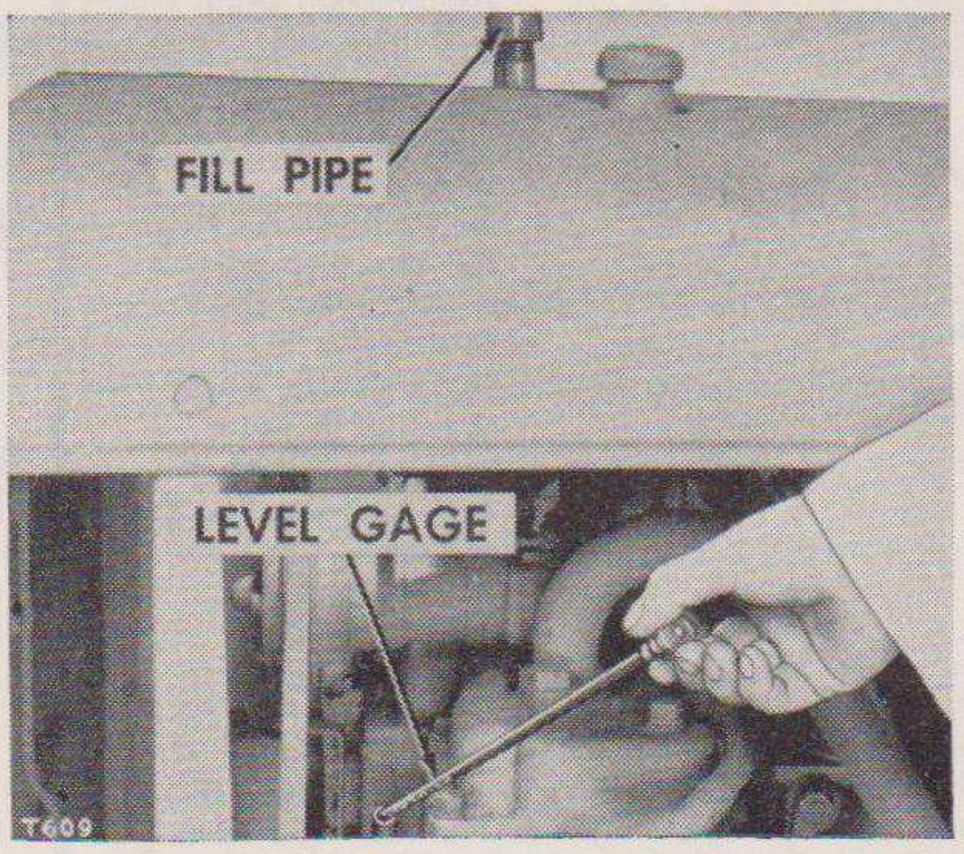


REF. 2—STARTING ENGINE CLUTCH LEVEL

Fill, level and drain plugs, Drain when lubricant is warm. Keep lubricant to level of level hole.

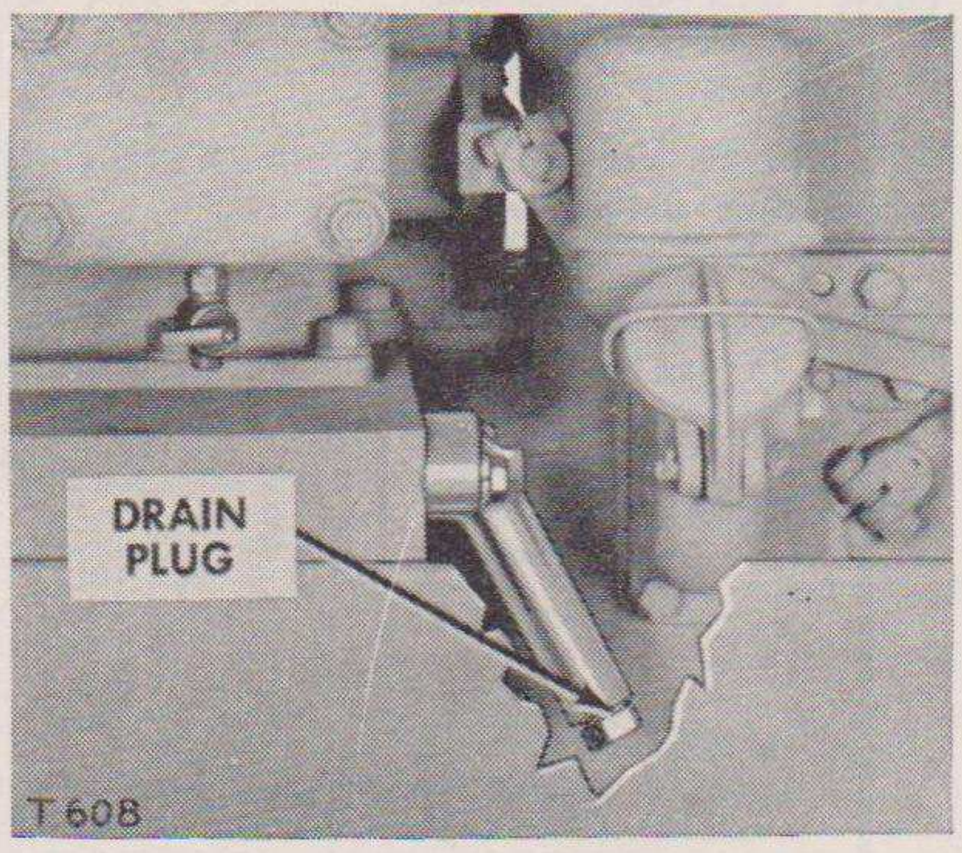
STARTER PINION, THROTTLE CONTROL BEARING.

Fill oil cups immediately before operation.



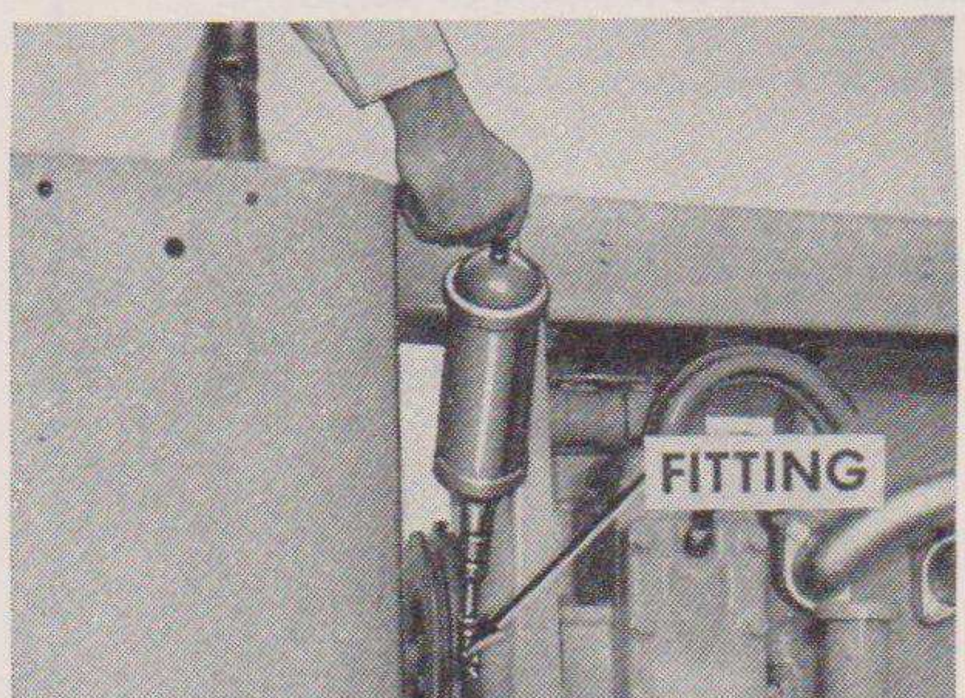
REF. 3—STARTING ENGINE CRANKCASE

Remove cap to fill or replenish through filler pipe, replace cap. Remove level gage and clean with wiping cloth, insert and again remove. Oil level should be up to "FULL" mark.



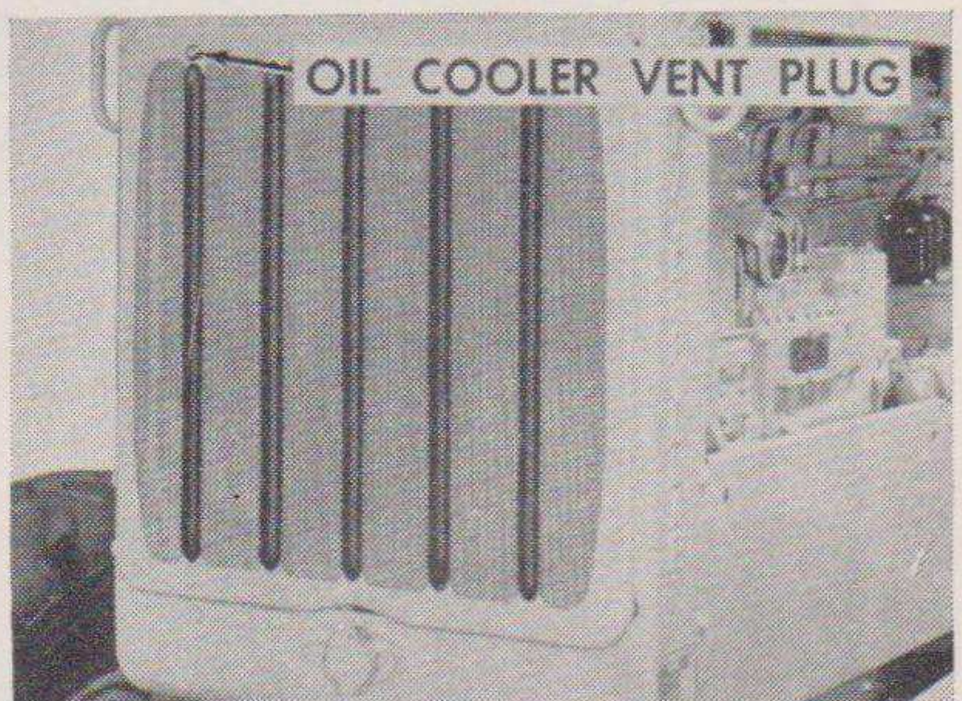
REF. 4—STARTING ENGINE CRANK CASE DRAIN PLUG

Remove drain plug when lubricant is warm. Tighten plug securely when installing.



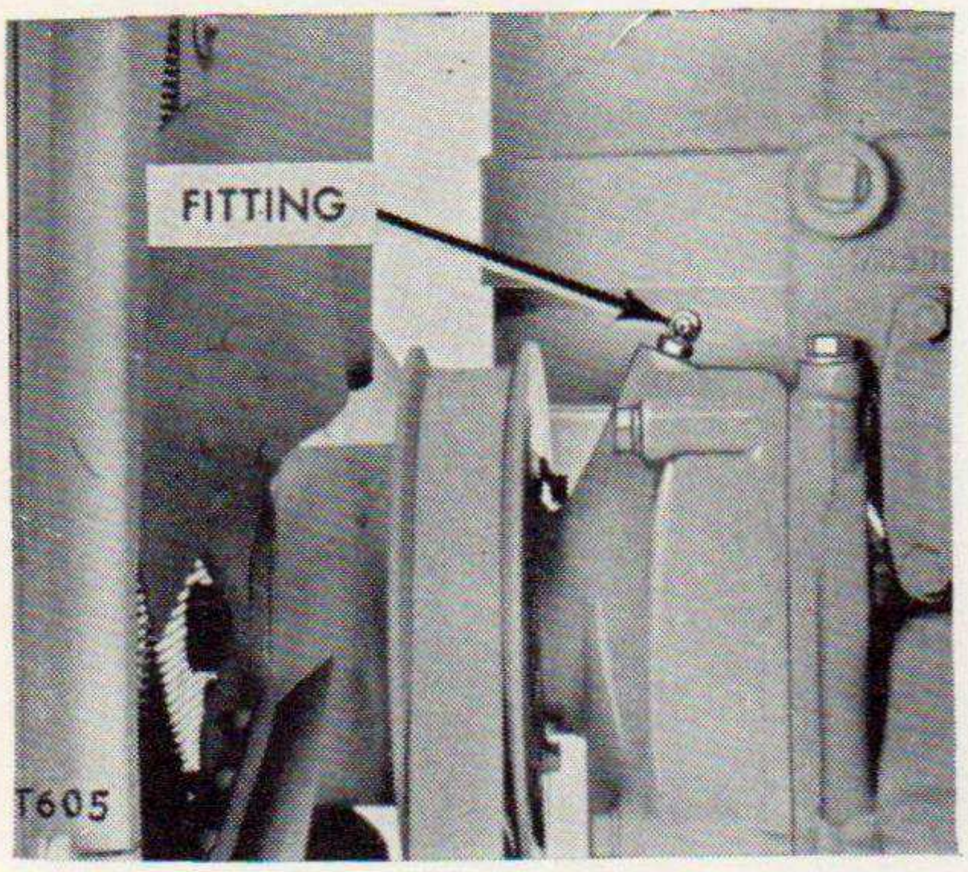
REF. 5—STARTING ENGINE WATER PUMP DRIVE SHAFT

One fitting—clean fitting, apply lubricant through fitting.



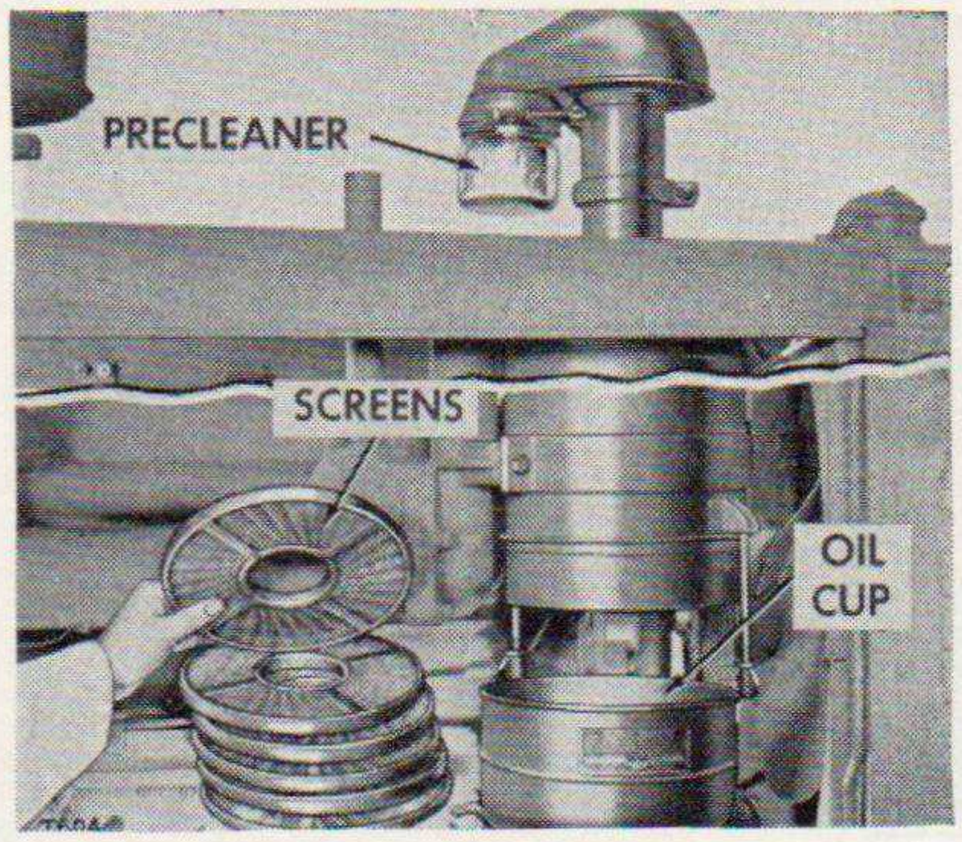
REF. 6—DRAINING CRANKCASE

Remove vent plug from upper left hand corner of oil cooler. Remove crankcase drain plug from under engine. Drain when lubricant is warm. Tighten plugs securely when installing.



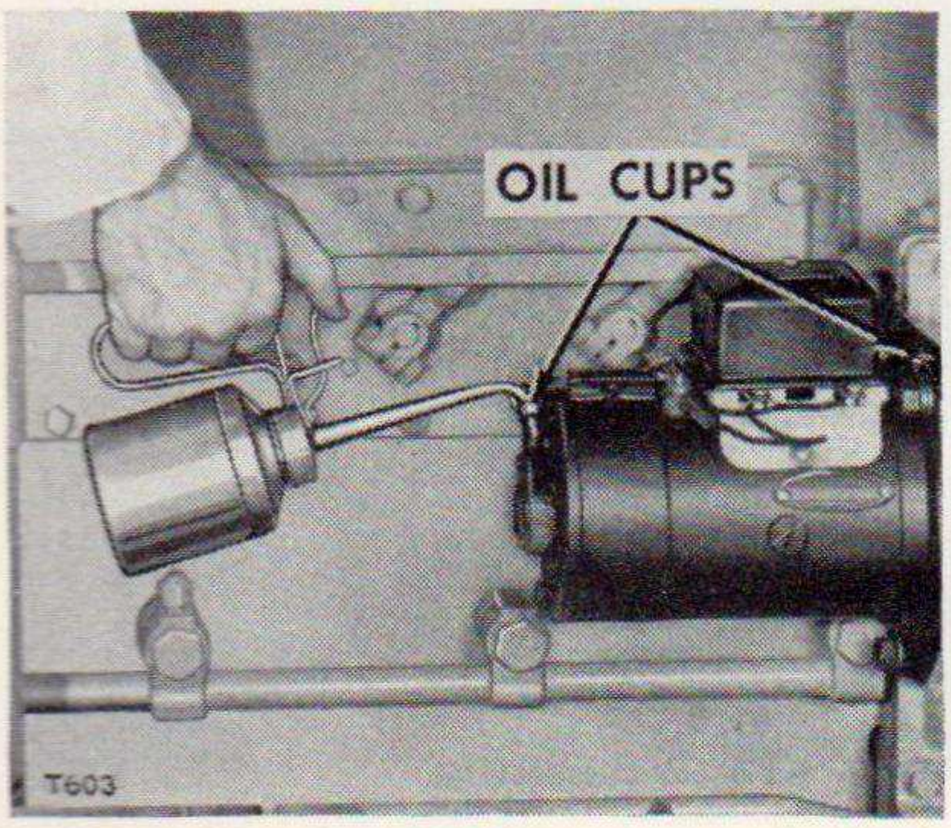
REF. 7—FAN

One fitting. Apply two or three shots of lubricant through fitting. Do not over lubricate.



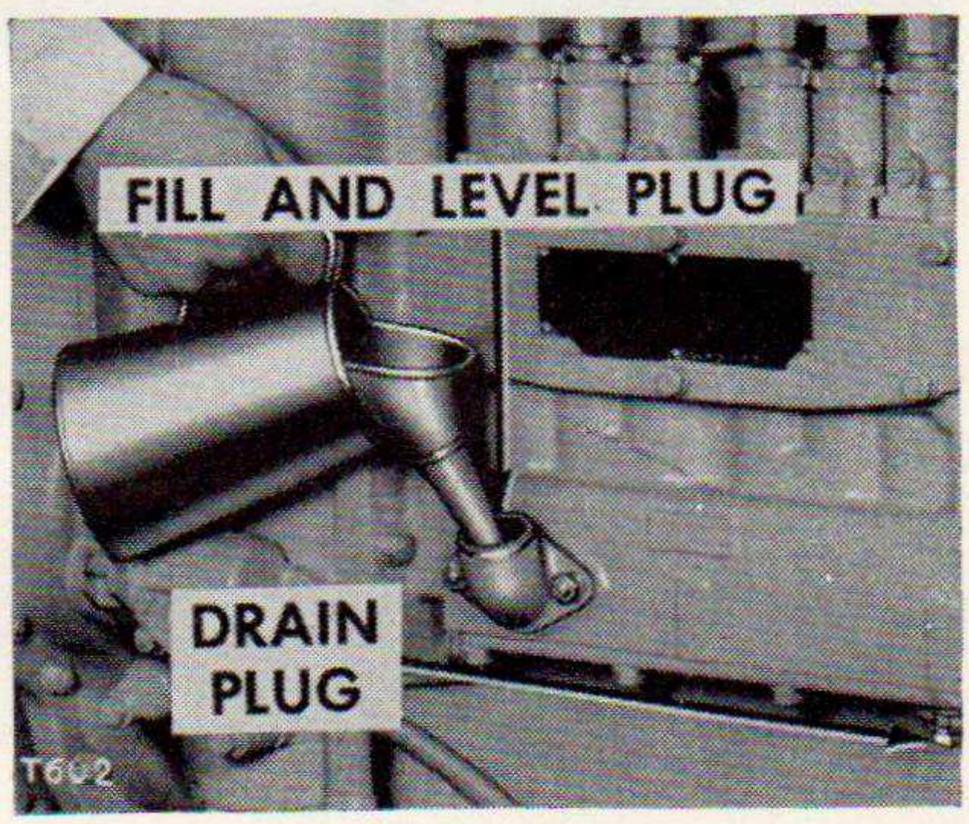
REF. 8—AIR CLEANER

Remove oil cup, clean and refill to oil level bead. Remove screens and wash in dry cleaning solvent, install screens in pairs with crossarms facing each other. Remove and empty glass jar on precleaner when it becomes three-fourths full of dirt.



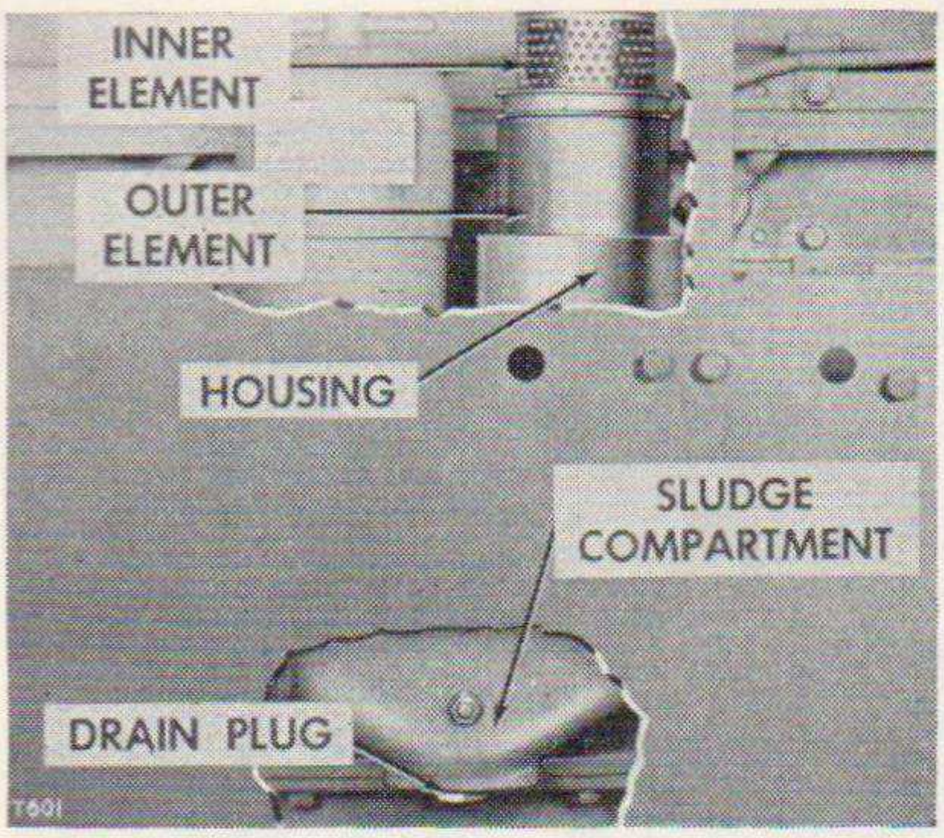
REF. 9—GENERATOR

One or two oilers. Apply two or three drops of oil. Some generators have packed bearings. No lubrication necessary.



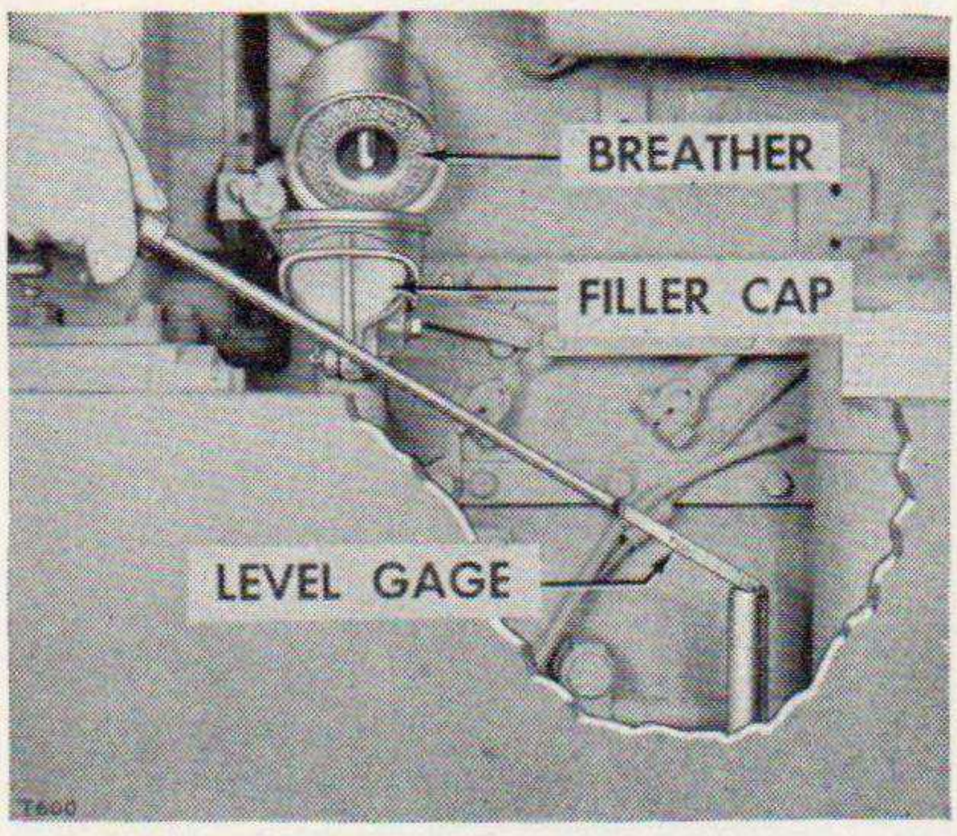
REF. 10—FUEL INJECTION PUMP HOUSING

Drain when oil is warm. Fill with oil to top of filler elbow.



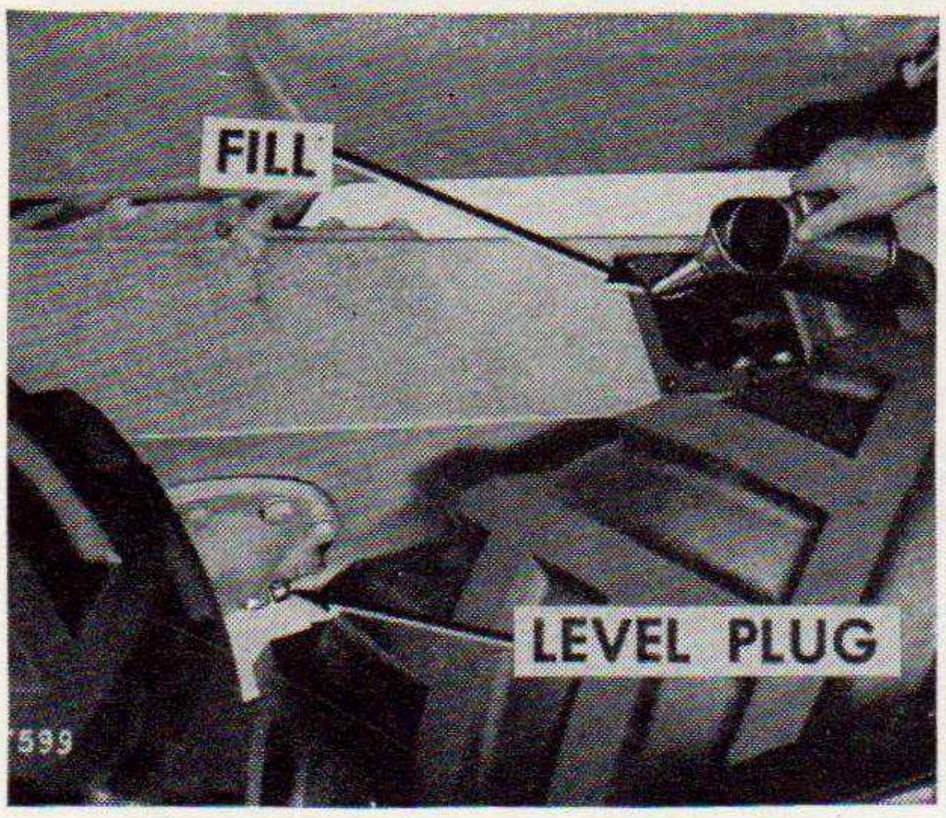
REF. 11—OIL FILTERS

Remove plug to drain sludge compartment. Remove covers, wash metallic elements, sludge compartment and housing with dry cleaning solvent. Install new inner filter elements.

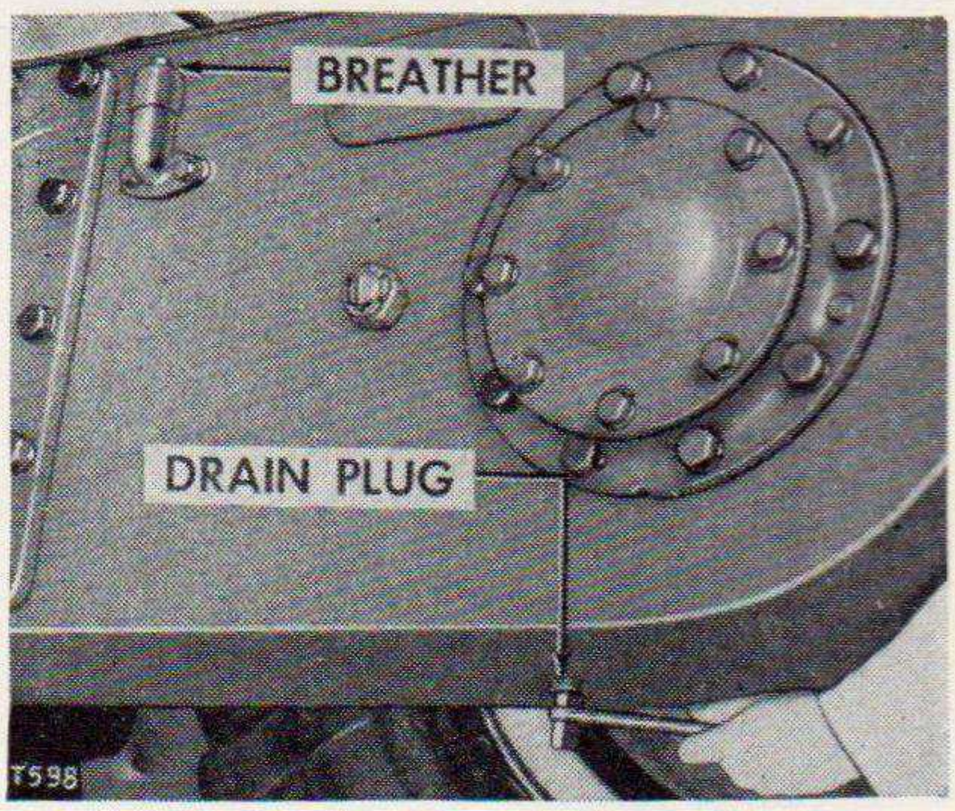


REF. 12—CRANKCASE

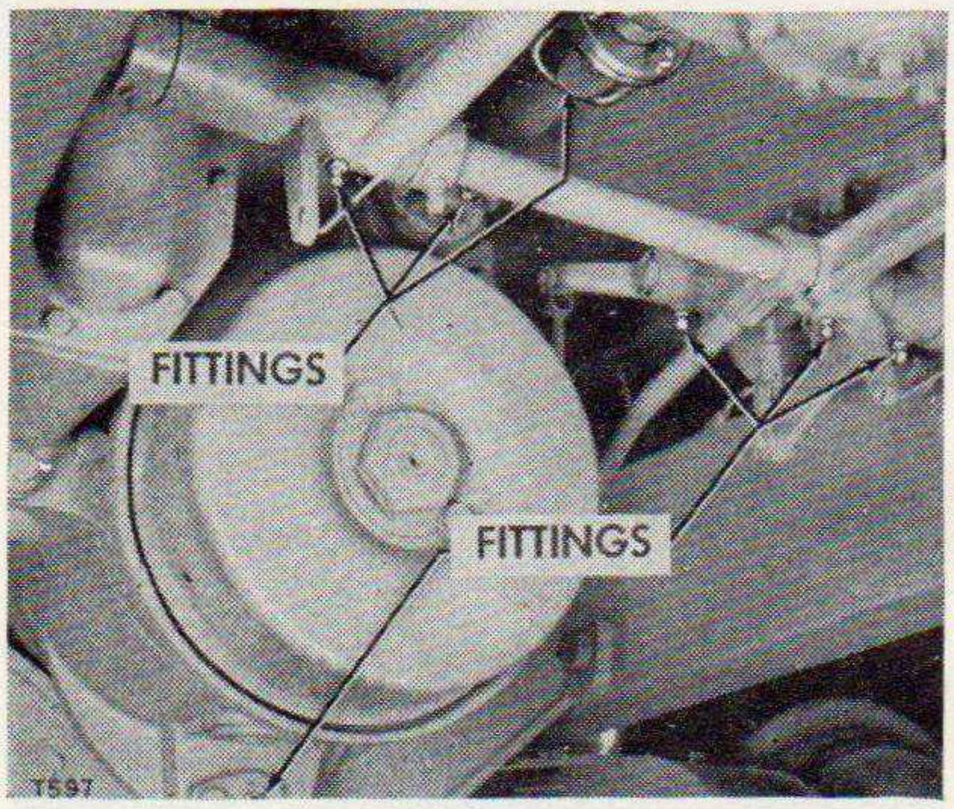
Remove level gage and clean with wiping cloth, install and again remove. Oil level should be up to "FULL" mark. On machines beginning with Serial No. 9K2854 check with engine running. Remove fill cap and fill or replenish through filler pipe. Remove breather and pour ¼ pt. OE through element when draining crankcase.



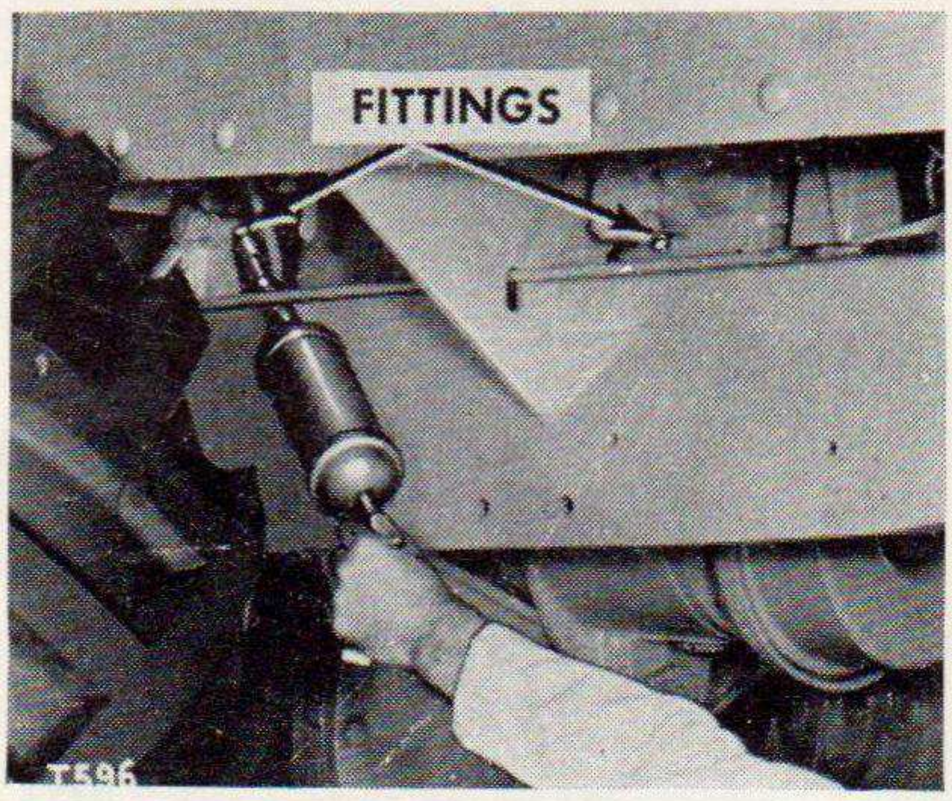
REF. 13—TANDEM DRIVE HOUSING
Fill cover and level plug.
Remove cover to fill or replenish housing. Keep lubricant to level of level plug hole.



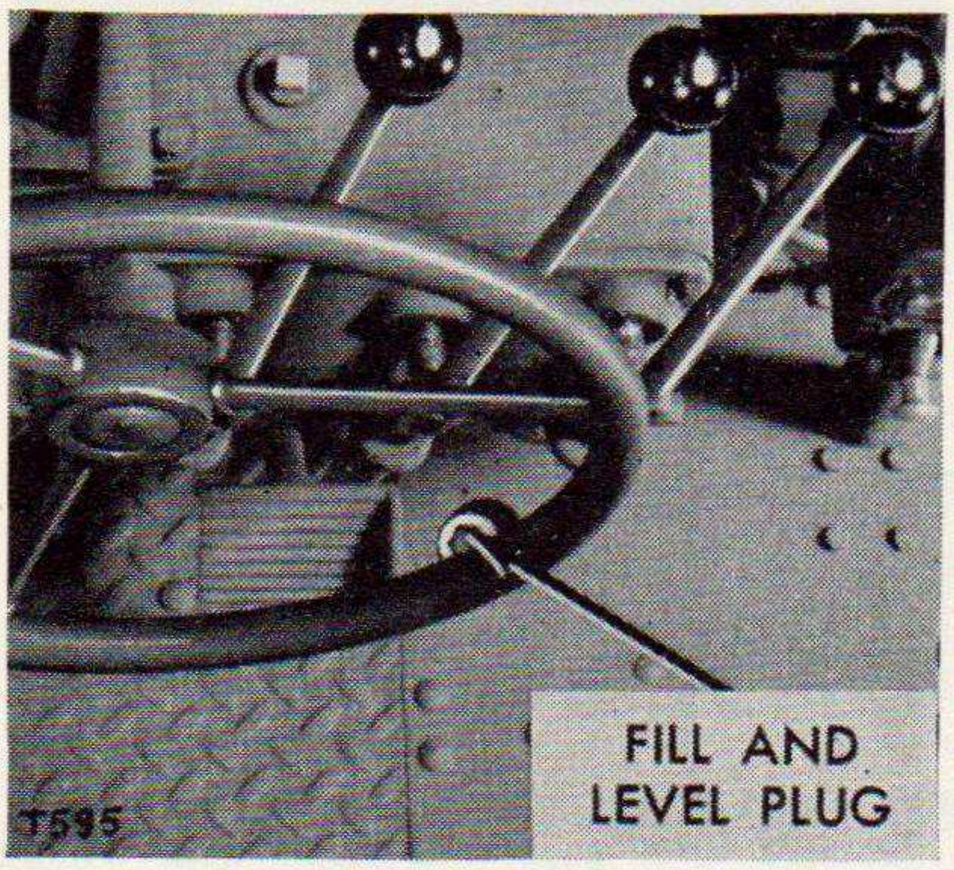
REF. 14—TANDEM DRIVE HOUSING
Drain plug and breather.
Remove drain plug when lubricant is warm, remove breather and wash in dry cleaning solvent. Put several drops of oil in breather cap and replace.



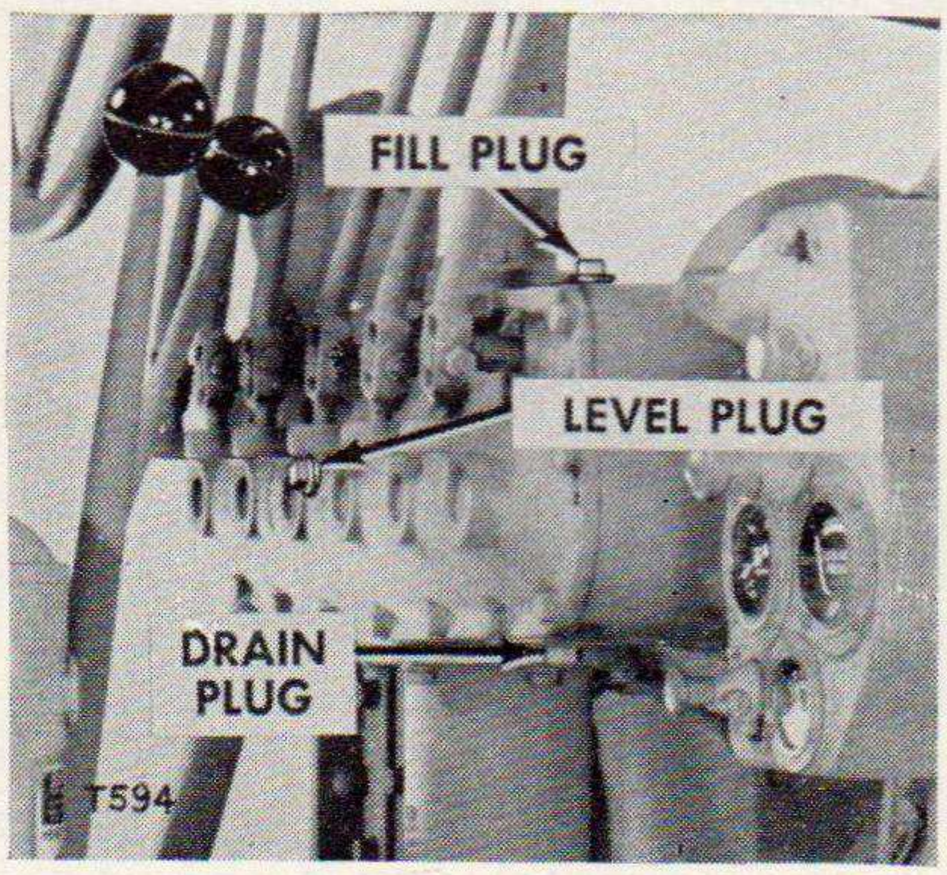
REF. 15—POWER UNIT CRADLE BEARING
Power control shaft universal joints.
Brake control shaft bearings.
Seven fittings, clean and apply lubricant through fittings.



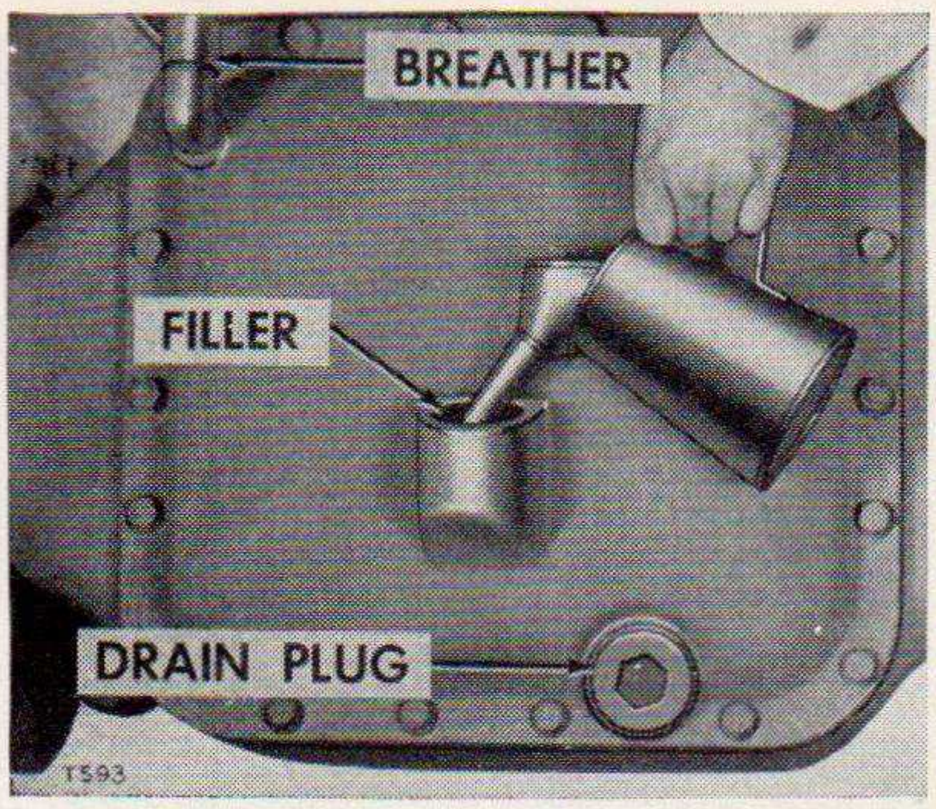
REF. 16—THROTTLE CONTROL BEARING
Gear shift lever bearing.
Two fittings, clean and apply lubricant through fittings.



REF. 17—BRAKE MASTER CYLINDER
Fill and level plug. Replenish fluid through filler pipe and maintain level within ½ in. of filler plug.



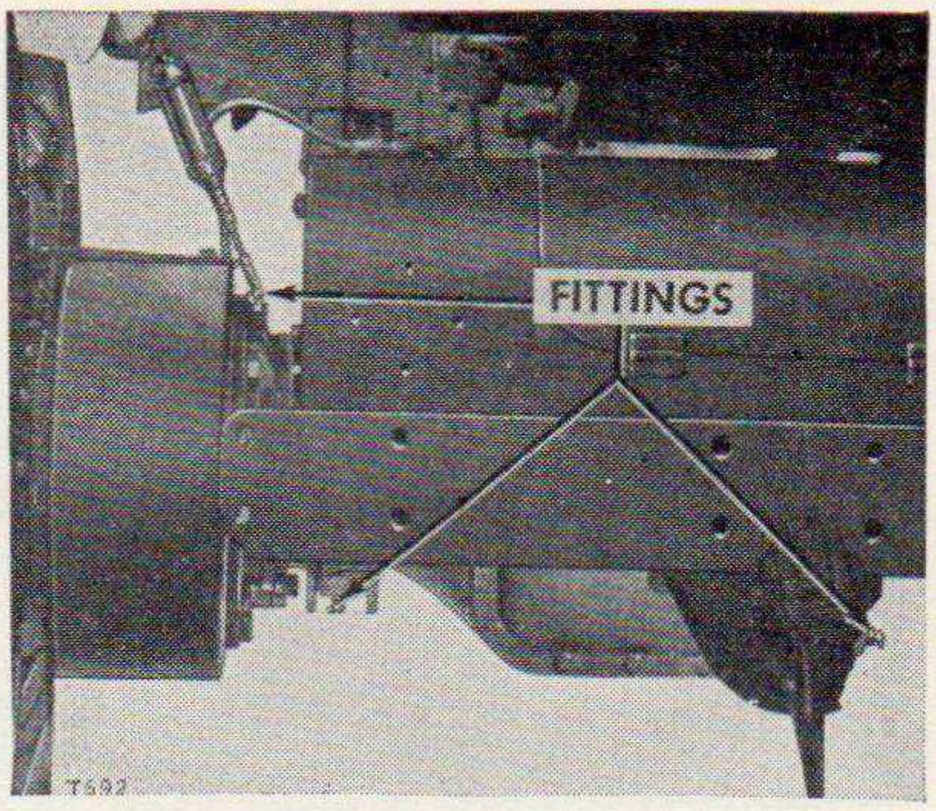
REF. 18—POWER CONTROL HOUSING
Fill, level and drain plugs.
Fill or replenish through filler plug opening. Keep oil to level of level plug hole. Drain immediately after operation.



REF. 19—REAR AXLE HOUSING

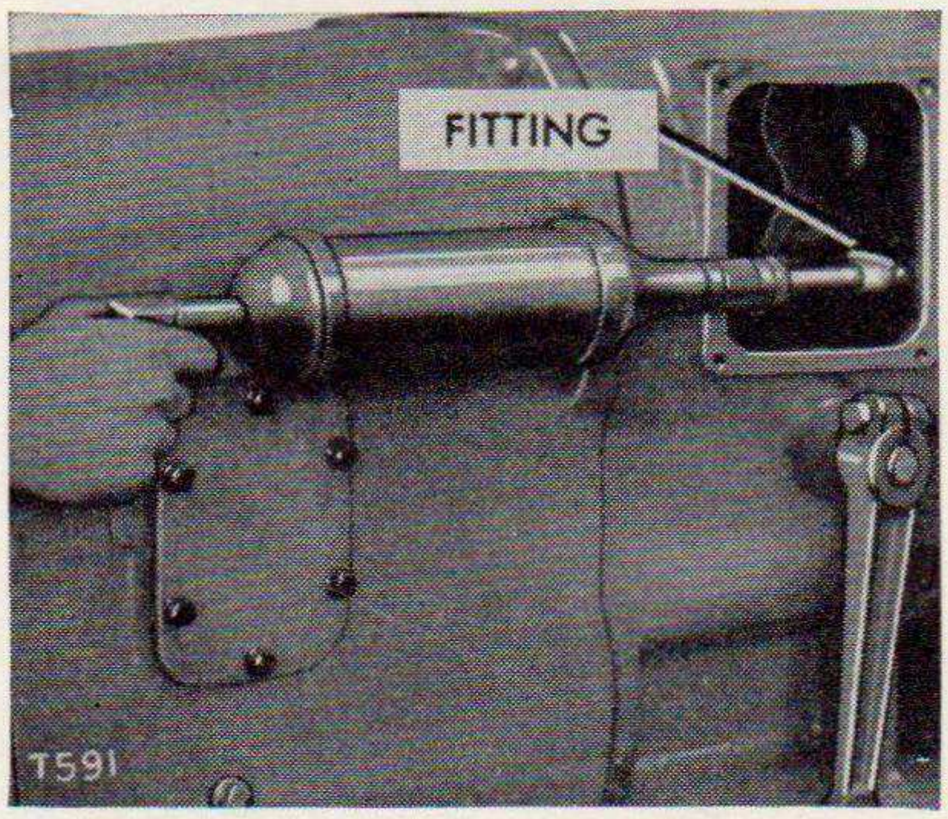
Fill or replenish through filler pipe.

Maintain level to top of filler elbow. Drain when lubricant is warm. Remove breather and wash in dry cleaning solvent. Put several drops of oil in breather cap and replace.



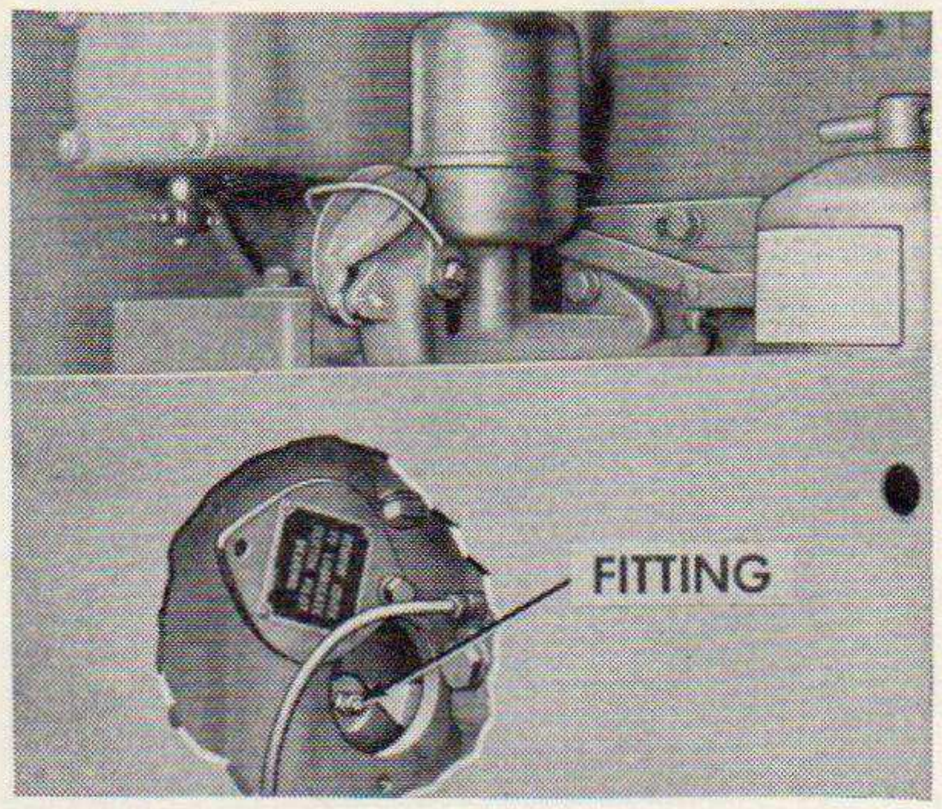
REF. 20—AXLE HOUSING BRACKET CAP, TANDEM DRIVE PIVOT

(Four fittings.) Two each side, clean fittings—apply lubricant through fittings. Drawbar hook mechanism (one fitting).



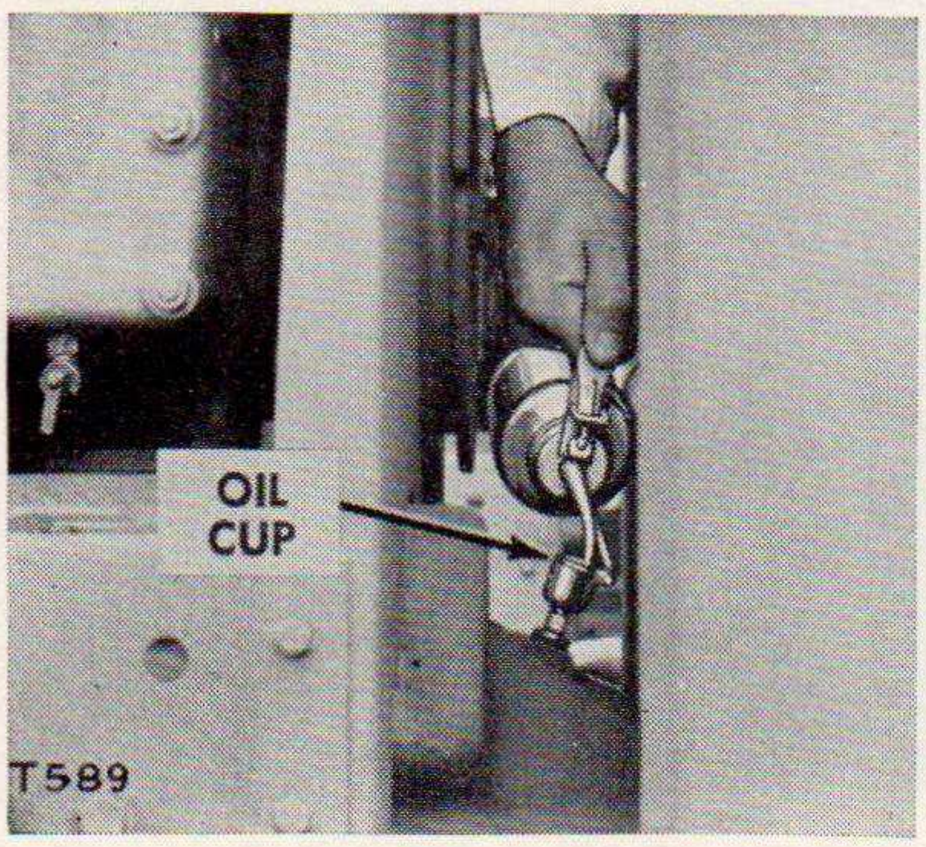
REF. 21—FLYWHEEL CLUTCH PILOT BEARING

(One fitting.) (Before 9K7650.) Remove cover and turn flywheel until fitting is visible. Apply two or three shots of lubricant through fitting.



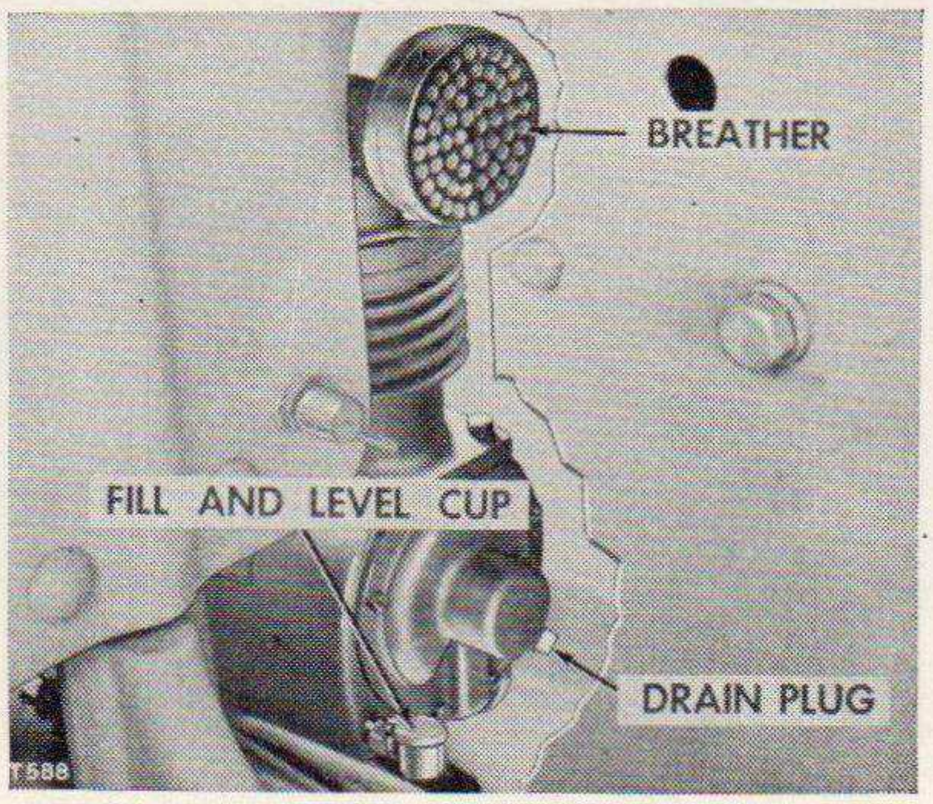
REF. 22—FLYWHEEL CLUTCH PILOT BEARING

(One fitting.) (After 9G7649.) Remove cover under crankcase filler, turn flywheel until fitting is visible. Apply two or three shots of lubricant through fitting.



REF. 23—FLYWHEEL CLUTCH RELEASE BEARING

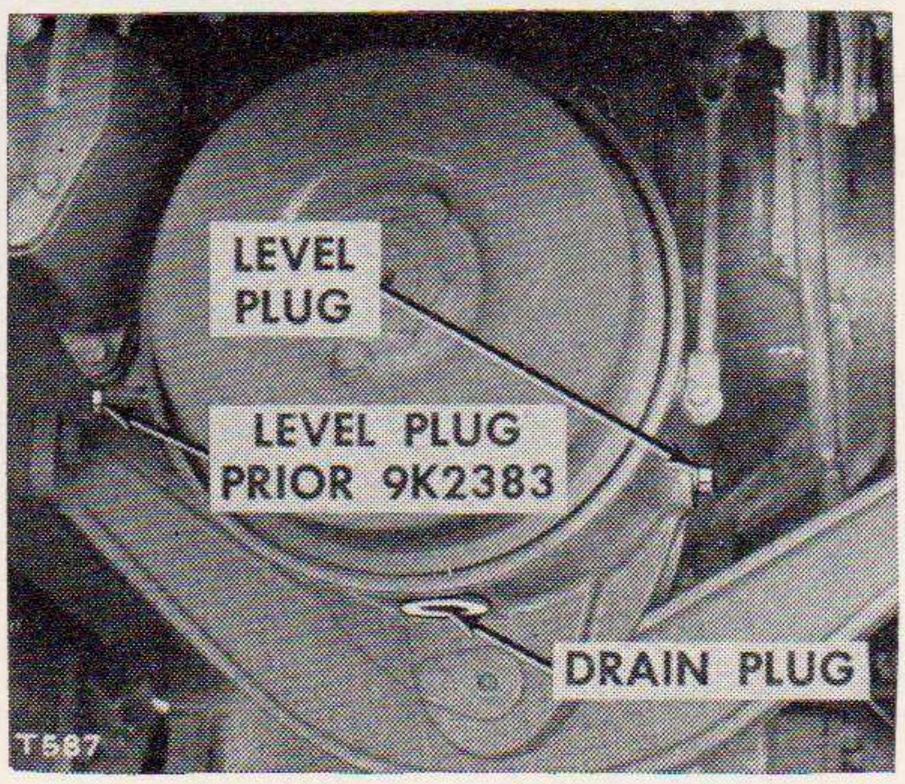
One oil cup—fill cup immediately before operation.



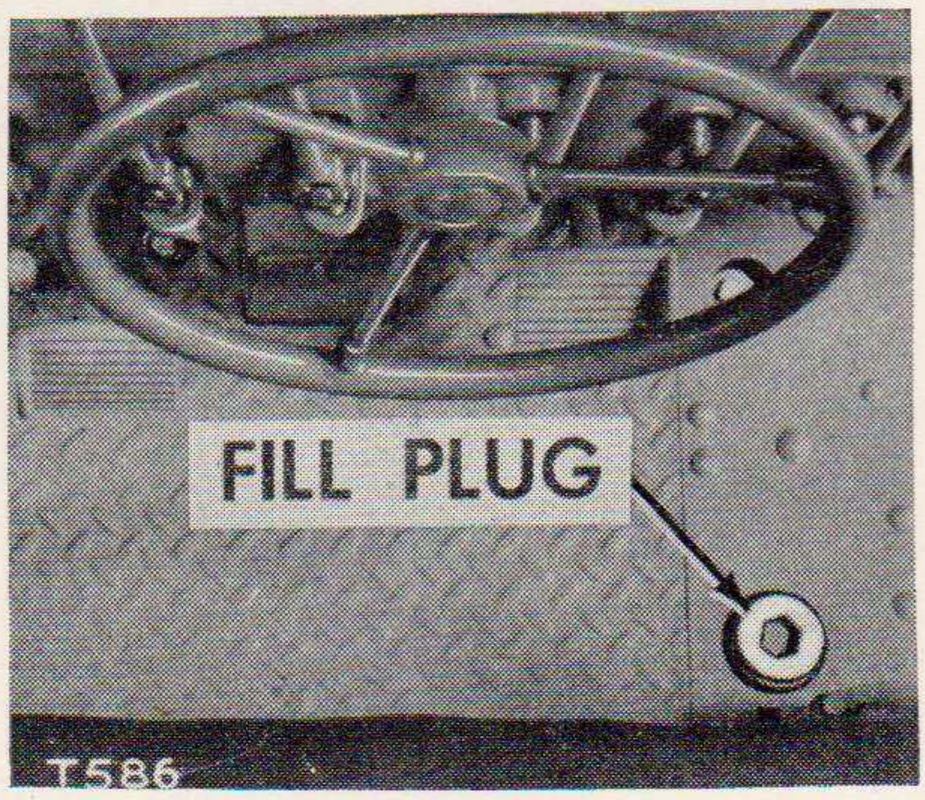
REF. 24—TIRE PUMP

Fill or replenish oil through oil cup.

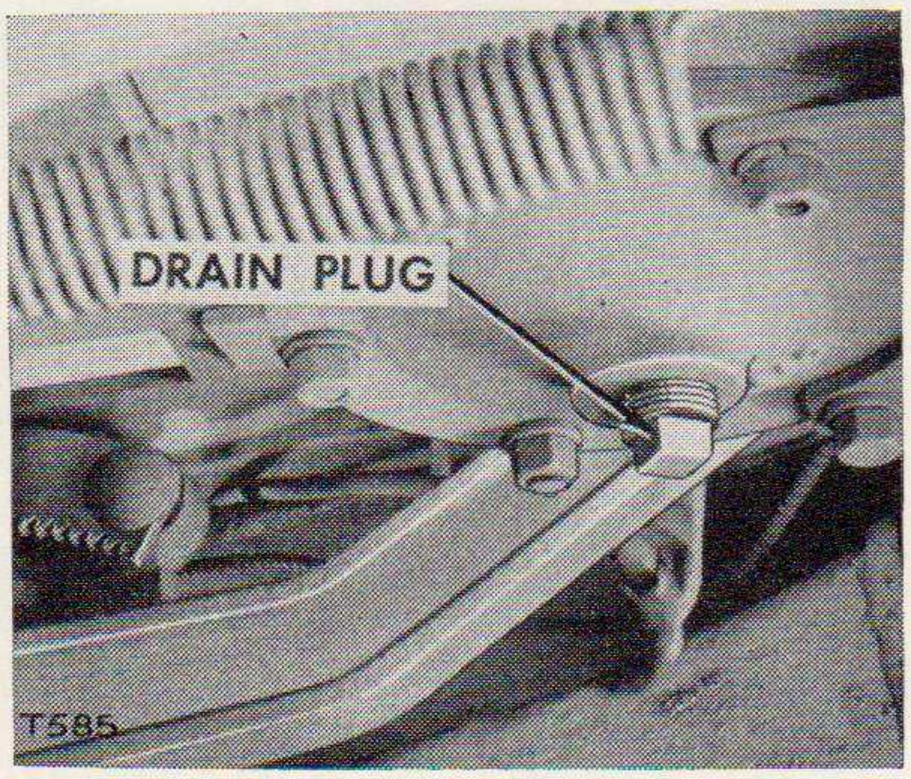
Keep oil level to top of filler cup. Drain when lubricant is warm.



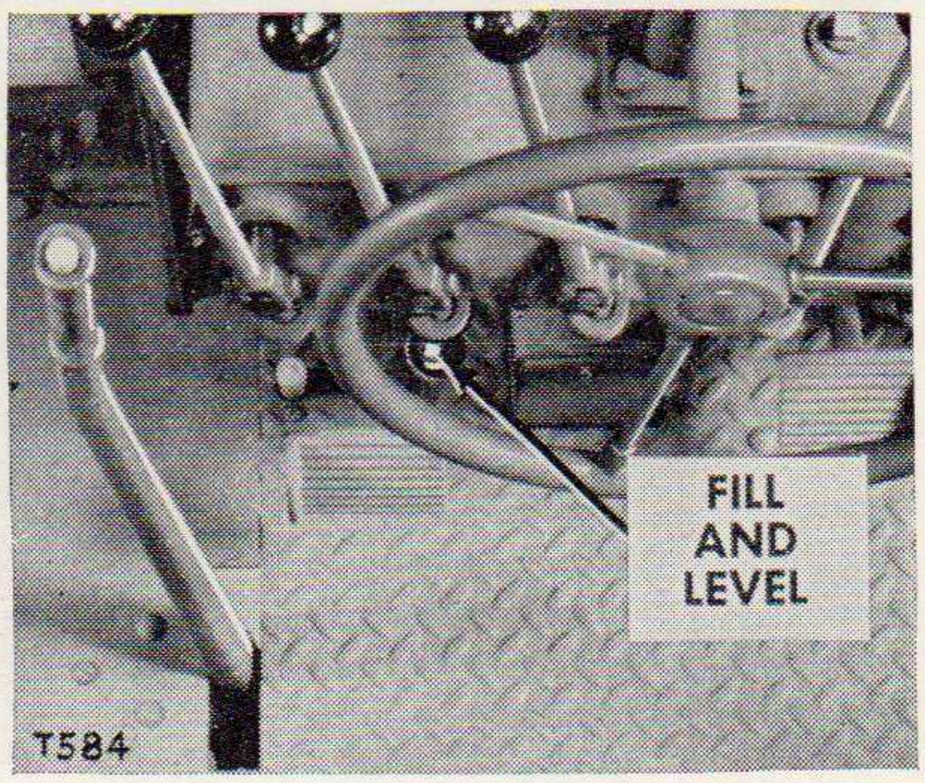
REF. 25—TRANSMISSION
Maintain oil level to level plug hole.
Drain when lubricant is warm. (On machines before 9K2383 level plug is on right hand side.)



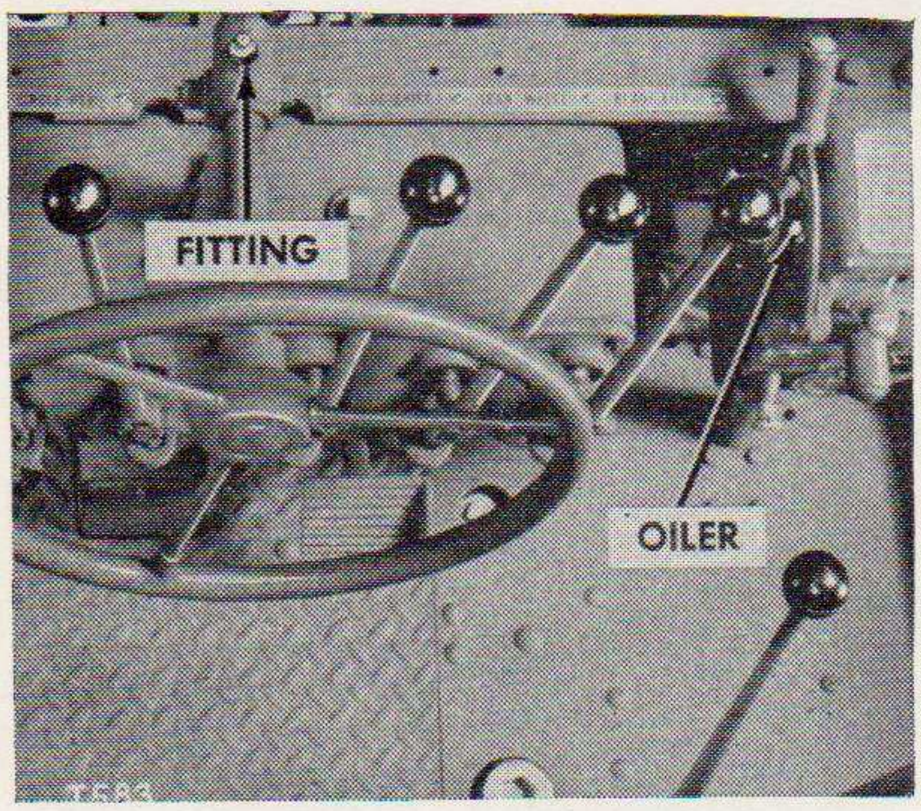
REF. 26—TRANSMISSION
Fill or replenish through filler pipe in floor plates.



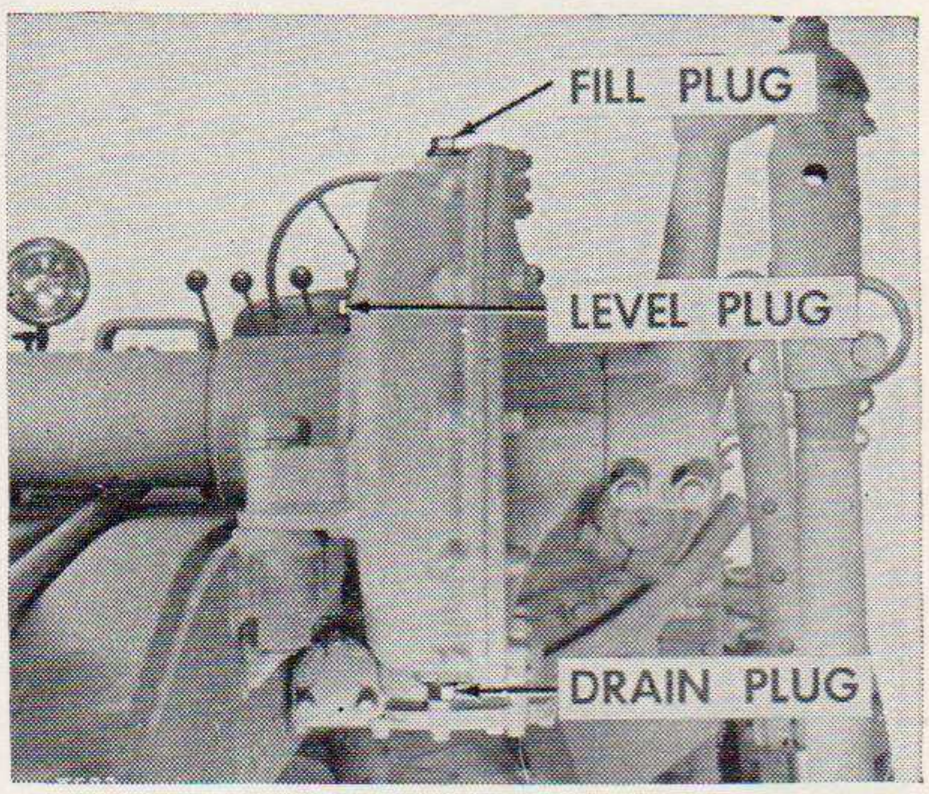
REF. 27—POWER CONTROL SHAFT HOUSING DRAIN PLUG
Drain when lubricant is warm.



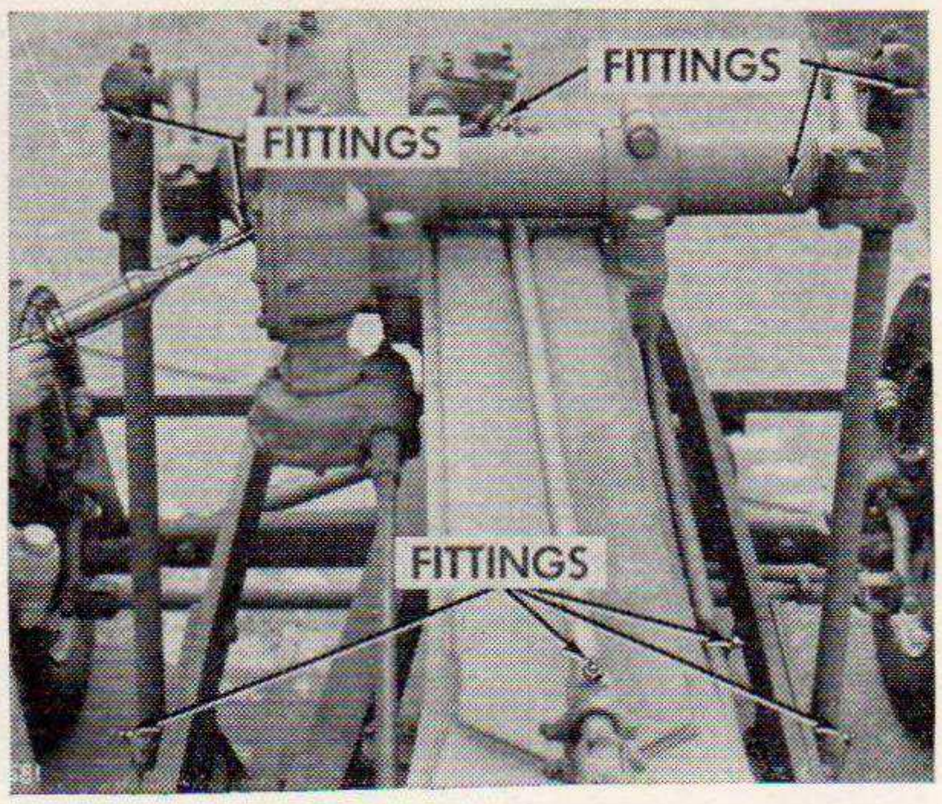
REF. 28—POWER CONTROL SHAFT HOUSING
Fill or replenish oil through filler opening. Maintain oil level to filler pipe elbow.



REF. 29—STEERING CONTROL SHAFT —THROTTLE CONTROL SHAFT
(One fitting.) (One oil cup.) Clean fitting. Apply lubricant through fittings.

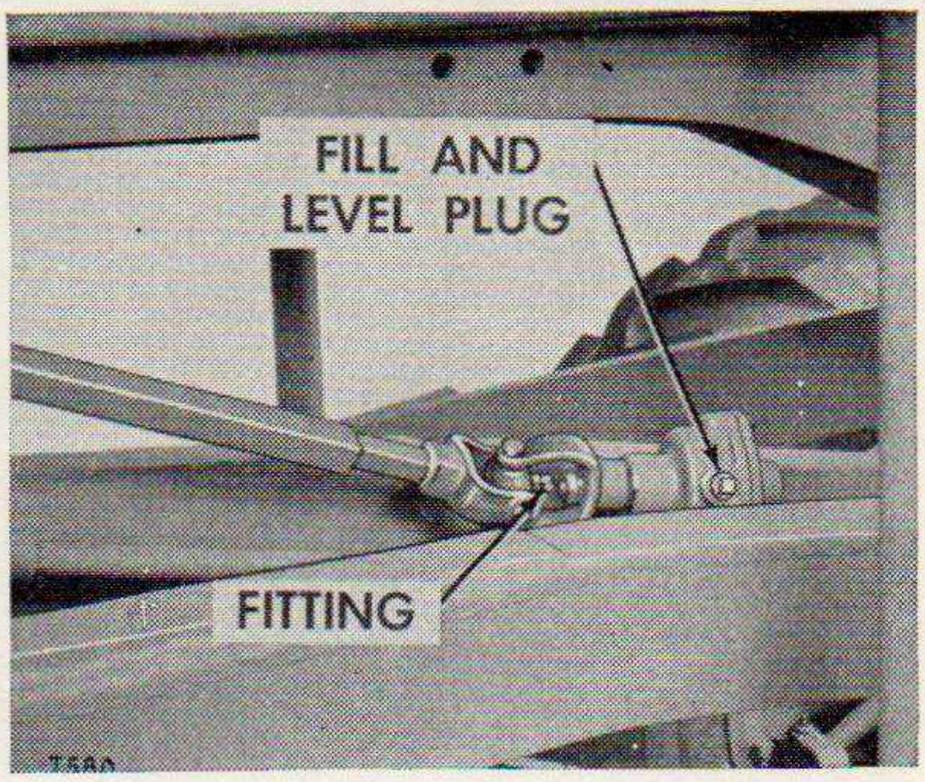


REF. 30—SCARIFIER CONTROL HOUSING
Fill or replenish through filler plug opening. Maintain oil level to level plug opening. Drain when lubricant is warm.



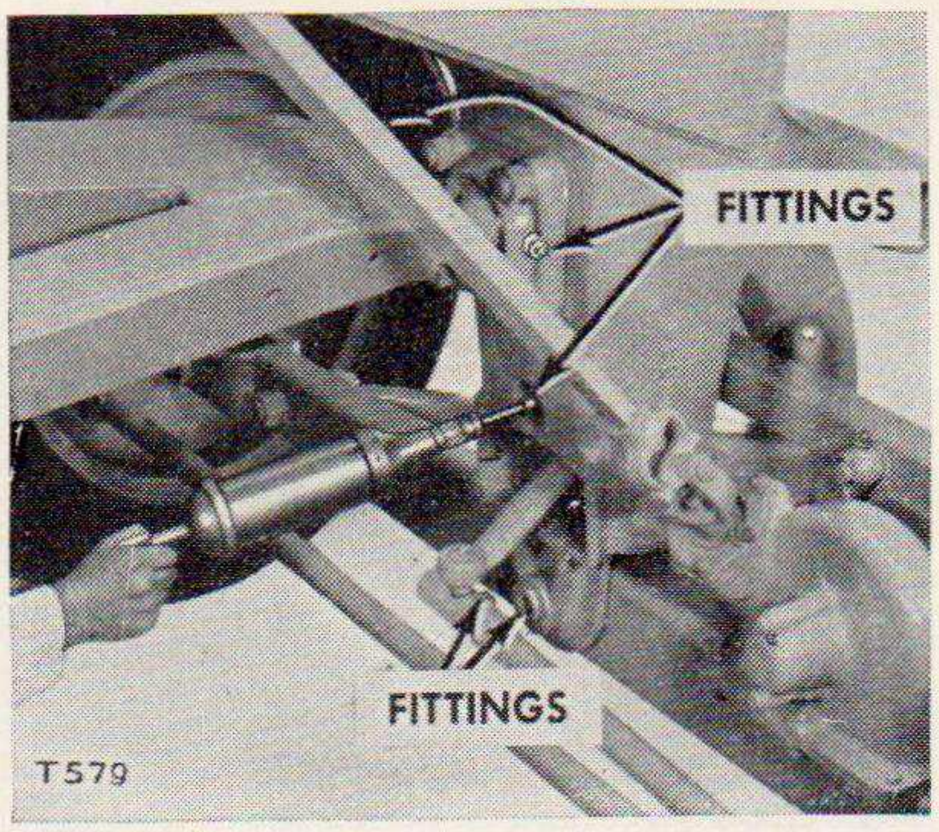
REF. 31—SCARIFIER CONTROL ARM SHAFT—SCARIFIER CONTROL ARM —STEERING CONTOL SHAFT BEARINGS

Nine fittings. Clean fittings, apply lubricant through fittings.



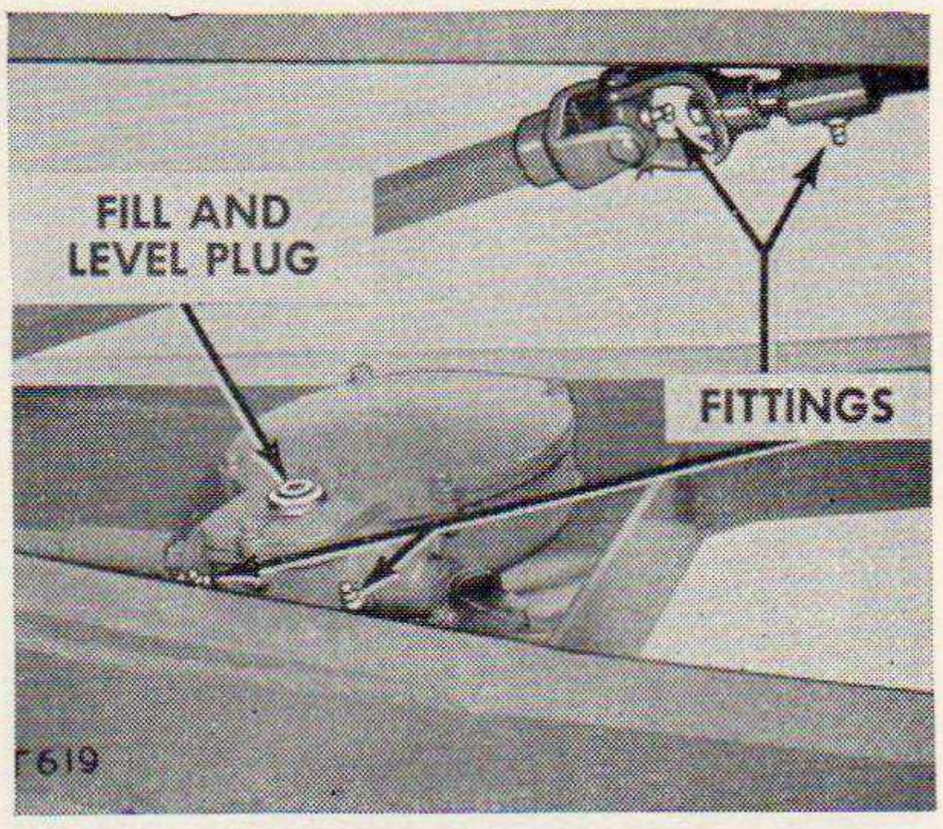
REF. 32—CIRCLE REVERSE CONTROL HOUSING

Fill and level plug and universal joint. (One plug.) (One fitting.) Maintain oil level to bottom of filler plug hole. Clean fitting, apply lubricant through fitting.



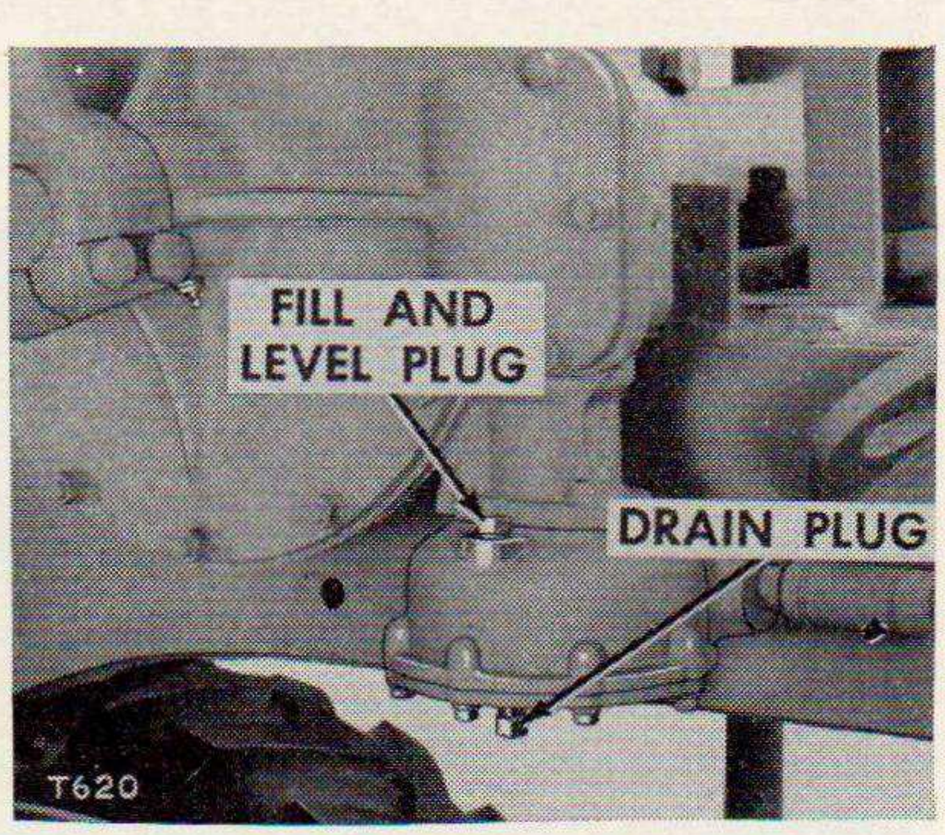
REF. 33—CIRCLE DRAFT BALL JOINT—STEERING GEAR SHAFT—DRAG LINK AND PIVOT PIN BEARINGS

Five fittings. Clean fittings, apply lubricant through fittings.



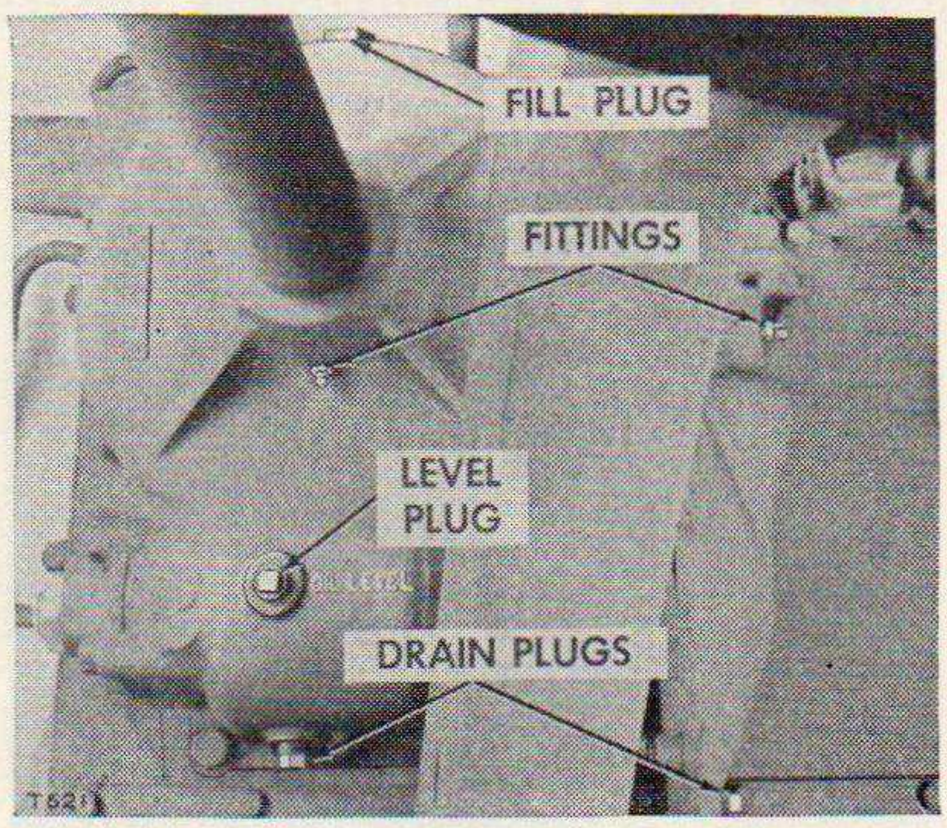
REF. 34—CIRCLE REVERSE HOUSING

Fill and level plug. Control shaft and universal joint bearings. Maintain oil level to bottom of filler plug opening. (Four fittings.) (Clean fittings, apply lubricant through fittings.)



REF. 35—SCARIFIER DRIVE HOUSING

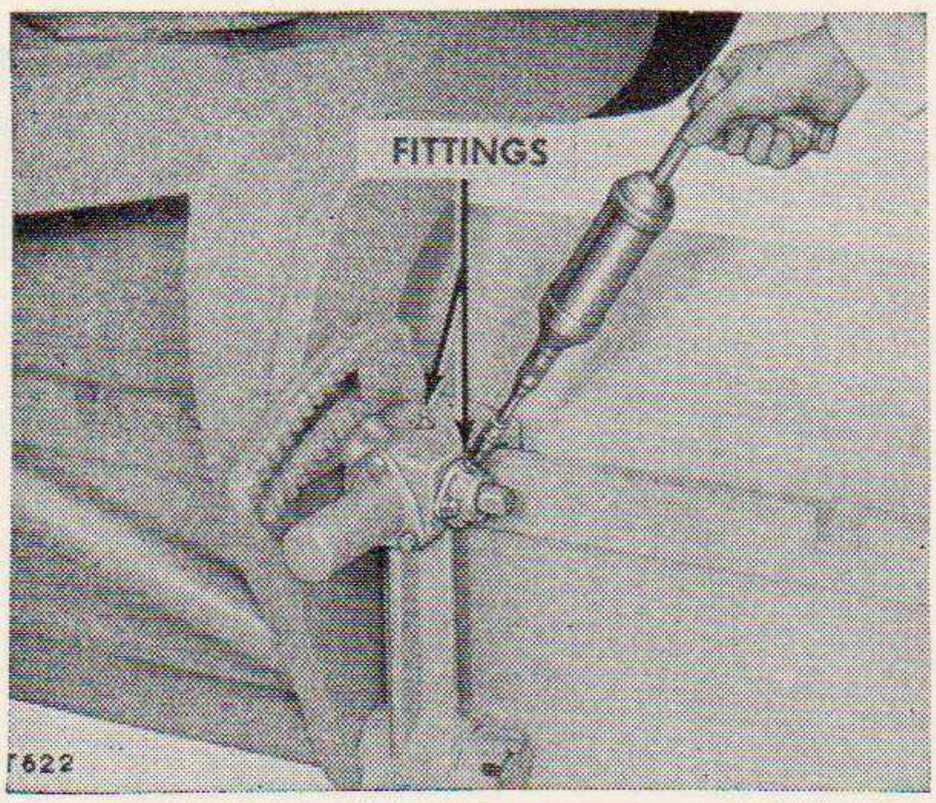
Fill and level plug. Drain plug. Maintain oil level to bottom of filler plug opening. Drain when lubricant is warm.



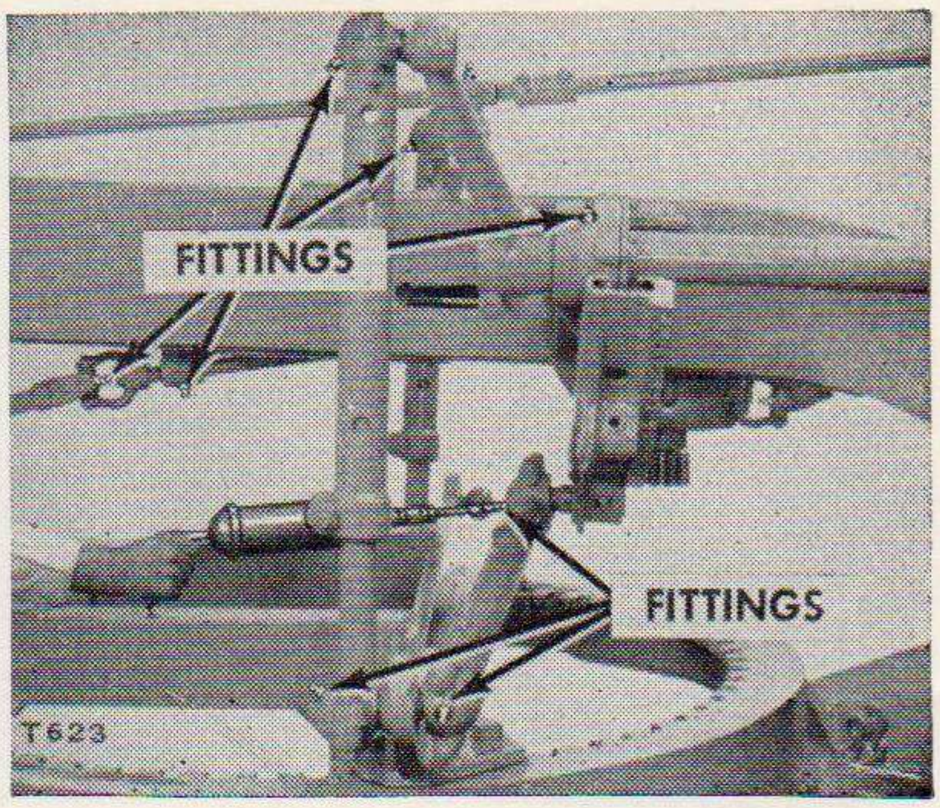
REF. 36—BLADE LIFT CONTROL HOUSING AND LIFT ARM CONTROL SHAFT

Fill, level and drain plugs and shaft bearings. Eight plugs—one fill, one level and two drain plugs each side. Fill or replenish oil through filler plug opening. Maintain oil level to level plug opening. Drain when lubricant is warm.

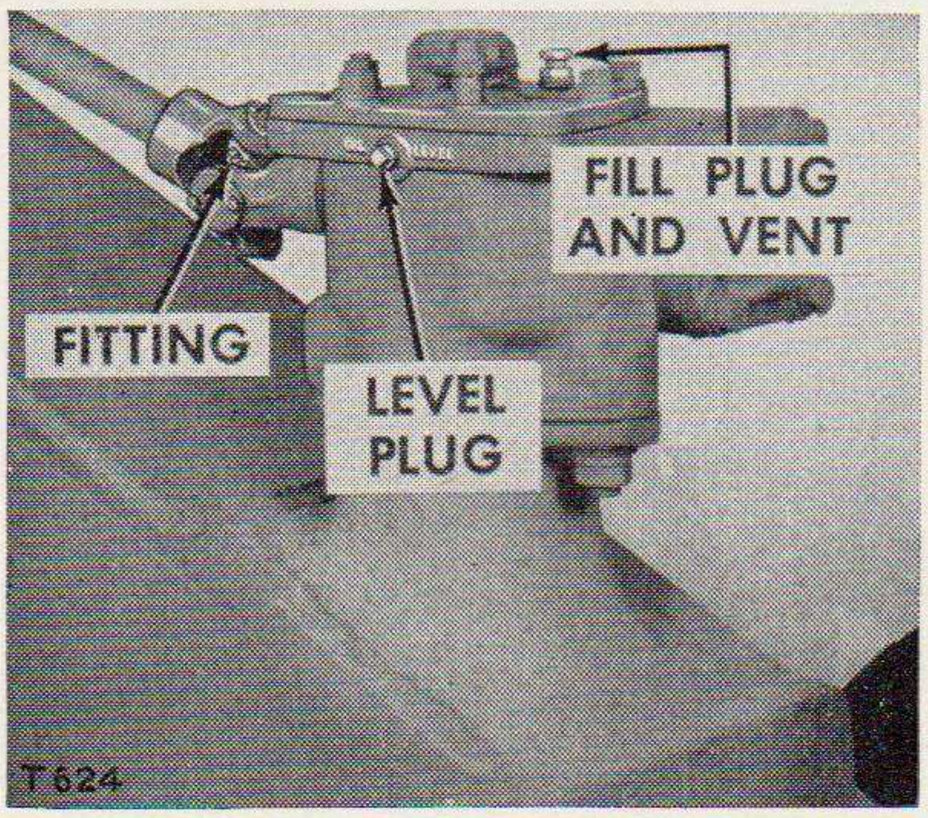
Four fittings (two each side). Clean fittings. Apply lubricant through fittings.



REF. 37—BLADE LOCKING MECHANISM
Four fittings—two each side. Clean fittings, apply lubricant through fittings.

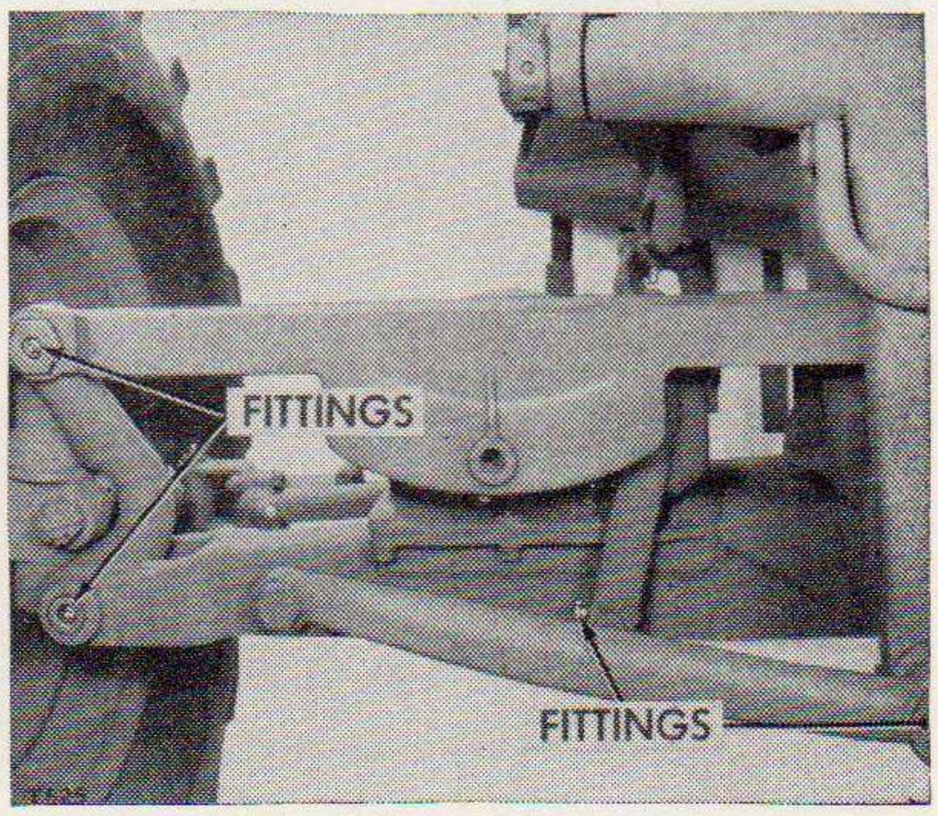


REF. 38—CIRCLE CENTER SHIFT LINK —LIFT ARM SHAFT—CIRCLE AND BLADE CONTROL ARM
Eight fittings. Clean fittings and apply lubricant through fittings.

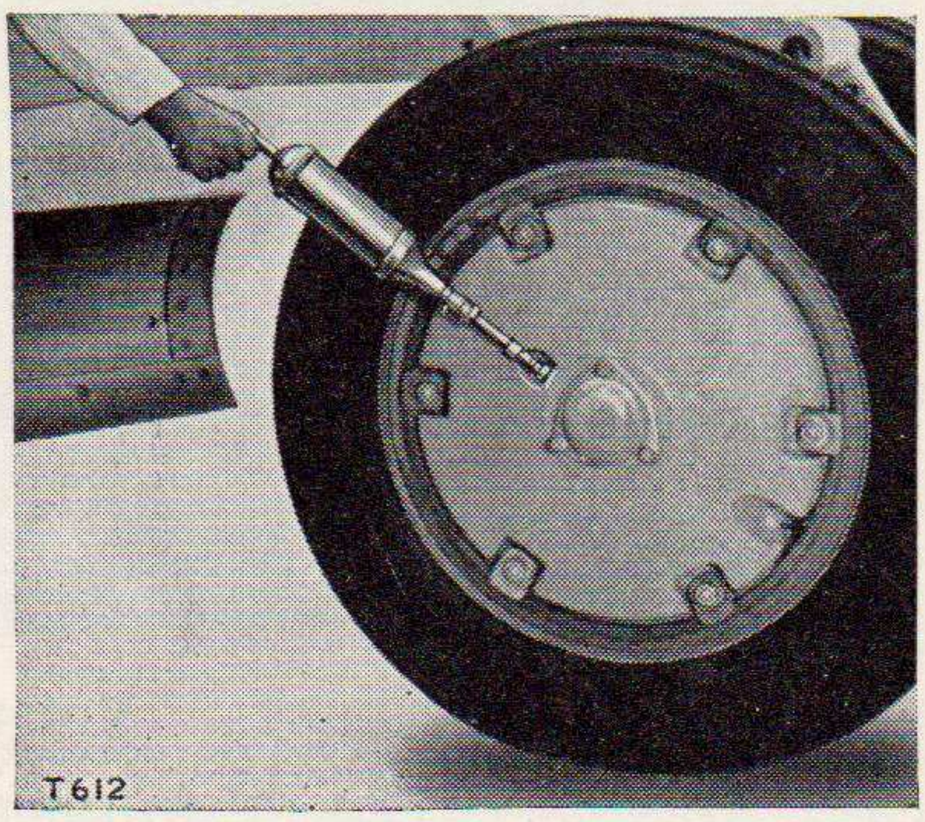


REF. 39—STEERING GEAR HOUSING
Remove combination, fill plug and vent to fill or replenish. Maintain oil level to level plug hole.

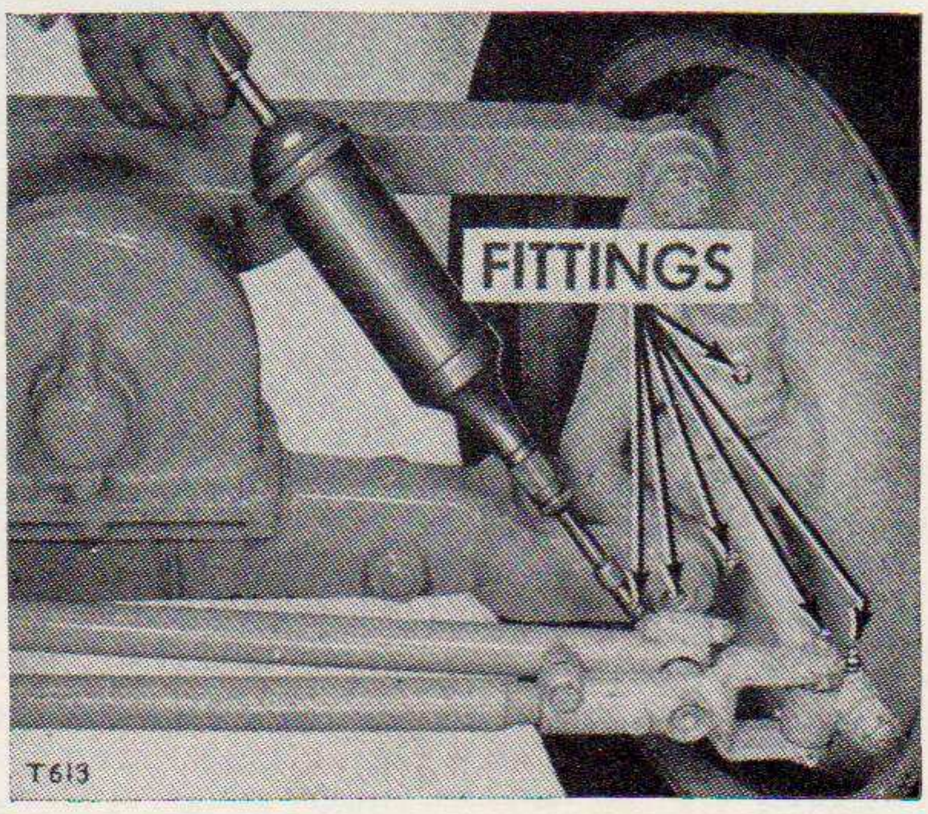
STEERING CONTROL SHAFT UNIVERSAL JOINT
(One fitting.) Clean fitting, apply lubricant through fitting.



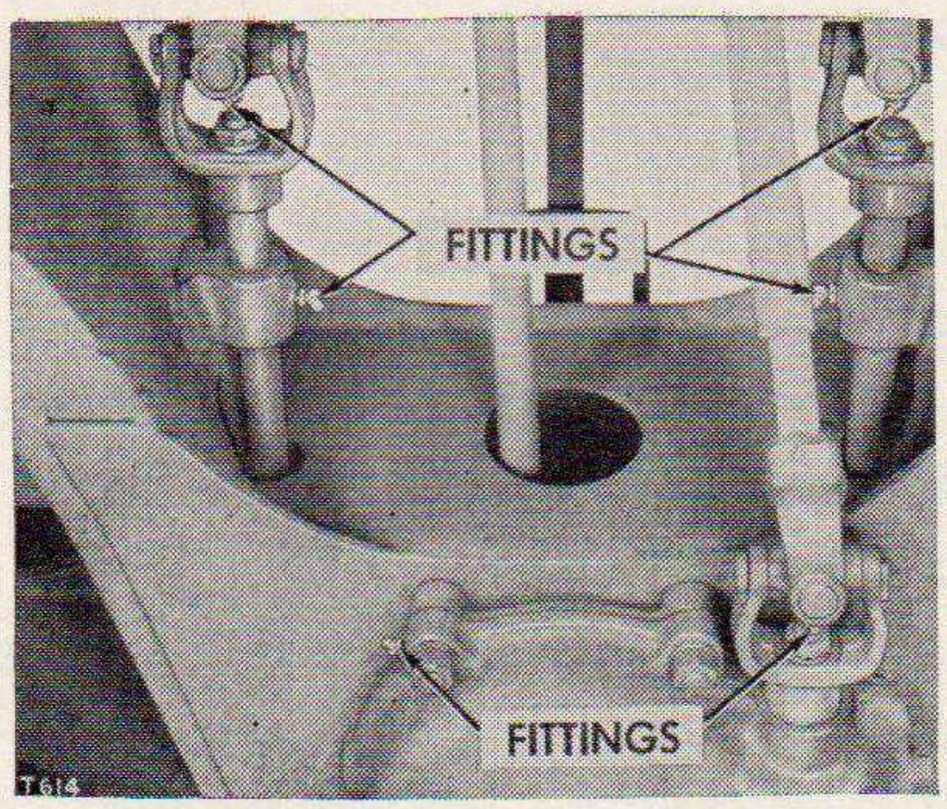
REF. 40—FRONT WHEEL LEAN AND UPPER AND LOWER BEARINGS
Four fittings—two each side.
Axle pivot bearing (one fitting). Control arm (one fitting). Clean fittings, apply lubricant through fittings.



REF. 41—FRONT WHEEL BEARINGS
Two fittings, one each front wheel. Clean fittings, apply lubricant through fittings. Remove wheels, clean and repack bearings.

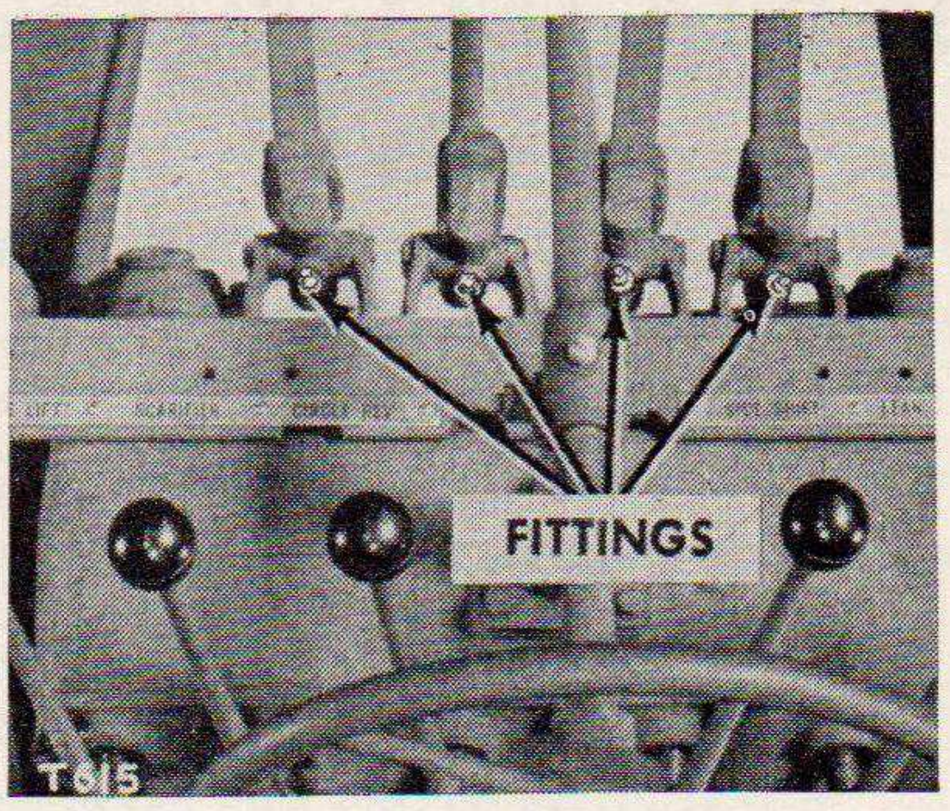


REF. 42—SPINDLE PINS, TIE ROD, DRAG LINK AND FRONT WHEEL LEAN BEARINGS
Twelve fittings—six each side. Clean fittings, apply lubricant through fittings.



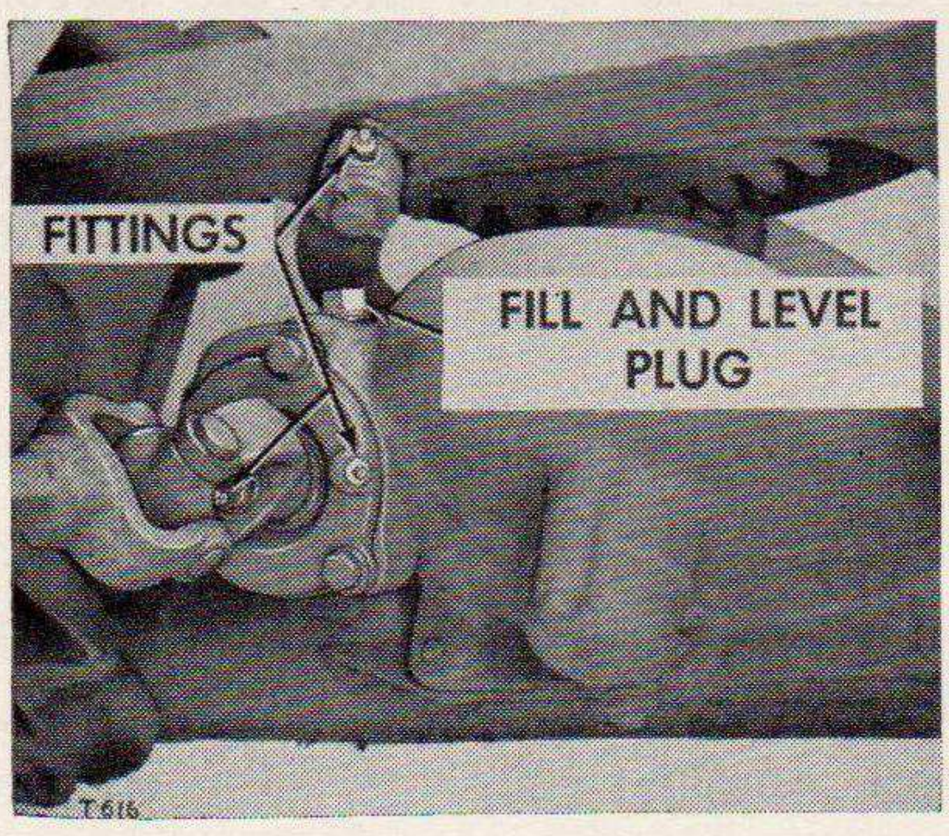
REF. 43—CONTROL SHAFTS—UNIVERSAL JOINTS AND CENTER SHIFT HOUSING BEARINGS

Six fittings. Clean fittings, apply lubricant through fittings.



REF. 44—CONTROL SHAFT—UNIVERSAL JOINTS

Four fittings—clean fittings, apply lubricant through fittings.

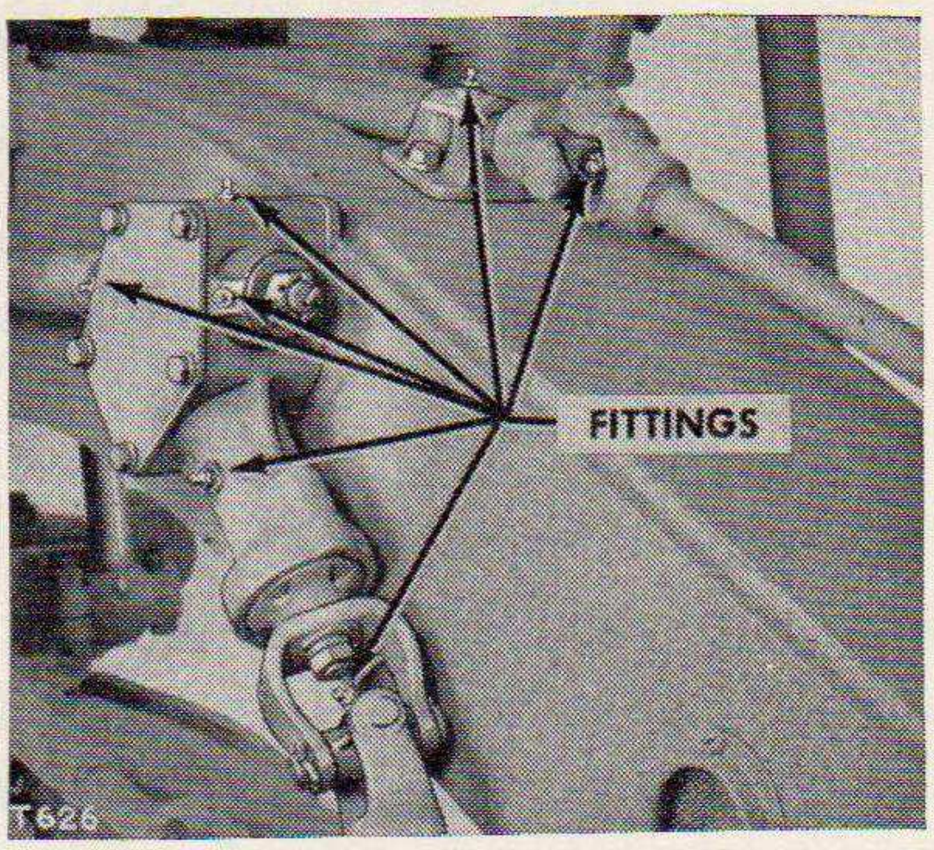


REF. 45—FRONT WHEEL LEAN CONTROL HOUSING

Fill and level plug. Remove filler plug to fill or replenish. Maintain oil level to bottom of filler plug hole.

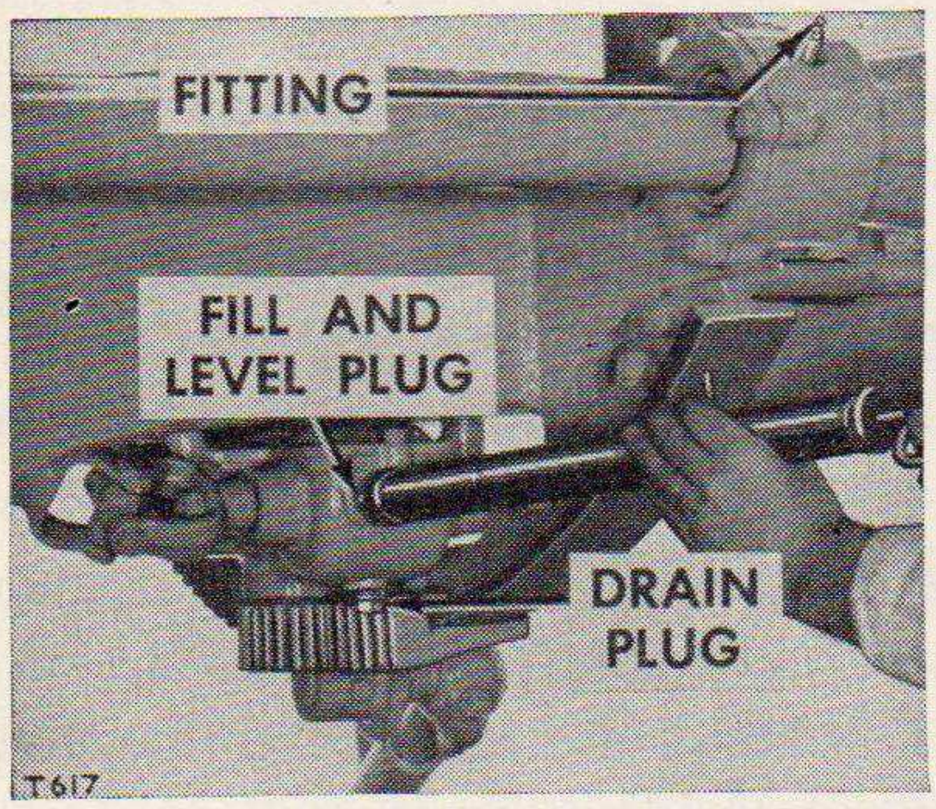
FRONT WHEEL CONTROL ARM—FRONT WHEEL CONTROL HOUSING BEARINGS

Three fittings (clean fittings). Apply lubricant through fittings.



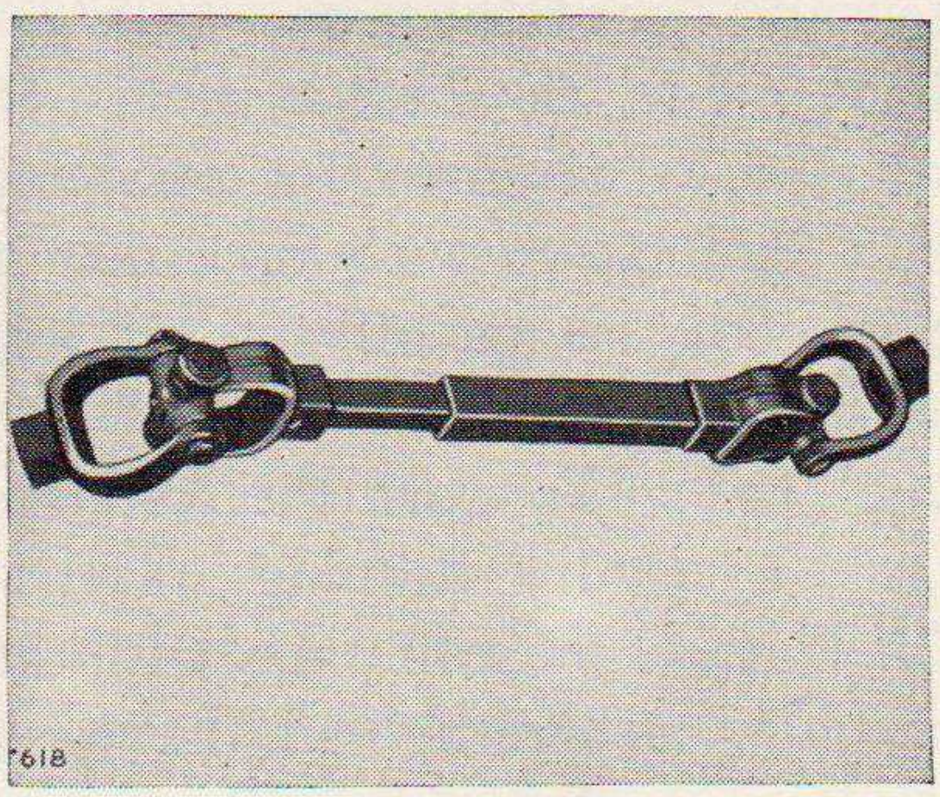
REF. 46—FRONT WHEEL LEAN CONTROL SHAFT HOUSING, BEARING AND UNIVERAL JOINTS—STEERING CONTROL SHAFT BEARINGS AND UNIVERSAL JOINTS

Seven fittings (clean and apply lubricant).



REF. 47—CENTER SHIFT CONTROL HOUSING

Fill or replenish through fill and level opening. Maintain level to level plug opening. Drain when lubricant is warm—Lift arm shaft bearing (two fittings). Clean fittings, apply lubricant through fittings.



REF. 48—UNIVERSAL JOINTS

Disconnect telescopic control shafts at universal joint. Slide apart and apply lubricant with a paddle. Reassemble the fork on each end of the shaft in the same plane (parallel to each other).

36. Detailed Lubrication Instructions

a. Air Cleaners.

(1) *Starting engine air cleaner.*

(a) *Air cleaner cup.* To change the oil in the air cleaner cup, unscrew the wing nut on top of the air cleaner and remove the filter section. Clean out the cup and refill with clean oil up to the oil level bead.

(b) *Filter.* The filter section can be cleaned by shaking it in a pan of dry cleaning solvent. Be sure there is a gasket between the air cleaner and its mounting as the connection must be air tight.

(2) *Diesel engine air cleaner.*

(a) *General.* The air cleaner does its work efficiently as long as the oil in the cup is thin enough to spray into the screen section and wash the dirt collected there back into the cup. When the oil becomes thickened with dust it is unable to do this. However, even in cold weather, the oil should not be too thin. Very thin oil can carry over in the intake manifold and carry dirt with it.

(b) *Pre-cleaner.* The pre-cleaner prevents the larger particles of dust from entering the air cleaner. It will function only when the glass jar is in place. Inspect the jar regularly and empty it when it is about half full of dust. The jar is removed by unscrewing the clamp that holds it in place. (On earlier tractors the jar is screwed in position on the pre-cleaner.) Inspect the fins in the pre-cleaner regularly and clean when dirty.

(c) *Air cleaner inlet pipe.* At the same time the oil in the cup is being changed, inspect the inlet pipe with the oil cup removed. Clean off any dirt that has collected on the walls of the pipe.

(d) *Air cleaner screens.* Six of the air cleaner screens can be removed for servicing. To remove the first screen, unscrew two wing nuts that hold it in place. The other screens will come off the air inlet pipe one at a time. If one of the screens is clean there is no reason for removing any above it. To wash the screens shake them in a pan of Diesel fuel or dry cleaning solvent. When replacing the screens arrange them in pairs with the cross arms facing each other. Be sure and tighten the wing nuts holding the screens to prevent them from vibrating and eventually disintegrating.

b. Diesel Engine Crankcase Breather. The breather is mounted on the crankcase oil filter assembly. The filter element fits in the cap assembly and can be removed by unscrewing the cap and prying the

element out of the cap. After the cap has been removed the skirt assembly can be lifted off of the oil filler assembly and cleaned.

c. Compartments Containing Lubricant. Mud, dust, or water should be prevented from entering all compartments containing lubricant. Excessive leakage of oil from a compartment indicates seals or gaskets are defective and should be replaced to prevent the entrance of dirt and water. If dirt is detected in a compartment the oil should be changed immediately but the mechanism should be disassembled and cleaned at the first opportunity.

Section XV. PREVENTIVE MAINTENANCE SERVICES

37. General

Regular execution of preventive maintenance services by the operator and maintenance personnel of the using organization is imperative to insure satisfactory operation of the equipment and to reduce the probabilities of mechanical failure.

38. Operator, Driver, or Crew Maintenance

a. Inspections must be made before operation, during operation, at halt, and after operation, as described in this section. Numbers appearing opposite the specified services correspond to those appearing on the reverse of WD Form 48 (Driver's Trip Ticket and PM Service Record). All inspections of assemblies, subassemblies, or parts must include any supporting members or connections and must determine whether the unit is in good condition, correctly assembled, secure, or excessively worn. Any deficiencies noted must be corrected or reported to proper authority. Any mechanical condition which may result in further damage to the unit must be corrected before equipment is operated.

(1) The inspection for "good condition" is usually an external visual inspection to determine whether the unit is damaged beyond safe or serviceable limits, or to determine if it is in such a condition that damage will result from operation. The term "good condition" is explained further by the following terms: not bent or twisted; not chafed or burned; not broken or cracked; not bare or frayed; not dented or collapsed; not torn or cut; adequately lubricated.

(2) The inspection of a unit to see that it is "correctly assembled" is usually an external visual inspection to determine whether it is in its normal assembled position in the vehicle.

(3) The check of a unit to determine if it is "secure" is usually an external inspection, a hand-feel, a pry-bar, or wrench check for looseness in the unit. Such an inspection should include

brackets, lock washers, lock nuts, locking wires, or cotter pins used in the assembly.

(4) "Excessively worn" means worn to or beyond serviceable limits, a condition likely to result in a failure if replacement of affected parts is not made before the next scheduled inspection.

b. Operator will report all deficiencies on WD Form 48, Driver's Trip Ticket and Preventive Maintenance Service Record.

c. Before-Operation Services. These services will be performed to determine whether condition of equipment has changed since last operated and to make sure machine is ready for operation. Any deficiencies must be corrected or reported to proper authority before unit is put in operation.

(1) *Item 1. Tampering and damage.* Check for tampering or damage which may have occurred since unit was last operated.

(2) *Item 2. Fire extinguisher.* See that extinguisher is in good condition, fully charged, and securely mounted. The state of charge of the carbon-tetrachloride type of extinguisher can usually be determined by tilting it from side to side. If carbon-dioxide (CO_2) type of extinguisher is used, see that the wire seal is in place. If seal is broken, extinguisher should be weighed to make sure it is fully charged. The empty weight of extinguisher is stamped on the head.

(3) *Item 3. Fuel, oil, and water.* Check fuel tanks to see that they are full. Check oil in Diesel- and starting-engine crankcases and coolant level in radiator. Oil level in Diesel engine crankcase should be slightly above full mark when engine is cold. When filling cold radiator containing antifreeze, allow room for expansion.

(4) *Item 4. Accessories.* See that accessories are properly mounted, in good operating condition, and that all connections are tight.

(5) *Item 6. Leaks, general.* Check entire unit for leaks, paying particular attention to lines and connections and to signs of leaks under machine. If leaks are noted, correct or report. Check affected levels and refill as necessary.

(6) *Item 7. Engine warm-up (starting and Diesel engines).* Before cranking starting engine, see that clutch and starter-pinion control levers and main transmission gear-selector lever are in disengaged position. After engine is started, allow it to warm up at fast idling speed. When engine is thoroughly warmed up, crank Diesel engine. As soon as Diesel engine starts, disengage starting-engine clutch and shut off fuel supply to stop starting-engine. Allow Diesel engine to run at half-open throttle for 5 minutes and at full governed speed for an additional 5 minutes before applying load. See paragraph 15.

(7) *Item 8. Choke (starting engine).* Use choke when starting cold engine. As soon as engine starts, adjust choke so engine runs normally. When engine is thoroughly warm, see that choke is fully open. See paragraph 12*b*.

(8) *Item 9. Instruments.* Check all gages for proper operation. At normal operating speed and temperature, gages should read as follows: engine oil pressure in OPERATING RANGE; fuel pressure in NORMAL range; coolant temperature, 175° to 185° F. See paragraph 14.

(9) *Item 12. Lamps.* Check lamps and switches for condition, secure mounting, and proper operation.

(10) *Item 14. Tires.* If high-pressure tires are used in front, inflate them to 70 pounds. If low-pressure tires are used in front, inflate them to from 28 to 30 pounds. Under usual operating conditions, rear tires should be inflated to 28 to 30 pounds. When operating in snow or sand 20 to 22 pounds of pressure in rear tires is permissible to secure better traction.

(11) *Item 24–2–d. Lubrication.* Lubricate as indicated in LO 5–1018 (see par. 35).

(12) *Item 21. Tools and equipment.* See that all tools and equipment assigned to the unit are serviceable, clean, and properly stowed or mounted. Check reserve supply of fuels and lubricants and replenish if necessary. See that containers are in good condition and that caps or lids fit tight.

(13) *Item 22. Engine operation.* Check engine for normal operation. If any unusual sounds or other unsatisfactory characteristics are noted, see that deficiencies are corrected.

(14) *Item 23. Operator's publications.* Operator must have required operator's permit in his possession. See that Standard Form 91 (Operator's Report of Motor Vehicle Accident), TM 5–1018, LO 5–1018, and TB 5–1018–1 on preventive maintenance services are on the equipment. See that all forms, manuals, or other publications are legible and safely stowed.

(15) *Item 25. During-operation check.* Before starting operation, see that all power-control levers operate properly. On models using sheer pins, see that extra pins are available. Check condition of scarifier-teeth tips and replace if necessary. See paragraph 23*d*. Check condition of moldboard cutting edge and end bits and reverse or replace as necessary. See paragraph 95*b*.

d. DURING-OPERATION SERVICES. The operator is responsible for correcting or reporting unusual sounds or odors, deficiencies in performance, or other signs of abnormal operation.

(1) *Item 27. Foot and hand brakes.* Check brakes for proper operation. Foot brakes should hold securely when pedal is depressed from one-half to three-fourths of the way down and should

be free from drums when pedal is released. Hand brake should hold securely when lever is pulled back approximately three-fourths of the distance on the quadrant.

(2) *Item 28. Clutch.* Check clutch for proper operation. Clutch should hold securely when fully engaged and should not drag when released.

(3) *Item 29. Transmission.* Check for unusual gear noise during operation. See whether gear and high- and low-range selector levers operate freely. Report any deficiencies noted.

(4) *Item 31. Engine and controls.* Check engine for unusual noise, lack of power, and response to controls.

(5) *Item 32. Instruments.* Check all gage readings frequently. If oil-pressure indicator shows an unusual drop or no pressure, stop engine immediately and report irregularity to proper authority. Do not operate until failure is corrected.

(6) *Item 33. Steering gear.* Check steering mechanism for proper operation. Steering should operate freely and there should be no excessive slack in steering connections.

(7) *Item 37–2–b. Controls.* See whether controls engage and release properly. To avoid breaking sheer pins, be sure to release control levers before limit of travel is reached.

e. AT-HALT SERVICES. During halts, even if only for short periods, the operator should make a general check of the equipment and correct or report any deficiencies noted, in addition to performing the following specific duties:

(1) *Item 53–2–b. Shut-down precautions.* When grader is stopped but engine is to be left running, move throttle-control lever to low idling position and move gear-selector lever to neutral position. See paragraph 15*f*. Before stopping engine, allow it to run for a few minutes at half-open throttle. To stop engine, move throttle lever to the extreme forward STOP position and place compression release lever in START position. See paragraph 15*g*.

(2) *Item 38. Fuel, oil, and water.* Check fuel supply, oil level in engine crankcase, and coolant level in radiator. Add fuel, oil, or coolant if necessary.

(3) *Item 43. Steering.* Correct or report any steering irregularities noted during operation.

(4) *Item 44. Wheel nuts.* See that all wheel and rim mounting studs and nuts are in place and secure.

(5) *Item 45. Tires.* Check tires for loss of air pressure, cuts, bruises, and embedded foreign matter. Record all time damage on WD Form 48.

(6) *Item 46. Leaks, general.* Check entire unit for leaks, paying particular attention to lines and connections and to signs of

leaks under machine. If leaks are noted, correct or report. Check affected levels and refill as necessary.

(7) *Item 47. Accessories and belts.* See that all accessories are in good operating condition and securely mounted. Check condition of belts.

(8) *Item 48. Air cleaner.* If operating under extremely dusty conditions, inspect air cleaner and service as required. See paragraph 36.

(9) *Item 53–2–a. General.* Check entire unit for loose or missing bolts and nuts and for bent, cracked, or broken parts.

(10) *Item 53–2–c. Lubrication.* Lubricate as specified in LO 5–1018. See paragraph 35.

f. After-Operation Services. To insure that machine is ready to operate at any time, the following services must be performed by the operator or crew immediately after any operating period of 8 hours or less. All deficiencies must be corrected or reported to proper authority.

(1) *Item 88–e. Shut-down precautions.* Place grader on firm footing, especially in freezing weather, using planking or other suitable material if necessary. Always let engine idle for a few minutes at half-open throttle before stopping. To stop engine, move throttle lever to the extreme forward STOP position and place compression release lever in START position. See paragraph 15*g*. If grader is to be left standing for any length of time, moldboard and cutting edges should be coated with grease to prevent rusting. See paragraph 95.

(2) *Item 54. Fuel, oil, and water.* Fill Diesel and starting-engine fuel tanks with clean fuel. Check oil in crankcases and fill to proper level with correct lubricant. Check coolant in radiator; proper level is at or near overflow when engine is hot. Change coolant if it is contaminated with oil, rust, or dirt. When using antifreeze, check its value. If antifreeze is added, mix solution thoroughly by running engine.

(3) *Item 55. Engine operation.* Correct or report unusual noises, insecure mountings, or performance irregularities noted during operation.

(4) *Item 56. Instruments.* See that all instruments are in good condition, securely mounted, and properly connected.

(5) *Item 59. Lamps and reflectors.* See that lamps are clean, in good operating condition, and securely mounted.

(6) *Item 60. Fire extinguisher.* See that extinguisher is in good condition, fully charged, and securely mounted. The state of charge of the carbon-tetrachloride type of extinguisher can usually be determined by tilting it from side to side. If carbon-dioxide (CO_2) type of extinguisher is used, see that the wire seal is in place. If seal is broken, extinguisher should be

weighed to make sure it is fully charged. The empty weight of the extinguisher is stamped on the head.

(7) *Item 63. Accessories and belts.* See that all accessories are securely mounted and in good operating condition. Check tension of Diesel-engine fan belt and starting-engine governor belt, and adjust if necessary. Correct deflection is 1 inch for Diesel-engine belt and ½ inch for starting-engine governor belt. See paragraphs 55 and 64.

(8) *Item 64. Electrical wiring.* Check all wiring for worn, cracked, frayed, and oil-soaked insulation; broken wires; and loose or corroded connections.

(9) *Item 65. Air cleaner.* Check oil and fill bowl to proper level. If oil is dirty, clean and refill bowl as specified in LO 5–1018. (See par. 35.) Clean precleaner jar. Reassemble cleaner and see that all connections are tight.

(10) *Item 66. Fuel filter (starting engine).* Remove and clean sediment bowl if it contains water or dirt. See that gasket is in good condition before replacing bowl.

(11) *Item 67. Engine controls.* Check for worn or disconnected linkage. Correct or report any unsatisfactory operation of engine controls.

(12) *Item 68. Tires.* Check tires for unusual wear, cuts, bruises, and underinflation. See that all valve caps are in place.

(13) *Item 70. Steering linkage.* Check steering linkage for bent and damaged parts and loose connections. See that all deficiencies are corrected or reported.

(14) *Item 73. Leaks, general.* Check entire unit for leaks, paying particular attention to lines and connections and to signs of leaks under machine. If leaks are noted, correct or report. Check affected levels and refill as necessary.

(15) *Item 88–a. General.* See that moldboard cutting edges and end bits and scarifier-teeth tips are in good condition and securely mounted. Check entire unit for loose or missing bolts and nuts, and tighten or replace as necessary.

(16) *Item 83. Lubrication.* Lubricate as indicated in LO 5–1018. (See par. 35.) See that all fittings and lines are in place and in good condition.

(17) *Item 84. Clean unit.* Remove all dirt, debris, and excess grease from entire unit.

(18) *Item 85. Tools and equipment.* See that tools and equipment assigned to the unit are serviceable, clean, and properly stowed or mounted. Check reserve supply of fuels and lubricants and replenish if necessary. See that containers are in good condition and that caps or lids fit tight.

(19) *Item 88–f. Protection.* Cover exhaust pipes if grader is stored outside. See that tool-compartment lid is closed and fastened.

39. Timely Maintenance and Safety Suggestions

a. Correct or report any mechanical deficiencies that may result in further damage to the unit if operation is continued.

b. Always stop engine and be sure machine will not move, before attempting adjustments, repairs, or lubrication.

c. Never pour cold water or other coolant into radiator while engine is hot as there is danger of cracking the cylinder head.

d. Always assume a safe position when inflating a tire to avoid the possibility of personal injury. (See par. 100 and fig. 119.)

e. See that moldboard and scarifier are raised clear of the ground so they do not drag backwards, before reversing the machine.

f. Keep transmission gears and clutch engaged when traveling down a steep grade.

g. Always keep fluid in brake master cylinder up to proper level to prevent air from entering hydraulic system.

h. Be sure the front-wheel tie-bar lock screw is removed before operating the front-wheel lean control lever (see par. 15*h*(6) and fig. 27).

40. Organizational Maintenance (Second Echelon)

a. Organizational preventive maintenance services are performed by organizational maintenance personnel, with the assistance of the operator, at monthly and weekly intervals. The W or weekly interval covers approximately 60 hours of use and the M or monthly interval is equivalent to four weeks of use. The column headed TI (Technical Inspection) is provided for the information and guidance of personnel performing technical inspection and constitutes the minimum inspection requirements for the equipment.

b. The preventive maintenance services to be performed at these regular intervals are listed and described below. The numbers appearing in the columns opposite each service refer to a corresponding number appearing on DA AGO Form 464 (Work Sheet for Preventive Maintenance and Technical Inspection of Engineer Equipment), and indicate that a report of the service should be made at that particular number on Form 464. These numbers appear in the second, third, or both columns as an indication of the interval at which the service is to be performed.

TI	*M*	*W*	
1	1	1	*Before-operation services.* Check and perform services required in items 1, 3, 6, 7, 9, 14, and 22 listed under Before Operation Services.

TI	M	W	
			STARTING ENGINE
26	26	26	*Air cleaner.* Inspect air cleaner for secure mounting and tight connections. Check condition and level of oil in bowl.
	26	26	Remove and wash filter section and oil bowl in fuel oil or solvent. Refill bowl to proper level with correct lubricant. See paragraph 35. Reassemble cleaner and see that all connections are tight.
28	28	28	*Cylinder head, manifold, and gaskets.* Inspect for cracks, leaks, and loose mounting bolts.
	28	28	On new or reconditioned engines, tighten bolts on cylinder heads at the first weekly service. Correct or report any other deficiencies noted.
29	29	29	*Crankcase, breather.* Inspect crankcase for leaks. Check oil level. Check condition and mounting of crankcase breather.
	29	29	Drain crankcase and refill with correct lubricant at interval specified in LO 5–1018. See paragraph 35. Perform this service while engine is warm. Remove and wash crankcase breather at each oil change. Correct or report any leaks noted.
31	31		*Ignition system.* Inspect spark plugs for condition and proper adjustment. Correct point gap is 0.022 inch. Check condition and adjustment of magneto breaker points. Correct gap is 0.020 inch.
	31		Clean spark plugs and adjust point gap. See that plugs and gaskets are in good condition before replacing. Adjust magneto breaker points if necessary. Replace if badly burned or pitted. See paragraph 50. See that wiring is clean and in good condition.
32	32	32	*Carburetor and governor.* Inspect carburetor and governor for secure mounting. Check all connections for leaks. Check governor for proper operation. Check condition and tension of belt; allow ½ inch deflection.
	32	32	Tighten any loose mounting bolts or leaky fuel line connections. See that linkage is in good condition and operates freely. Clean fuel filter if sediment bowl contains water or dirt. See paragraph 51. Adjust governor drive belt if necessary. See paragraph 55. Replace if frayed or badly worn.
33	33	33	*Clutch and starter pinion.* Check clutch for proper operation and adjustment. Clutch should engage smoothly, with a distinct snap, and a reasonably hard lever action. Check clutch housing for correct oil level. Check starter pinion for proper operation. Pinion should move freely, should stay engaged while Diesel engine is being cranked, and should release promptly when engine starts.
	33	33	Adjust clutch if necessary. See paragraph 53. Add or change oil as indicated in LO 5–1018. See paragraph 35. Adjust starter-pinion latch springs if necessary. See paragraph 54. Make sure latch springs are not adjusted too tight, as overspeeding and damage to starting engine may result if pinion does not release promptly as soon as Diesel engine starts.
			DIESEL ENGINE
43	43	43	*Fuel tank, filler element, cap, and gasket.* Inspect fuel tank and lines for condition and secure mounting. Check all connections for leaks.
	43	43	Tighten any loose mounting bolts and correct any leaks noted. Open drain cock in bottom of fuel tank and drain out any sediment or water that may have accumulated. Remove filler-cap elements, and wash cap and elements in fuel oil or solvent. Reassemble and

reoil elements. See that gasket is in good condition and cap fits securely. Remove and clean fuel tank vent line if necessary. See paragraph 67.

16 16 16 *Radiator and oil cooler.* Inspect radiator and oil cooler for leaks and insecure mounting, and for obstructions in core air passages. Check engine operating temperature and condition of coolant. If antifreeze is used, check its value.

16 16 Tighten any loose mountings and correct any leaks. Flush and refill radiator if coolant is contaminated with oil, rust, or dirt. Remove and clean pressure overflow valve if necessary. See paragraph 65. Clean guard and core air passages. Protect coolant from freezing and record its value on DA AGO Form 464.

17 17 17 *Water pump, fan, and shroud.* Inspect pump for leaks and wear. Check fan blades and shroud for condition, alinement, and secure mounting.

17 17 Tighten fan and shroud mounting bolts, if necessary, and correct any misalinement. If pump leaks, replace with new or reconditioned pump.

18 18 18 *Belts and pulleys.* Check condition and tension of fan belt; allow 1-inch deflection. Inspect alinement and condition of pulleys.

18 18 Adjust tension of belt if necessary and correct any misalinement. Replace frayed or badly worn belt. See paragraph 64.

11 11 11 *Cylinder heads, manifold, and gaskets.* Inspect for cracks and leaks. Check condition and mounting of exhaust pipe.

11 11 On new or reconditioned engines, tighten cylinder-head stud nuts at the first weekly service. Nuts should be tightened to 71 foot pounds. See paragraph 60. Valve-clearance adjustment must be made after tightening stud nuts.

12 12 *Valve mechanism.* Check condition of valve mechanism. Check tappet adjustment while engine is hot. Correct adjustment is 0.010 inch for both intake and exhaust.

12 Adjust valve clearance if necessary. See paragraph 61. Valve-clearance adjustment must be made, or clearance checked, with compression-release lever in RUN position.

14 14 14 *Crankcase, breather.* Inspect crankcase for leaks. Check oil level. Check condition and mounting of crankcase breather.

14 14 Drain crankcase and refill with correct lubricant at interval specified in LO 5–1018. Perform this service while engine is warm. Remove, wash, and reoil breather at each oil change. See paragraphs 35 and 36.

15 15 15 *Oil filter.* Inspect filter assembly and connections for leaks while engine is running.

15 15 Clean and replace filter elements as specified in LO 5–1018. See paragraph 35. After reassembling filter, check carefully for leaks while engine is running.

41 41 41 *Air cleaner.* Inspect air cleaner for secure mounting and tight connections. Check condition and level of oil in bowl. Check precleaner dust-collector jar for excessive accumulation of dust.

41 41 Remove and clean oil bowl and screens and dust-collector jar as specified in LO 5–1018. See paragraph 35. See that all connections are tight after reassembling.

40 40 40 *Filter (Diesel fuel).* Inspect filter housing, lines, and connections for leaks while engine is running. Check for proper fuel pressure.

	40	40	Drain water and sediment from filter housing. If fuel pressure drops below the NORMAL range with engine running at normal operating speed, absorbent filter elements must be replaced. See paragraph 69. After draining filter housing or installing new filter element, fuel system must be primed. See paragraph 70.
42	42	42	*Nozzles, injector (pump).* Inspect injector-pump housing, lines, and connections for leaks. See whether engine runs irregularly or if exhaust shows an excessive amount of smoke.
	42	42	Correct any leaks noted. If engine runs irregularly or if exhaust shows an excessive amount of smoke, check injector valves and clean or renew as necessary. See paragraph 71.
47	47	47	*Battery.* Inspect battery and cables for condition and secure mounting. Check level of solution. Check specific gravity and record readings on DA AGO Form 464.
	47	47	Clean battery and terminals with brush or dampened cloth and apply thin film of CG over terminals. Add distilled water if necessary. See that caps are tight and ventholes are open. See paragraph 76.
48	48	48	*Generator.* Check generator for secure mounting. Inspect commutator and brushes for wear and oil deposits.
	48	48	Replace brushes if badly worn. Clean commutator if necessary. See paragraph 78.
50	50	50	*Wiring, switches.* Check all wiring for worn, cracked, frayed, and oil-soaked insulation; broken wires; and loose or corroded connections. See that switches are securely mounted and in good operating condition. Correct any deficiencies noted.
52	52	52	*Lights.* See that all lights are in good condition and securely mounted, and that they operate properly.

POWER-TRANSMISSION UNITS, FRAME, AND MOUNTINGS

95	95	95	*Master clutch.* Inspect clutch for proper operation and adjustment. Adjustment is correct when there is 3/16-inch clearance between the clutch-release bearing and the end of the release levers. Inspect clutch facings for excessive wear.
	95	95	Adjust clutch if necessary. See paragraph 81. If clutch facings show excessive wear report to proper authority. Remove clutch-housing drain plug to drain out any accumulation of oil. Lubricate pilot and release bearings as specified in LO 5–1018. See paragraph 35.
93	93	93	*Transmission.* Check transmission for any unusual noise during operation. See whether gear-selector levers operate freely through all positions. Check for correct oil level.
	93	93	Correct or report any deficiencies noted. Fill case to proper level with correct lubricant as specified in LO 5–1018. See paragraph 35.
82	82	82	*Rear axle.* Check oil in axle housing and fill to proper level with correct lubricant as specified in LO 5–1018. Service breather as required. See paragraph 35.
106	106	106	*Tandem drive.* Check tandem-drive housings for proper oil level. Add oil if necessary. Service breathers as required. See LO 5–1018.
99	99	99	*Service brakes.* Check brakes for proper operation and adjustment. Inspect entire hydraulic system for leaks. Check master cylinder for correct oil level. Proper level is ½ inch below filler plug. Check brake lining for excessive wear.

TI	M	W	
			POWER-TRANSMISSION UNITS, FRAME, AND MOUNTINGS—*Continued*
	99	99	Adjust brakes if necessary. See paragraph 86. Correct any leaks noted. Fill master cylinder to proper level. See that brake shoes are replaced before lining is worn flush with rivets.
100	100	100	*Emergency brake.* Check brake for proper adjustment. Brake should hold securely when lever is pulled back approximately three-fourths of the distance on the quadrant.
	100	100	Adjust brake if necessary. See paragraph 88. Be sure brake is free from drum when brake is released.
79	79	79	*Front wheels.* Inspect wheel bearings for proper adjustment. If any in-and-out movement can be detected, bearings should be adjusted. Check wheels for correct amount of toe-in. Wheels should toe-in ¼ inch.
	79	79	Adjust wheel bearings or correct toe-in, if necessary. See paragraph 92. Remove, clean, and repack wheel bearings at interval specified in LO 5–1018. See paragraph 35.
56	56	56	*Steering assembly.* See whether all steering connections are in good condition, properly adjusted, and lubricated. Check all rods and levers for bends and twists.
	56	56	Adjust any loose steering connections. Straighten or replace any bent or twisted rods or levers.
76	76	76	*Tires.* Inspect tires for cuts, bruises, and embedded foreign matter. Check for proper inflation. If high-pressure tires are used in front, inflate to 70 pounds. Low-pressure tires, front and rear, should be inflated to from 28 to 30 pounds.
	76	76	Inflate tires to correct pressure. Report all bad cuts and bruises. See that all valve caps are in place.
80	80	80	Frame. Check for cracks, breaks, broken welds, and misalinement. See that all mounting bolts and nuts are in place and secure.
			POWER-CONTROL SYSTEM
64	64	64	*Gear housings.* Inspect all gear housings for condition and secure mounting. Check for leaks.
	64	64	Tighten any loose mounting bolts and correct any leaks noted. Lubricate as specified in LO 5–1018. See paragraph 35.
62	62	62	*Control levers.* Inspect all control levers for condition, secure mounting, and proper operation. See whether clutches engage and release properly and if power is transmitted to units and attachments. If power is not transmitted, with control lever in proper position, check for broken sheer pin.
	62	62	Renew sheer pins if necessary. Correct any other deficiencies noted. See paragraph 90.
66	66	66	*Bearings and shaft.* See that control-system shafts, bearings, and lift arms are in good condition, securely mounted, and properly adjusted and lubricated. See paragraph 90.
63	63	63	*Universal joints, ball-and-socket joints.* Inspect universal and ball-and-socket joints for excessive wear, damage, and looseness. Check for proper lubrication.
	63	63	Replace universal joints if badly worn or damaged. Adjust ball-and-socket joints if necessary. See paragraph 90.
65	65	65	*Gears and pinions.* Check exposed gears and pinions for excessive wear and damage.
	65	65	Report any deficiencies noted.

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TI	M	W	
			ATTACHMENTS
124	124	124	*Cutting edge, end bits, teeth.* Check moldboard cutting edge and end bits and scarifier-teeth tips for excessive wear and damage.
	124	124	Replace badly worn or damaged cutting edge and teeth tips, and reverse or replace end bits as necessary. Always change cutting edge, end bits, or teeth tips before they are worn to the point where wear will occur on moldboard or scarifier teeth.
			GENERAL
2	2	2	*Lubrication.* Lubricate as specified in LO 5–1018. See paragraph 35. See that all lines and fittings are in place and in good condition.
3	3	3	*Tools and equipment.* See that tools and equipment assigned to the unit are serviceable, clean, and properly stowed or mounted. Check reserve supply of fuels and lubricants and replenish if necessary. See that containers are in good condition and that caps or lids fit tight.
4	4	4	*Fire extinguisher.* Inspect for full charge, proper working order, and secure mounting.
	4	4	See that extinguisher is refilled if necessary. To avoid serious corrosion when refilling the carbon-tetrachloride type of extinguisher, see that no moisture comes in contact with the extinguisher or with the carbon tetrachloride during refilling operation.
5	5	5	*Publications.* See that TM 5–1018, LO 5–1018, TB 5–1018–1 on preventive maintenance services, and Standard Form 91 are on the equipment and in serviceable condition.
6	6	6	*Appearance.* Inspect machine for condition of paint and for markings, damage, and general appearance. See that hood and tool compartment are in good condition.
7	7	7	*Modification.* See if all available modification work orders applying to this machine have been completed and are recorded on WD AGO Form 478 (MWO and Major Unit Assembly Replacement Record and Organizational Equipment File).

Section XVI. TROUBLE SHOOTING GUIDE

41. Starting Engine

a. Starting Engine Will Not Start.

Possible Cause	*Possible Remedy*
(1) Lack of gasoline in tank.	Fill tank.
(2) Water in gasoline or gasoline of improper quality.	Drain and refill with good gasoline.
(3) Gasoline not reaching carburetor.	
(a) Gasoline shut off at tank.	Turn valve "ON" under gasoline tank.
(b) Clogged vent in filler cap.	Remove dirt from hole in cap.
(c) Dirt or ice in sediment bowl.	Remove and clean.
(d) Clogged filter within sediment bowl.	Remove and wash. (See par. 51.)
(e) Clogged gasoline line.	Remove and clean.
(4) Flooded engine.	Turn gasoline off at tank, open draincock and spin the starting engine to blow out accumulated gas.

Possible Cause	*Possible Remedy*
(a) Improper use of choke.	(See par. 12*b*.)
(b) Dirty starting engine cleaner.	Service air cleaner. (See par. 35.)
(c) Float and valve in carburetor not functioning.	Report to proper authority.
(5) Broken or corroded spark plug wires.	Repair or replace.
(6) Defective spark plugs.	Clean, adjust or replace. (See par. 50*h*.)
Test. Remove plugs ground them to engine and check spark while cranking.	
(7) Grounded switch.	Replace.
Test. Remove switch wire from the magneto and try to start the engine. (If engine runs switch is O.K.)	
(8) Wet ignition system.	Dry off system.
(9) Faulty magneto.	Repair or replace. (See par. 50*e*.)
Test. Remove wire from spark plug, hold it ⅛ in. from metal of spark plug crank and check spark. (Spark should jump ⅛ in. gap.)	
(10) Lack of compression.	
(a) Oil washed from cylinder walls by flooded engine.	Remove spark plugs and put oil in cylinder.
(b) Worn or broken piston rings.	Report to proper authority.

b. STARTING ENGINE BACKFIRES.

Possible Cause	*Possible Remedy*
(1) Crossed spark plug wires.	Attach in correct position.
(2) Magneto timing off.	Time magneto. (See par. 50*f*.)
(3) Cracked distributor plate.	Replace plate.

c. STARTER PINION WILL NOT STAY ENGAGED.

Possible Cause	*Possible Remedy*
(1) Diesel engine not sufficiently warm.	Let starting engine crank Diesel a longer period of time.
(2) Diesel engine throttle open or throttle rod bent.	Close throttle or straighten rod.
(3) Starting engine running too fast.	Report to proper authority.
(4) Improper adjustment of latches.	Adjust. (See par. 54*b*.)
(5) Worn or broken latches.	Report to proper authority.

d. STARTER PINION WILL NOT RELEASE.

Possible Cause	*Possible Remedy*
(1) Dirt, gum and corrosion in mechanism.	Clean and wash with kerosene.
(2) Improper adjustment of latches.	Adjust. (See par. 54*b*.)
(3) Diesel engine running too slow.	Open throttle ¾ way back when starting Diesel.
(4) Broken starter pinion release spring.	Report to proper authority.

e. STARTING ENGINE CLUTCH SLIPS.

Possible Cause	*Possible Remedy*
(1) Improper adjustment.	Adjust. (See par. 53*c*.)
(2) Facings worn out.	Report to proper authority.

f. Starting Engine Has Not Enough Power to Rotate Diesel.

Possible Cause	*Possible Remedy*
(1) Transmission and flywheel clutch engaged.	Place gear shift lever in neutral.
(2) Oil in Diesel engine crankcase too stiff.	(See par. 35.)
(3) Starting engine in poor mechanical condition.	See proper authority.

42. Diesel Engine

a. Diesel Engine Will Not Start.

Possible Cause	*Possible Remedy*
(1) Diesel engine not sufficiently warm.	Let starting engine crank Diesel for a longer period of time.
(2) Lack of fuel in tank.	Fill tank.
(3) Fuel line shut off at tank.	Open valve under tank and prime system. (See par. 70.)
(4) Fuel system air locked.	Prime system. (See par. 70.)
(5) Clogged or mashed fuel line.	Clean, repair or replace and prime fuel system.
(6) Clogged air cleaner or blocked manifold.	Service air cleaner. Check manifold. (See par. 35.)
(7) Slide bar sticking in shut off position	Remove plate from side of fuel pump housing, remove dirt and corrosion to free slide bar.
(8) Fuel transfer pump failure.	Clean bypass valve. (See par. 68.) Replace pump. (See par. 68.)
(9) Poor compression.	Report to proper authority.
(10) Badly worn injection pumps.	Check and replace if necessary. (See par. 72.)

b. Diesel Engine Knocks Excessively.

Possible Cause	*Possible Remedy*
(1) Poor grade of fuel.	Improve quality of fuel.
(2) Faulty injection valve.	Test and replace if necessary. (See par. 71.)
(3) Clogged air cleaner.	Service air cleaner. (See par. 35.)
(4) Piston hitting exhaust or intake valve.	Adjust valves. (See par. 61.)
(5) Loose connecting rod bearings.	Report to proper authority.
(6) Loose main bearings.	Report to proper authority.

c. Diesel Engine Smokes.

Possible Cause	*Possible Remedy*
(1) Clogged air cleaner.	Service air cleaner. (See par. 35.)
(2) Faulty injection valves.	Replace. (See par. 71.)
(3) Altitude.	None. (See par. 29.)
(4) Oil entering combustion chamber from crankcase.	Report to proper authority.
(5) Poor grade of fuel.	Improve quality of fuel.

d. Diesel Engine Misses.

Possible Cause	*Possible Remedy*
(1) Air in fuel system.	Prime system. (See par. 70.)

Possible Cause	*Possible Remedy*
(2) Clogged fuel filters. *Symptom.* A low fuel pressure gage reading.	Check and replace. (See par. 69.)
(3) Faulty injection valves.	Test and replace if necessary. (See par. 71.)
(4) Defective transfer pump.	
(a) Dirt under bypass valve (sudden drop in pressure).	Remove and clean. (See par. 68.)
(b) Worn or broken parts.	Replace. (See par. 68.)
(5) Water in fuel.	Drain and refill with clean fuel and prime system. (See par. 70.)
(6) Defective inlet or exhaust valves.	
(a) Improper adjustment.	Adjust. (See par. 61.)
(b) Burnt or sticking valves.	Report to proper authority.
(7) Broken valve spring.	Report to proper authority.

e. LACK OF POWER.

Possible Cause	*Possible Remedy*
(1) Hand brake partially applied.	Release hand brake.
(2) Clogged air cleaner.	Service air cleaner. (See par. 35.)
(3) Worn injection pumps.	Check and replace if necessary. See par. 72.)
(4) Poor compression.	
(a) Worn piston rings.	Report to proper authority.
(b) Improper adjustment of exhaust or intake valves.	Adjust valves. (See par. 61.)
(5) Altitude.	None. (See par. 29.)
(6) Excessive amount of water in fuel filter housing sump.	Drain the sump.

f. DIESEL ENGINE OVERHEATS.

Possible Cause	*Possible Remedy*
(1) Insufficient coolant.	Check and fill.
(2) Dirt and trash on oil cooler and between radiator fins.	Clean out the dirt and trash.
(3) Loose or broken fan belt.	Adjust or replace. (See par. 64.)
(4) Failure of water temperature regulator to open.	Report to proper authority.
(5) Excessive scale of sediment deposits in system.	Clean and refill. (See par. 63.)
(6) Defective water pump.	Report to proper authority.

g. LOW OR NO OIL PRESSURE.

Possible Cause	*Possible Remedy*
(1) Low or no oil in crankcase.	Check and fill to full mark.
(2) Clogged oil filters.	Service oil filters. (See par. 74.)
(3) Defective oil gage.	Check and replace.
(4) Clogged or broken line to gage.	Clean, repair or replace.
(5) Oil pump failure.	Report to proper authority.
(6) Leak in oil cooler lines or connections.	Repair or replace.
(7) Loose connecting rod or main bearing.	Report to proper authority.

43. Flywheel Clutch

a. Flywheel Clutch Slips.

Possible Cause	*Possible Remedy*
(1) Improper adjustment.	Make adjustment. (See par. 81.)
(2) Oil on clutch facings.	Drain compartment and flush with dry cleaning solvent.
(3) Glazed facings.	Report to proper authority.
(4) Facings worn out.	Report to proper authority.
(5) Broken or weak clutch springs.	Report to proper authority.

b. Flywheel Clutch Will Not Disengage.

Possible Cause	*Possible Remedy*
(1) Improper adjustment.	Make adjustment. (See par. 81.)
(2) Faulty release bearing.	Report to proper authority.
(3) Sprung power control shaft.	Report to proper authority.
(4) Seized power control shaft, or pilot bearing.	Report to proper authority.

44. Transmission

a. Transmission Will Not Stay Engaged.

Possible Cause	*Possible Remedy*
(1) Gears not fully engaged.	Fully engage gears when shifting.
(2) Interlock not functioning.	
(a) Interlock linkage disconnected.	Connect interlock. (See par. 82.)
(b) Interlock shaft sticking.	Clean with dry cleaning solvent.

b. Transmission Will Not Engage Any or All Gears.

Possible Cause	*Possible Remedy*
(1) Interlock linkage disconnected.	Connect linkage. (See par. 82.)
(2) Bent or broken shifter fork.	Report to proper authority.

c. Transmission Becomes Locked.

Possible Cause	*Possible Remedy*
(1) Chip of metal between gears.	Report to proper authority.
(2) In two gears at once because of interlock not functioning or bent shifter fork.	Report to proper authority.

d. Transmission Makes Excessive Noise.

Possible Cause	*Possible Remedy*
(1) Insufficient lubricant.	Fill to oil level.
(2) Worn or broken parts in transmission.	Report to proper authority.

e. Oil Level Raises.

Possible Cause	*Possible Remedy*
(1) Oil level raises in gear change compartment.	Clean breather on rear axel housing.
(2) Oil level raises in rear axel housing.	Clean breathers on each tandem drive housing.

45. Brakes

a. HYDRAULIC WHEEL BRAKES DO NOT HOLD.

Possible Cause	*Possible Remedy*
(1) Improper adjustment.	Make adjustment. (See par. 86.)
(2) Fluid low in master cylinder.	Fill reservoir in master cylinder and bleed system. (See par. 87.)
(3) Air in lines. *Symptom.* Pedal will have a spongy action.	
(4) Oil on the linings.	Report to proper authority.
(5) Linings worn out.	Report to proper authority.

b. HYDRAULIC WHEEL BRAKES DRAG.

Possible Cause	*Possible Remedy*
(1) Brake adjustment too tight.	Make adjustment. (See par. 86.)
(2) Weak or broken return springs.	Report to proper authority.

c. HAND BRAKE WILL NOT HOLD.

Possible Cause	*Possible Remedy*
(1) Improper adjustment.	Make adjustment. (See par. 88.)
(2) Oil on linings.	Report to proper authority.
(3) Lining worn out.	Report to proper authority.

46. Power Controls

POWER CONTROLS WILL NOT OPERATE.

Possible Cause	*Possible Remedy*
a. Shear pin sheared off.	Replace shear pin. (See par. 90*a*.)
b. Power control shaft or universal joint of power control shaft broken.	Report to proper authority.

47. Blade and Circle

a. BLADE WILL NOT STAY IN POSITION.

Possible Cause	*Possible Remedy*
Blade lift worm gear improperly adjusted.	Make adjustment. (See par. 90*b*.)

b. BLADE VIBRATES UP AND DOWN OR "CHATTERS."

Possible Cause	*Possible Remedy*
(1) Too much clearance between circle and drawbar.	Make circle vertical play adjustment. (See par. 96*a*.)
(2) Operating in too high a speed.	Operate in a slower speed.

c. BLADE WILL NOT CUT.

Possible Cause	*Possible Remedy*
(1) Incorrect blade pitch.	Make blade pitch setting. (See par. 16*c*.)
(2) Cutting edges worn out.	Report to proper authority.
(3) Material frozen or too hard.	Use only the point of the blade or scarifier and report to proper authority.

d. BLADE HAS TOO MUCH SIDE PLAY.

Possible Cause	*Possible Remedy*
(1) Circle and circle shoes worn.	Make adjustment for side play. (See par. 96*b*.)

48. Front Axel and Steering Mechanism

a. FRONT WHEELS WILL NOT LEAN.

Possible Cause	*Possible Remedy*
Locking capscrew in place.	Remove locking capscrew from leaning wheel mechanism. (See par. 15*h*(6).)

b. FRONT WHEELS WILL NOT STAY IN SET POSITION.

Possible Cause	*Possible Remedy*
(1) Oil or grease on brake disc facing.	Report to proper authority.
(2) Broken or weak spring in brake assembly.	Report to proper authority.
(3) Facing worn out.	Report to proper authority.

c. EXCESSIVE WEAR ON FRONT TIRES.

Possible Cause	*Possible Remedy*
(1) Slipping sideways while operating.	Balance the load. (See par. 18*c*.)
(2) Wheels not properly alined.	Aline the front wheels. (See par. 92.)

d. STEERING WHEELS SPINS CAUSED BY SHOCK ON FRONT WHEEL.

Possible Cause	*Possible Remedy*
Snubber assembly not functioning.	Report to proper authority.

Section XVII. STARTING ENGINE

49. Description and Data (See fig. 53.)

a. DESCRIPTION. The starting engine is a two-cylinder, four-stroke cycle gasoline engine mounted to the rear of the engine on top of the flywheel housing. The starting engine cooling system and that of the Diesel engine are inter-connected, and the starting engine exhaust gases pass through a tube in the Diesel engine inlet manifold. This arrangement conditions the Diesel engine for starting. The starting engine transmits its power through a multiple disc clutch to a pinion which is engaged with the Diesel engine flywheel ring gear by means of a hand lever.

b. DATA.

Horsepower—15-hp
Low Idle Speed—800-rpm
High Idle Speed—3350-rpm
Weight—340-lb

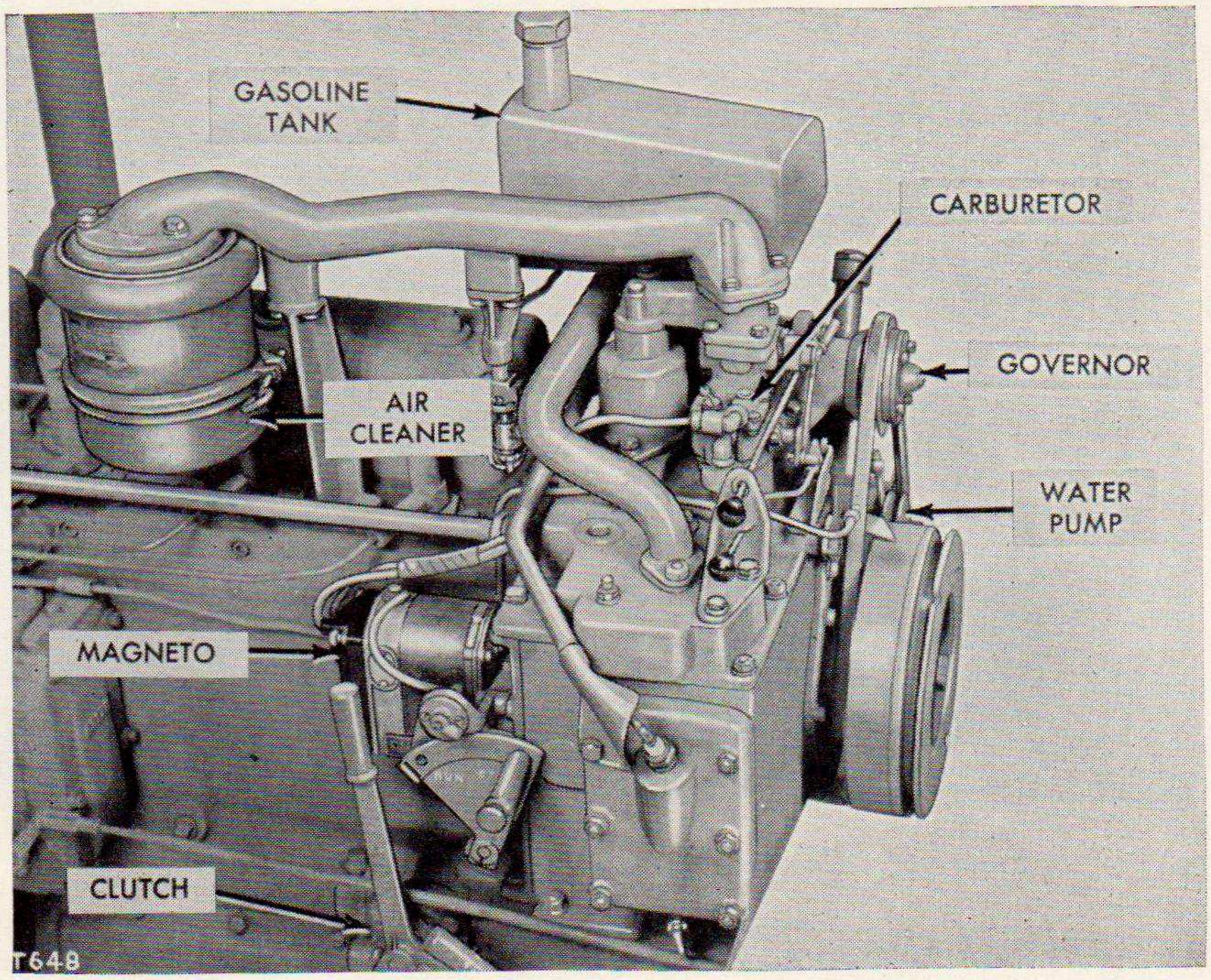


Figure 53. Starting engine.

50. Ignition System

a. DESCRIPTION. An Eiseman Magneto Model RC-2H with an impulse starter and nonadjustable drive hub is used on the starting engine.

b. TESTING MAGNETO.

(1) *Turn the switch on.* Turn the switch on and remove the cable from a spark plug.

(2) *Hold the cable terminal 1/8 inch away from spark plug.* The spark should jump the 1/8-inch gap from the cable terminal to the metal of the spark plug, as the starting engine is cranked with a starting rope.

(3) *Remove the wire from the switch.* If no spark passes from the cable to the plug, disconnect the magneto switch wire from the magneto and try again, as the switch may be faulty.

(4) *If magneto fails to fire.* If the magneto fails to fire, check the contact point opening. If the contact point opening is correct refer to the proper authority.

c. CHECKING THE CONTACT POINT OPENING.

(1) *Remove the distributor plate.* Remove the distributor plate and lift out the rotor.

(2) *Turn flywheel.* Turn the flywheel backwards (to prevent the impulse from catching) until the magneto point bumper is on the highest elevation of the cam.

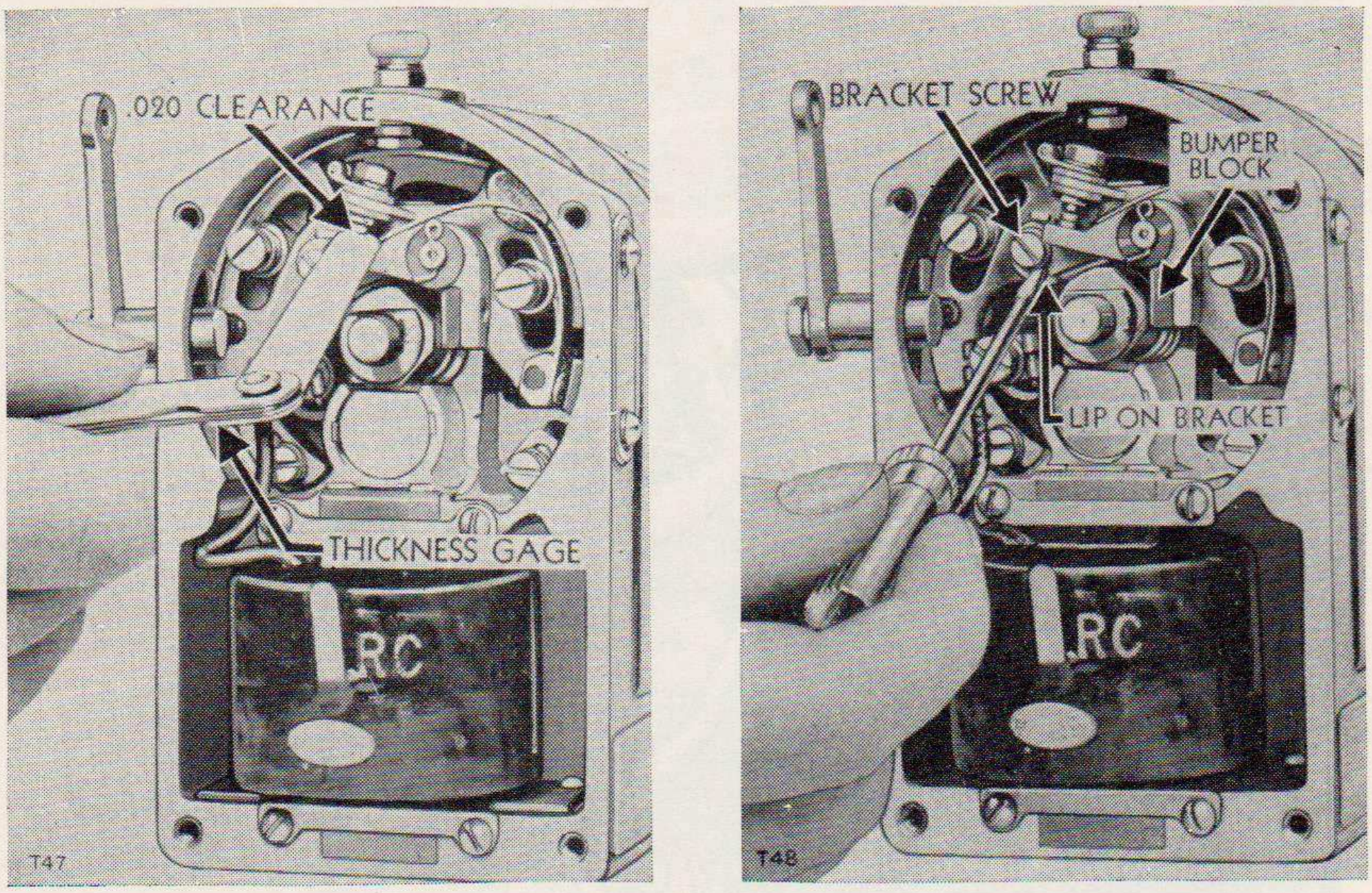


Figure 54. Checking and adjusting contact point opening.

(3) *Check clearance.* (See fig. 54.) Check the clearance between the points, which should be .020 inch.

d. ADJUSTING CONTACT POINT OPENING. (See fig. 54.)

(1) *Loosen contact point bracket screw.* Loosen the screw that holds the contact point bracket.

(2) *Move bracket.* Move the bracket by inserting a screwdriver in the space between the head of the screw and the lip of the bracket.

(3) *Tighten screw.* Tighten the bracket screw and recheck the adjustment.

e. REMOVING MAGNETO.

(1) Disconnect the switch wire and pull the cables out of the distributor plate.

(2) Remove the two nuts that hold the magneto in place and pull it away from the cylinder block.

f. TIMING MAGNETO TO ENGINE.

(1) Locate the firing point of No. 1 cylinder. No. 1 cylinder is the cylinder on the same side as the magneto. Open the cylinder head drain cock on No. 1 cylinder and place a finger over the opening, rotate the flywheel in the normal direction until air is felt rushing out of the drain cock opening. This indicates that the piston is coming up on the compression stroke. Continue to rotate the flywheel until the "MAG" mark on it lines up with the pointer on the starting engine. (See fig. 55.)

(2) Remove the small cover from the end of the magneto. (See fig. 56.) Turn the magneto shaft counterclockwise until the

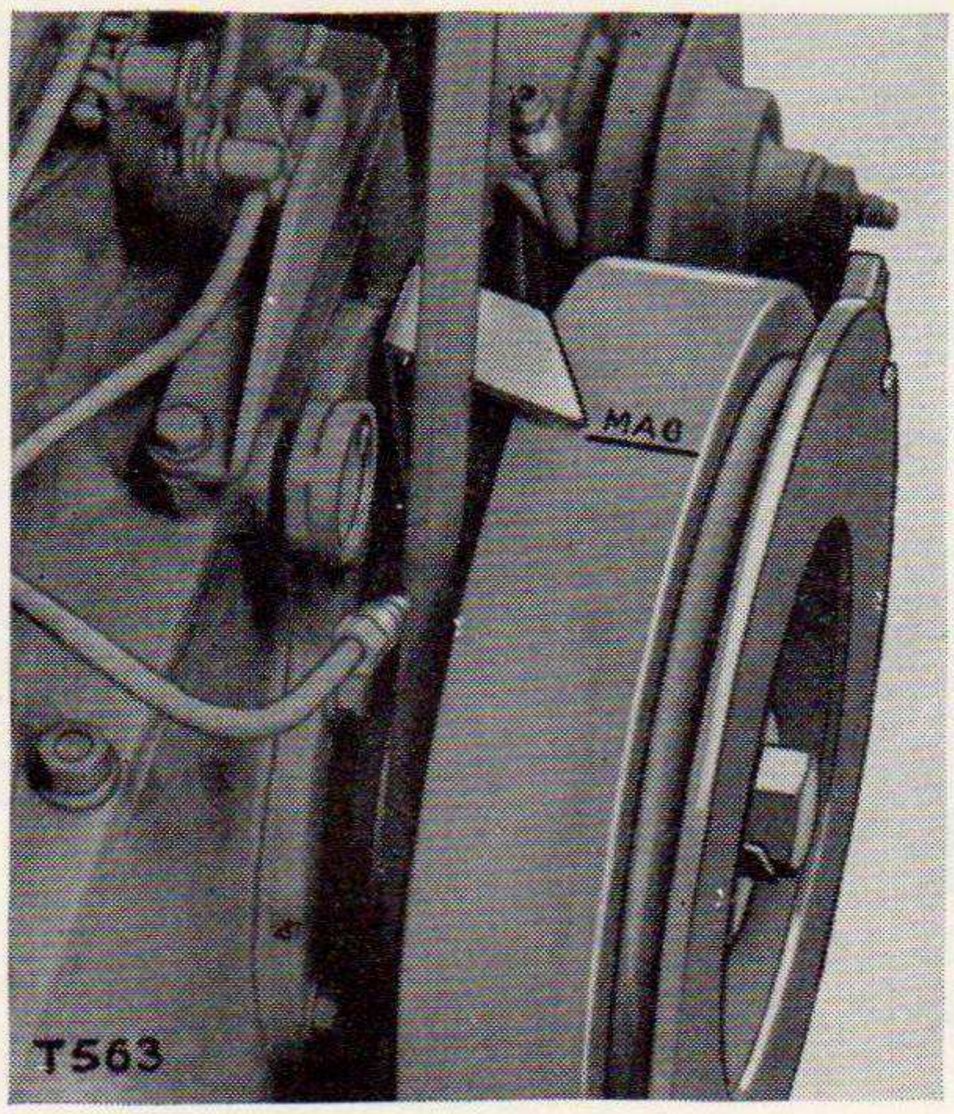


Figure 55. Alining "Mag" mark on flywheel with pointer.

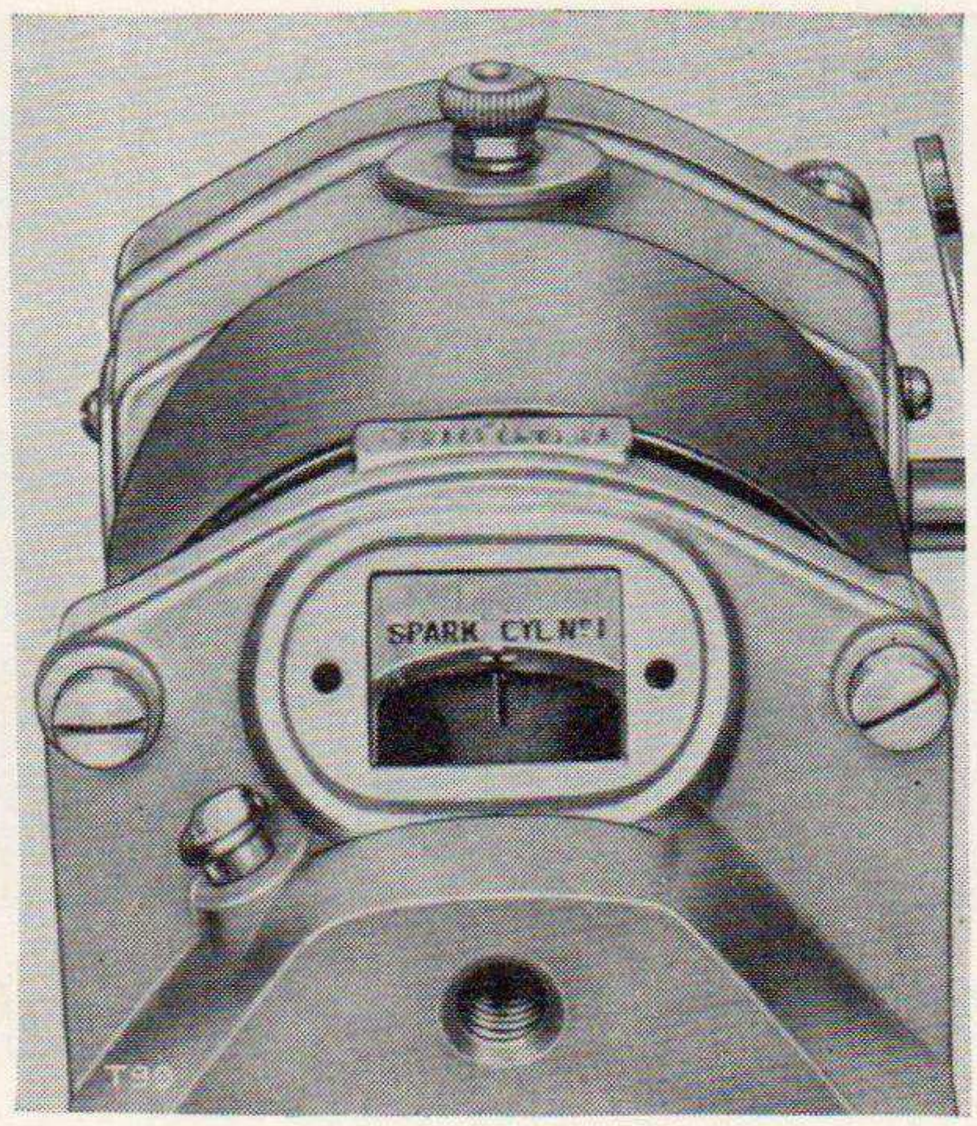


Figure 56. Magneto timing marks.

white line on the distributor gear lines up with the pointer in the end plate casting.

(3) Place the magneto in place taking care not to rotate the magneto coupling.

g. Checking Timing with Magneto in Place.

(1) Remove the distributor cap from the magneto.

(2) Locate the firing point of No. 1 cylinder as described in paragraph 50, f. Trip the impulse by turning the flywheel and

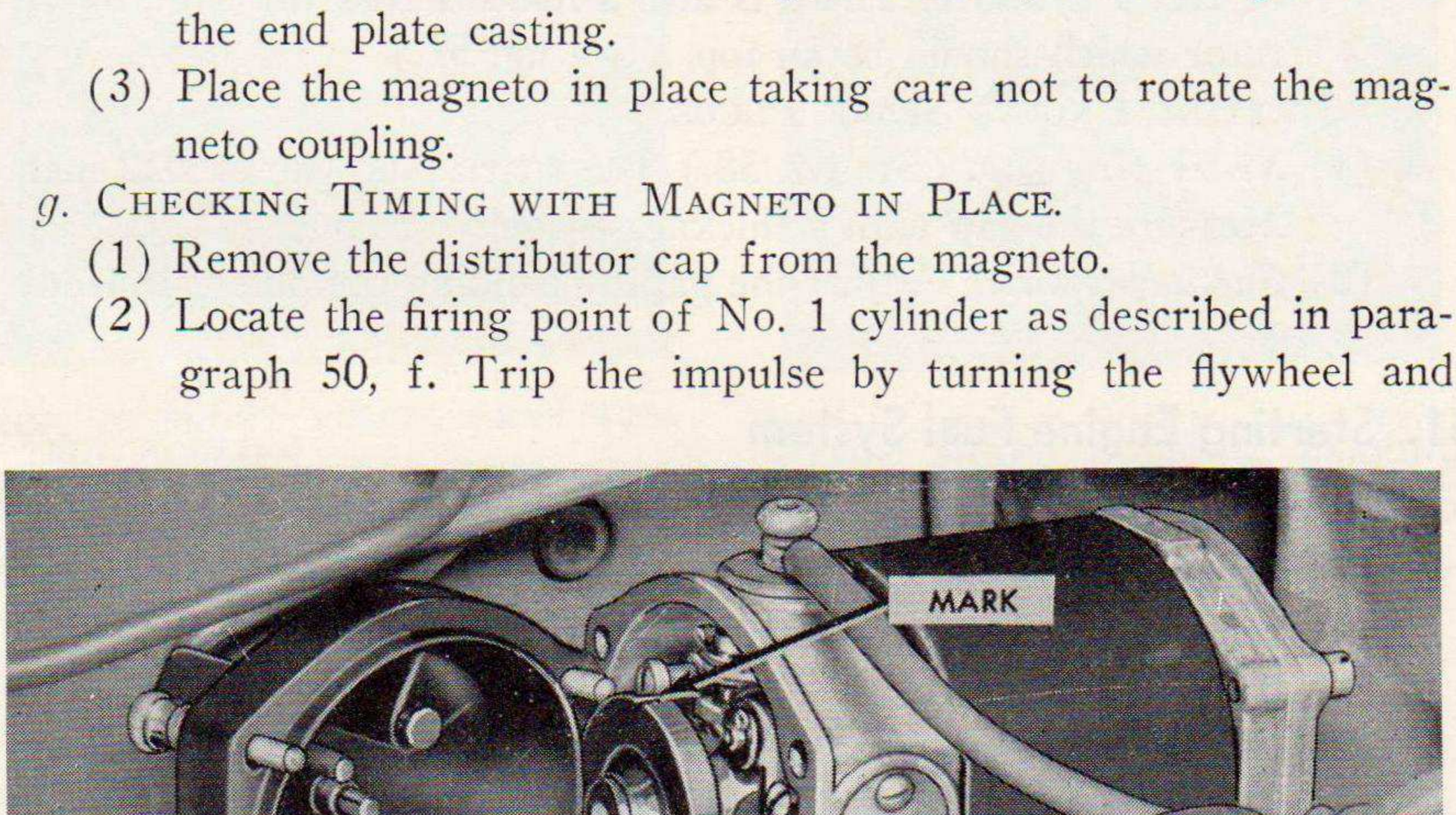


Figure 57. Checking timing, magneto in place.

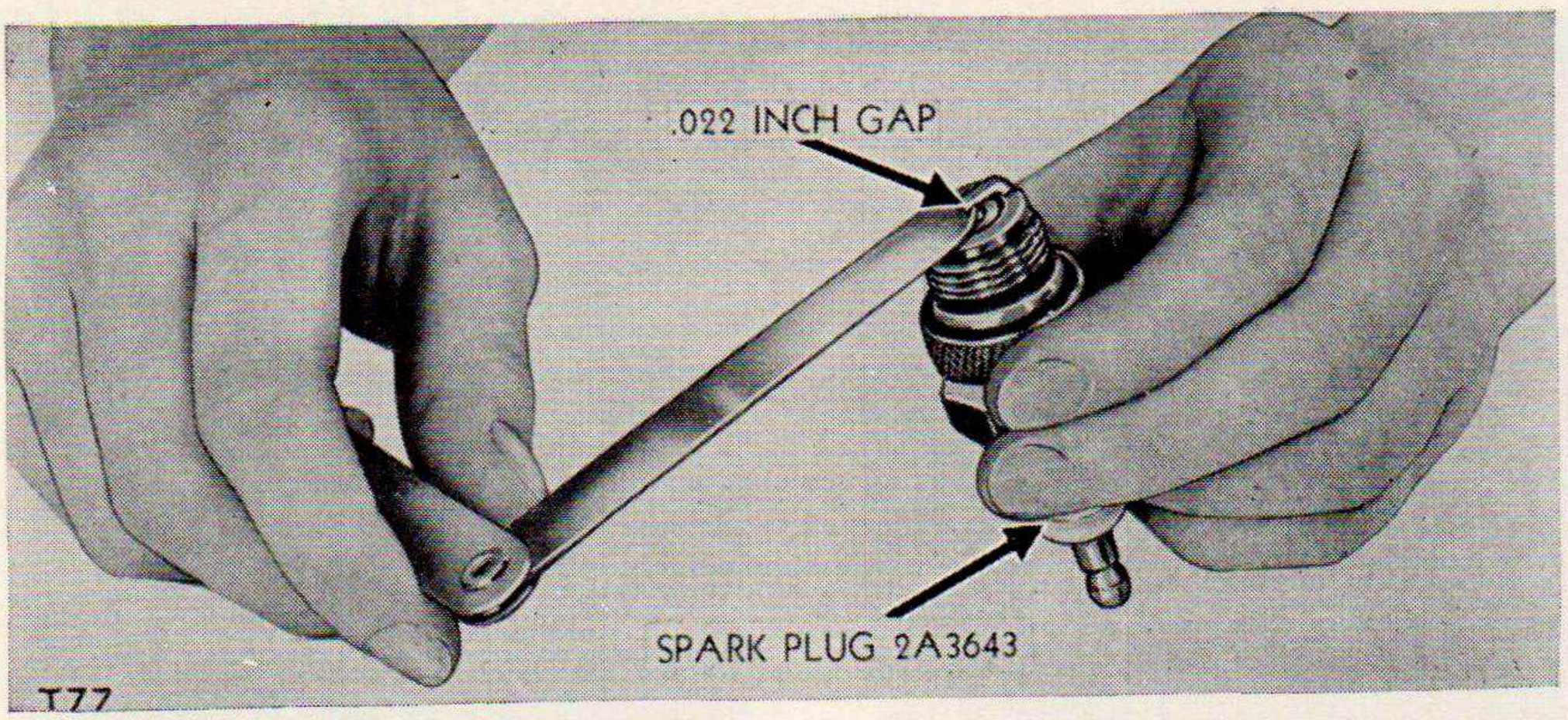


Figure 58. Checking spark plug gap.

"MAG" mark past the pointer, then turn it back until the "MAG" mark lines up with the pointer.

(3) In this position the distributor rotor contact should be in line with the conductor which is connected by wire to the spark plug of No. 1 cylinder. There is also a mark across the edge of the rotor which should be on top. (See fig. 57.)

h. STARTING ENGINE SPARK PLUGS.

(1) *Spark plug gap.* (See fig. 58.) The spark plug gap is .022 inch. Measure the gap with a thickness gage.

(2) *Gap adjustment.* Adjust the gap by bending the outer electrode.

51. Starting Engine Fuel System

a. MAINTENANCE. (See fig. 59.)

(1) *Remove sediment bowl.* Close the valve under the fuel tank and remove the bowl by unscrewing the nut clamping it to the body of the valve.

(2) *Clean filter.* Unscrew the edge type filter, shake it in dry cleaning solvent and screw it back in place.

(3) *Replace bowl.* See that the gasket is clean and replace the bowl. Tighten the screw with the fingers until there are no leaks.

b. CARBURETOR.

(1) *Description.* A Zenith TU–4C series carburetor of the down draft type is used.

(2) *Approximate jet adjustment.* (See fig. 60.)

(a) *Adjust idling jet screw.* Turn the idling jet screw gently against the seat and back it off one-half turn from the closed position.

(b) *Adjust high speed jet screw.* Turn the high speed jet adjusting screw gently against its seat and back it off three-fourths turn from closed position.

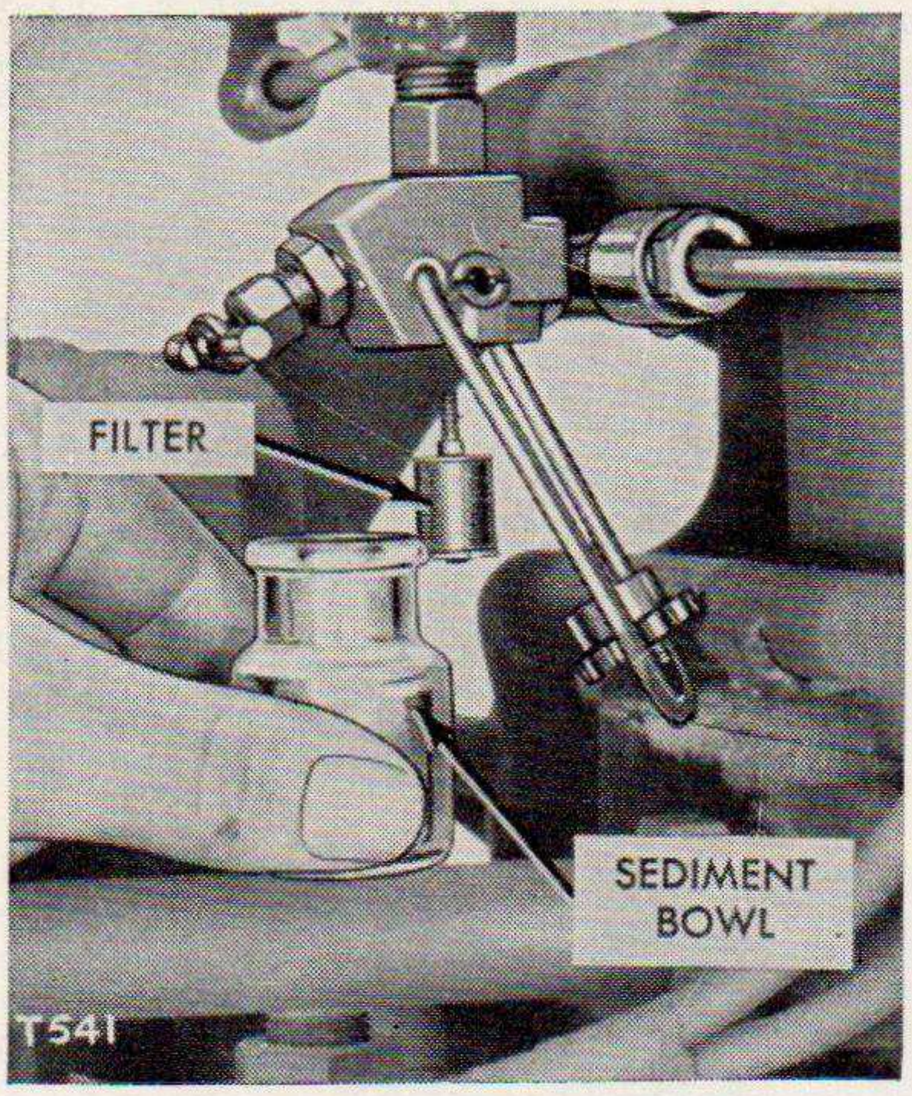


Figure 59. Sediment bowl and filter removed.

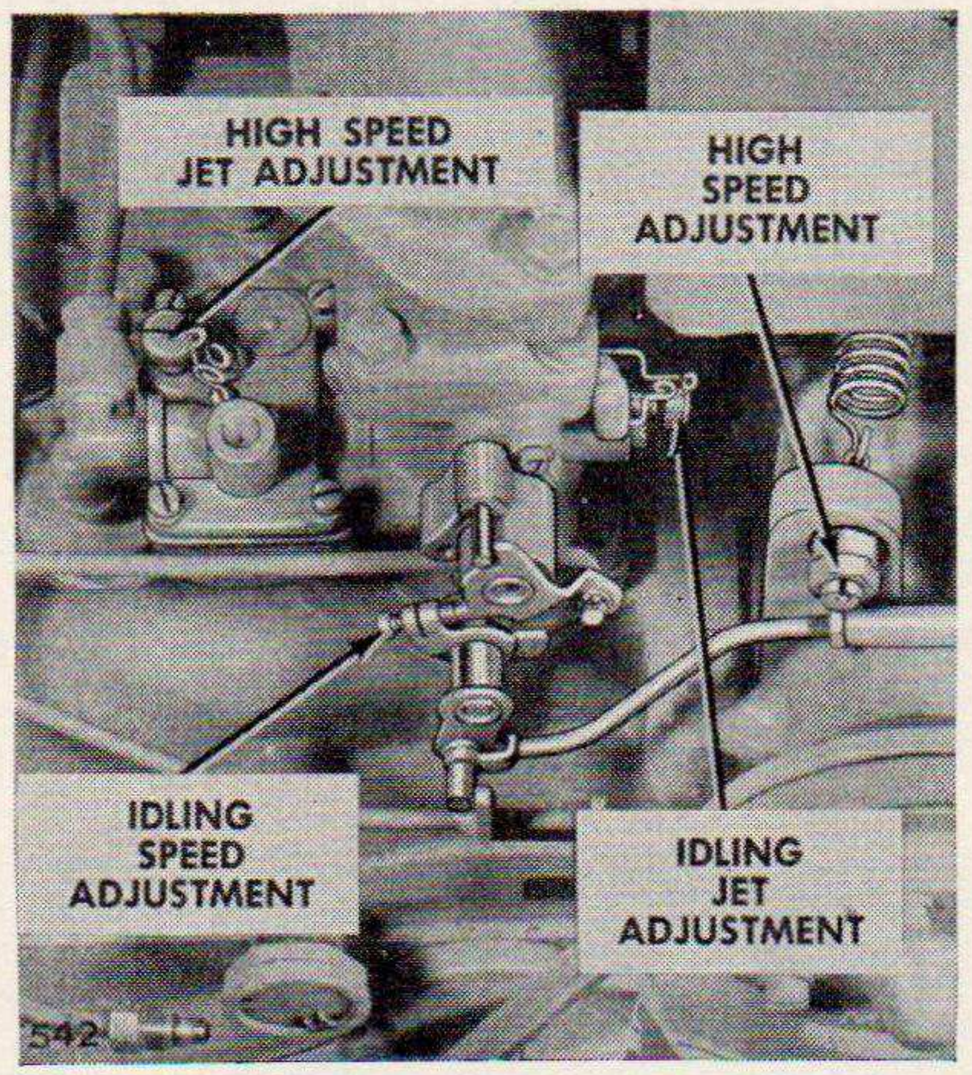


Figure 60. Carburetor adjustments.

(c) *Start engine.* Start the engine and allow it to warm up.

(3) *Final jet adjustment* (engine running).

(a) *Adjust idling jet screw.* Pull the throttle control out to the idling position. Turn the idling jet adjusting screw until engine idles evenly without emitting black smoke from the exhaust.

(b) *Adjust high speed jet screw.* Push the throttle control into the high idle position so that engine will run at full governed speed. Turn the high speed jet adjusting screw to a point where the engine runs evenly without surging and does not emit black smoke from the exhaust.

(4) *Low idling speed rpm adjustment.* (See fig. 60.) The low idle speed is controlled by an adjusting screw on the carburetor throttle shaft lever assembly. This screw should be set to give a low idle of 800 rpm.

(5) *High idle speed rpm adjustment.* (See fig. 60.) The adjusting nuts at the end of the governor spring control the high idle speed. The correct high idle speed is 3350 rpm.

52. Starting Engine Valve Clearance

The starting engine valve clearance is obtained by grinding off the end of the valve stem when the engine is assembled. Periodic adjustment is unnecessary.

53. Starting Engine Clutch

a. MAINTENANCE. Test the clutch frequently and adjust when necessary. The oil must be checked and changed as ordered in paragraph 35.

b. TESTING ADJUSTMENT. Push the lever to the engaged position. The lever should go into this position with a distinct snap, and should require a reasonably hard push.

c. ADJUSTING PROCEDURE. (See fig. 61.)

(1) *Remove plug.* Remove the plug from the top of the clutch housing.

(2) *Locate lock pin.* Working through the hole turn the adjusting collar with a screwdriver, until the lock pin is accessible. In the illustration the clutch lever and cover have been removed to show the adjusting collar and lock pin.

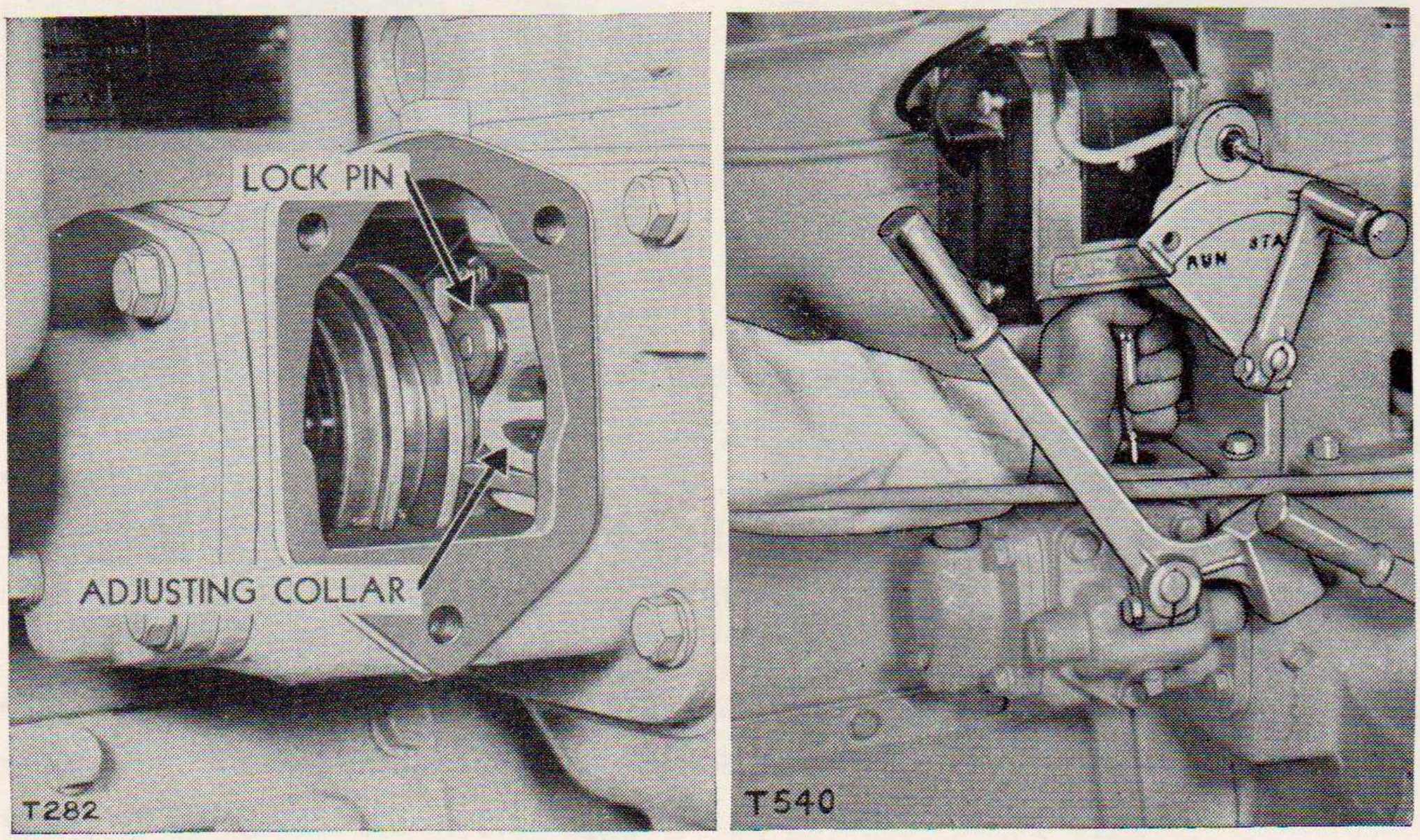


Figure 61. Adjusting starting engine clutch.

(3) *Pry out lock pin.* Pry out the spring loaded lock pin with the screwdriver.

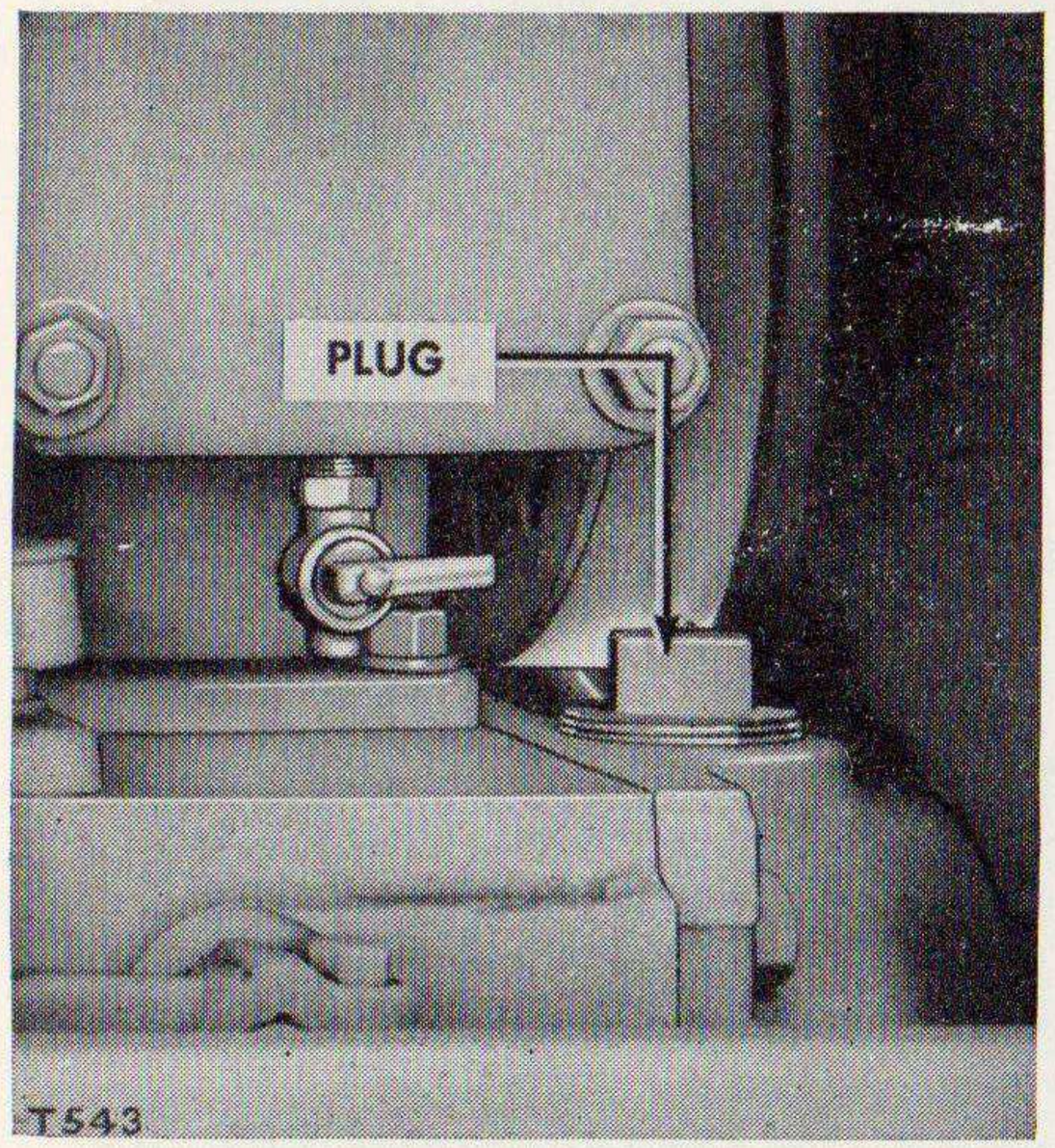
(4) *Turn adjusting collar.* Turn the adjusting collar clockwise until the lock pin snaps into the next hole.

(5) *Test adjustment.* Test the adjustment by engaging the clutch. If one hole gives a slightly loose adjustment and the next hole gives too tight an adjustment, use the loose adjustment.

(6) *Replace the oil filler plug.*

54. Starter Pinion

a. DESCRIPTION. The starting engine power is transmitted to the Diesel engine flywheel through a pinion which is manually engaged with the flywheel ring gear. The pinion is held in engagement by latches which are released by the increased centrifugal force when the Diesel engine starts. When the latches release, a spring pushes the pinion out of engagement with the ring gear.



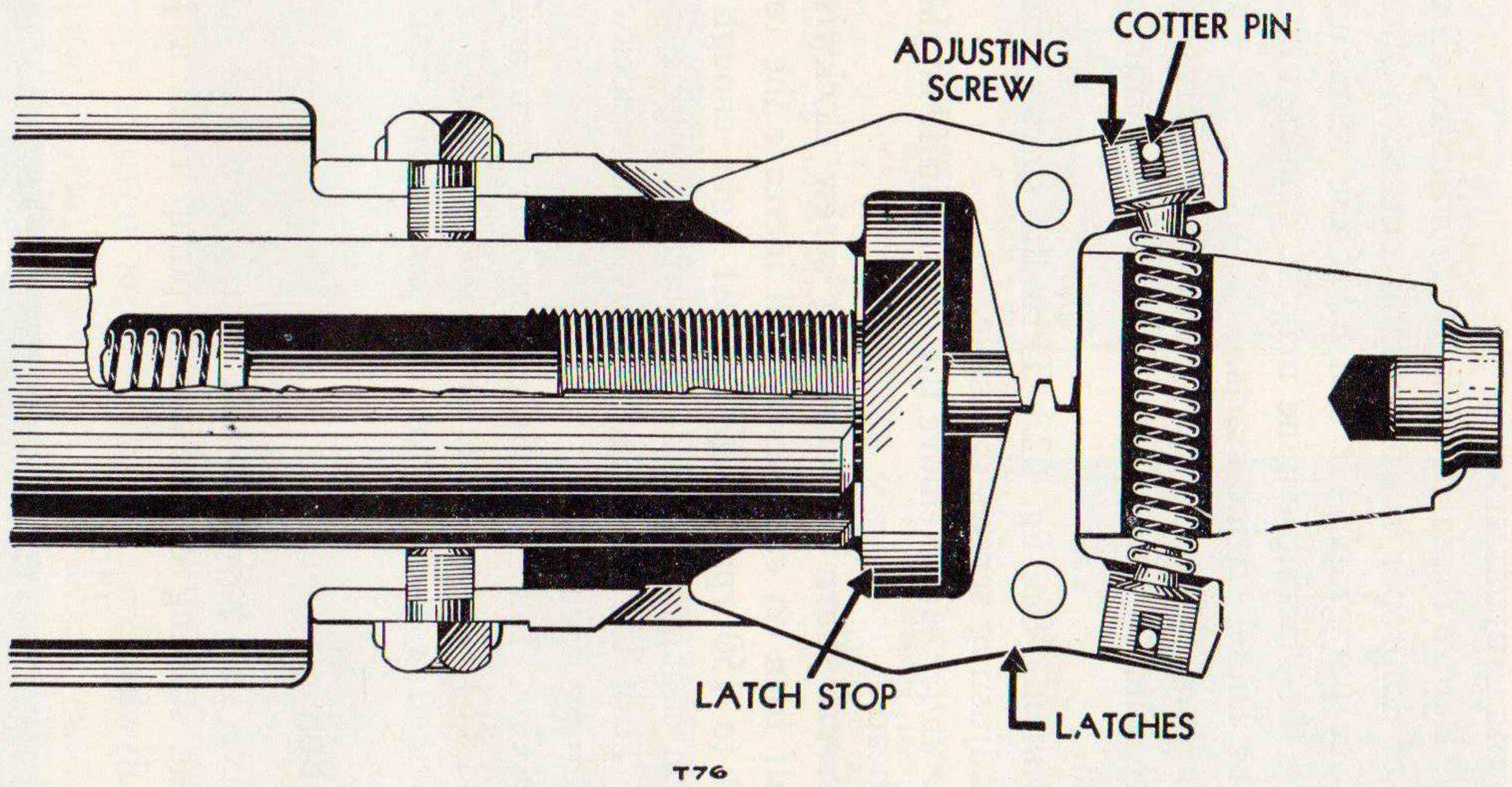


Figure 62. Starter pinion latch adjustment.

b. Latch Spring Adjustment.

(1) *General.* Before the latch springs are adjusted all other possible causes of improper starter pinion operation should be eliminated. See paragraph 41*c* and *d*. If the releasing speed is set too high the starting engine may be damaged by overspeeding when the Diesel engine starts.

(2) *Remove plug.* (See fig. 62.) Remove the large plug from the flywheel clutch housing located between the starting engine and the dash.

(3) *Turn pinion.* (See fig. 62.) Turn the starter pinion until one of the adjusting screws is visible.

(4) *Remove cotter pin.* Remove the cotter pin from the latch spring screw head.

(5) *Turn screw.* Turn the adjusting screw clockwise to tighten. One-half turn on each screw will increase the releasing speed by 100 to 150 rpm. Tighten just tight enough to keep the pinion in engagement while the starting engine is cranking the Diesel. Turn the adjusting screws counterclockwise to reduce the releasing speed.

(6) *Turn pinion.* Turn the pinion one-half turn and repeat steps (4) and (5) to adjust the other latch spring.

(7) *Replace cotter pins.* Replace the cotter pins and pipe plug.

55. Governor Belt

a. Description. The governor belt is a V-belt and drives both the governor and the starting engine water pump from a pulley on the starting engine flywheel.

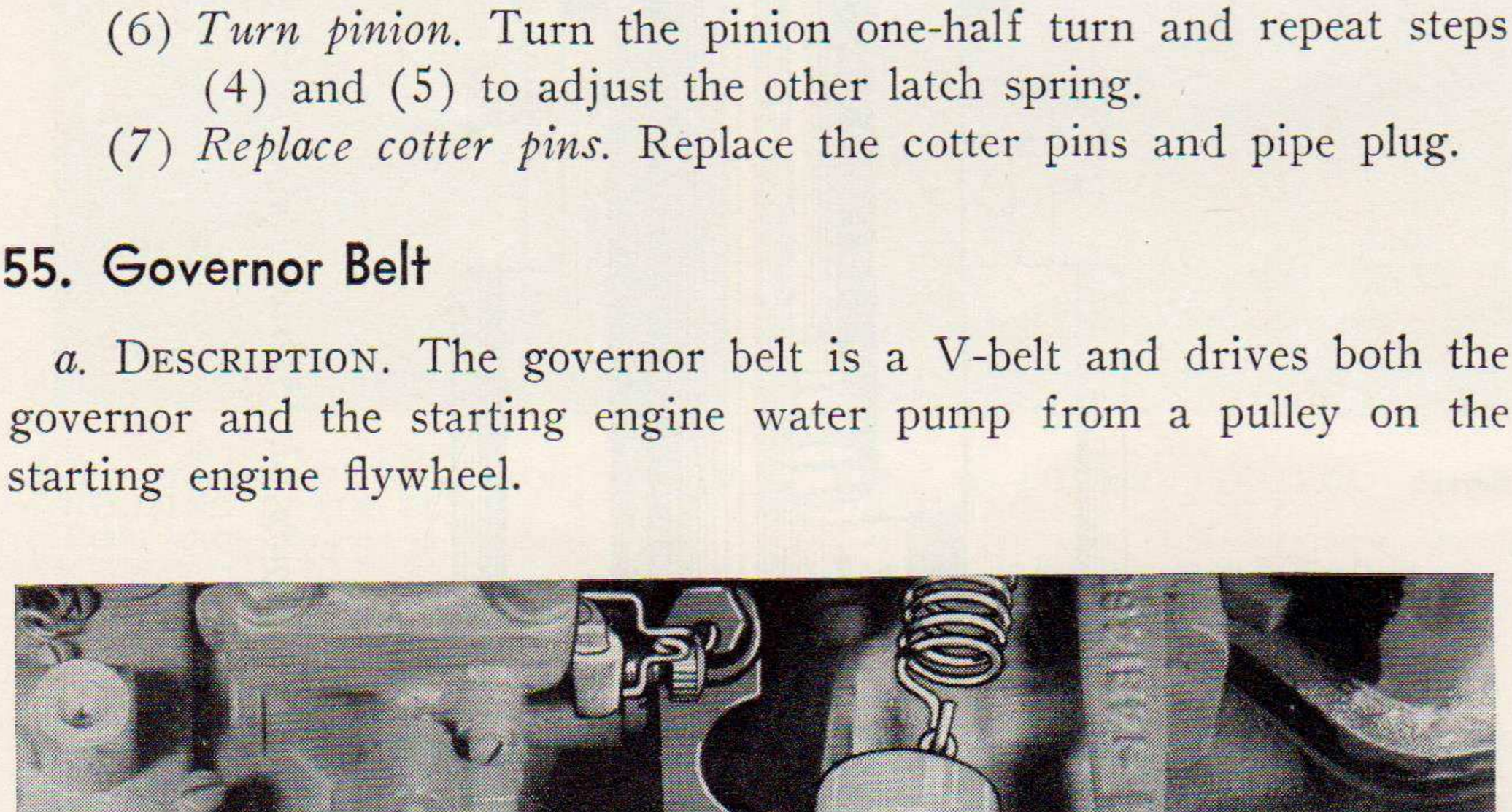


Figure 63. Governor belt (part No. 4B2544) adjustment.

b. ADJUSTMENT. (See fig. 63.)

(1) *General.* The governor belt adjustment is made by adding shims under the governor to tighten and removing shims to loosen. Shims for this adjustment are located on top of the governor base held by the same capscrews that are removed for adjustment. The belt must be kept just tight enough to keep the belt from flopping. To operate with it too tight will cause excessive wear on the governor bushings.

(2) *Adjusting procedure.*

(a) Remove the two capscrews that hold the governor in place.

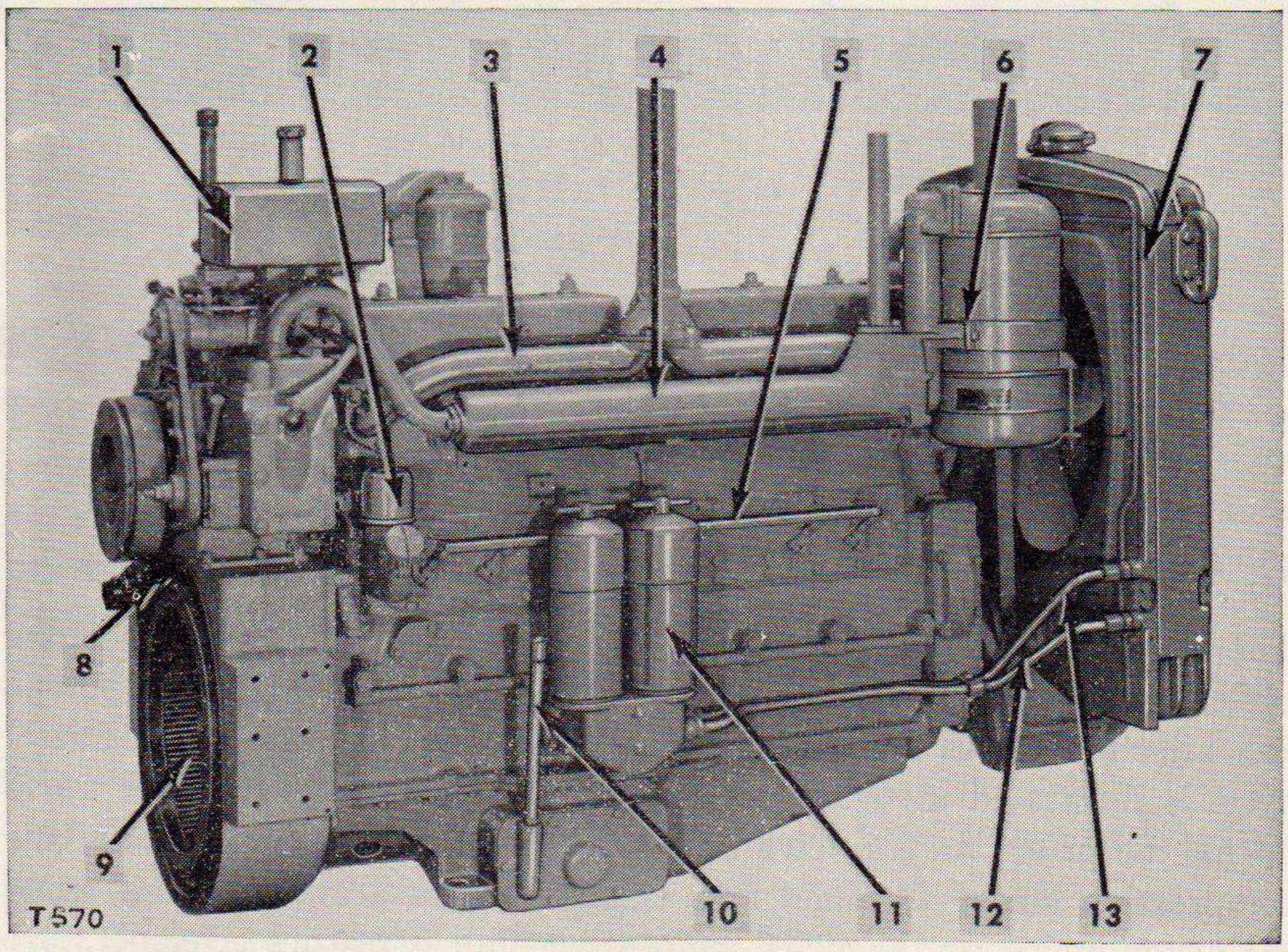
(b) Add shims, to tighten, until the desired belt tension is obtained.

(c) Replace the capscrews.

Section XVIII. DIESEL ENGINE

56. Scope

The following section covers the basic engine and identifies the accessories in the two illustrations. (See figs. 64 and 65.)



1. Starting engine gasoline tank.
2. Crankcase breather.
3. Exhaust manifold.
4. Intake manifold.
5. Compression release.
6. Diesel engine air cleaner.
7. Radiator.
8. Starter pinion.
9. Flywheel.
10. Oil level gage.
11. Lubricating oil filters.
12. Oil line from cooler.
13. Oil line to cooler.

Figure 64. Air cleaner side of engine.

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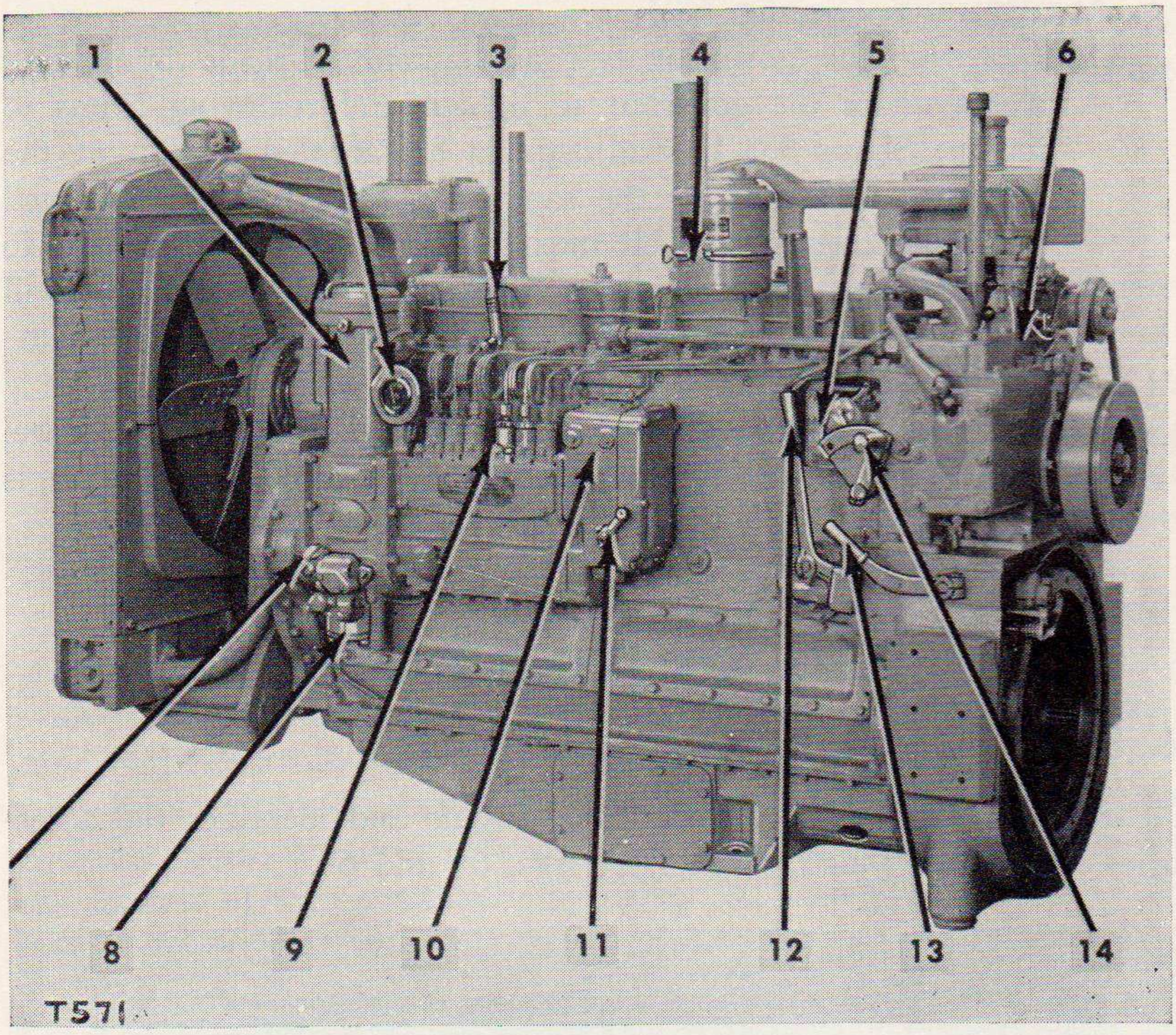

1. Fuel filter housing.
2. Fuel pressure gage.
3. Fuel injection valve.
4. Starting engine air cleaner.
5. Starting engine magneto.
6. Gasoline starting engine.
7. Hour meter.
8. Fuel transfer pump.
9. Fuel injection pump.
10. Governor.
11. Throttle control lever.
12. Starting engine clutch lever.
13. Starter pinion lever.
14. Compression release lever.

Figure 65. Fuel injection pump side of engine.

57. Description

The engine in the No. 12 motor grader is a six-cylinder, four-stroke cycle, valve in head Diesel engine. Individual fuel injection pumps and injection valves are used for each cylinder. The four-stroke Diesel cycle is illustrated in figure 66. During the inlet stroke the inlet valve opens, the piston moves down and only air enters the cylinder. On the compression stroke the inlet and exhaust valves are closed and when the piston moves up the air is compressed until it reaches a temperature of over 1000°F. Near the end of the compression stroke and beginning of the power stroke, fuel is injected into the hot air and spontaneously ignited. The expansion of the burning fuel forces the piston down producing the power stroke. When the piston moves up again on the exhaust stroke the exhaust valve is opened, the burned gases are forced out of the cylinder and the cycle starts over again.

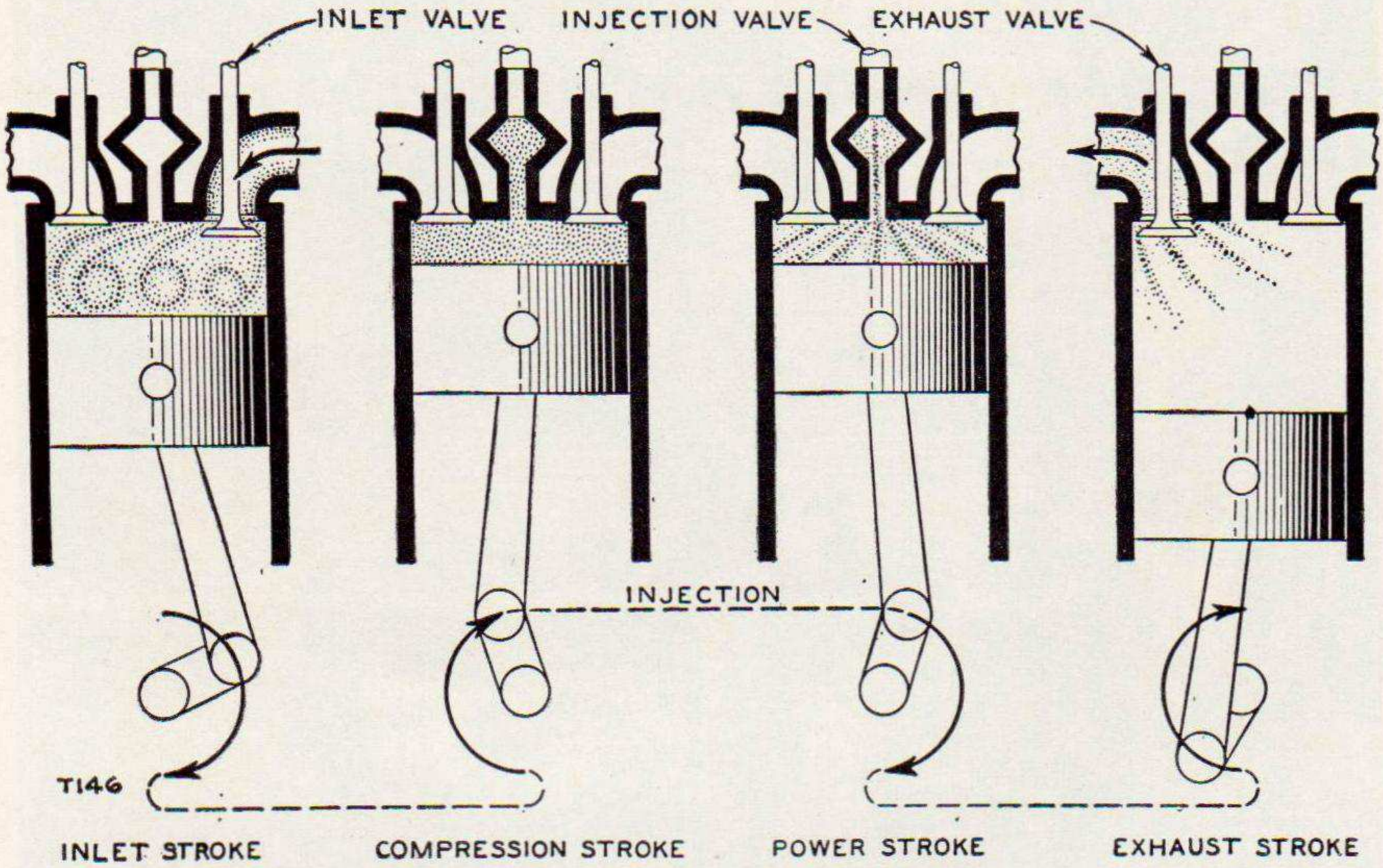

Figure 66. Diesel four-stroke cycle.

58. Data

Model—4-stroke cycle, water cooled.
Number of cylinders—6.
Bore and stroke—4¼-in x 5½-in.
Firing order—1-5-3-6-2-4.

59. Cylinder Heads

This engine has two cylinder heads, each covering three cylinders. Water directors within the cylinder heads direct water around the valve ports and precombustion chambers. The main cylinder head gasket is a copper asbestos gasket but all water passages between the cylinder heads and block are sealed with rubber seals and ferrules. The inlet and exhaust valves are located in the cylinder heads.

60. Cylinder Head Stud Nuts

a. GENERAL. In order to tighten the cylinder head stud nuts it is first necessary to remove the valve rocker arm assemblies.

b. REMOVING ROCKER ARMS. (See fig. 67.)

(1) Remove the four nuts that hold the valve rocker arm assemblies in place.

(2) Disconnect the oil lines and lift the rocker arm assemblies off the studs.

c. NUT TIGHTENING PROCEDURE. Tighten the cylinder head stud nuts evenly, starting with those nearest the center of each head. If a torque wrench is used, tighten each nut to 71 foot pounds.

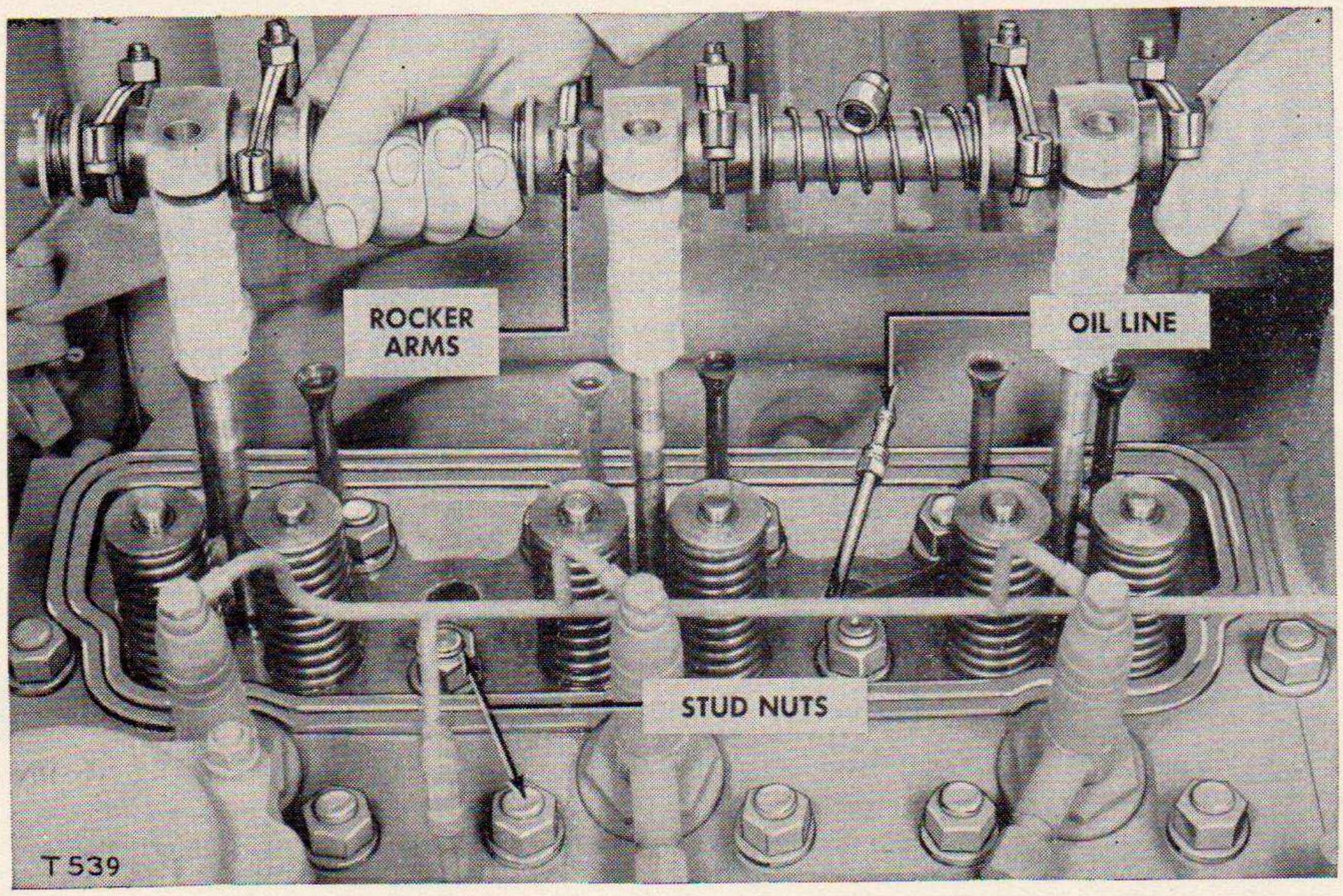

Figure 67. Removing rocker arms preparatory to tightening head stud nuts.

61. Valves and Valve Mechanism (See fig. 68.)

a. DESCRIPTION. The inlet and exhaust valves are located in the cylinder head. The valves are operated by a gear driven camshaft, through a lifter, push rod and rocker arm arrangement. The valve stems operate in replaceable bushings. Compression release for starting is accomplished by a manually controlled cam arrangement which acts on the inlet valve lifter to lift the inlet valves off their seats.

b. ADJUSTMENT.

(1) *General.* The valve clearance adjustment is correct on both inlet and exhaust valves when there is .010 inch clearance between the valve rocker and the valve stem, with the engine hot, the valves closed and the compression release in the "RUN" position. If the adjustment is not completed while the engine is still warm, start the engine and allow it to warm up again. At the end of the day's operation, while the engine is at its normal operating temperature, is the most desirable time for valve clearance adjustment.

(2) *Remove the valve cover.* Remove the engine hood and the valve cover.

(3) *Close the valves.* (See fig. 69.) The valves being checked must be entirely closed before the valve clearance can be checked or adjusted. To close both valves on each of the cylinders listed under A, rotate the crankshaft until the exhaust valve is about to close and the inlet valve starts to open on the cylinders listed opposite under B. If the valves are adjusted

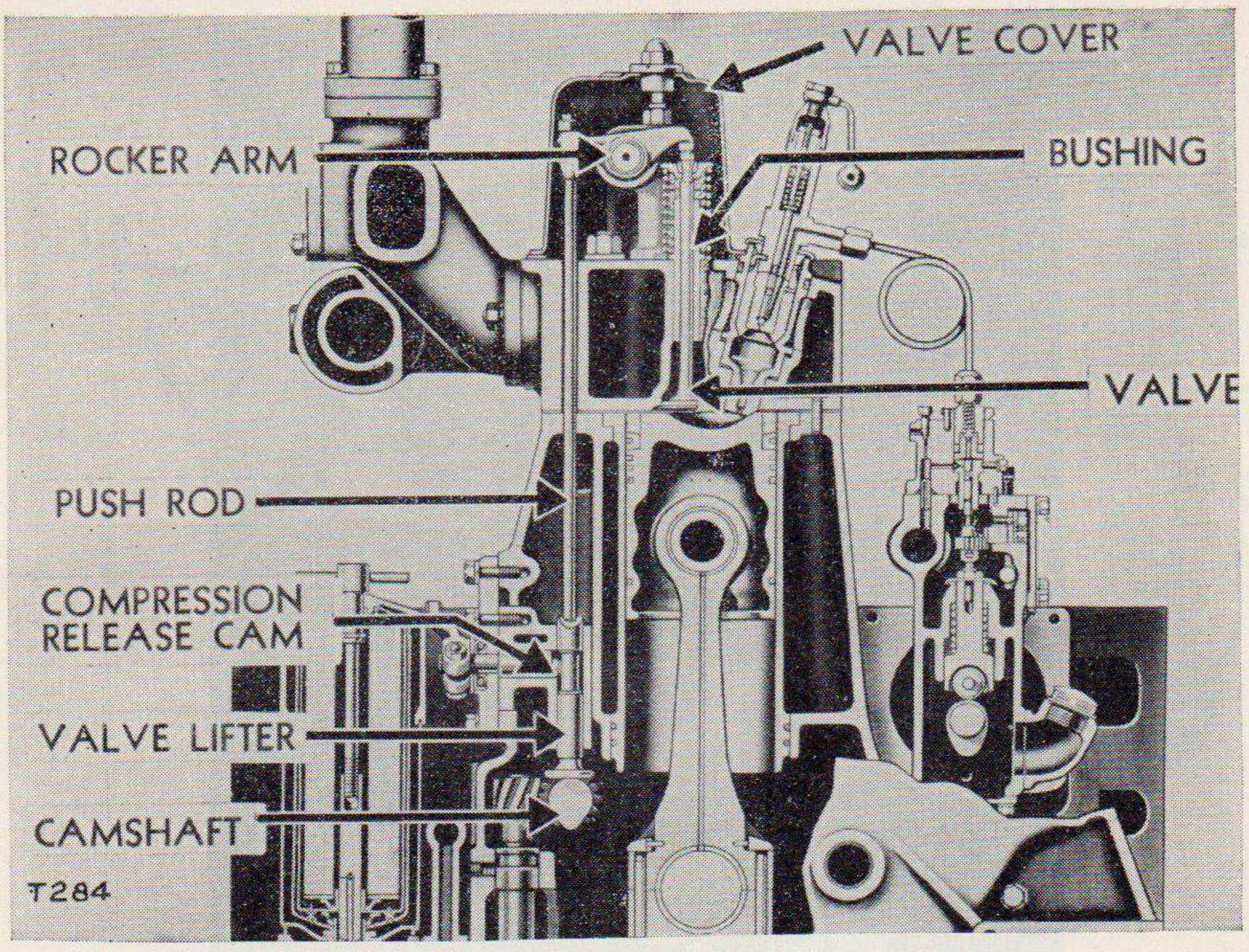

Figure 68. Valve mechanism.

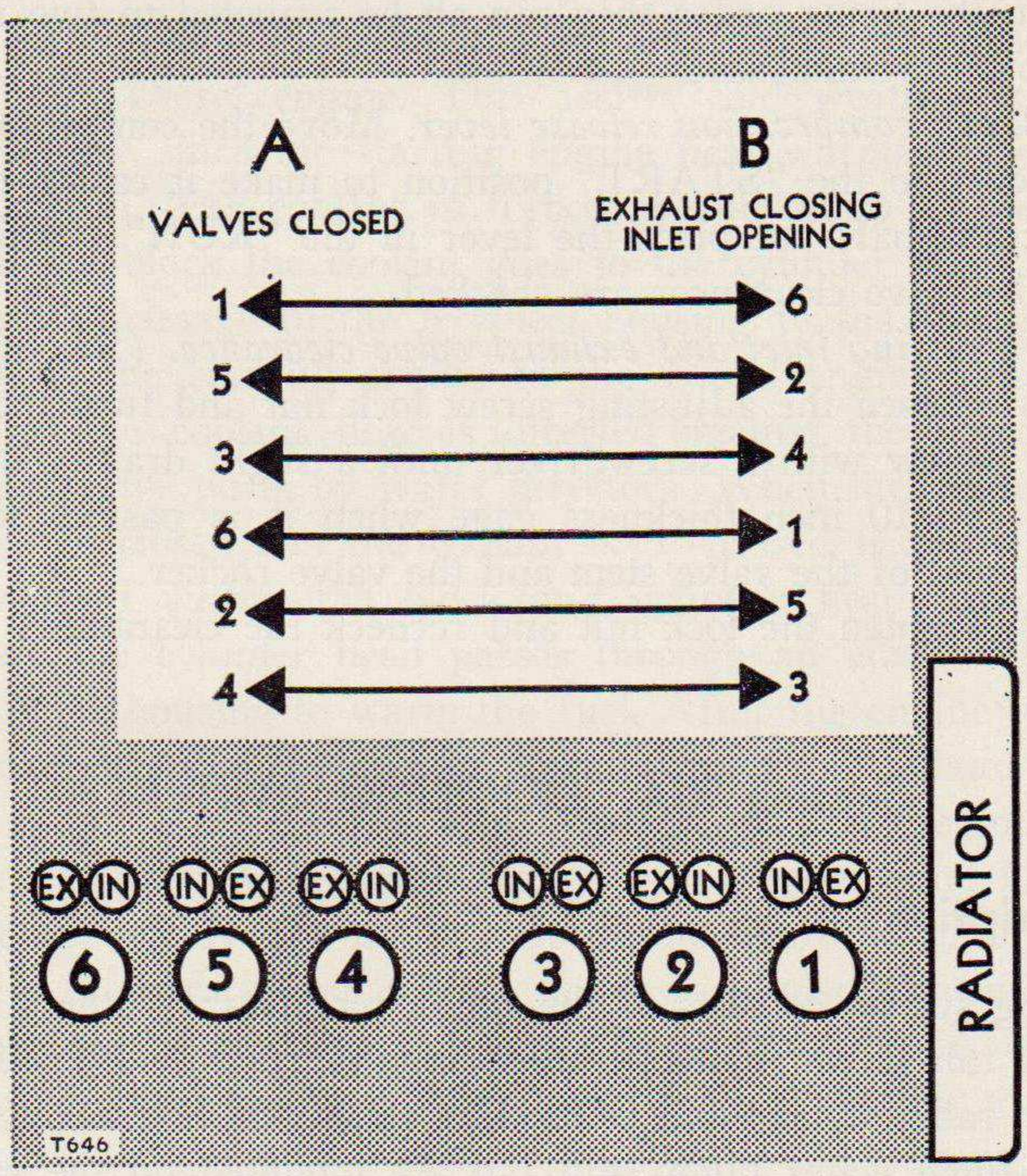

Figure 69. Valve closing procedure.

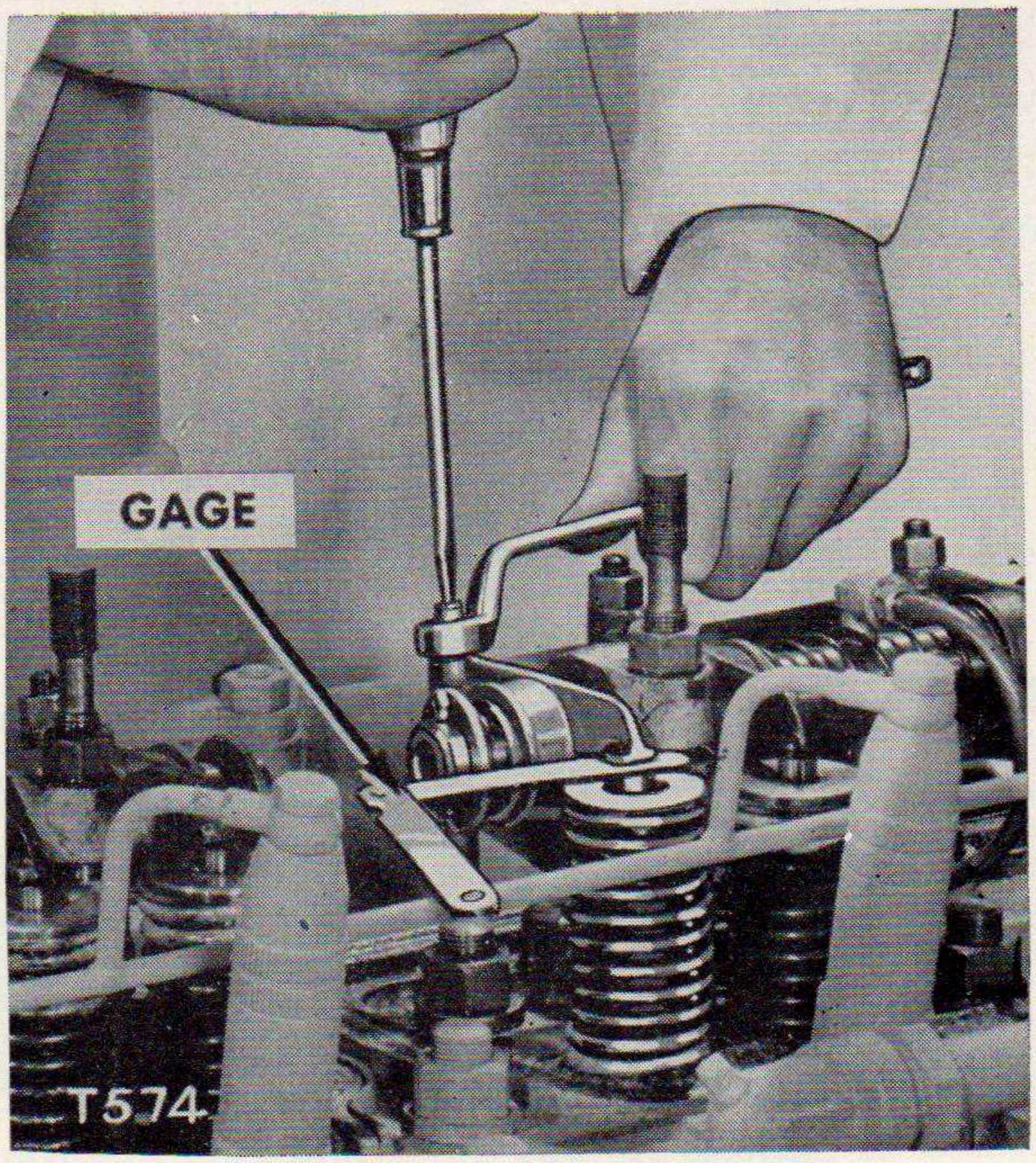

Figure 70. Adjusting inlet and exhaust valve clearance.

in the firing order they can all be adjusted in two revolutions of the crankshaft.

(4) *Move compression release lever.* Move the compression release lever to the "START" position to make it easier to turn the crankshaft but place the lever in the "RUN" position, before the valve clearances are checked.

(5) *Adjusting inlet and exhaust valve clearance.* (See fig. 70.)

(a) Loosen the adjusting screw lock nut and turn the adjusting screw with a screwdriver until a slight drag is obtained on a .010 inch thickness gage when it is passed between the end of the valve stem and the valve rocker.

(b) Tighten the lock nut and recheck the clearance.

Section XIX. COOLING SYSTEM

62. Description

The cooling system consists of the following units: Water pump, water directional tubes, water temperature regulators, sealed pressure overflow valve, radiator, fan and connecting pipes and hoses. (See fig. 71.) The centrifugal water pump and fan are mounted on the same shaft, driven with a vee-type belt by the pulley on the front end of the crank-

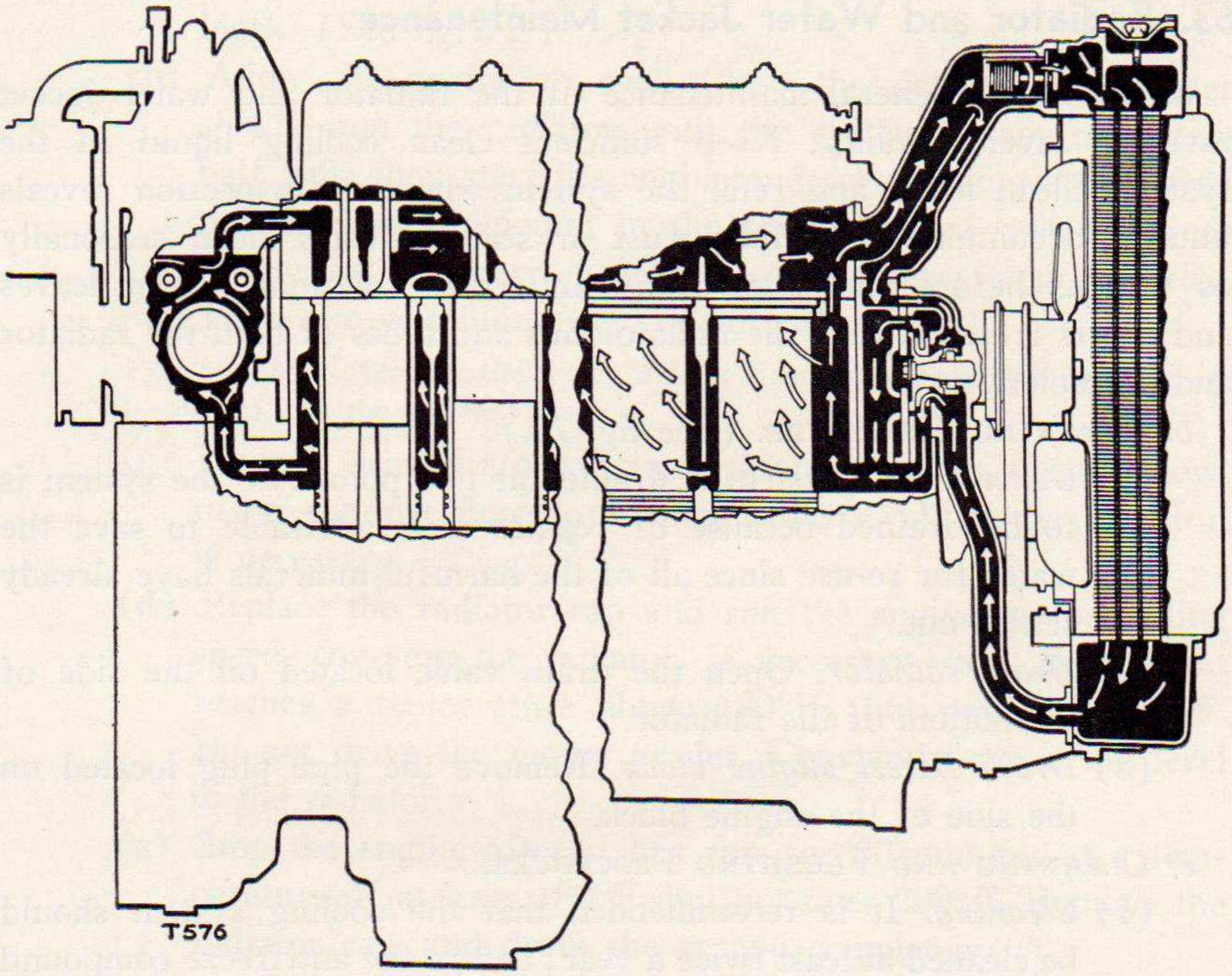

Figure 71. Cooling system (schematic drawing).

shaft. The water pump circulates the coolant through both the starting engine and the Diesel engine. This assists cold weather starting of the Diesel engine since the starting engine heat warms the coolant in the entire system. The coolant is forced by the pump to the cylinder block, from the block the coolant goes to the cylinder head and some goes through a passage in the flywheel housing to the starting engine block, through the starting engine to the Diesel engine head. In the cylinder head the coolant flow is directed against the precombustion chambers and valve ports by water directors. When the engine is cold, the regulator is closed and the coolant is by-passed back to the pump and is circulated within the block and cylinder head. Some of the coolant from the cylinder head passes through an elbow on the side of the fuel filter housing to warm the fuel. After the engine warms up, the regulator opens and the coolant flows through the radiator and back to the pump to complete the cycle. Motor graders beginning with 9K4669 are equipped with a sealed pressure overflow unit. This serves to keep the coolant from running out of the overflow pipe when the motor grader is operating at extreme angles and also prevents in some measure the loss of alcoholic antifreeze by evaporation. A centrifugal water pump in the starting engine driven by a "V" belt maintains a normal flow of coolant within both engines while the starting engine is running.

63. Radiator and Water Jacket Maintenance

a. GENERAL. General maintenance of the radiator and water jacket involves several points: Keep sufficient clean cooling liquid in the system. Clean flush, and refill the system whenever inspection reveals unusual accumulation of lime, rust or scale. Always clean seasonally as well as before and after using antifreeze solutions. Clean leaves and debris from between the radiator fins and tubes of both the radiator and oil cooler.

b. DRAINING PROCEDURE. (See fig. 72.)

(1) *General.* The system is drained at two points. If the system is to be drained because of repairs it is advisable to save the water for re-use since all of the harmful minerals have already settled out.

(2) *Drain radiator.* Open the drain valve located on the side of the bottom of the radiator.

(3) *Drain Diesel engine block.* Remove the pipe plug located on the side of the engine block.

c. CLEANING AND FLUSHING PROCEDURE.

(1) *Cleaning.* It is recommended that the cooling system should be cleaned at least twice a year; before the antifreeze compound (ethylene-glycol type) is put into the system, and again after it is removed.

(a) Run the engine until the temperature is within operating range. Stop the engine, remove the radiator cap, and drain the system by opening the drain valve in the radiator base

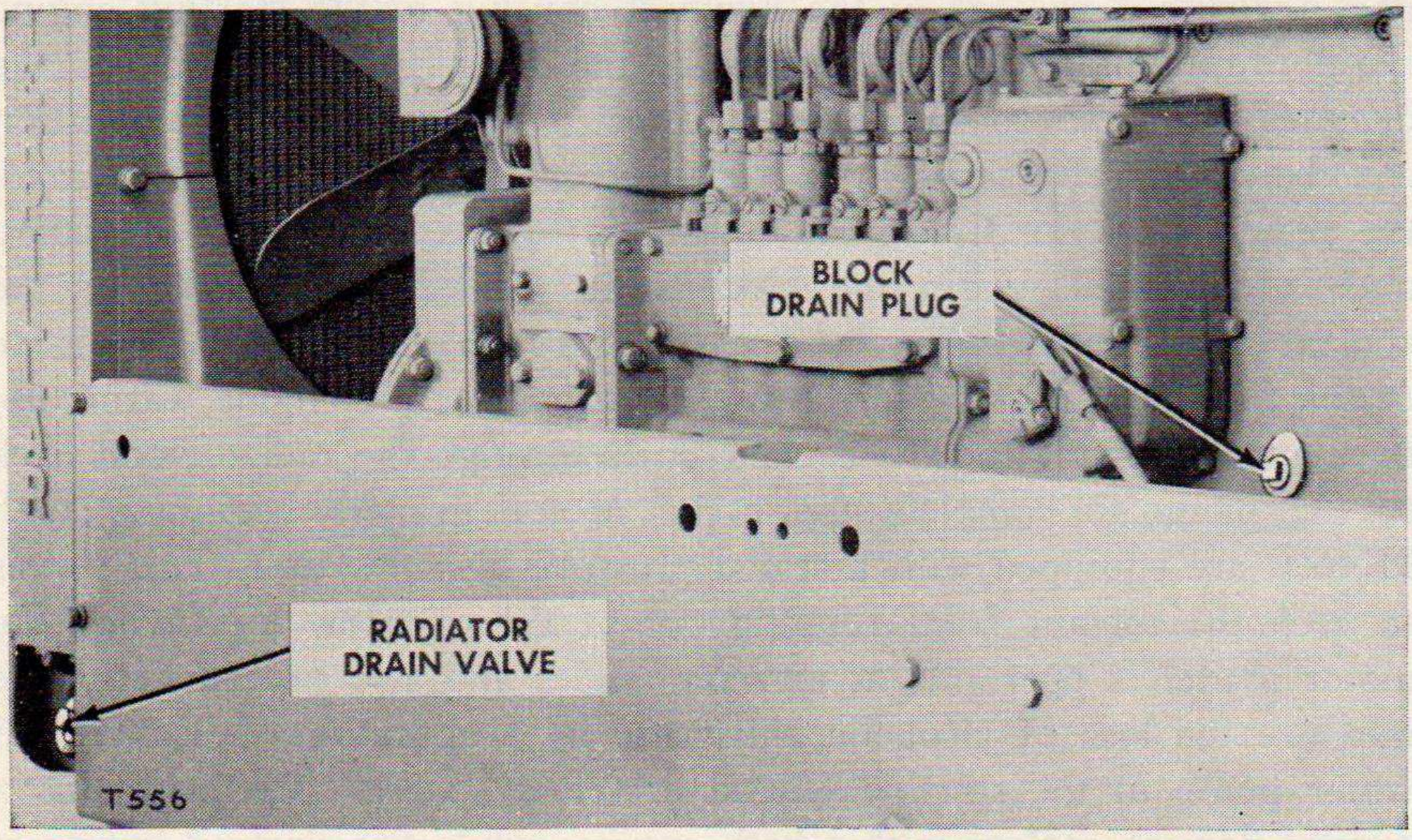

Figure 72. Location of drain plug and valve.

and removing the drain plug located on the side of the block. (See fig. 72.)

(b) Allow the engine to cool. Close the drains; pour water slowly into the radiator until the system is approximately half full; then start the engine and set at idling speed. Add the cleaning compound in the proportion of one container of cleaner to every 4 gallons of cooling system capacity. Then complete filling the system with water.

Note. Never mix the water and the cleaning compound before putting them into the system.

(c) Place a clean drain pan in position to collect the overflow, using the overflow to maintain the level in the radiator, if necessary.

(d) Replace the radiator cap and run the engine at fast idling speed, covering the radiator, if necessary, until the coolant reaches a temperature above 180°F., but not over 200°F. Do not drive the motor grader. Constantly check the level in the radiator.

(e) Stop the engine after it has run for 30 minutes at a temperature of at least 180°F, but not over 200°F. Remove the radiator cap, and drain the system completely.

(2) *Neutralizing.*

(a) Allow the engine to cool. Close the drains; pour water slowly into the radiator until the system is approximately half full; then start the engine and set at idling speed. Add the neutralizer compound in the proportion of one container of neutralizer to every 4 gallons of cooling system capacity. Then fill the system with water.

(b) With the radiator covered, let the engine idle for at least 5 minutes at the normal operating temperature; then stop the engine.

(c) Drain the system completely by removing the radiator cap and opening all the drains.

(3) *Flushing.*

(a) Allow the engine to cool. Close the drains. Pour water slowly into the radiator until the system is approximately half full; then run the engine at idling speed and fill the system completely.

(b) Run the engine, keeping the radiator covered, if necessary, until the coolant is heated to the normal operating temperature.

(c) Drain the system by removing the radiator cap and opening all the drains. Repeat the flushing operation until the drain water is clear.

(d) Allow the engine to cool and then clean all sediment from

the radiator cap, drains and the overflow pipe. Blow insects and dirt from the radiator core air passages with compressed air, blowing from the rear. Use water to soften obstructions if necessary.

(4) *Leaks.* After completing the flushing operation, make certain that the engine has been allowed to cool again. Close the drains. Pour water slowly into the radiator until the system is approximately half full; then run the engine at idling speed, and fill the system completely. Stop the engine when the cooling system is completely full. Examine the entire cooling system for leaks. This is important because the cleaning solution uncovers leaks which already exist, but are plugged with rust or corrosion. Leaks that cannot be corrected by the using organization should be reported to higher authority.

d. Coolant Service.

(1) When servicing the motor grader for summer, fill the cooling system nearly full with clear water. Add corrosion inhibitor compound in the proportion of one container of inhibitor to each 4 gallons of cooling system capacity; then complete filling the system with water.

(2) When servicing the motor grader for winter, refer to the antifreeze table in paragraph 25, for the proper proportions of ethylene glycol and clear water.

64. Fan Belt

a. Adjustment.

(1) *General.* The fan belt should be adjusted so that with a light pressure it can be pushed inward at the center approximately 1 inch. (See fig. 73.)

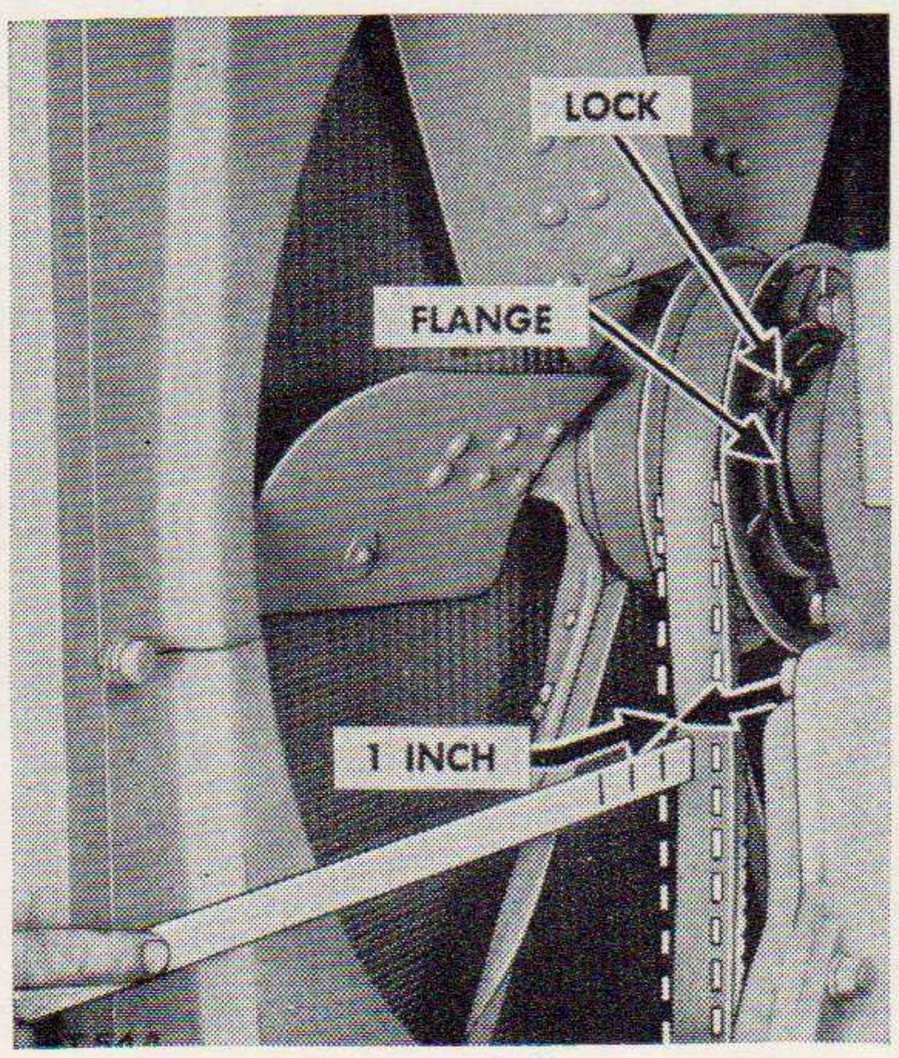

Figure 73. Adjusting fan belt.

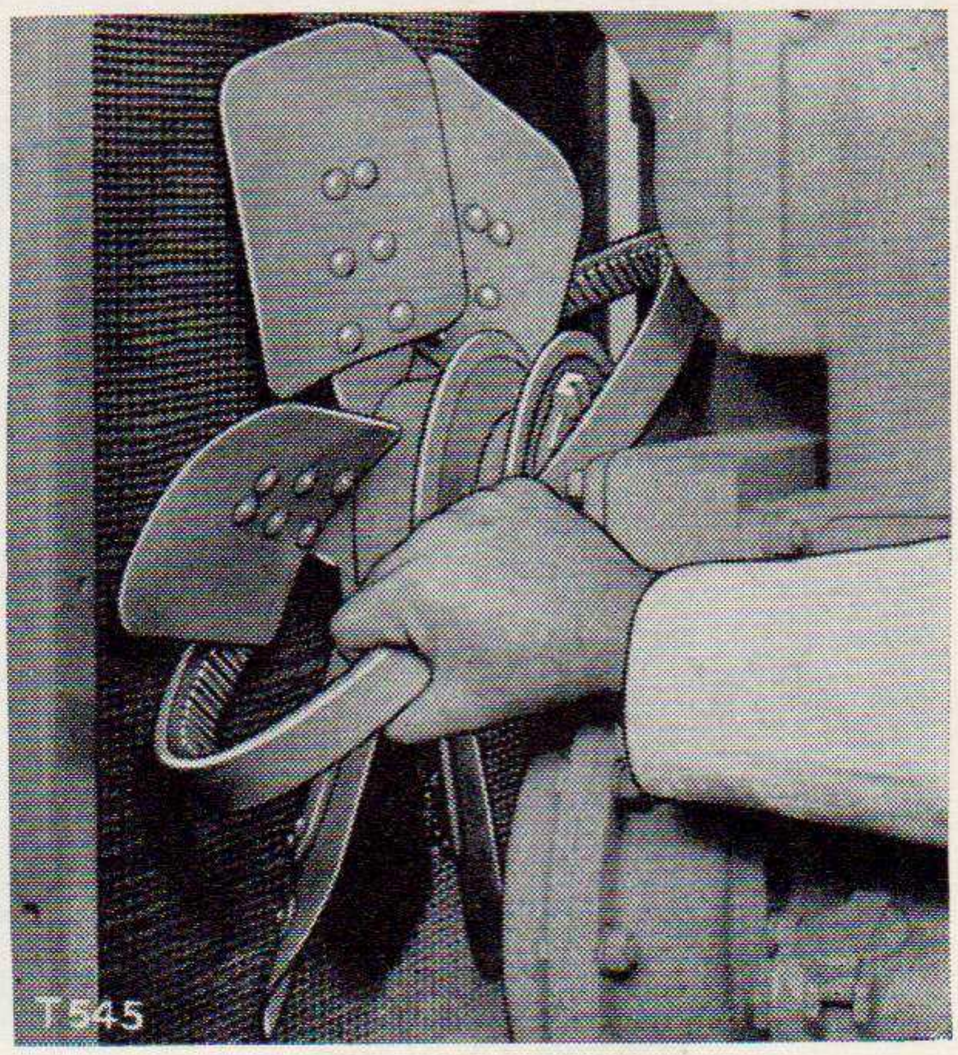

Figure 74. Replacing fan belt (part No. 7B2774).

(2) *Remove locks.* Remove the two small locks on the fan hub.
(3) *Rotate flange.* Rotate the flange nearest to the engine clockwise to tighten.
(4) *Replace locks.* Be sure the slots in the flange are lined up with the slots in the hub and replace the locks.

b. Belt Replacement.

(1) *Loosen fan belt adjustment.* Remove the two locks and rotate flange nearest the engine counterclockwise to loosen the belt.
(2) *Remove fan shields.* Remove the capscrews that hold the shields to the radiator and remove them.
(3) *Remove belt.* Take the belt off the pulley on the crankshaft and work it up and out between the fan and radiator.
(4) *Installing belt.* Install the belt in the reverse order of removal.

65. Sealed Pressure Overflow Valve

a. Description (See fig. 75.) The sealed pressure overflow valve serves two purposes: To prevent the loss of coolant when the machine operates at extreme angles and to reduce the loss of coolant and antifreeze by evaporation. It operates in the following manner: Due to expansion of the coolant by rising temperatures, a pressure will be built up in the cooling system each time the engine is started. When the pressure rises above 6 pounds per square inch, the pressure relief valve opens to relieve the pressure, or, if the cooling system has been overfilled, allows some of the coolant to escape. The valve closes when the temperature of the coolant levels off and remains closed unless there is a further increase in pressure. When the temperature of the coolant falls, a vacuum will result in the cooling system. The vacuum release valve opens when the vacuum reaches 1 pound per square inch and

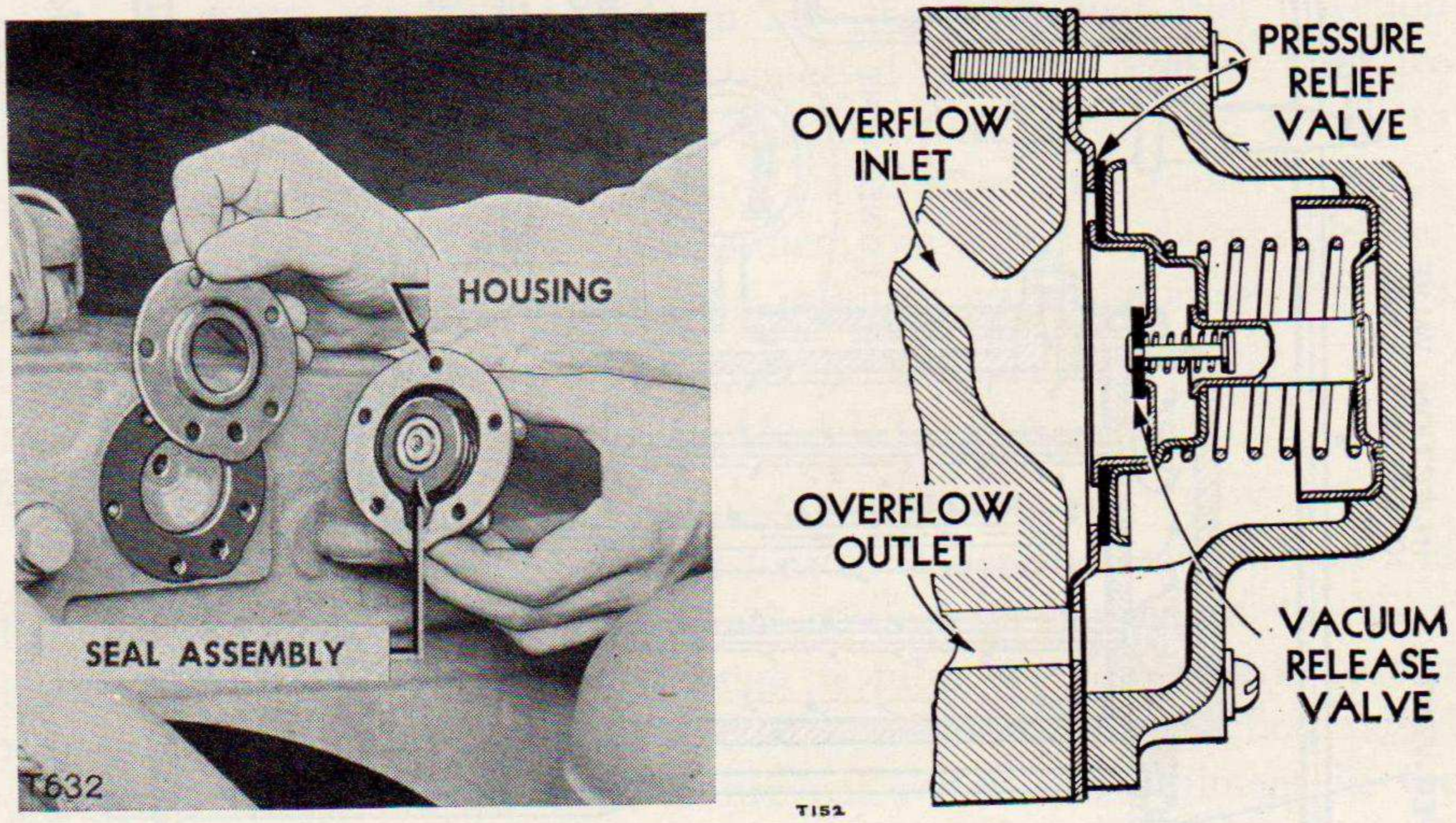

Figure 75. Sealed pressure overflow.

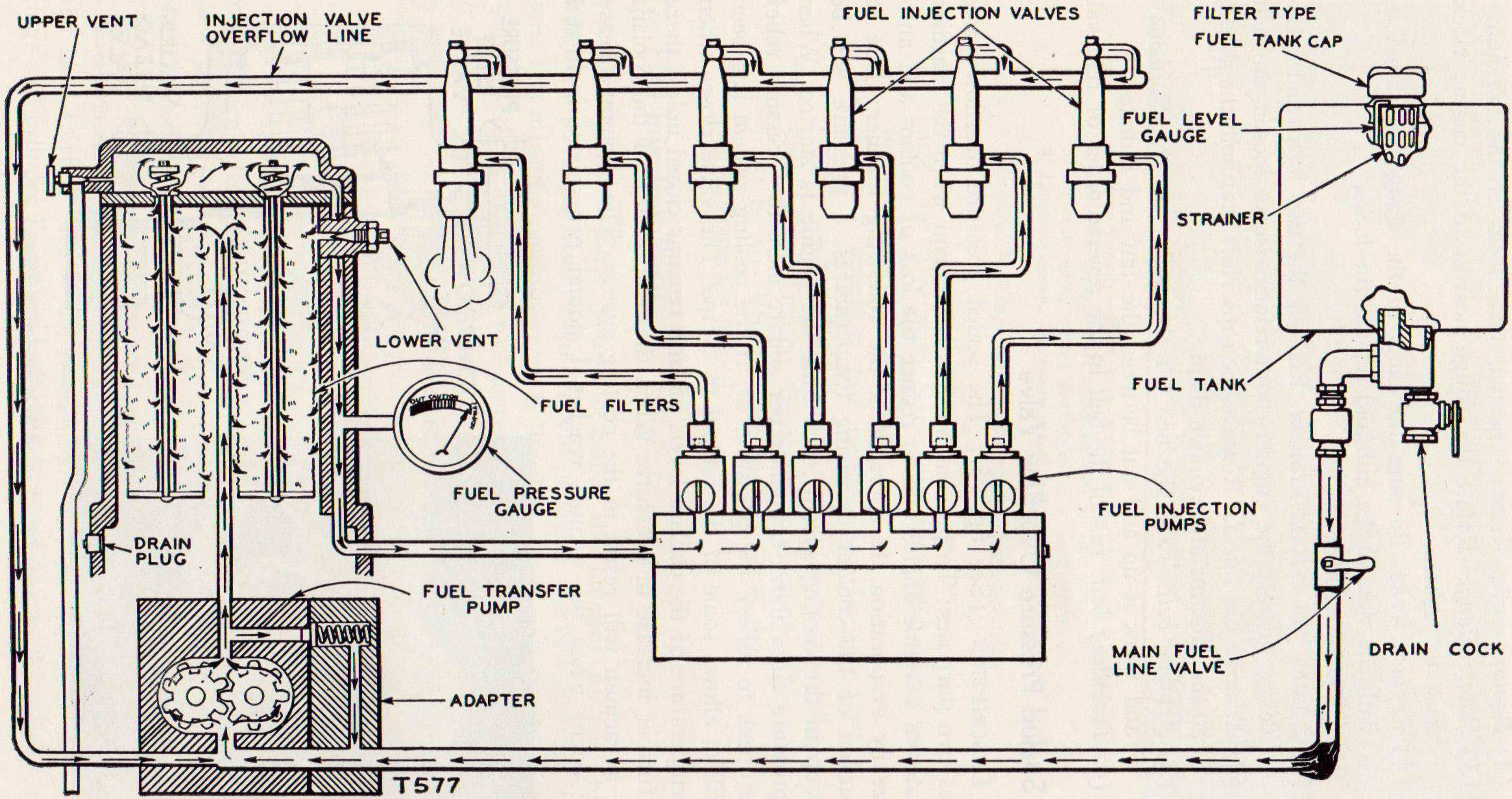

Figure 76. Fuel system (schematic drawing).

lets in air through the overflow tube. This valve also functions when draining the cooling system.

b. MAINTENANCE. The sealed pressure overflow unit should be removed occasionally for inspection and cleaning.

c. REPLACEMENT PROCEDURE. (See fig. 75.)

(1) *Remove the housing.* Remove the housing from the radiator top tank by taking out the screws that hold it in place.

(2) *Remove the seal assembly.* Remove the seal assembly by prying under opposite edges of the relief valve.

(3) *Install the seal assembly.* The seal assembly is installed by placing it in the housing and pressing down evenly with the thumbs on the pressure release valve seal. Be sure the seal assembly is firmly seated in the housing before installing the housing on the radiator.

Section XX. FUEL SYSTEM

66. General Description (See fig. 76.)

a. The fuel system is divided into two sections which are referred to as the supply or low pressure side and the injection or high pressure side. The supply side consists of the fuel tank, transfer pump, fuel filters, fuel pressure gage, and connecting lines. The injection side is made up of the fuel injection pump, fuel injection valves, and connecting lines.

b. On the supply side of the fuel system, the fuel flows by gravity from the main fuel tank to the transfer pump. The transfer pump forces the fuel through the fuel filter elements into the upper chamber of the fuel filter housing and down into the individual fuel injection pumps. The fuel pressure gage is connected so as to register pressure on the fuel between the filters and the injection pumps and serves to indicate the condition of the fuel filter elements and the transfer pump.

c. On the injection side of the system the injection pumps deliver the fuel to the injection valves. The injection valves atomize the fuel delivered to the cylinders.

67. Fuel Tank

a. DESCRIPTION. The fuel tank is located under the seat cushion and has a capacity of 40 gallons. A fuel strainer is located in the filler opening. The tank is vented through a tube extending back to the rear of the seat. The main fuel line is connected to a projection raised above the bottom of the tank to prevent water and sediment in the bottom of the tank from going to the fuel transfer pump. A drain cock is provided to drain off this water and sediment.

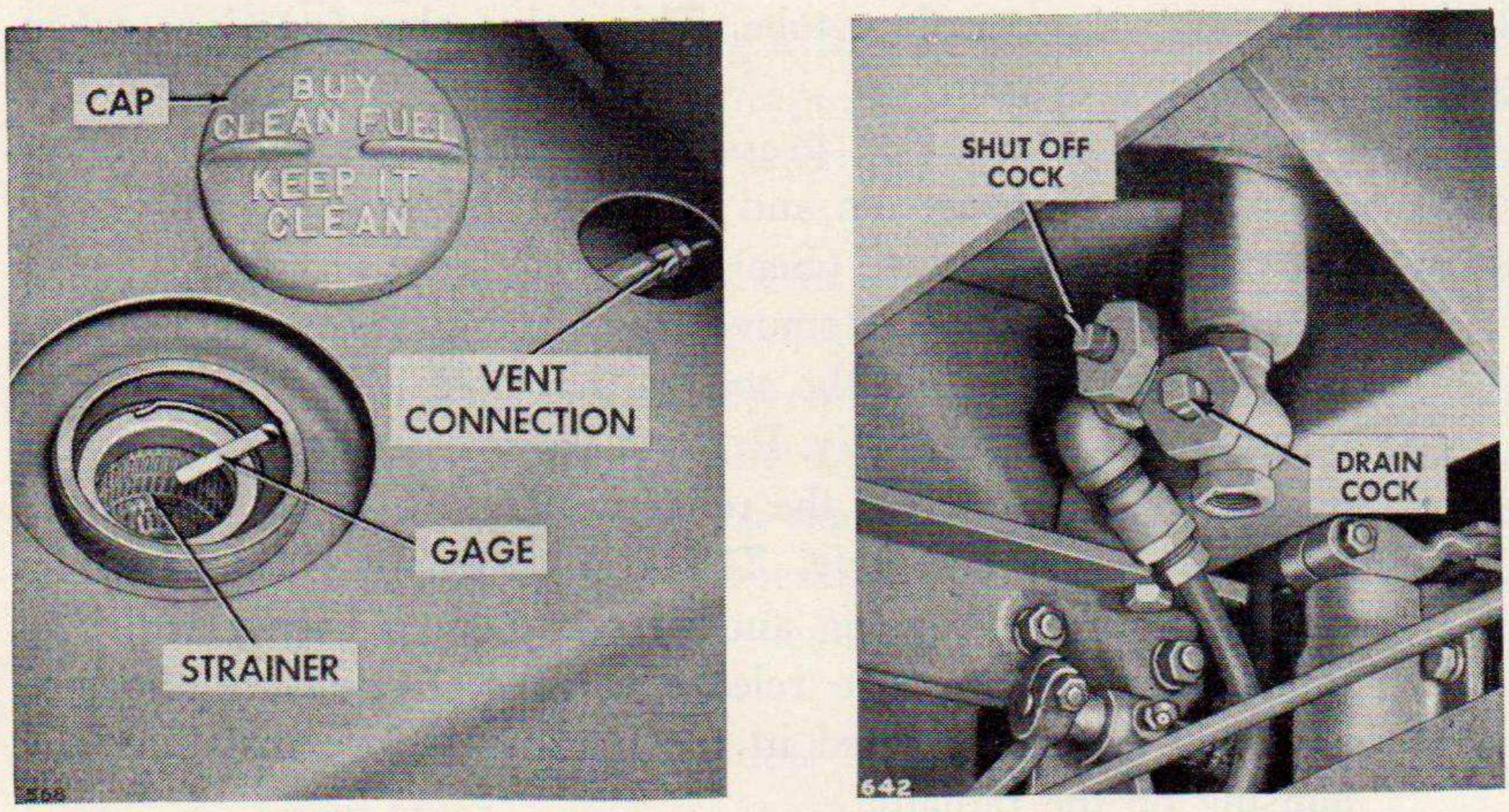

Figure 77. Fuel tank details.

b. MAINTENANCE. (See fig. 77.)

(1) Fill the fuel tank at the end of each day's operation. This will drive out moisture-laden air and prevent condensation. Every 64 hours, open the drain cock under the fuel tank before starting the engine. Drain off any sediment or water which may have accumulated. The strainers in the fuel tank filler opening should be removed and cleaned regularly.

(2) The fuel tank vent should be disconnected from the fuel tank and cleaned occasionally. Remove the seat cushion and disconnect the vent line from the top of the tank. Clean the line by attaching an air hose to the end removed from the tank.

c. FUEL.

(1) *Fuel specifications.* While the Diesel engine will operate on almost any petroleum fuel for some time, it is important that good grades of CLEAN DISTILLATES be supplied, if the engine is to give trouble-free service. Commercial No. 3 domestic burner fuel, U. S. Army Specification 2–102B or Navy Department Specification, oil, fuel, Diesel 7–0–2D provide satisfactory operation. In subzero weather, where warm storage is not provided for the tractor, distillates with unusually low pour points may be required. It is necessary that the fuel be fluid enough to flow from the main tank to the engine transfer pump at the lowest temperature at which the engine must start and operate.

(2) *Care of fuel.* Too much emphasis cannot be placed on the importance of using only clean fuel. The best fuel can be rendered unsatisfactory by inadequate storage facilities or careless handling. Dirty fuel will result in rapid clogging of

the filters and excessive wear on the fuel transfer pump. Water in the fuel will also cause difficulty in the form of unsatisfactory engine performance and rusting of the finely finished parts in the injection equipment. The following suggestions will help assure a clean fuel supply:

(a) *Where possible use a large storage tank.* Allow the dirt and water to settle for at least 32 hours before using the fuel, then draw from the top, preferably with a pump. Periodically drain water and sediment from the bottom.

(b) *Avoid the use of open cans and funnels.* If cans must be used select clean cans with tight caps.

(c) *Clean area around fuel tank cap.* Before removing the fuel tank cap, clean the dust and dirt from around the cap and surrounding area. If a pump is used on a storage tank, wipe off the nozzle before filling the fuel tank or if cans are used wipe off the cap and top of the can.

68. Fuel Pump Transfer

a. DESCRIPTION. The fuel transfer pump is a gear type pump mounted below the fuel filter housing. This pump forces fuel through the fuel filter elements to the injection pumps. An adapter mounted on the side of the transfer pump contains a spring loaded plunger which opens to bypass fuel not required by the fuel injection pumps or when the fuel filters become clogged.

b. FUEL TRANSFER PUMP ADAPTER. (See fig. 78.)

(1) *General.* If dirt lodges between the plunger in the adapter and the seat on the machined surface of the transfer pump, the effect at slow speed will be similar to that produced by clogged

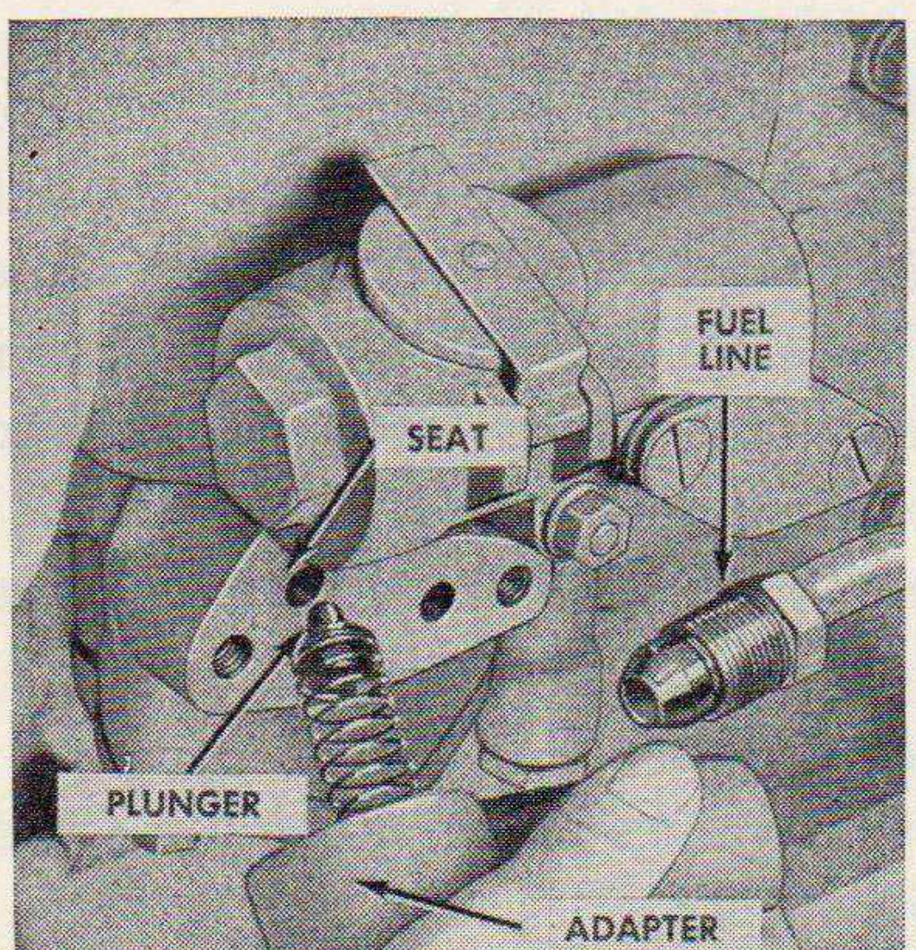

Figure 78. Removing fuel transfer pump adapter.

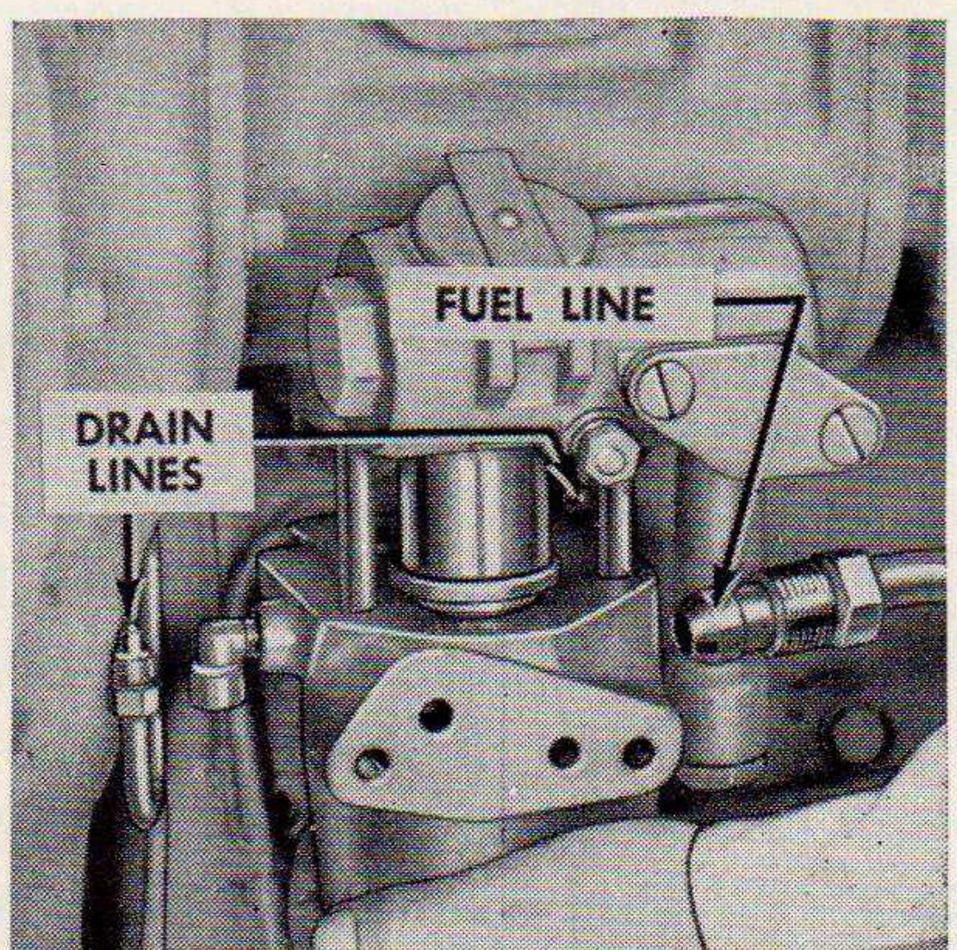

Figure 79. Removing fuel transfer pump (part No. 1F1532).

filters. The fuel pressure gage indicator will drop out of the "NORMAL" white range.

(2) *Procedure for cleaning plunger and seat.*

(a) *Close main fuel line valve.* Close the valve in the main fuel line below the fuel tank and disconnect the main fuel line from the adapter.

(b) *Remove adapter.* Take out the two capscrews holding the adapter to the transfer body and remove the adapter.

(c) *Clean plunger and seat.* Clean the plunger and seat and replace the adapter in the reverse order of removal. Reconnect the main fuel line and turn on the fuel.

c. Removing Fuel Transfer Pump. (See fig. 79.)

(1) *Close main fuel line valve.* Close the main fuel line valve in the main fuel line below the fuel tank and disconnect the main fuel line from the transfer pump adapter.

(2) *Remove engine side plate.* Remove the side plate on the right side of the engine.

(3) *Disconnect drain lines.* Disconnect the two drain lines from the transfer pump body.

(4) *Remove stud nuts.* Remove the four stud nuts holding the transfer pump to the engine and remove the pump as illustrated in figure 79.

d. Installing Fuel Transfer Pump.

(1) *Check seals and gaskets.* Be sure the rubber seal, metal ferrule and gasket are in good condition and in place as the pump is installed.

(2) *Install pump.* Install the pump in the reverse order of removal.

69. Fuel Filters

a. Description. The fuel filters are located in one housing on the right side of the engine. The four replaceable filter elements consist of absorbent material wound up on inner sleeve. As the filters become clogged with foreign material the position of the fuel gage indicator will work back from the original position in the "NORMAL" white range to the "OUT" red range (engine running).

b. Care. Drain the fuel filter housing every 64 hours to remove the water and sediment. (See fig. 80.)

(1) *Shut off the main fuel tank cock.* (See fig. 77.)

(2) *Remove drain plug.* Open the vent valves and remove the drain plug in the fuel filter housing.

(3) *Replace drain plug.* Replace the drain plug, close the vents and prime the system as outlined in paragraph 70.

c. Filter Element Replacement. When the absorbent filters have collected enough contamination to cause the fuel pressure gage indicator

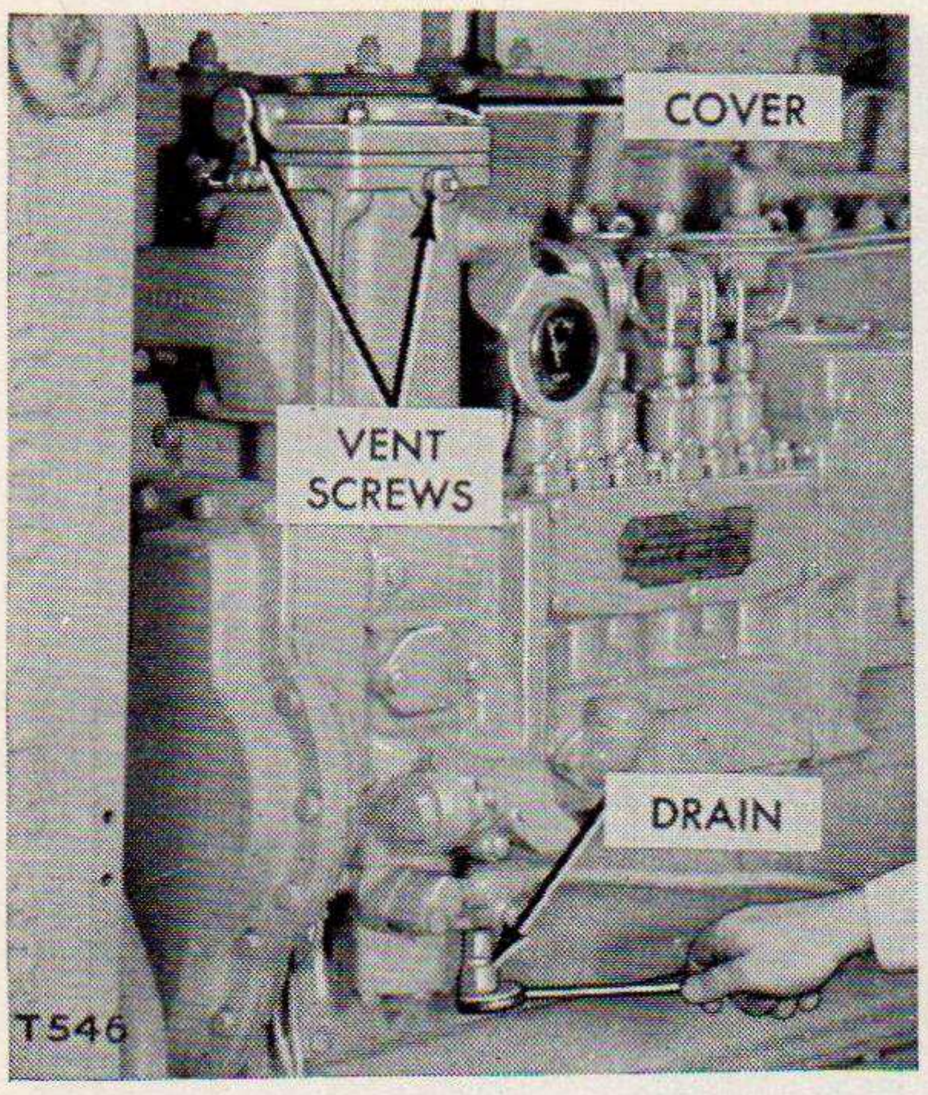

Figure 80. Draining filter housing.

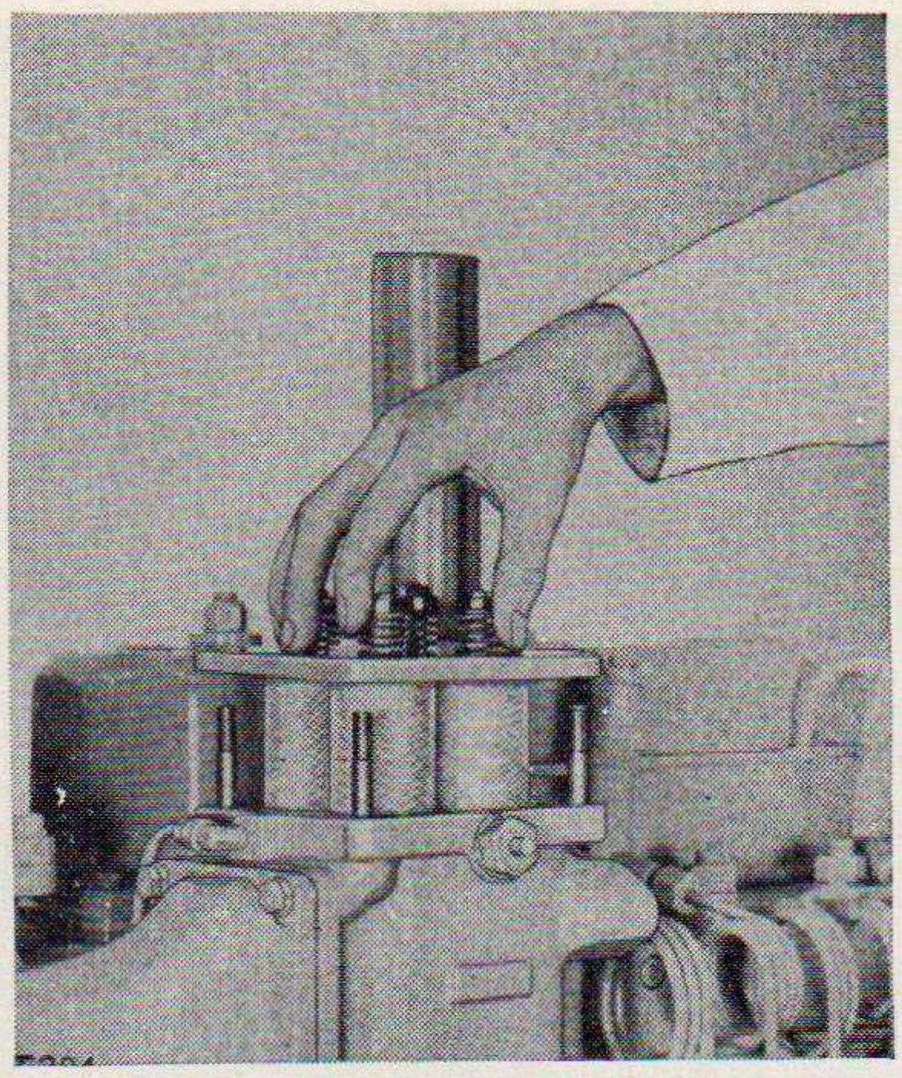

Figure 81. Lifting out filter element.

to register in the "OUT" range (engine running), they must be replaced. Since these filter elements absorb and hold contaminants, they cannot be washed or otherwise restored.

(1) *Removal procedure.*

(a) *Close main fuel line valve.* Close the main fuel line valve in the main fuel line below the fuel tank.

(b) *Drain the filter housing.* (See fig. 80.) Remove the drain plug and drain the fuel filter housing.

(c) *Clean the filter cover.* Remove the hood and clean the top of the filter housing cover to prevent loose dirt from dropping into the filter housing. Take off the four nuts holding the cover to the housing and remove the cover.

(d) *Remove the filter assembly.* (See fig. 81.) Lift out the filter assembly and place it on a flat clean surface.

(e) *Remove elements.* (See fig. 82.) Compress each spring and remove the pins. Lift off the plate and remove the elements from the rods.

(2) *Installation procedure.*

(a) *Wash all parts.* Wash the cover, plate, retainers, pins and springs carefully in Diesel fuel or dry-cleaning solvent. Flush out the housing with Diesel fuel and replace the drain plug.

(b) *Place new elements over retainer rods.* Place new elements over the rods and attach each rod to the plate by compressing the spring and inserting the pin so it is held securely in the counterbore of the retainer.

(c) *Seat new elements.* Grasp each element at the bottom end and give it a half turn under light pressure to seat the ends of

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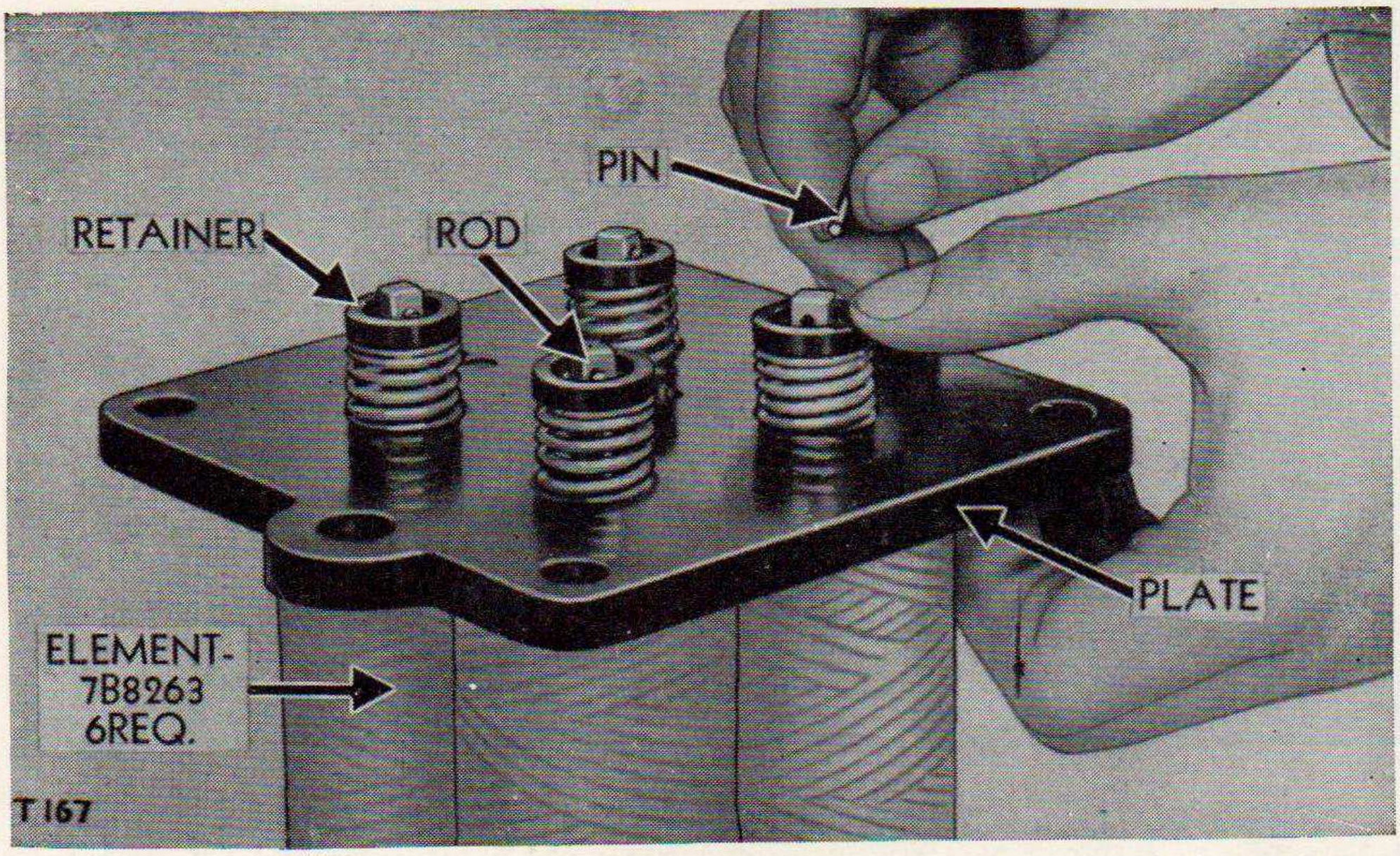


Figure 82. Removing filter elements (assembly 7B8264) from plate.

the elements against the plate and against the discs on the bottom of the rods.

(d) *Install filter assembly in housing.* Be sure the cork gaskets are in place and in good condition (one above and one below the plate), then lower the filter assembly into place.

Caution: Keep the top side of the retainer plate and the inside of the housing cover clean. These parts are on the "Clean" side of the elements and if dirt is not completely removed it will find its way into the fuel injection equipment.

(e) *Replace cover.* Replace the cover. Install the hood and turn on the fuel.

(f) *Prime the fuel system.* Prime the fuel system as directed in paragraph 70.

70. Priming the Fuel System

a. PURPOSE. Any time the fuel flow is broken and air is allowed to get into the fuel system, the fuel system must be primed. If air is left in the lines, the fuel system will become air bound, resulting in inability to start the Diesel engine or the misfiring of one or more cylinders.

b. PRIMING PROCEDURE. (See fig. 83.)

(1) *Make sure main fuel line valve is open.*

(2) *Shut off throttle.* Place the Diesel engine throttle in the "SHUT OFF" position.

(3) *Place compression release lever in "START" position.*

(4) *Open lower vent valve.* Using the vent wrench 4A62, open the lower fuel housing vent valve.

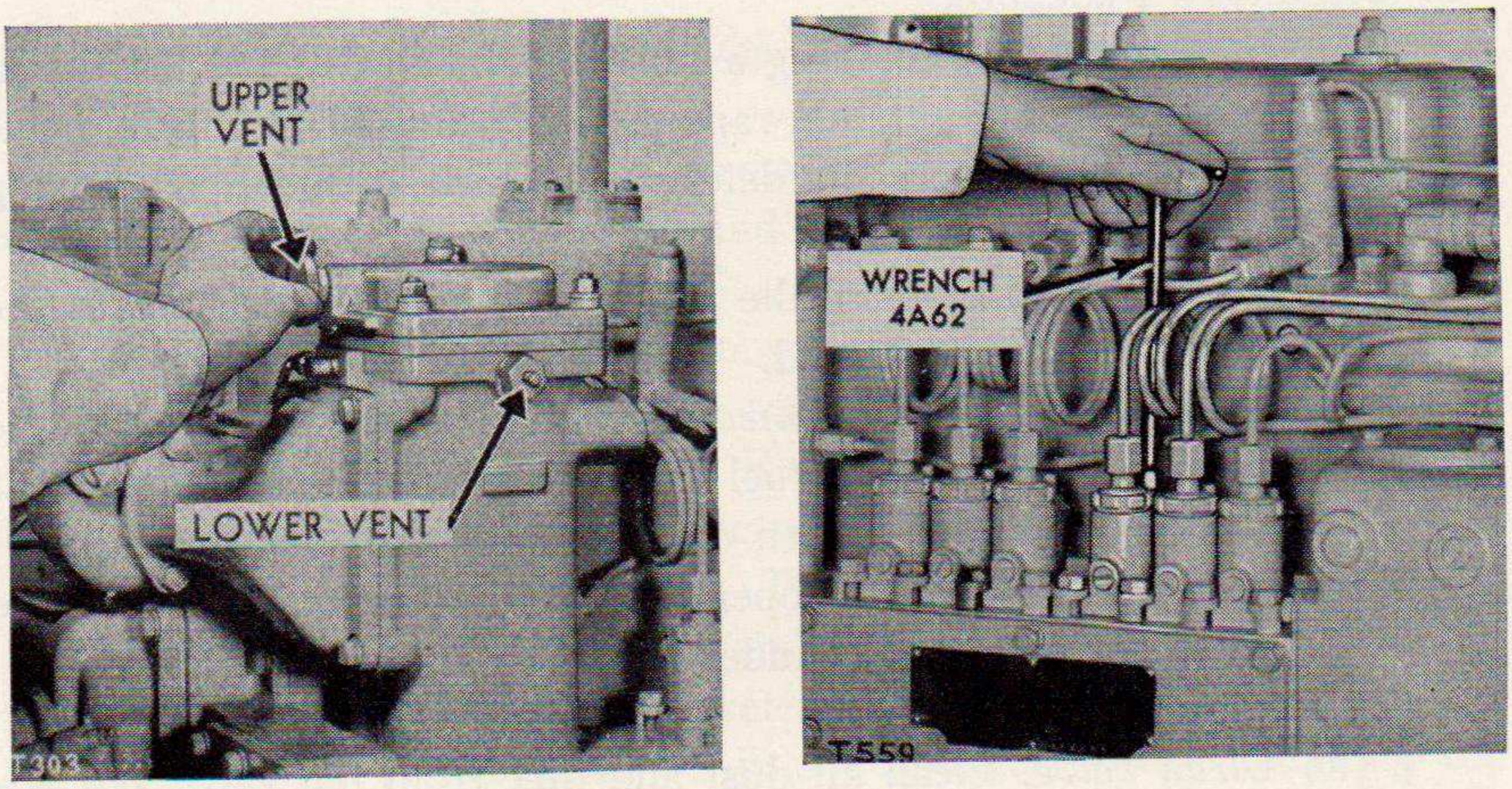


Figure 83. Priming fuel system.

(5) *Start starting engine.* Start the starting engine and crank the Diesel engine at full cranking speed. Observe the flow of fuel from the vent until it is a steady stream without air bubbles.

(6) *Close vent valve.* Close the vent valve as soon as the fuel flows without air bubbles.

(7) *Repeat procedure.* Repeat the above procedure with the upper fuel filter vent valve and each of the fuel injection pump vent valves in turn, starting with the one nearest the filter housing.

(8) *Start Diesel engine.* Start the Diesel engine to determine if all the air is out of the system. If the engine misses, repeat the priming procedure on each of the fuel injection pump vents with the engine running at idling speed.

71. Fuel Injection Valves

a. DESCRIPTION. The fuel injection valves are located on top of the cylinder head and each is held in a precombustion chamber by a single large nut. Fuel pressure developed by the injection pump, raises a needle in the injection valve against spring pressure and the fuel is sprayed through a single orifice into the precombustion chamber.

b. ADJUSTMENTS. The injection valves have no operating adjustments. When the valve is assembled at the factory precise adjustments are made and these adjustments should not be altered during the life of the injection valve.

c. CARE. To protect fuel injection valves, drain the sediment and water from the fuel tank and filter housing regularly and never operate the engine without fuel filters. Dirt and water is the most likely cause of fuel injection valve trouble.

d. Checking Procedure.

(1) *General.* Before removing a fuel injection valve for testing on an engine that is missing, rapping, or puffing black smoke, make the following check to determine which cylinder is causing the difficulty.

(a) *Run the engine.* Run the engine at a speed which makes the defect most pronounced.

(b) *"Cut out" one fuel injection pump at a time.* Loosen the fuel line nut on one fuel injection pump at a time to "cut out" the cylinder. When one is found that makes no difference in the irregular operation of the engine, probably the valve for only that cylinder need be removed and tested.

(2) *Removal procedure.*

(a) *Clean valve.* Clean all dust and dirt from the valve and adjacent areas.

(b) *Disconnect drain tube.* Disconnect the drain tube from the top of the injection valve and install a 1A7776 Seal in its place. (See fig. 84.)

Note. The seals 1A7776, caps 1A8634, plugs 2A913, and plug 1F1559 are included in the tool group.

(c) *Disconnect fuel inlet line.* Disconnect the fuel inlet line and cover the opening in the injection valve with a 1A8634 Cap. Cover the opening in the end of the fuel line by screwing in a 2A913 Plug. (See fig. 84.)

(d) *Remove injection valve.* (See fig. 85.) Unscrew the retaining nut using the wrench 9B2029 and handle 4B9918. Lift the injection valve out of the precombustion chamber.

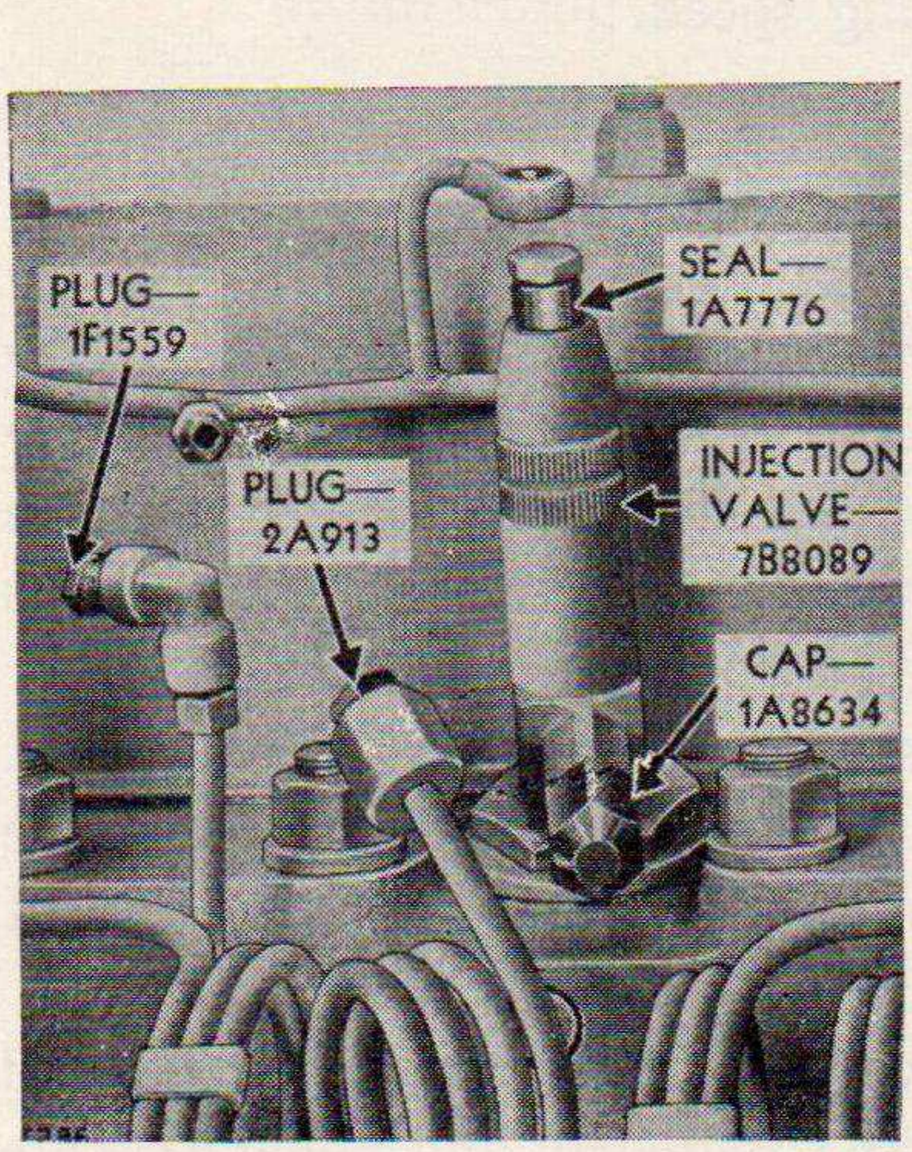


Figure 84. Preparing to remove injection valve.

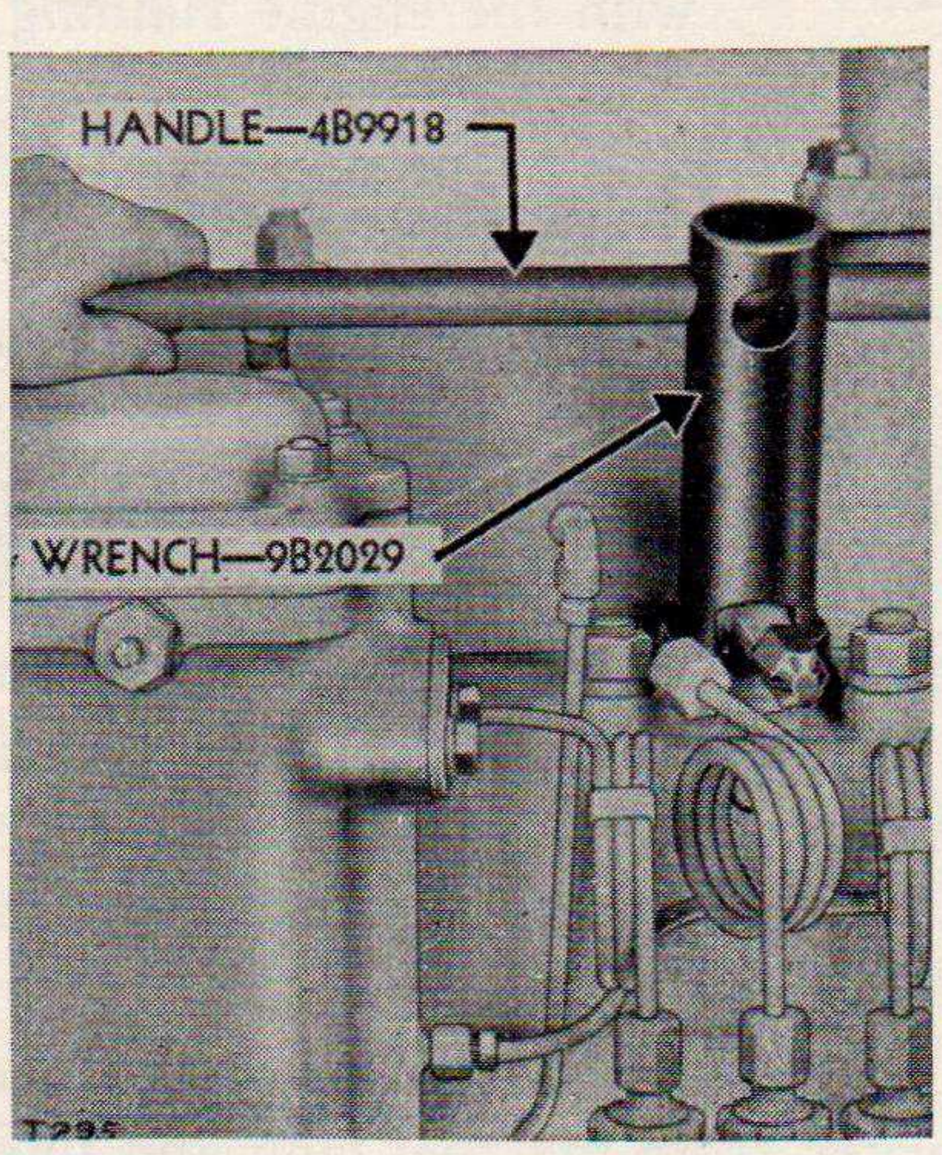


Figure 85. Removing injection valve (part No. 7B8089).

(3) *Testing a fuel injection valve.*

(a) *Invert the valve.* Turn the valve upside down in the precombustion chamber from which it was removed and reconnect the fuel line. (See fig. 86.)

(b) *On machines after 9K4825.* On motor graders built after serial number 9K4825, disconnect the drain tube and screw a 1F1559 Plug in its place in the fitting in the tube leading to the transfer pump. This is necessary to prevent an air lock in the fuel system while the inspection valves are being tested. (See fig. 84.)

(c) *If one valve is being tested.* If only one valve is being tested loosen the fuel line nut above each pump except the one that supplies the valve being tested. This will prevent fuel being injected into the cylinders.

(d) *Start starting engine.* Start the starting engine and with the compression release lever in the start position, crank the Diesel engine at the normal cranking speed.

(e) *Watch spray.* Open the Diesel throttle so that the valves will spray their full amount. Watch the spray that comes from the injection valve nozzle. If the discharge is in the form of a fine even mist, it indicates that the valve is in good condition. If the spray exhibits any of the abnormal characteristics illustrated in figure 87, the fuel injection valve should be replaced.

(4) *Injection valve installation.*

(a) *Tighten hold down nuts moderately.* Tighten hold down nuts only tight enough to prevent leaks between the valve

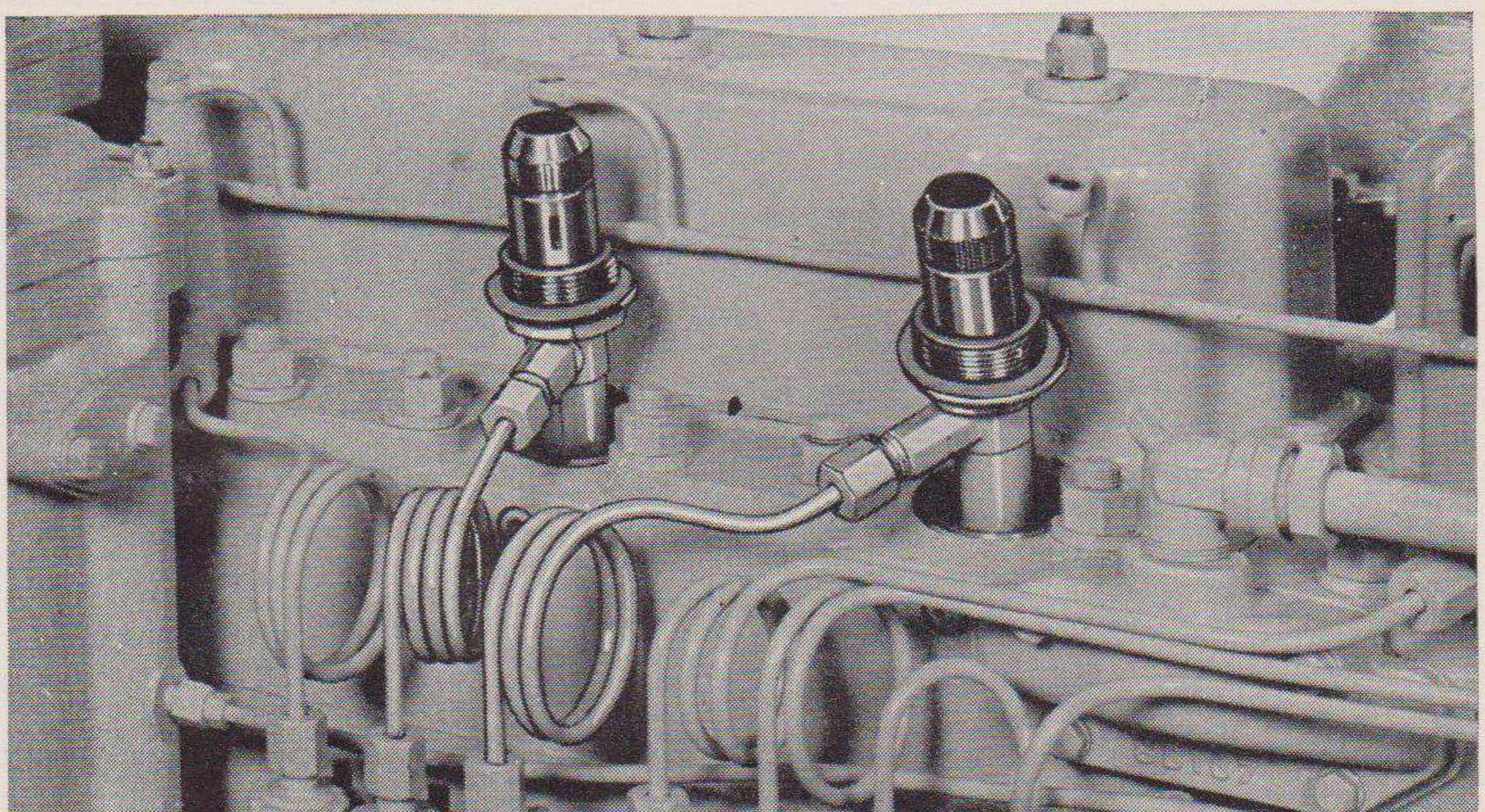
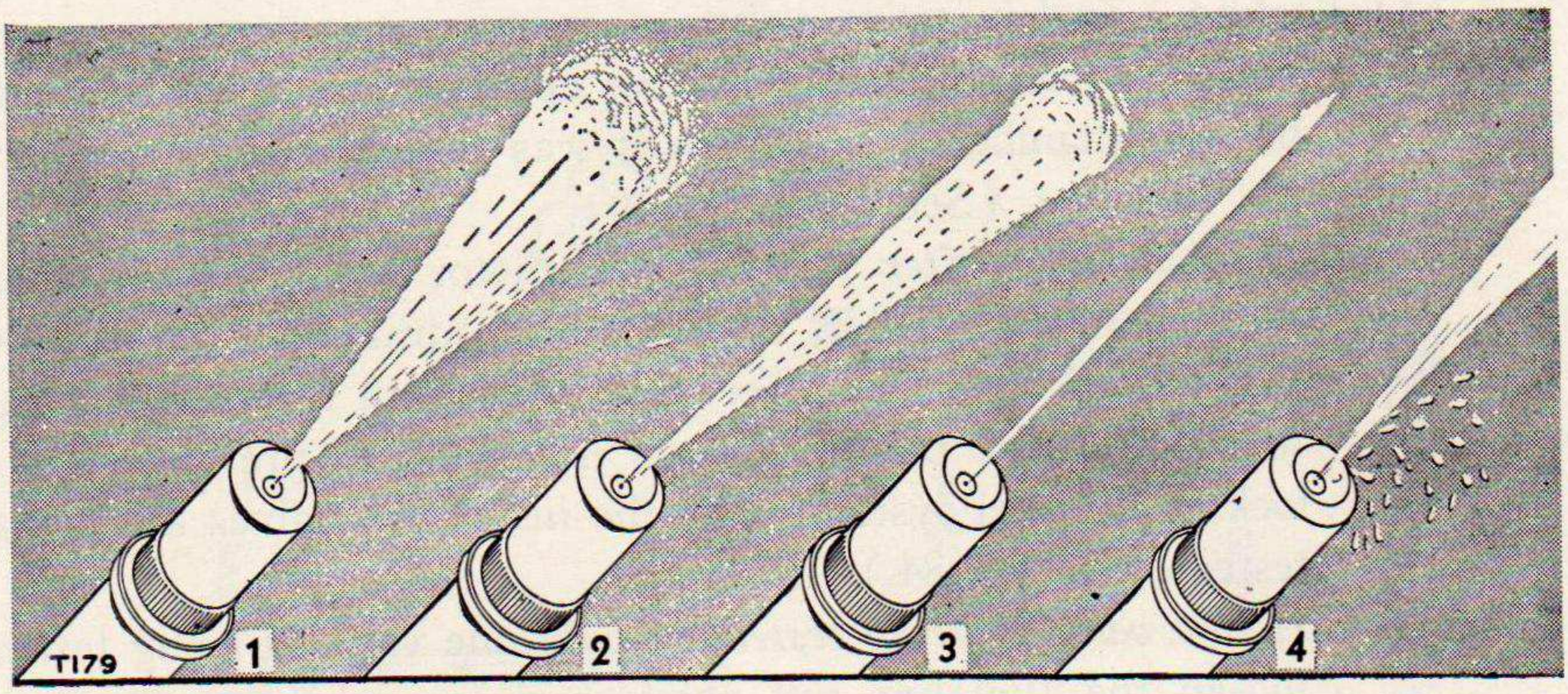


Figure 86. Fuel injection valves inverted for testing.



1. Correct spray.—Fine even spray in the form of a cone.
2. Incorrect spray.—Fuel spray emitted on one side.
3. Incorrect spray.—Fuel discharged in a solid stream or jet.
4. Incorrect spray.—Uneven cut off and dribble.

Figure 87. Injection valve spray characteristics.

and the valve seat. Excessive tightening might cause distortion of the injection valve.

(b) *Be sure overflow line washers are in place.* There is a copper washer above and below the drain tube connection at each valve. Tighten the screw moderately. This connection must be air tight on machines after 9K4825 or the system will become air locked.

72. Fuel Injection Pumps

a. DESCRIPTION. Each pump measures the amount of fuel to be injected into its particular cylinder and produces the pressure for injection. The injection pump plunger is lifted by a cam and always makes a full stroke. The amount of fuel pumped during any one stroke is varied by turning the plunger in the barrel. The plunger is turned by the governor action through a rack which meshes with a gear segment on the bottom of the pump plunger.

b. CARE. The life of fuel injection pumps depends on the precautions taken to keep the fuel supply clean. Dirt and water in the fuel contribute to premature pump failure.

c. ADJUSTMENT. All fuel pumps are interchangeable between cylinders on a particular engine and also between engines having the same cylinder bore whether they are four- or six-cylinder. Each pump is adjusted when assembled at the factory and stays permanently in adjustment. They can be individually replaced without skilled setting.

d. TESTING. Worn fuel injection pumps will result in loss of power and hard starting. These same conditions may be present if the piston rings and cylinder liners are badly worn. However, in the case of worn

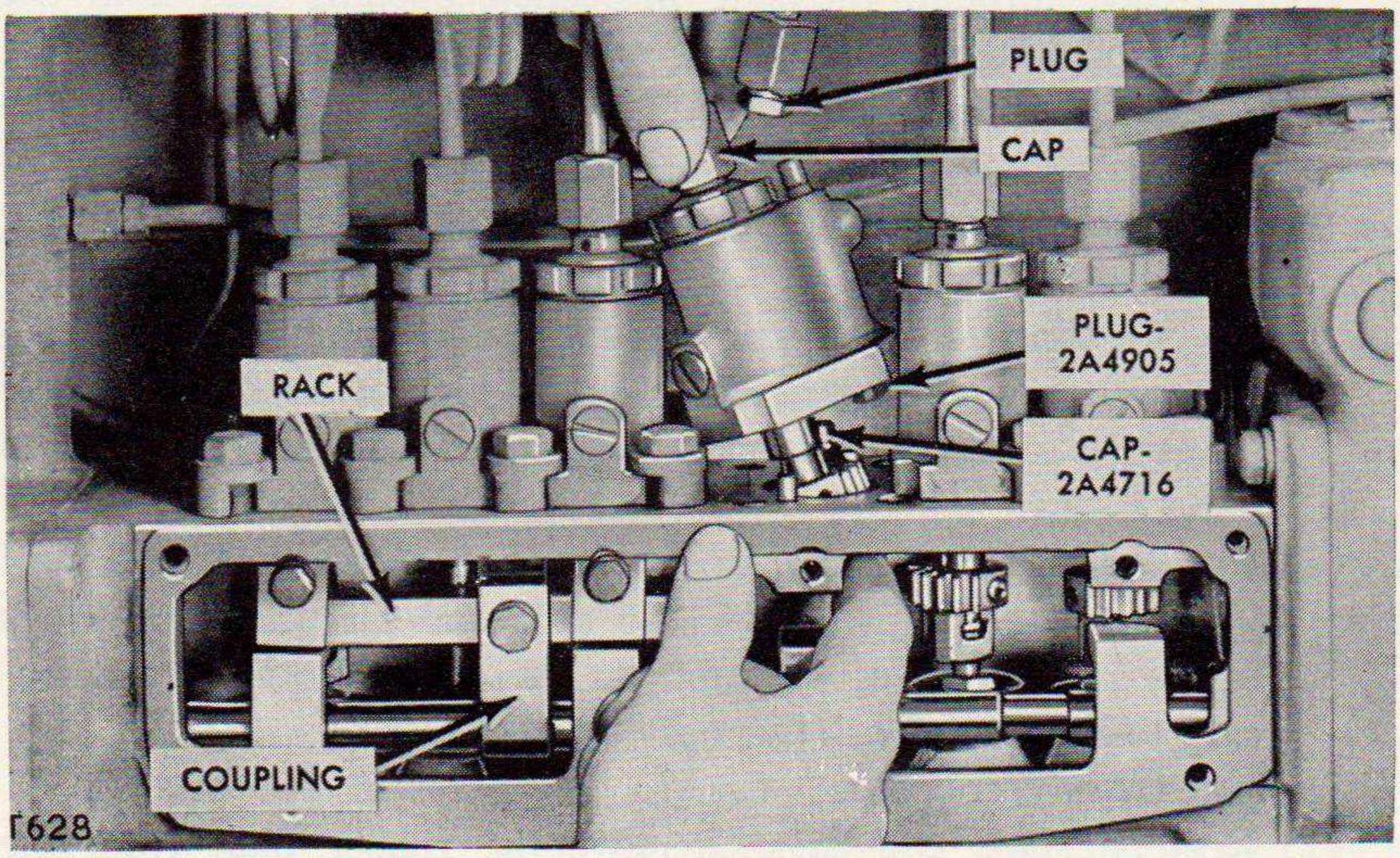


Figure 88.—Removing fuel injection pumps (part No. 2A3895).

piston rings and liners, the hard starting and loss of power will be accompanied by poor compression, a smoky exhaust and excessive blow-by gases from the crankcase breather.

e. INJECTION PUMP REMOVAL PROCEDURE. (See fig. 88.)

(1) *Clean the housing.* Clean the top of the housing and around the inspection plate on the side.

(2) *Disconnect fuel injection lines.* Disconnect the lines at the tops of the pumps and immediately cap the openings in the pumps with 1A8634 caps and the openings in the lines with 2A913 plugs.

(3) *Remove inspection plate.* Remove the inspection plate by taking out the six capscrews holding it. Note that one capscrew is longer than the others. Be sure it is replaced in the proper location.

(4) *Remove coupling and rack.* There are two racks, each of which meshes with three pump gears. Remove the capscrews and take out the rack retaining plates and the coupling between the rack and slide bar. Then carefully lift out the rack. Handle the rack with care since any nicks on its surfaces will result in rough governor action.

(5) *Remove the pump hold-down capscrews.* Remove the capscrews and clamps that hold the pumps in position using the L2303 wrench.

(6) *Remove pumps.* Lift out the pumps, individually, in the following manner. (See fig. 88.)

(a) Lift the pump straight up until it just clears the dowel pins.

(b) Reach through the side inspection opening and hold the pump plunger from sliding out of the barrel.

(c) Shift the pump sideways to free the plunger end from the lifter yoke.

(d) Lift the pump out of the housing, still holding the plunger in the barrel.

Caution: Never remove the pump plunger from the barrel for any reason. The slightest nick or dirt on the finely ground surfaces will make replacement of the entire pump necessary.

(7) *Cap the fuel outlet and inlet holes.* Cap the outlets on top of the pump housing with 2A4716 caps and place 2A4905 plugs in the inlet holes of the pumps. These precautions are necessary to keep out dirt. (See fig. 88.)

f. Installation Procedure.

(1) *Remove plugs and caps.* Remove the rubber plug from the injection pump and the cap from the fuel outlet on top of the housing.

(2) *Lower pump into housing.* Lower the pump assembly into the housing taking care not to drop the plunger out of the barrel. Slide the end of the plunger into the yoke on the lifter (see fig. 89) and lower the pump body onto the dowel pins.

(3) *Fasten pump in place.* Install the four hold-down capscrews and clamps. Rotate the pump plunger gear segment to make sure that the plunger turns freely and does not bind.

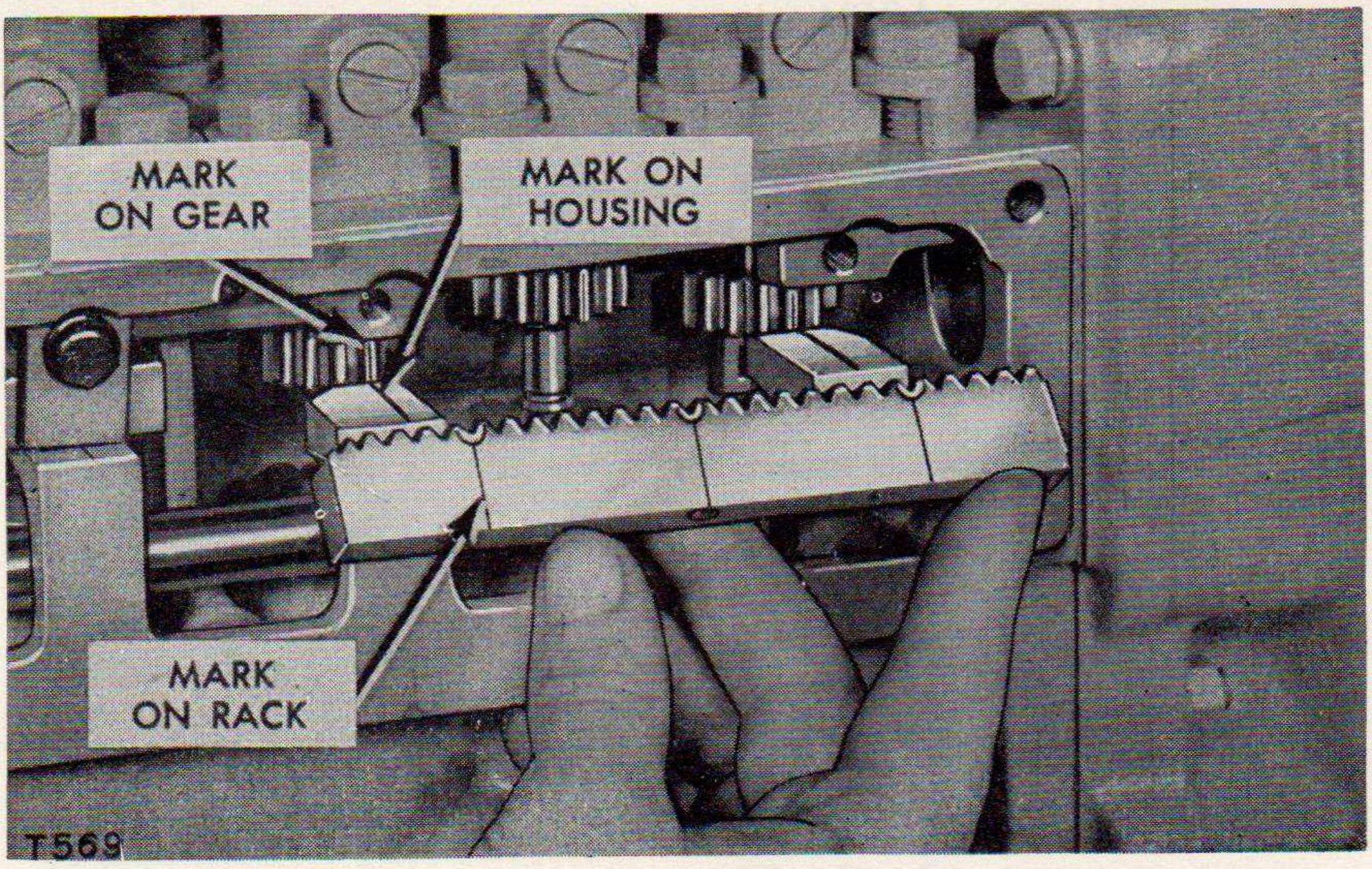


Figure 89. Alining gear and rack marks.

(4) *Line up gear segments.* Turn the pump gears until the marked tooth on each gear faces out. The end pumps can be alined with the marks on the rack supports of the fuel pump housing. (See fig. 89.)

(5) *Install rack.* The top of the rack is indicated by semicircular marks. As the rack is slipped into place, the marked teeth must be made to engage the marked teeth on the pump plunger gears.

(6) *Install rack retaining plates.* Install the rack retaining plates and capscrews. Make sure the beveled edge on the retaining plates in facing *in* and toward the top of the housing. Otherwise the plates may bind the rack. Try the rack movement to make absolutely sure that it works freely in the housing.

(7) *Install coupling.* Install the coupling between the rack and the fuel pump slide bar.

(8) *Connect fuel lines.* Connect the fuel injection lines and install side covers.

(9) *Prime the fuel system.* (See par. 70.)

Section XXI. LUBRICATION SYSTEM

73. Description (See fig. 90.)

One of the most important items contributing to the long life of an engine is proper lubrication. A full pressure lubricating system has been provided, consisting of an oil pump, filters, oil cooler and a pressure gage. The oil pump is a pressure pump driven by a gear on the camshaft. The screened suction bell or inlet of the pump extends down into a sump in the center of the bottom of the crankcase. The oil pump circulates the lubricant under pressure to all working parts of the engine. The oil is forced through passages in the oil filter base to the oil cooler behind the radiator, then back to the oil filters. After passing through the filters, the oil passes through a manifold and is distributed to the main bearings, connecting rod bearings, piston pins, valve rocker assembly and the timing gears.

74. Oil Filters (See fig. 91.)

a. DESCRIPTION. The two oil filters on the same base located on the left side of the engine filters the oil as it passes through. Each filter has an edge-type metal element surrounding an absorbent type element. The oil filtered by the outer or metal element goes directly to the working parts of the engine while the oil filtered by the inner or absorbent element returns to the sump in the crankcase.

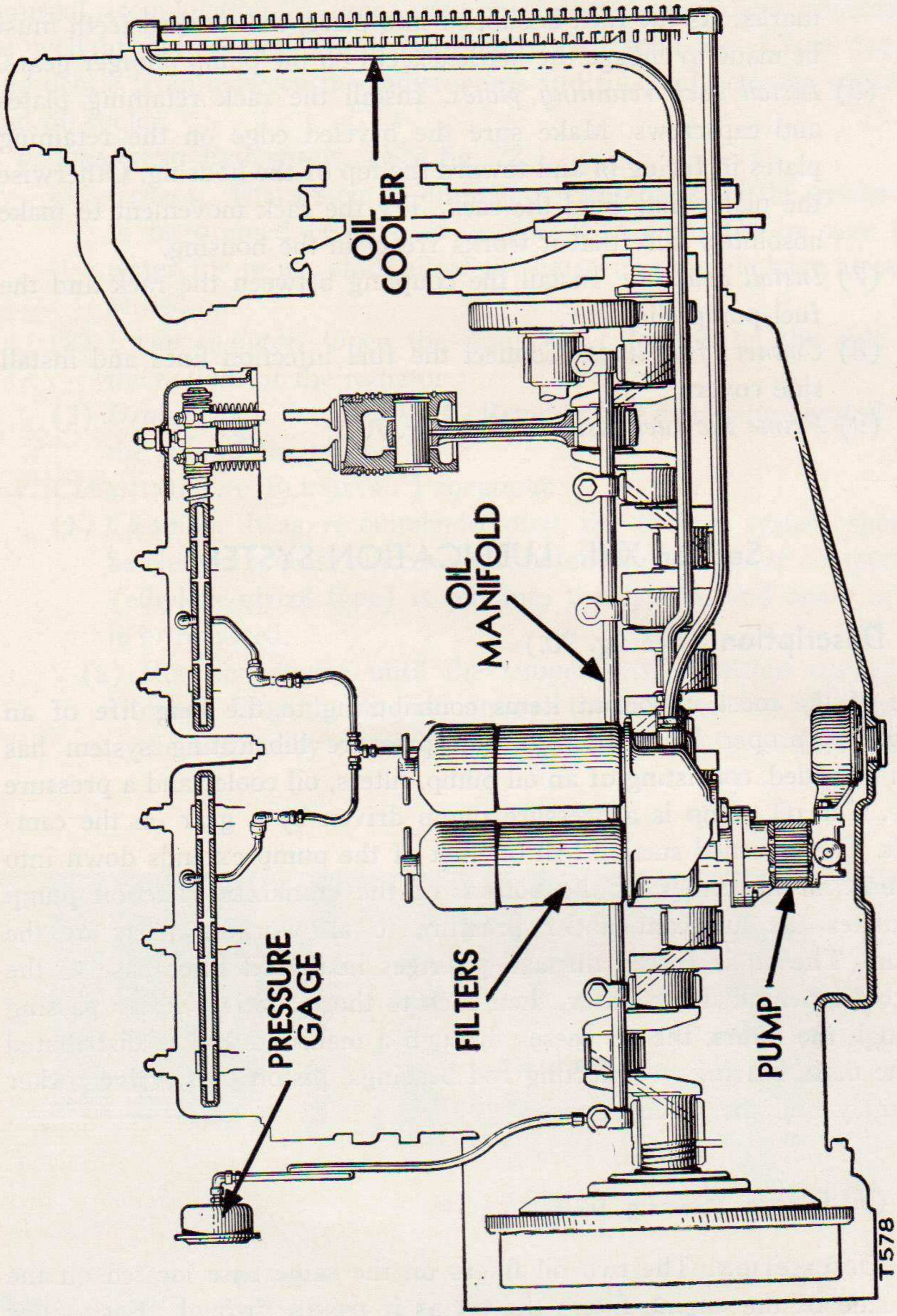


Figure 90. Lubrication system (schematic drawing).

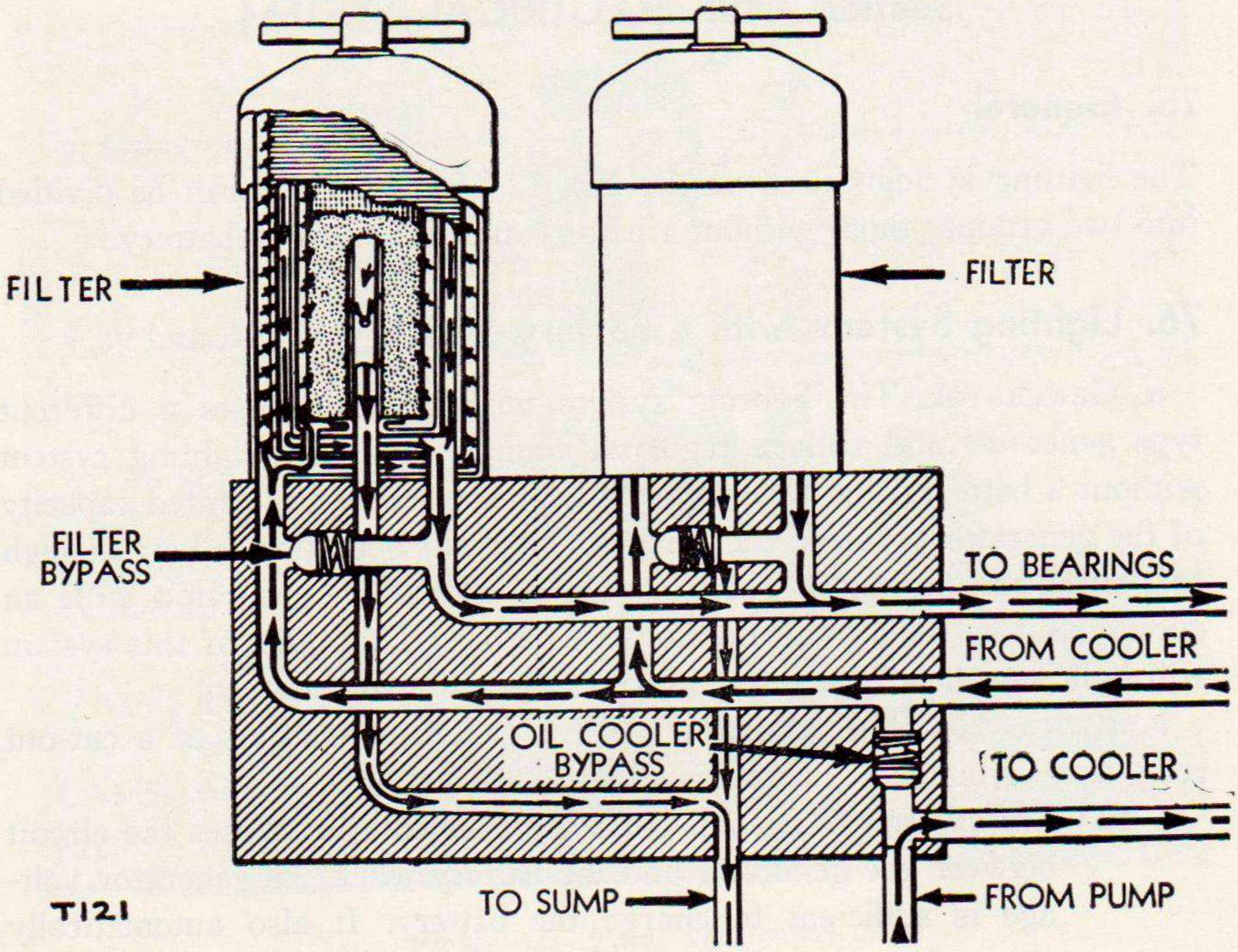


Figure 91. Oil filters (schematic drawing).

b. Removing the Filter Elements.

(1) *Remove filter case cover.* Remove the filter case cover (one for each filter) by turning the hold down wing screw with the hand or by tapping lightly with a hammer.

(2) *Lift out elements.* Lift out the two elements and discard the absorbent element. Handle the metal element with care since the winding is easily damaged.

c. Cleaning the Metal Element. Wash the metal element by shaking it in clean Diesel fuel or dry cleaning solvent. If the sludge must be brushed off, use the soft hair brush No. 284317 and stroke parallel with the winding. Eventually, gums and lacquers may clog the outer element, even though it appears clean on the outside. The internal condition of an element can be checked by comparing it with a new one. Plug the holes in the bottom of both elements and immerse them to the top rim in Diesel fuel. Compare the rate at which the fuel rises inside the elements. Discard the used one if it is not at least three-fourths full by the time the new one is completely filled.

d. Replacing the Absorbent Element. Replace the absorbent, inner elements.

e. Replacing the Cover. Replace the covers being sure to seat them properly. After the engine has been started examine for leaks.

Section XXII. ELECTRICAL SYSTEM

75. General

The lighting systems used on the No. 12 Motor Grader can be divided into two groups; those without a battery and those with a battery.

76. Lighting Systems with a Battery (See figs. 92, 94, and 95.)

a. GENERATOR. The lighting system with a battery uses a different type generator and voltage regulator than is used in a lighting system without a battery. The total lighting load may exceed the rated capacity of the generator provided the period of daylight operation is long enough to permit recharging the battery. Never operate a generator with an open circuit between the generator and battery. The lights of this system will light whether the Diesel engine is operating or stopped.

b. REGULATOR. The regulator for this generator consists of a cut-out relay and a voltage regulator.

(1) *Cut-out relay.* The cut-out relay automatically closes the circuit between the generator and the battery when the generator voltage is sufficient to charge the battery. It also automatically opens the circuit between the generator and the battery when the generator voltage is not sufficient to charge the battery. This prevents the battery from discharging back through the generator windings.

(2) *Voltage regulator.* The voltage regulator inserts resistance into the generator field to reduce the generator output when the

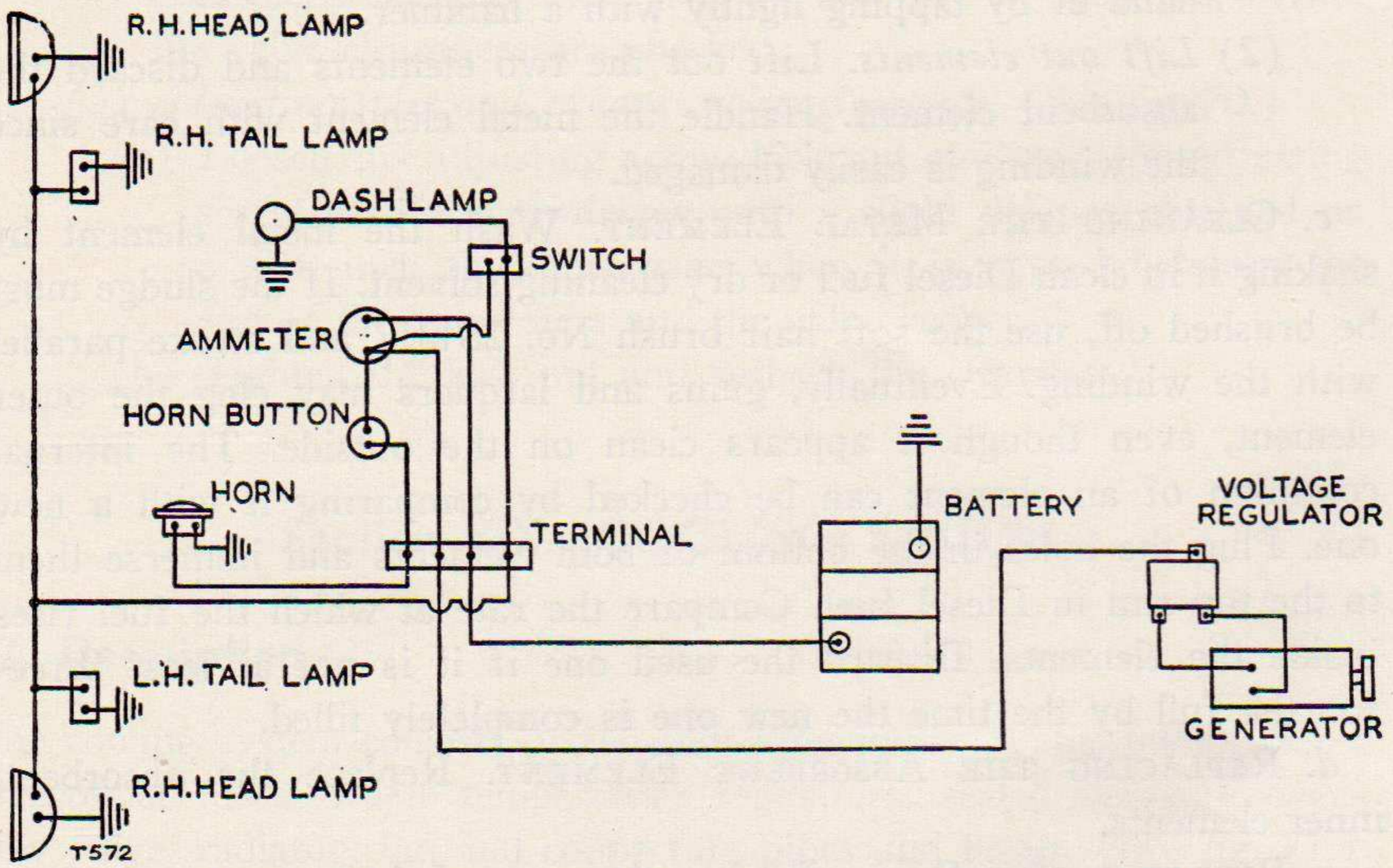


Figure 92. Wiring diagram (175-watt generator for use with battery, with or without cab).

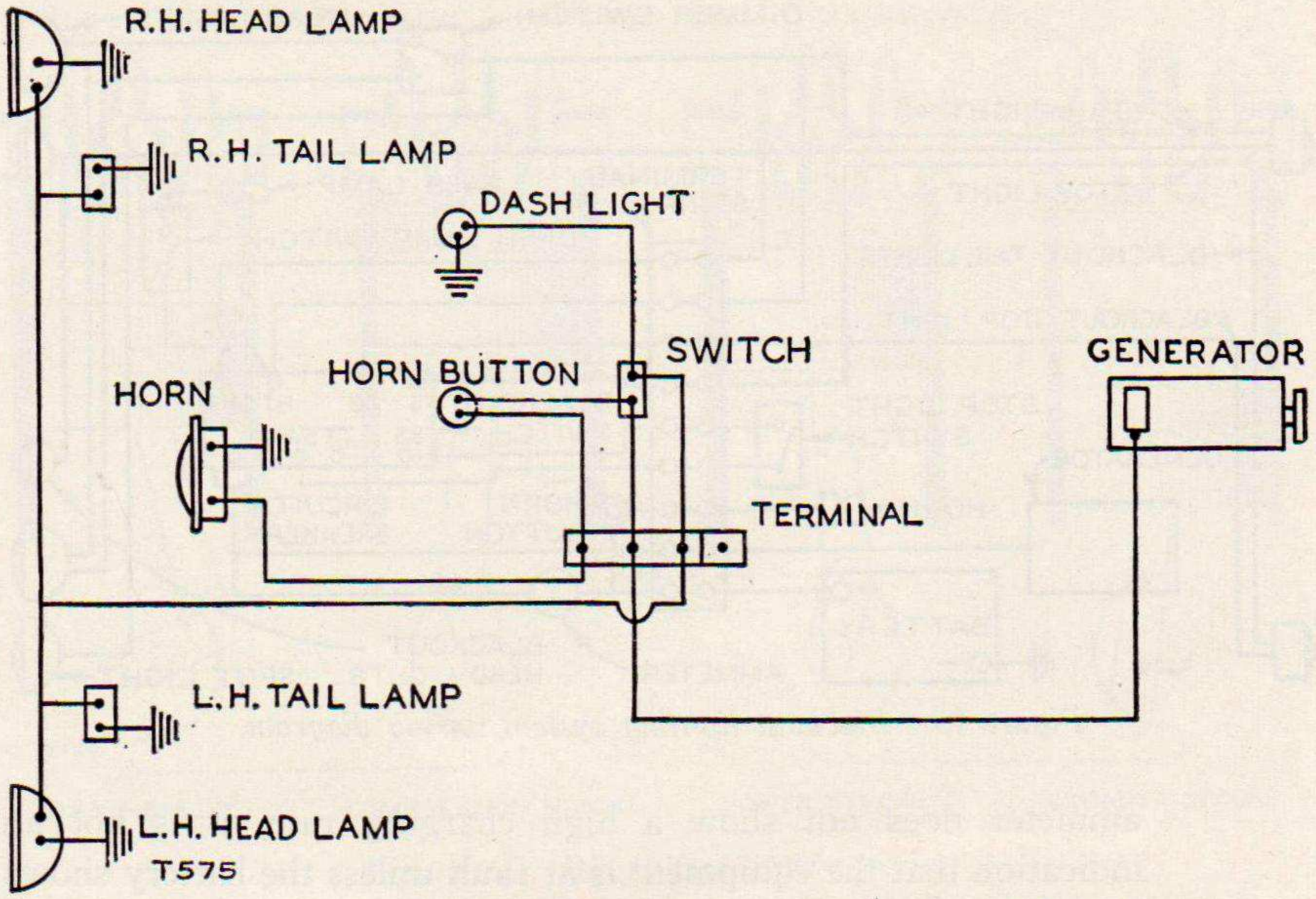


Figure 93. Wiring diagram (130-watt generator for use without battery, with or without cab).

battery becomes fully charged. The voltage regulator is properly adjusted at the factory and should not be changed except in case of failure. In case of failure both the regulator and generator should be taken to a shop equipped with necessary tools and trained personnel, where the output of the generator can be checked and the regulator adjusted accordingly. If the

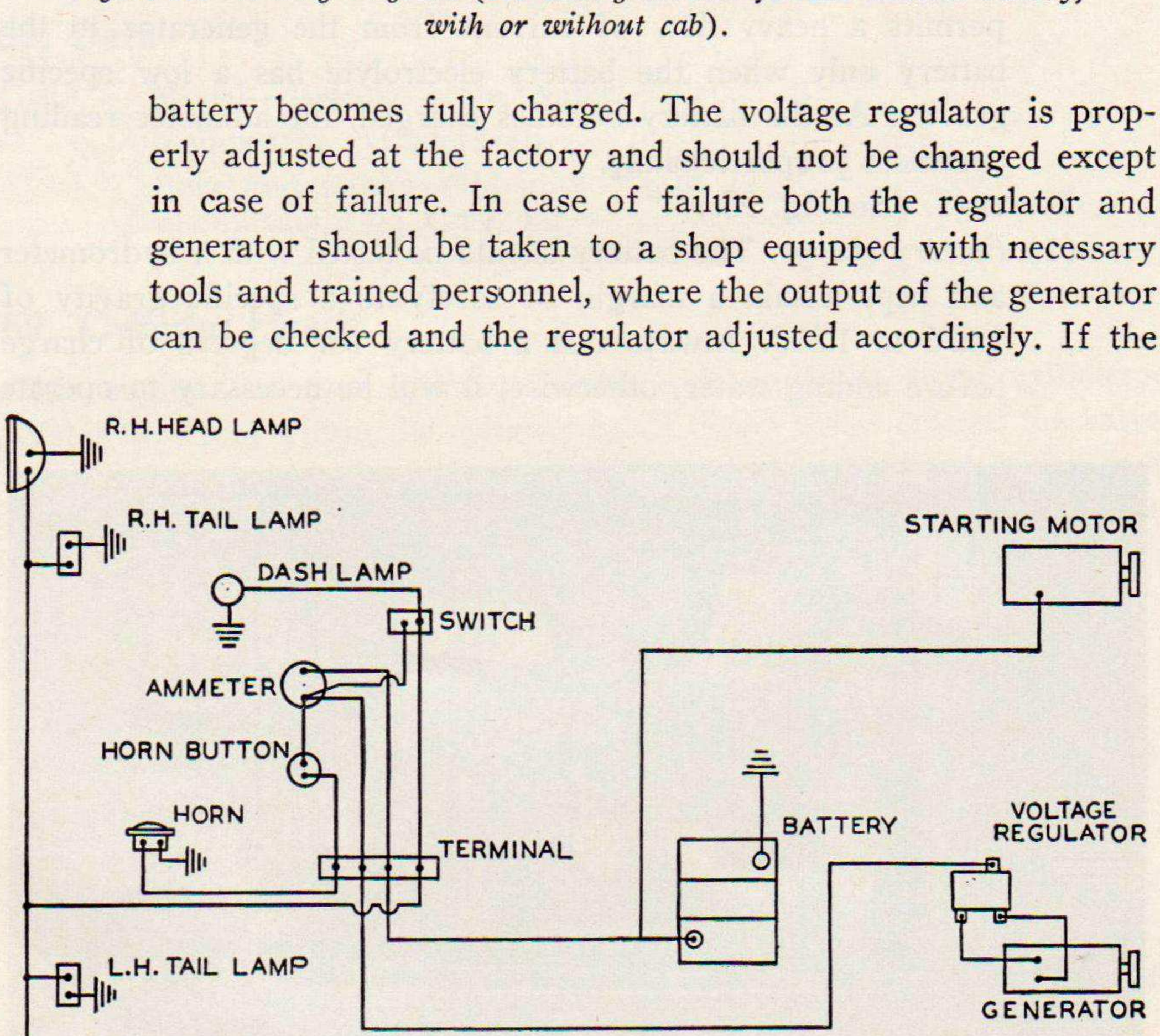


Figure 94. Wiring diagram (175-watt generator—starter 6-volt—for use with or without cab).

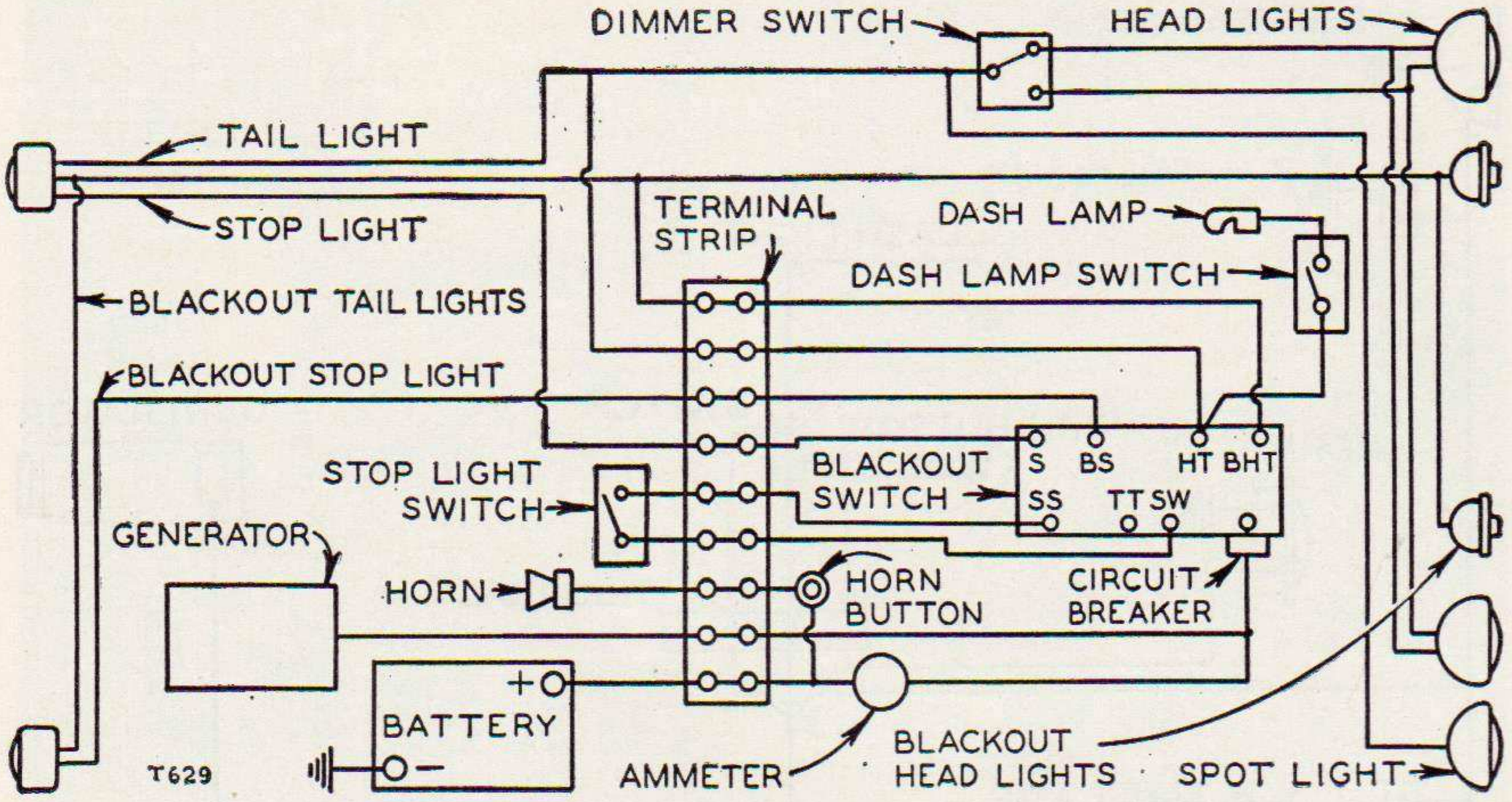


Figure 95. Blackout lighting system wiring diagram.

ammeter does not show a high charging rate, it is not an indication that the equipment is at fault unless the battery shows a low reading when checked with the hydrometer. The regulator permits a heavy flow of current from the generator to the battery only when the battery electrolyte has a low specific gravity. As the battery becomes charged, the ammeter reading decreases proportionately.

c. BATTERY. (See fig. 96.)

(1) *Battery charge.* The battery should be tested with a hydrometer and kept within a margin of safety to a specific gravity of 1.270 to 1.300. Always test a battery for degrees of charge before adding water, otherwise, it will be necessary to operate

Figure 96. Battery.

the tractor for a short period to charge it, thus allowing the water to mix with the electrolyte. A dangerously low point of charge is indicated by a hydrometer reading of 1.150 which will permit the battery to freeze. A specific gravity of 1.250 will permit the battery to withstand temperatures as low as —30°F., without freezing.

(2) *Battery water.* Water that escapes by evaporation should be replaced with distilled water or "approved water" (water free from impurities by analysis). This level should be maintained ⅜ inch above the top of the separators or insulators. Do not overfill or underfill the cells of the battery as either has a detrimental effect on battery life.

(3) *Battery trouble.* If when making weekly tests the battery shows evidence of becoming gradually undercharged, it should be removed and completely recharged. Check to determine the reason for the battery becoming undercharged. Inspect battery terminals and other points in the wiring. A loose connection of worn insulation may be the reason for the battery becoming undercharged. Also have the voltage regulator checked by the proper authority.

(4) *Battery terminals.* Keep the top of the battery clean and dry to prevent current losses and keep the terminals clean and tight. To clean corrosion from the battery terminals, scrub them with a weak solution of bicarbonate of soda (baking soda) and water. Dry the battery thoroughly, then coat the terminals with CG to prevent corrosion. Keep the battery securely fastened in its compartment at all times.

77. Lighting System without Battery (See fig. 93.)

a. GENERATOR. The generators used without batteries are automatically regulated to provide the amount of current required to operate the lights, within the capacity of the generator. Generators are plainly marked and those of 75 watt and 130 watt are most commonly used. Mazda bulbs consume approximately 1 watt per candle power. This being the case, it is easy to add up the candle power of the various bulbs in the circuit to determine if the lights in use are within the capacity of the generator. For this reason the generator size should always be checked before deciding to add additional lights or to increase the light intensity by replacing standard bulbs with those of higher candle power.

b. REGULATOR. The regulator is a combination voltage regulator and light switch and it is mounted on the generator frame. The regulator is properly adjusted at the factory and should not be changed except in case of failure when both the regulator and generator should be taken

to a shop equipped with necessary tools and trained personnel, where the output of the generator can be checked and the regulator adjusted accordingly.

78. Generator Maintenance

a. General. The generators are of similar construction, therefore this paragraph will cover all generators.

b. Removal. The generator is located on the left-hand side of the engine, below the air cleaner (see fig. 97), and is attached to a housing on the timing gear housing by three capscrews. Disconnect the wire from the terminal block on the regulator. Take out the capscrews and remove the generator.

c. Cleaning. Every 1,024 hours, the inspection cover should be removed and the commutator checked. If it is glazed or darkened, polish with "00" sandpaper. Never use emery cloth. Clean out all traces of sand particles from the commutator, brushes, and brush holders.

d. Brush Replacement. Brushes should be inspected and replaced if badly worn. When a new brush is installed, seat it properly with the contour of the commutator by using "00" sandpaper. (See fig. 98.)

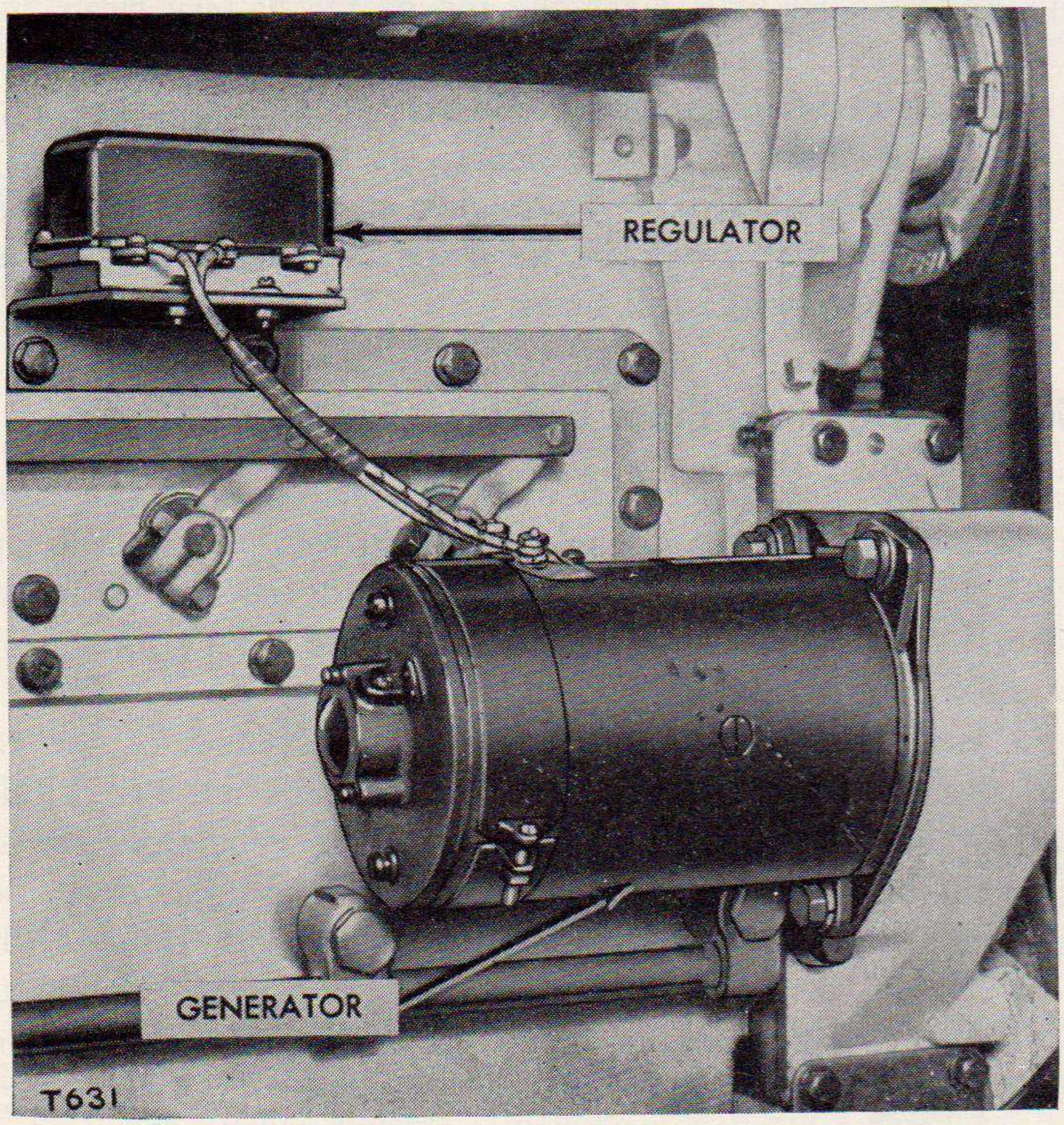


Figure 97. Generator and regulator.

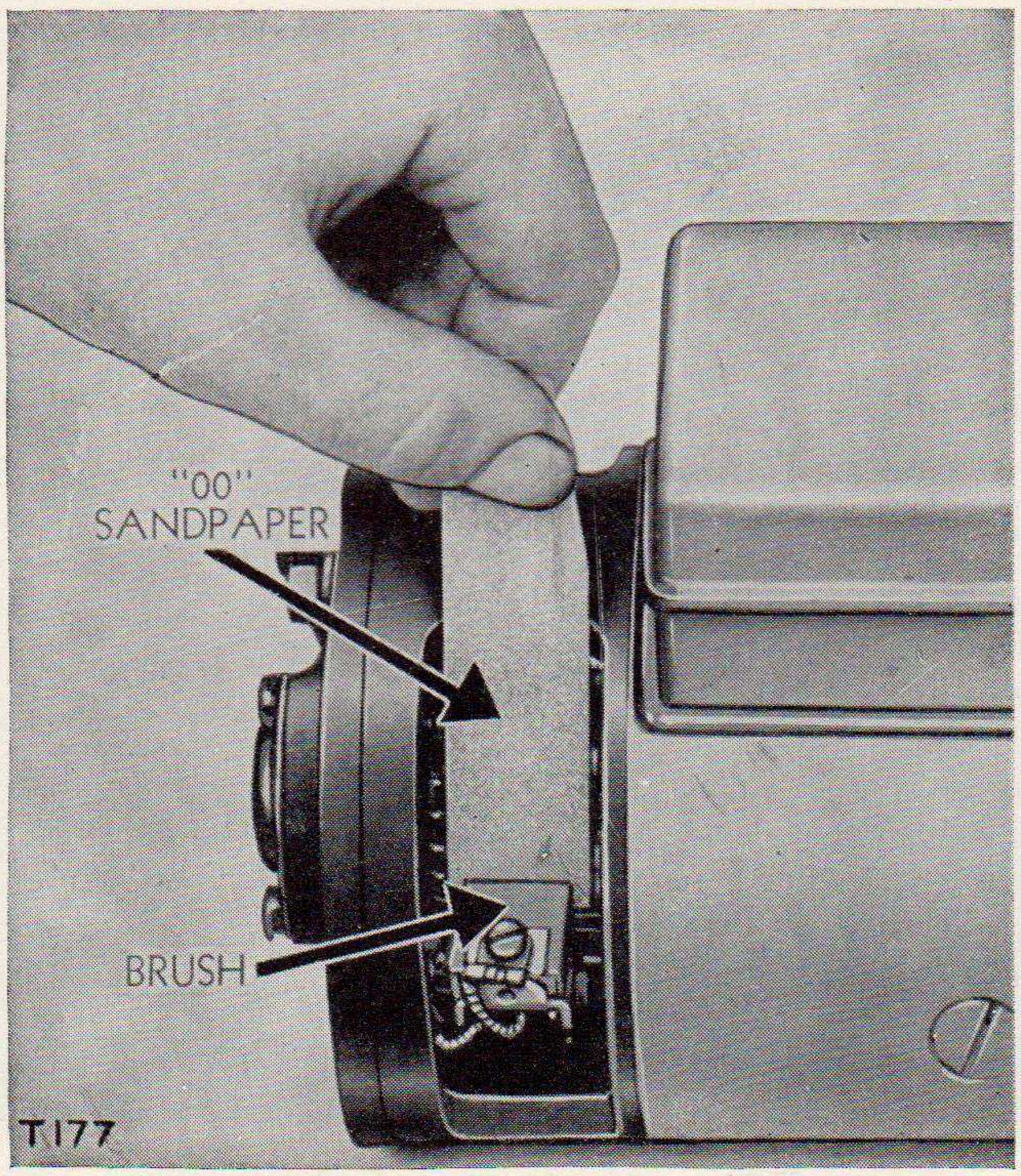


Figure 98. Fitting brushes.

Only a second or two is required to do this. Too much sanding only shortens the life of the brushes. Rotate armature in direction of normal rotation, as the sandpaper is passed between commutator and the brush. Remove all sand particles and make certain that all the connections are tight.

e. GENERAL RECONDITIONING. Every 4,096 hours, the generator should be removed to be completely disassembled, washed, and have all parts showing evidence of excessive wear replaced. Some generators have the bearings packed with a high melting point lubricant making lubrication necessary only when the generator is disassembled for cleaning or repair.

Section XXIII. FLYWHEEL CLUTCH

79. Description (See fig. 99.)

The flywheel clutch is a dry disc type clutch held in engagement by springs. The driving and pressure plates are connected to the Diesel engine flywheel by means of mating splines. The driven plates are

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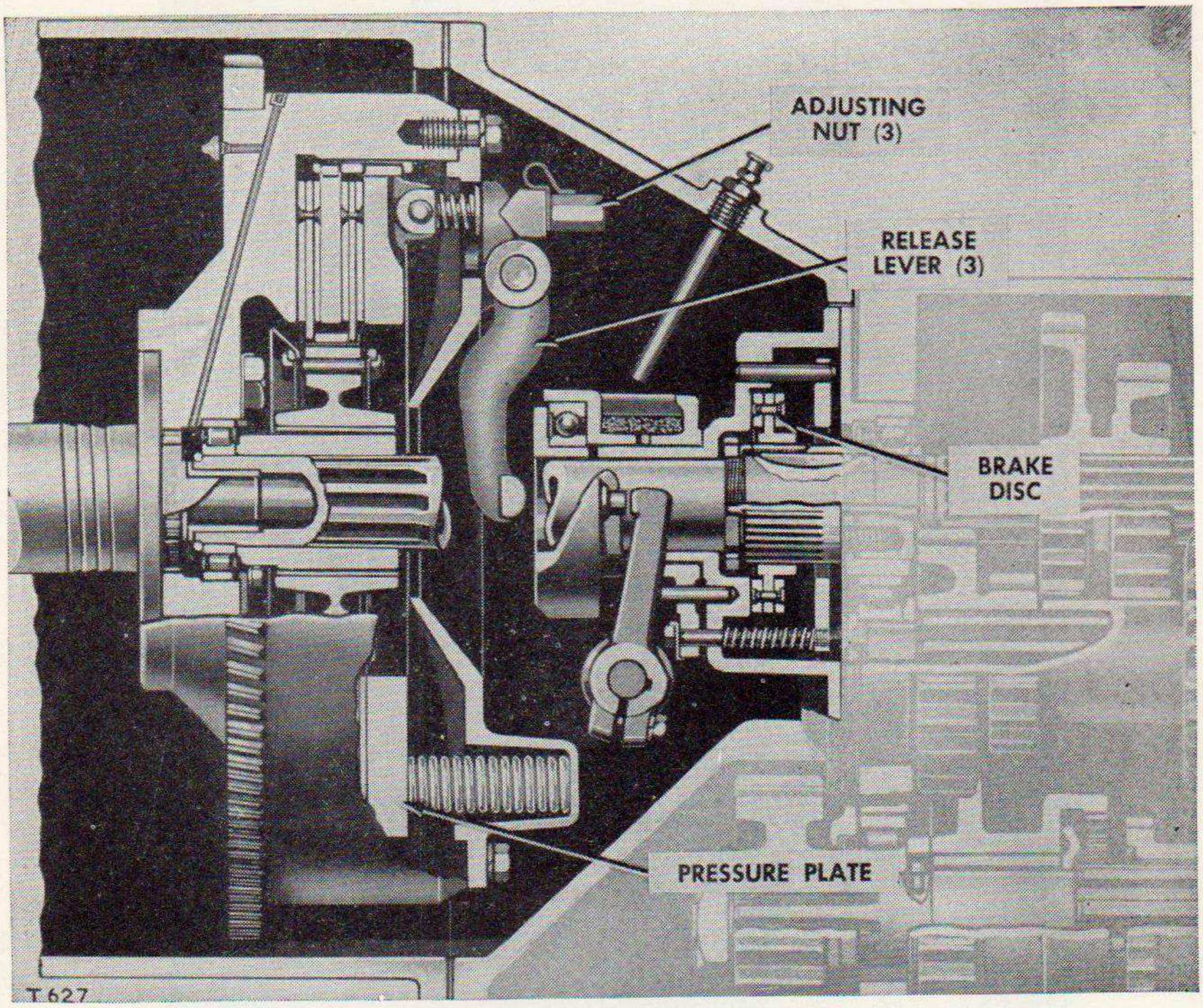


Figure 99. Flywheel clutch.

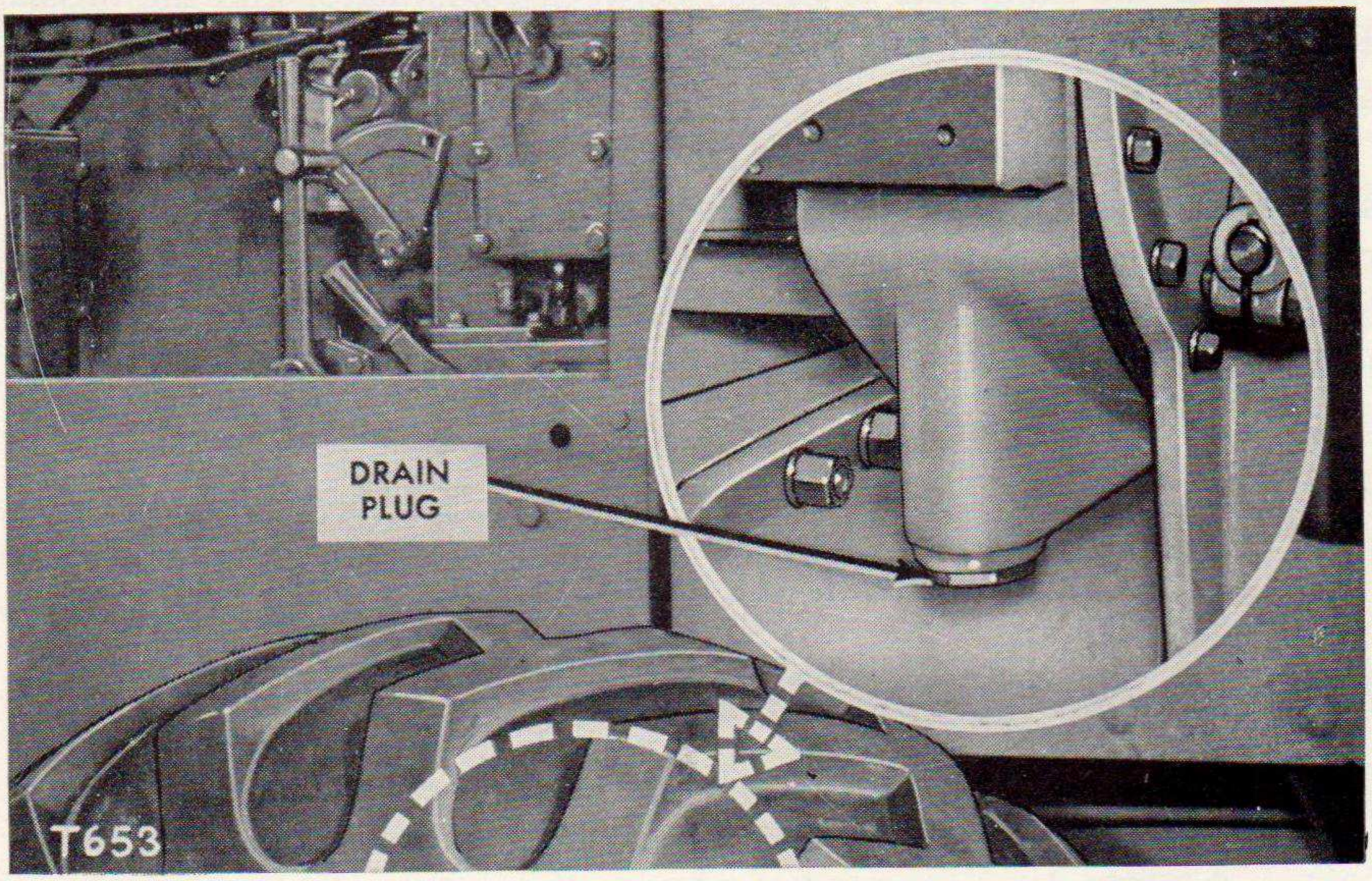


Figure 100. Flywheel clutch housing drain.

connected to the upper transmission shaft. The springs push the pressure plate against the front driven plate and it in turn pushes the center driving plate and rear driven plate against the inner face of the flywheel. As the driven plates are gripped by the pressure and driving plates the turning effort of the engine is transmitted to the transmission. When the clutch is disengaged, the clutch pedal actuates three release levers to compress the springs and pull the pressure plates away from the flywheel to release the driven plates. A brake is provided to bring the rotating clutch and transmission shafts to a stop when the clutch is disengaged and the foot pedal is pushed down. This makes it possible to shift gears without clashing them. The brake pressure plates grip the revolving brake disc when the clutch pedal is pushed to the extreme released position.

80. Care

The flywheel clutch is designed to operate dry. It is necessary to lubricate the clutch release and pilot bearings as directed in LO 5–1018. (See par. 35.) The plug in the right side of the flywheel clutch housing should be removed to drain any accumulated oil in the clutch compartment. (See fig. 100.) The clutch adjustment must be checked and made when necessary to prevent the clutch from slipping.

81. Adjustment

a. GENERAL. As the clutch facings wear the springs force the pressure plate closer to the flywheel. This decreases the distance between the release levers and the face of the release bearing. Adjustment is necessary before the release levers contact the face of the release bearing, to provide proper clutch engagement. The clutch adjustment is correct when there is $\frac{3}{16}$-inch clearance between the end of each release lever and the face of the release bearing. There should also be .015-inch to .020-inch clearance between the release yoke arms and the plugs on the release bearing cage but this adjustment when once made should not change.

b. CLUTCH ADJUSTING PROCEDURE. (See fig. 101.)

(1) *Remove inspection plate.* Remove inspection plate from the left side of the flywheel clutch case.

(2) *Locate adjusting nut.* Rotate the flywheel until the adjusting nut of one lever can be turned and the clearance checked through the inspection opening.

(3) *Turn adjusting nut.* Turn each adjusting nut counterclockwise to restore the clearance of $\frac{3}{16}$ inch between the end of each release lever and the face of the release bearing.

(4) *Check clearance.* Check the clearance between the end of the release lever and the face of the release bearing. The square

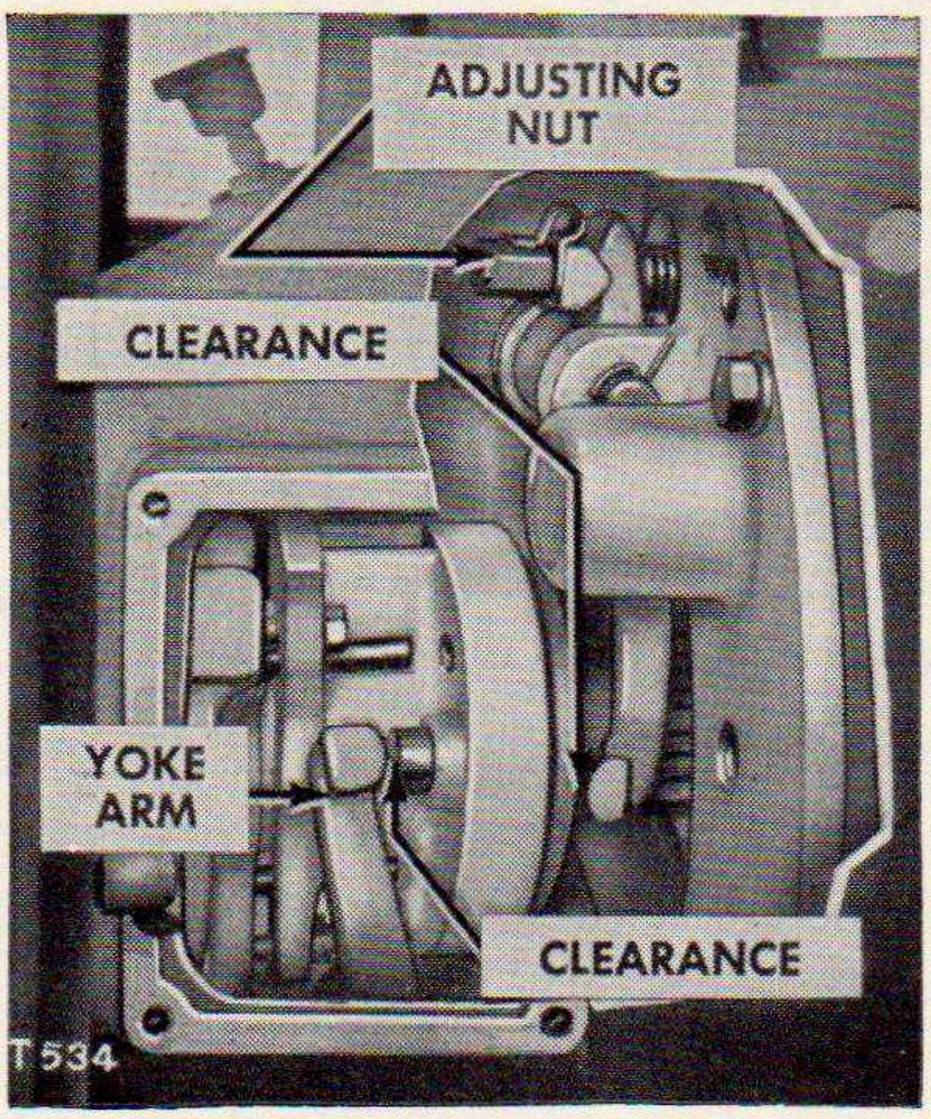


Figure 101. Adjusting flywheel clutch.

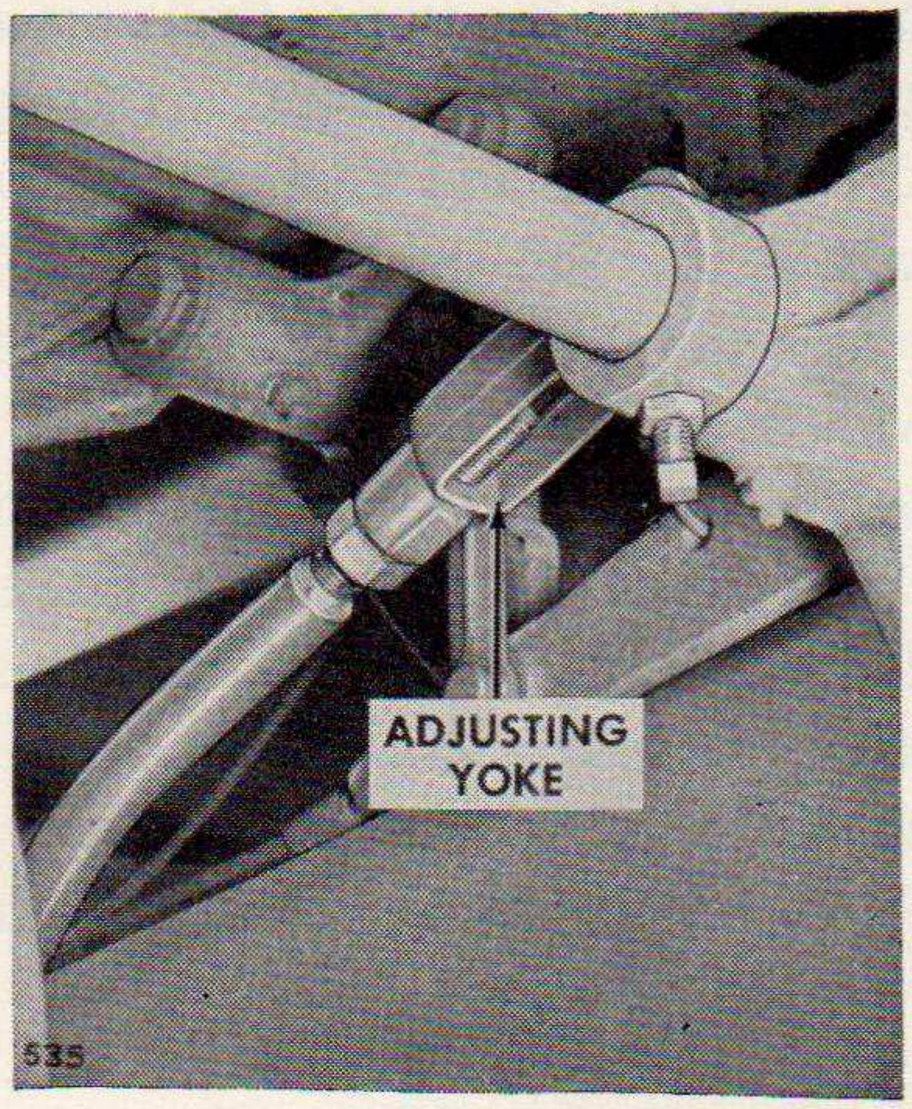


Figure 102. Adjusting clearance between yoke arms and plugs on release bearing.

end of the brake adjusting tool No. 5B3032 is $\frac{3}{16}$ inch thick and is a desirable gage to measure this clearance.

(5) *Make adjustment on the remaining two levers.* Repeat the above procedure on the other two release levers.

c. Clutch Control Rod Adjustment.

(1) *Check clearance between yoke arms and plugs.* Check the clearance between the yoke arms and the plugs on the release bearing cage with a 0.15-inch thickness gage.

(2) *Adjust rod to obtain desired clearance.* Remove the rod from the clutch pedal and turn the yoke end to get the desired clearance between the yoke arms and the plugs on the release bearing cage. (See fig. 102.)

Section XXIV. TRANSMISSION, REAR AXLE AND TANDEM DRIVE

82. Description

a. Transmission. The transmission consists of gears and their shafts, a gear shift mechanism, and an interlock mechanism. It is located under the operator's seat directly in front of the flywheel clutch. Various combinations of these gears give the six forward and the two reverse speeds. The gear shift mechanism enables the operator to shift the gears to obtain the various speeds and the interlock mechanism prevents the gears from sliding out of position while the clutch is engaged. The

power is transmitted from the upper transmission shaft through sliding gears to the gears on the intermediate shaft; from the intermediate shaft to gears on the lower transmission shaft. A sliding coupling controlled by the high speed shifter lever enables the operator to obtain a high and low speed for each of the three forward and one reverse speeds selected by the sliding gears on the upper shaft. The gear shift mechanism consists of two shifter levers to control three shifter forks. The gear shift lever controls the sliding gears on the upper transmission shaft and the high speed shifter lever controls the sliding coupling on the lower shaft. The gear shift interlock mechanism located on the right side of the transmission case holds the shifter forks and transmission gears in position when the flywheel clutch is engaged. (See fig. 103.)

b. Rear Axle and Tandem Drive. From the lower transmission shaft the power passes through reduction gears, bevel gears and final drive gears to drive the sprocket in the tandem drive housings. Two chains in each tandem drive housing are driven by the drive sprocket and in turn drive the sprocket on each drive wheel spindle.

83. Care

For lubrication details see paragraph 35. It is essential that the breathers on the rear axle and tandem drive housings be serviced according to the lubrication order. If breathers become dirty pressure will build up inside the compartments and oil will be forced through the oil seals.

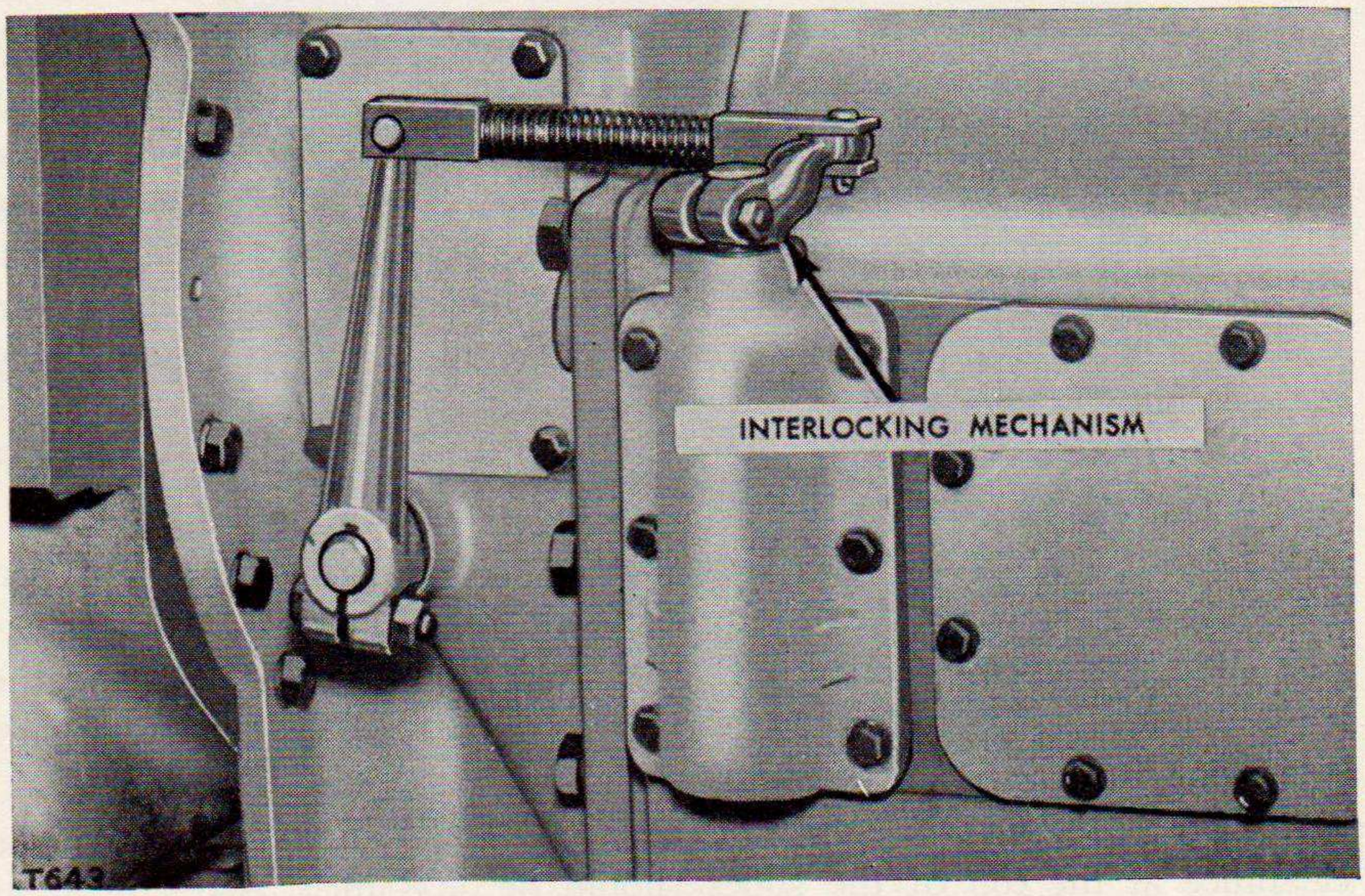


Figure 103. Transmission interlock mechanism.

Section XXV. BRAKES

84. Description

The brakes controlled by the foot pedal are hydraulically operated wheel brakes on the rear tandem drive wheels. The brake controlled by the hand lever is of the internal expanding type, mechanically operated. It is mounted on the forward end of the lower transmission shaft and is only used for a parking or emergency brake. When the hand lever is pulled back a cam and lever arrangement expands the two brake shoes against the brake drum. A pawl and ratchet locks the brake lever in any desired position.

85. Care

The brakes must be kept properly adjusted at all times and extreme care should be taken not to get grease or oil on the brake linings. To prevent damage to the brake drums the linings must be replaced before they are worn down to the heads of the rivets that hold them to the brake shoes.

86. Hydraulic Wheel Brake Adjustment (See figs. 104 and 105.)

a. REMOVE ADJUSTING SCREW COVER. Remove the adjusting screw hole cover and the thickness gage hole covers.

b. CENTRALIZE BRAKE SHOES.

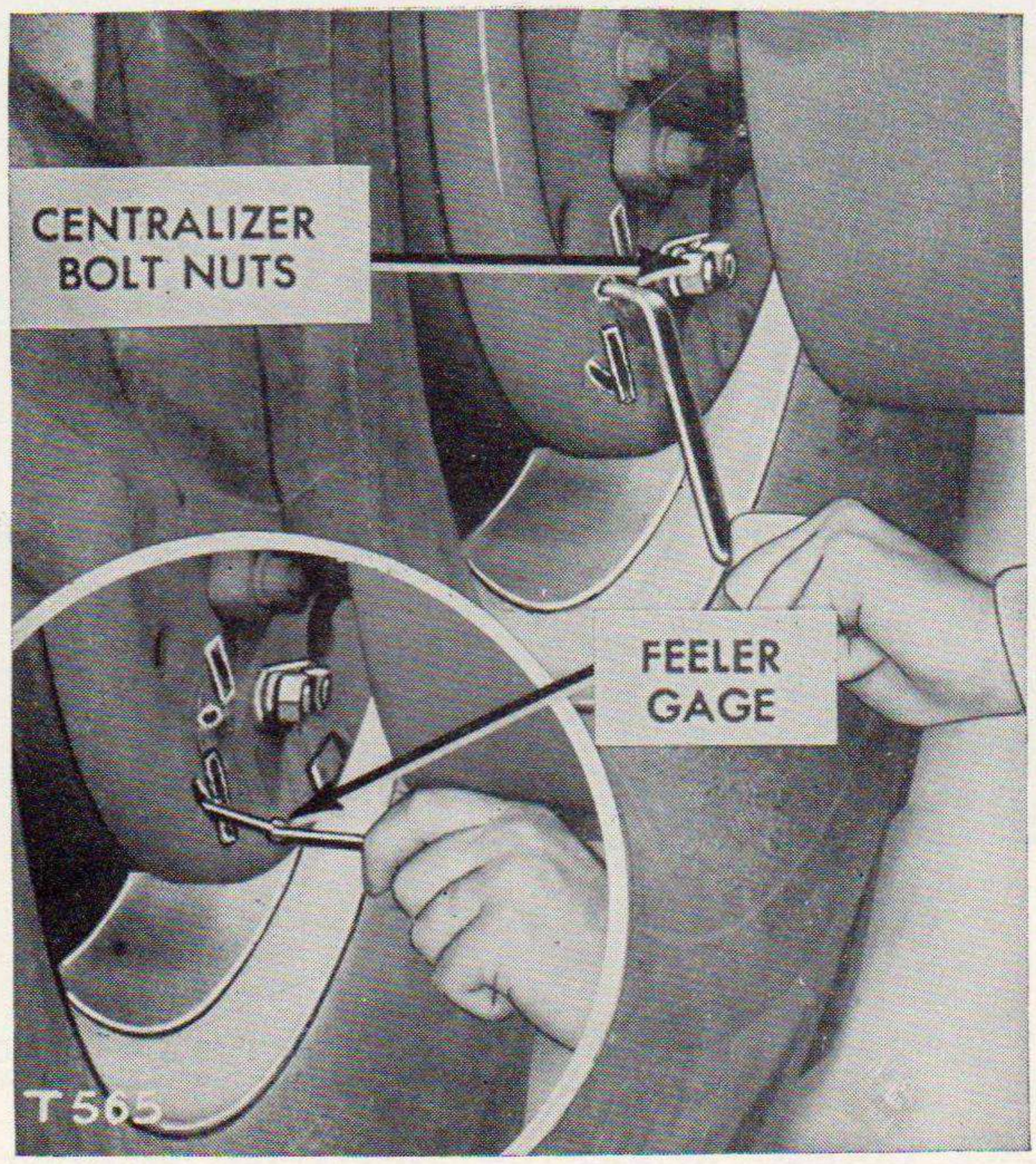
(1) Loosen the two centralizer bolt nuts on the outside near the bottom of the brake backing plate. These nuts should be loosened only enough to relieve the lockwasher tension.

(2) Expand the brake linings tightly against the brake drum by turning the adjusting screw with tool No. 5B3032. Pulling upward on the adjusting tool handle while using the opening as a pivot point, expands the shoes or tightens the brakes. Under some conditions, it may be necessary to tap lightly on the backing plate or centralizer bolt nuts to assure centralizing the shoes within the brake drum.

c. TIGHTEN CENTRALIZER BOLT NUTS. With the shoes expanded tightly against the brake drum tighten the centralizer bolt nuts.

d. ESTABLISH CLEARANCE AT BOTTOM OF SHOES. (See fig. 104.) Turn the adjusting screw back with the adjusting tool until a .020-inch thickness gage can be inserted between the lower ends of the shoes and the brake drum. The thickness gage can be used through the thickness gage holes, one for each shoe.

e. ESTABLISH CLEARANCE AT TOP OF SHOES. (See fig. 105.) The clearance at the top of the shoes should be .008 inch. Adjustment at the top of the shoes can be made by turning the anchor pins which will



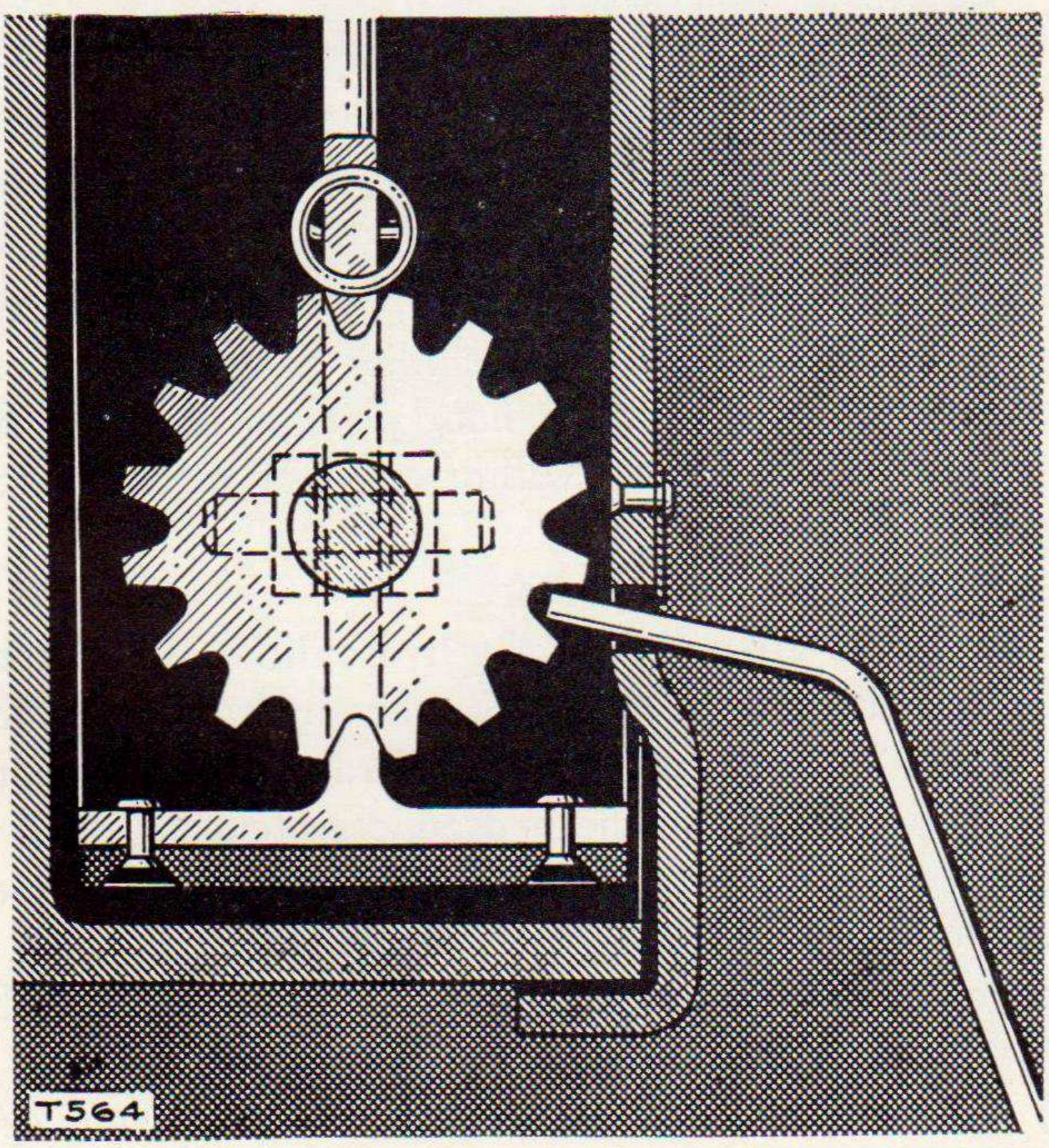


Figure 104. Adjusting clearance at bottom of shoes

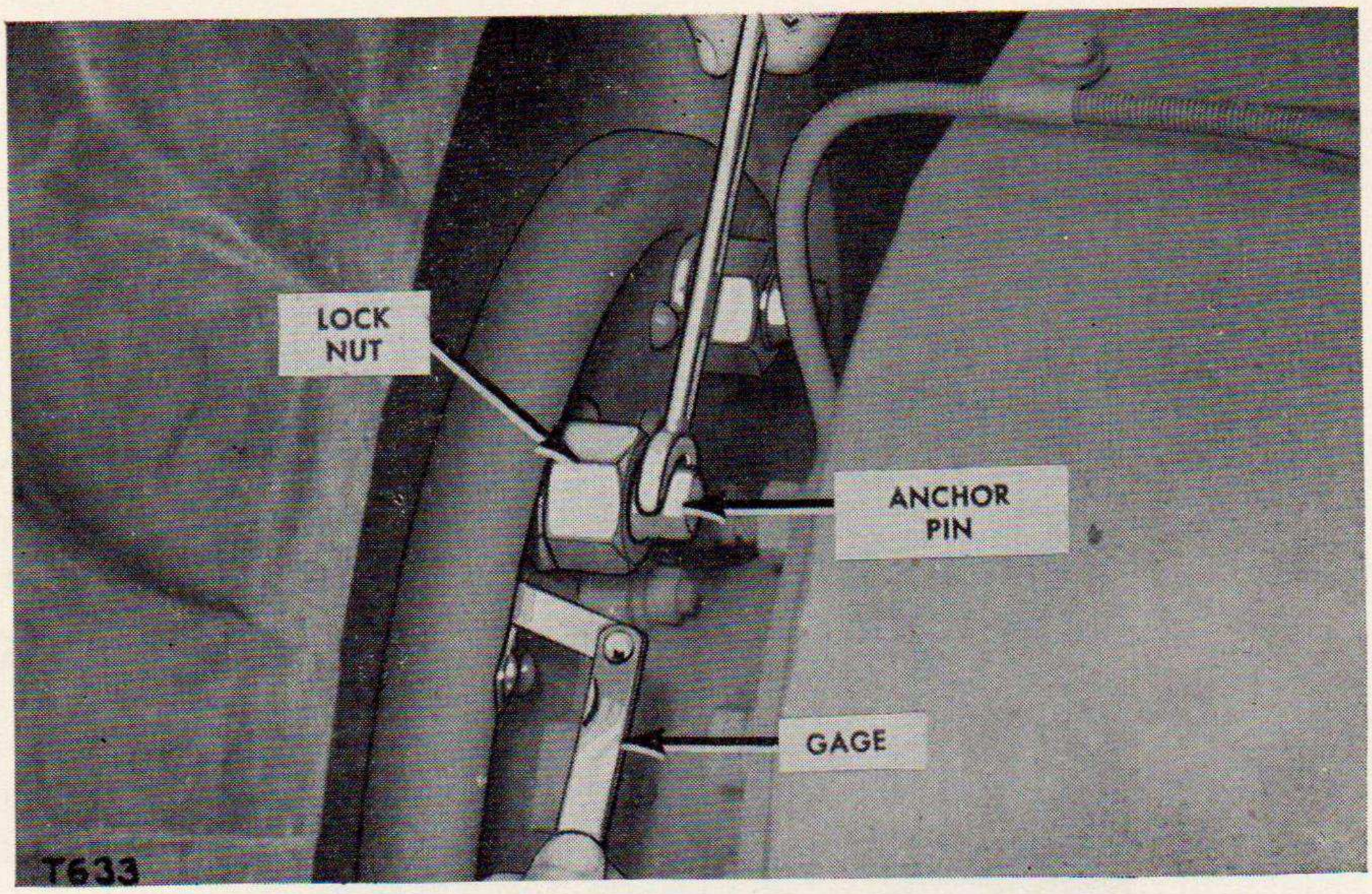


Figure 105. Adjusting clearance at top of shoes.

move the shoes against or away from the brake drum as desired. After the clearance is established tighten the lock nuts.

f. REPLACE COVERS. Replace the covers on adjusting screw and thickness gage holes.

g. ADJUST THE OTHER BRAKE. Repeat this procedure to adjust the brake on the other wheel.

87. Filling Hydraulic Brake System (See fig. 106.)

a. GENERAL. The brake fluid reservoir is in the master cylinder assembly under the floor plate. The filler plug can be removed and fluid added through a hole in the floor plate to the right of the brake pedal. Maintain the fluid level within one-half inch of the bottom of the filler plug.

b. BLEEDING THE BRAKE SYSTEM.

(1) *General.* If air gets into the hydraulic brake system, it should be expelled by "bleeding" the hydraulic brake tubes. A "spongy" action felt when the brake pedal is depressed is an indication of air in the hydraulic system. When a tube is disconnected from the master cylinder, or if air gets into the master cylinder, the entire system should be bled. If a wheel cylinder is removed, only that brake tube needs to be bled.

(2) *Bleeding procedure.* (See fig. 107.)

(a) Remove the filler plug and fill the master cylinder with hydraulic fluid and keep it at least one-half full while bleeding the system.

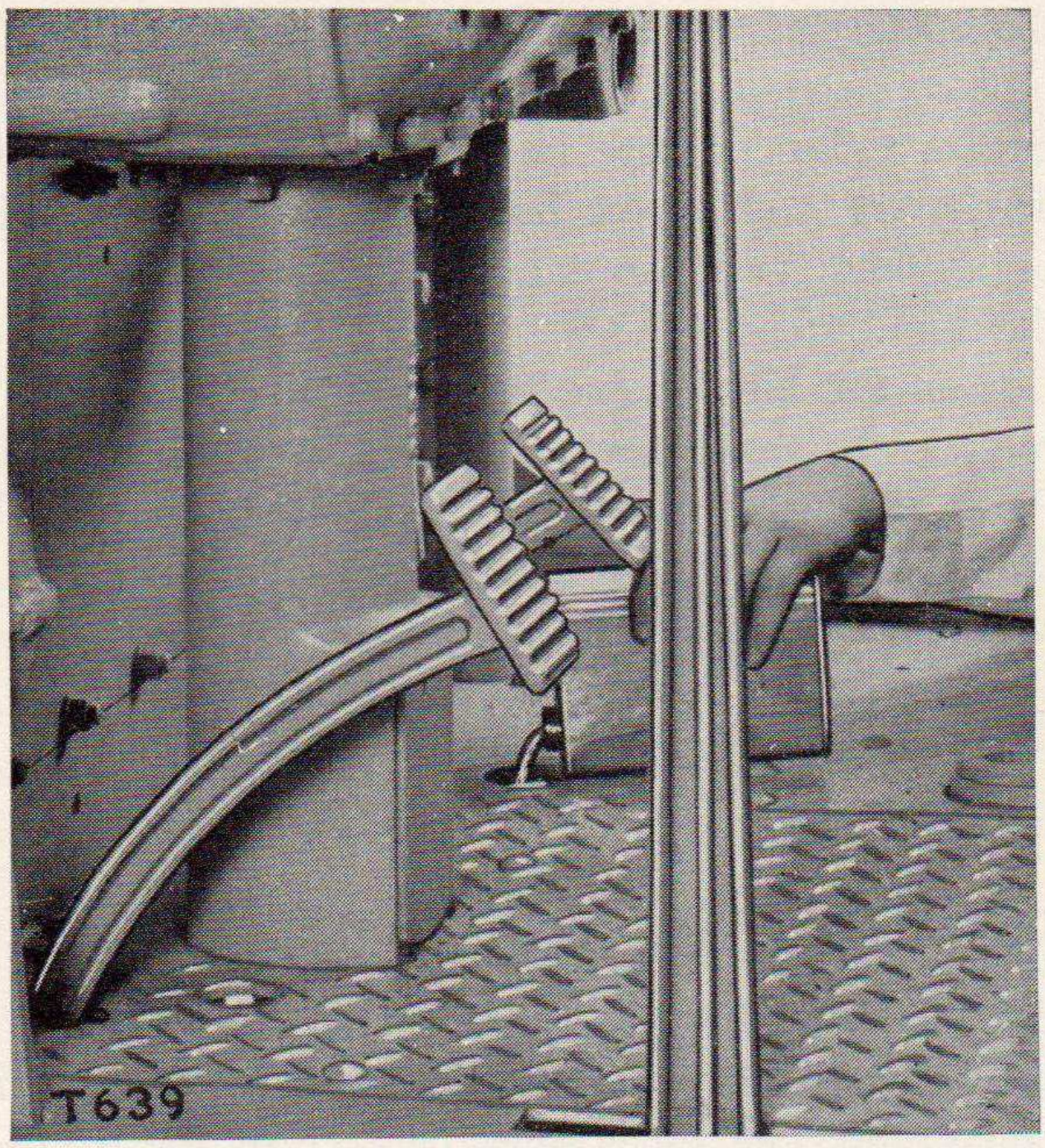


Figure 106. Filling the brake master cylinder.

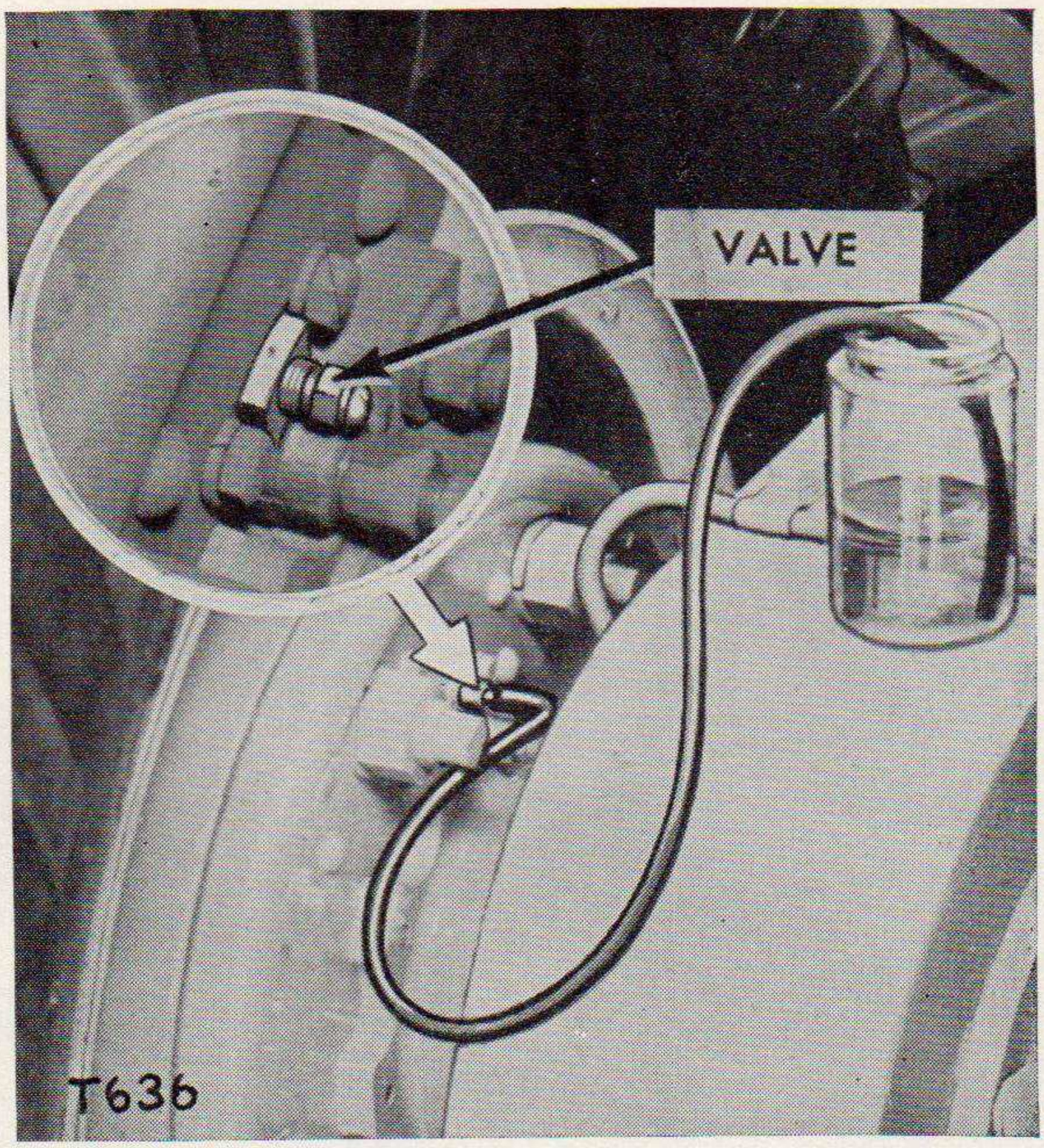


Figure 107. Bleeding the hydraulic system.

(b) Remove the screw from the bleeder connection located on the outside of the brake drum at the point just above brake tube connection.
(c) Screw a bleeder hose in this opening.
(d) Insert the end of the hose in a glass jar containing some brake fluid, with the end of the hose below the surface of the fluid.
(e) Loosen the bleed valve three-fourths of a turn. The bleed valve is the small hex nut located on the bleeder connection.
(f) Pump the brake pedal up and down slowly until brake fluid runs into the glass jar without air bubbles.
(g) Tighten the bleeder valve, disconnect bleeder hose and replace the screw in the bleeder connection.
(h) Fill the reservoir to the proper level with brake fluid and replace the filler plug.

88. Hand Brake Adjustment

a. GENERAL. The hand brake adjustment is correct when the brake is fully applied when the lever is pulled back three-fourths of the distance of the quadrant. The shoes must be free of the drum when the lever is in the released position. The adjustment is made by altering the length of the linkage between the hand lever and the brake.

b. ADJUSTING PROCEDURE. (See fig. 108.)

(1) Disconnect the brake rod from the lever by removing the pin.

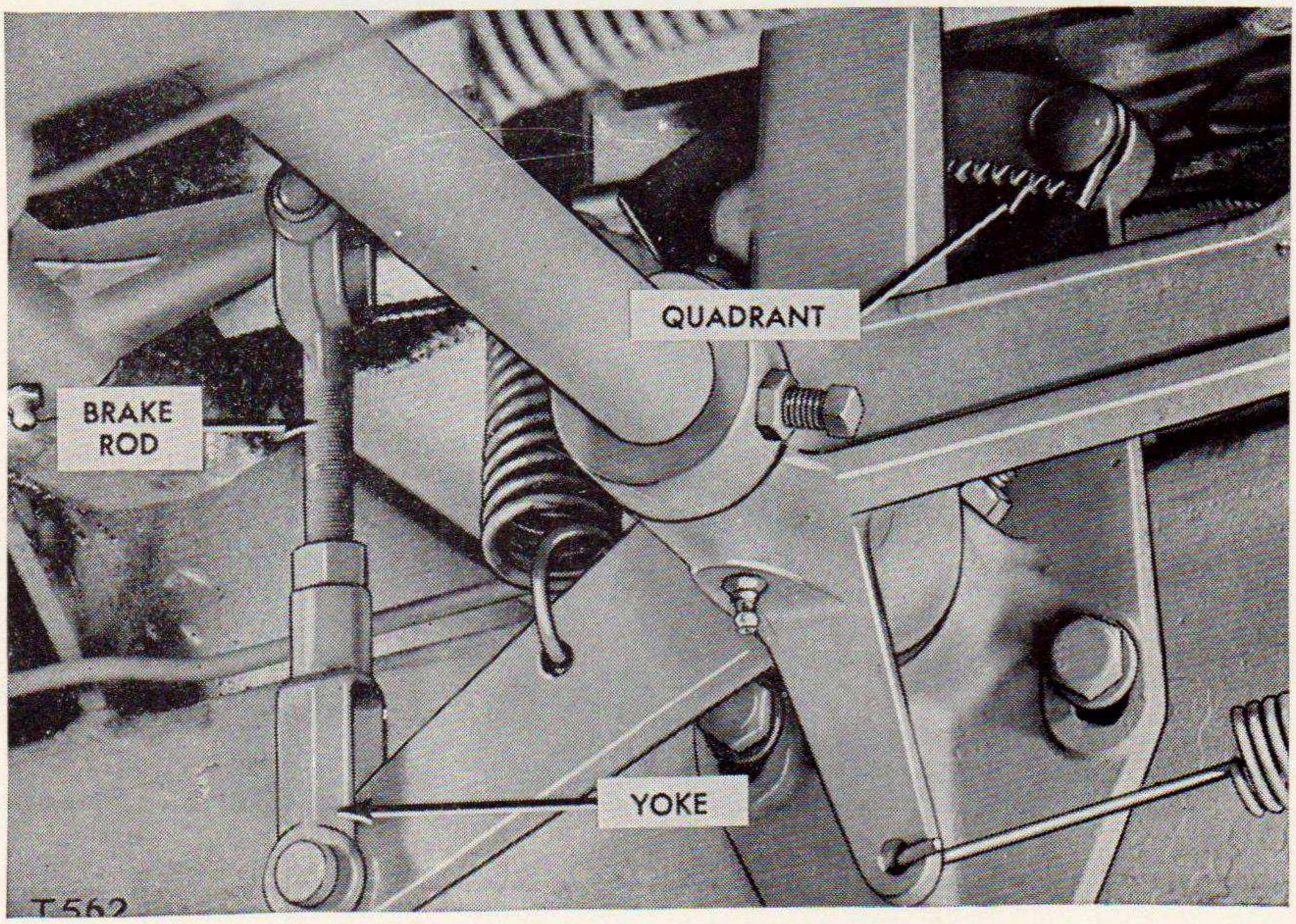


Figure 108. Hand brake adjustment.

(2) Loosen the lock nut.
(3) Turn the yoke end until the brake lever will be in the correct position with the rod connected and the brake applied.
(4) Tighten the lock nut.

Section XXVI. POWER CONTROLS

89. Description (See fig. 109.)

Power controls are used to operate the blade lift, circle reverse, circle centershift, leaning wheel and scarifier mechanisms. These controls and their individual clutches are located in the housing on the dash directly in front of the operator's seat. A shaft, driven from the center of the engine flywheel, delivers power through universal joints to the base of the control housing. The power is then transmitted vertically through the power control column to the control housing. By means of hand controlled levers, power can be transmitted through individual clutches to the various controls. In machines beginning with 9K3159 a shear pin is provided in the vertical power control shaft, which will break and protect the controls from damage, should any of the controls be overloaded. A new pin can be installed without the use of tools.

90. Power Control Maintenance

a. Shear Pin Installation.
(1) *General.* The shear pins are made of soft material and should never be replaced by a harder pin or bolt. The engine must be stopped while installing the shear pin to prevent an accident. It is not necessary to aline holes in the two flanges because the lower flange is made to make the connection as it rotates, with the pin in place in the upper flange.
(2) *Installation procedure.* (See fig. 109.)
(a) Stop the Diesel engine by putting the throttle lever in the "SHUT-OFF" position.
(b) Rotate the inspection cover away from the opening at the base of the vertical control shaft housing in front of the operator.
(c) Rotate the upper portion of the shaft by hand until the pin hole in the shaft flange is accessible. Lift out the broken pin.
(d) Insert a new pin and rotate the inspection cover over the opening.

b. Blade Lift Worm Gear Adjustment. (See fig. 110.)
(1) *General.* If the blade moves too freely and does not keep its set position, the blade lift arm worm shaft bearing should be tightened.

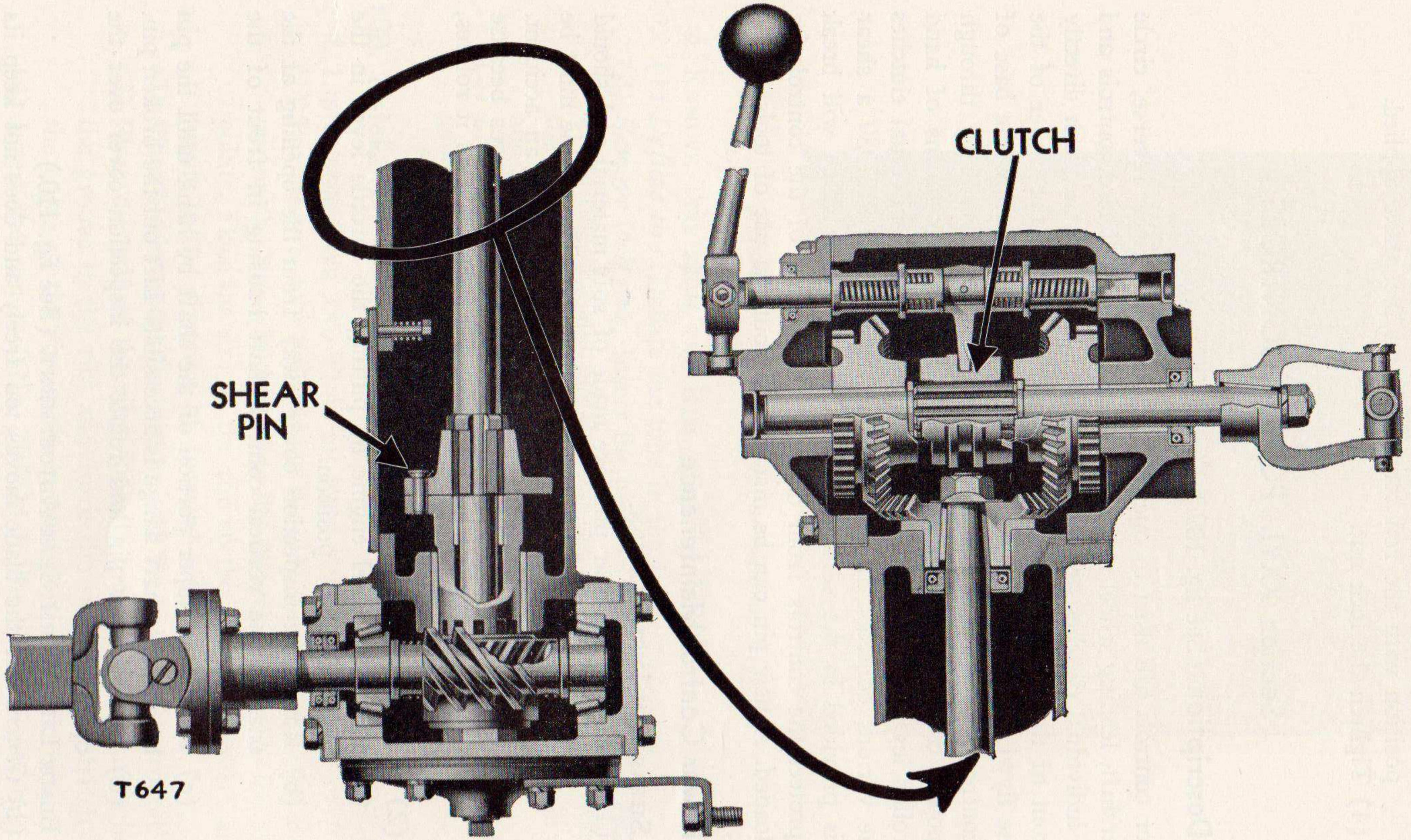


Figure 109. Power control mechanism.

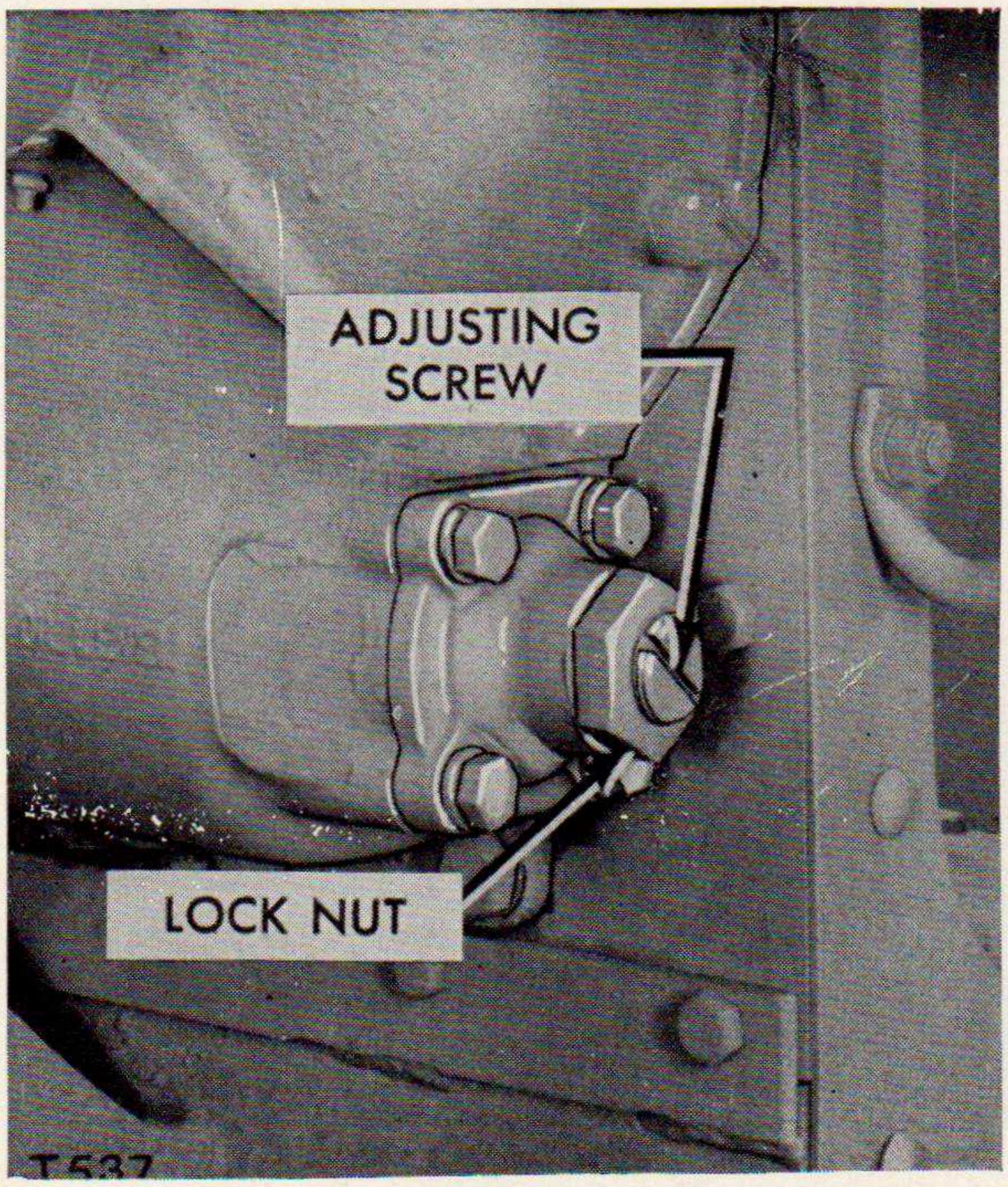


Figure 110. Blade lift worm gear adjustment.

(2) *Adjusting procedure.*

(a) Operate the controls to raise the blade off the ground and place the lift arms in a horizontal position.

(b) Loosen the adjusting screw lock nut. The adjusting screw is located on the outside of the blade lift worm shaft housing (one for each side).

(c) Turn the adjusting screw clockwise with a flat bar until it is snug. Tighten the lock nut.

(d) Check the adjustment. The blade should keep its position and not creep up or down.

c. Scarifier Worm Shaft Adjustment. (See fig. 111.)

(1) *General.* The worm shaft adjustment provides a means of placing tension on the worm shaft to prevent the scarifier from dropping to the ground when the control lever is in the neutral position.

(2) *Adjusting procedure.*

(a) Loosen the adjusting lock nut.

(b) Turn the adjusting screw clockwise with a flat bar until it is snug.

(c) Tighten the lock nut.

d. Ball and Socket Joints.

(1) *General.* Proper adjustment of the ball and socket joints should

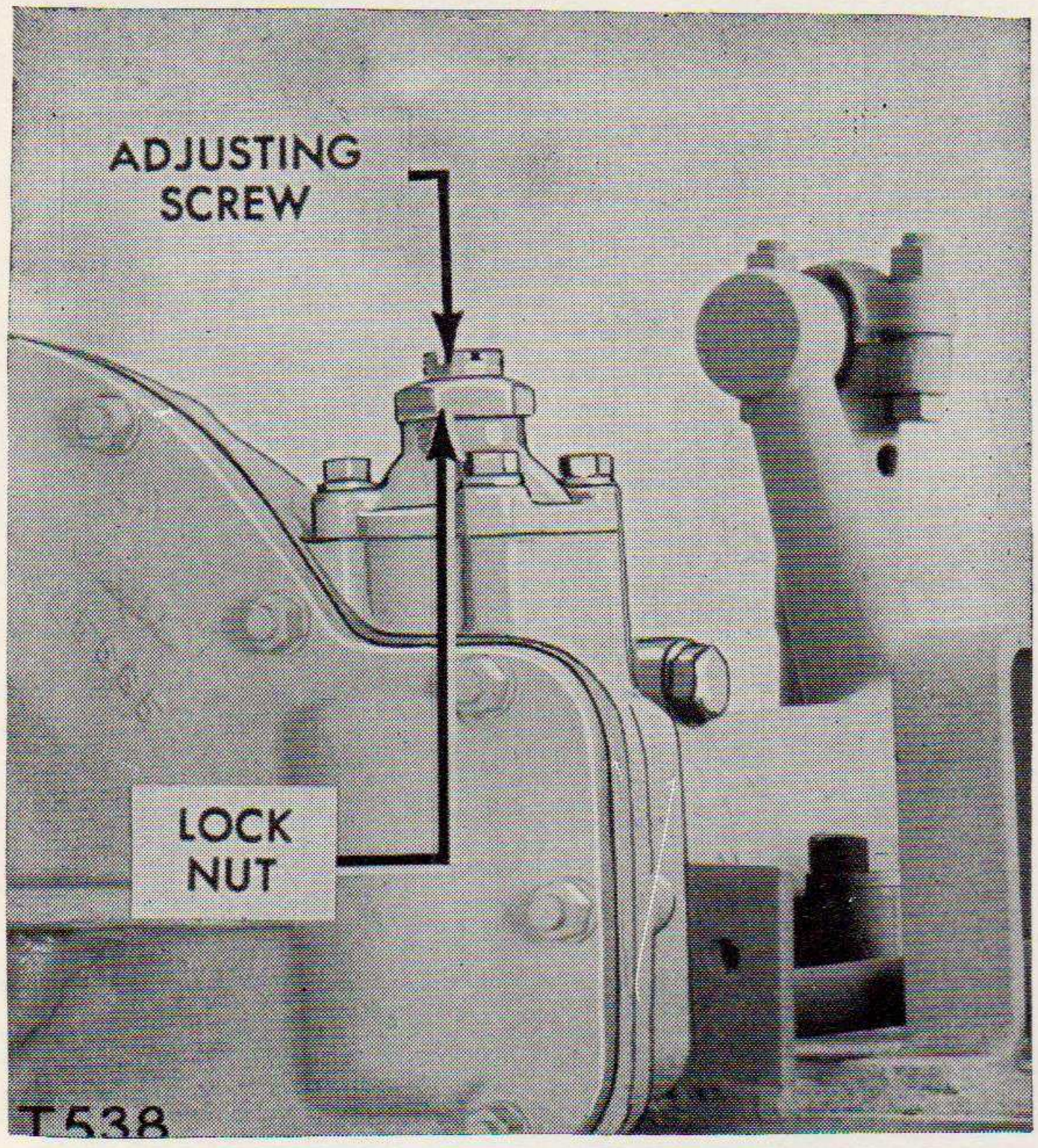


Figure 111. Scarifier worm shaft adjustment.

be maintained to insure maximum service and proper grader performance. The adjustment is made by the use of .030-inch shims. When the clearance between the cap and the socket sleeve reaches .045 inch one shim can be removed to reduce the clearance to .015 inch.

(2) *Adjusting procedure.* (See fig. 112.)

(a) Operate the controls to lower the blade to the ground.

(b) Remove the cap by removing the nuts and bolts.

(c) Clean the ball and socket joint by washing them in Diesel fuel.

(d) Replace the cap without the shims. Tighten the bolts and nuts only enough to snug the ball in the socket.

(e) Measure the gap between the cap and socket sleeve midway between the bolts with a thickness gage.

(f) Remove the cap and install only enough shims to obtain the desired .015- to .045-inch clearance.

(g) Repeat this procedure for all ball and socket joints.

e. Universal Joints and Control Shafts. (See fig. 113.) It is important that the universal joints of the control shafts be properly assembled to insure smooth operation. The universal joints at each end of the shaft should be in the same plane (parallel to each other). If the shaft is assembled with the universal joints one-fourth turn out of line, the shaft will jerk or whip.

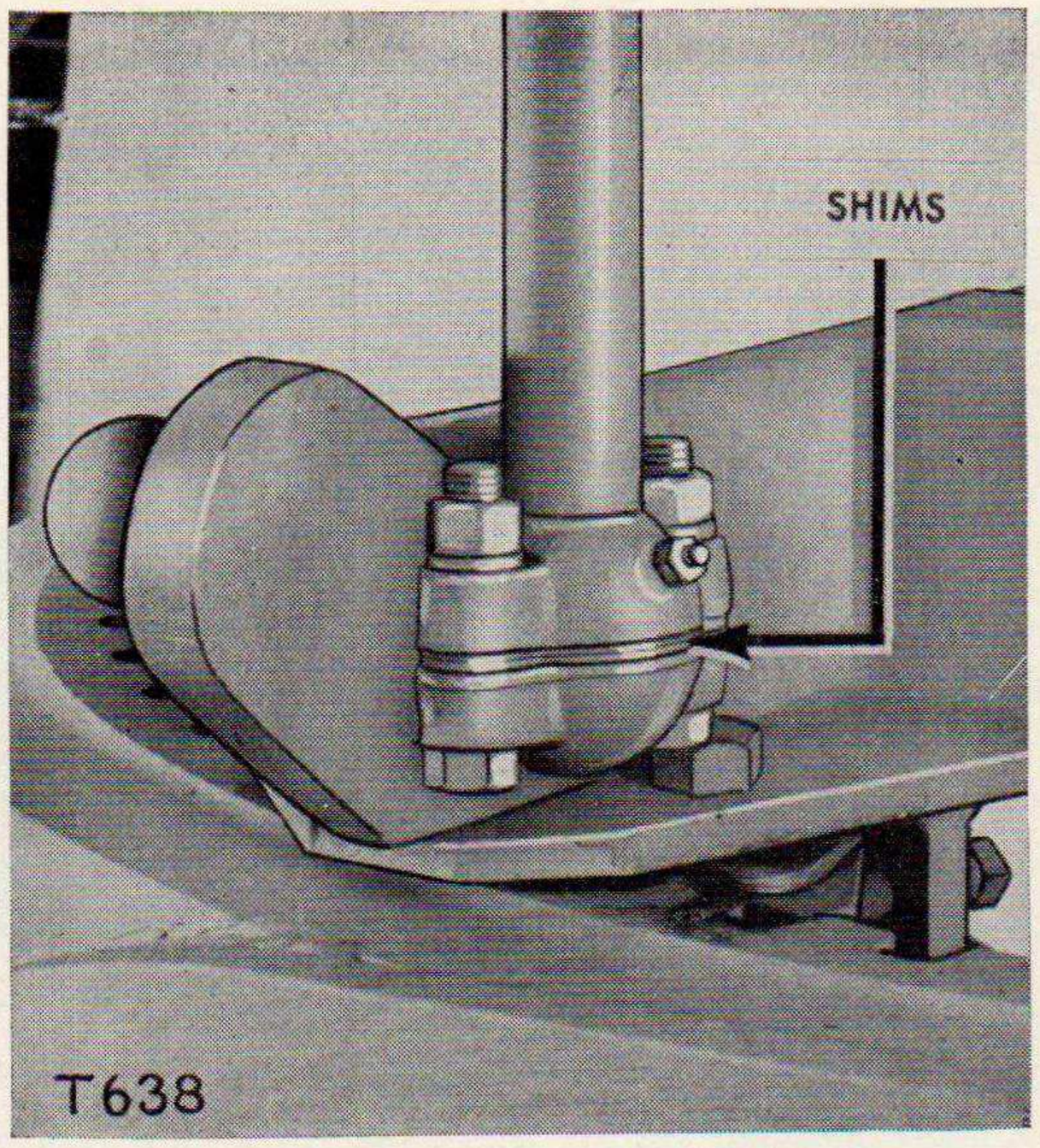


Figure 112. Ball and socket adjustment.

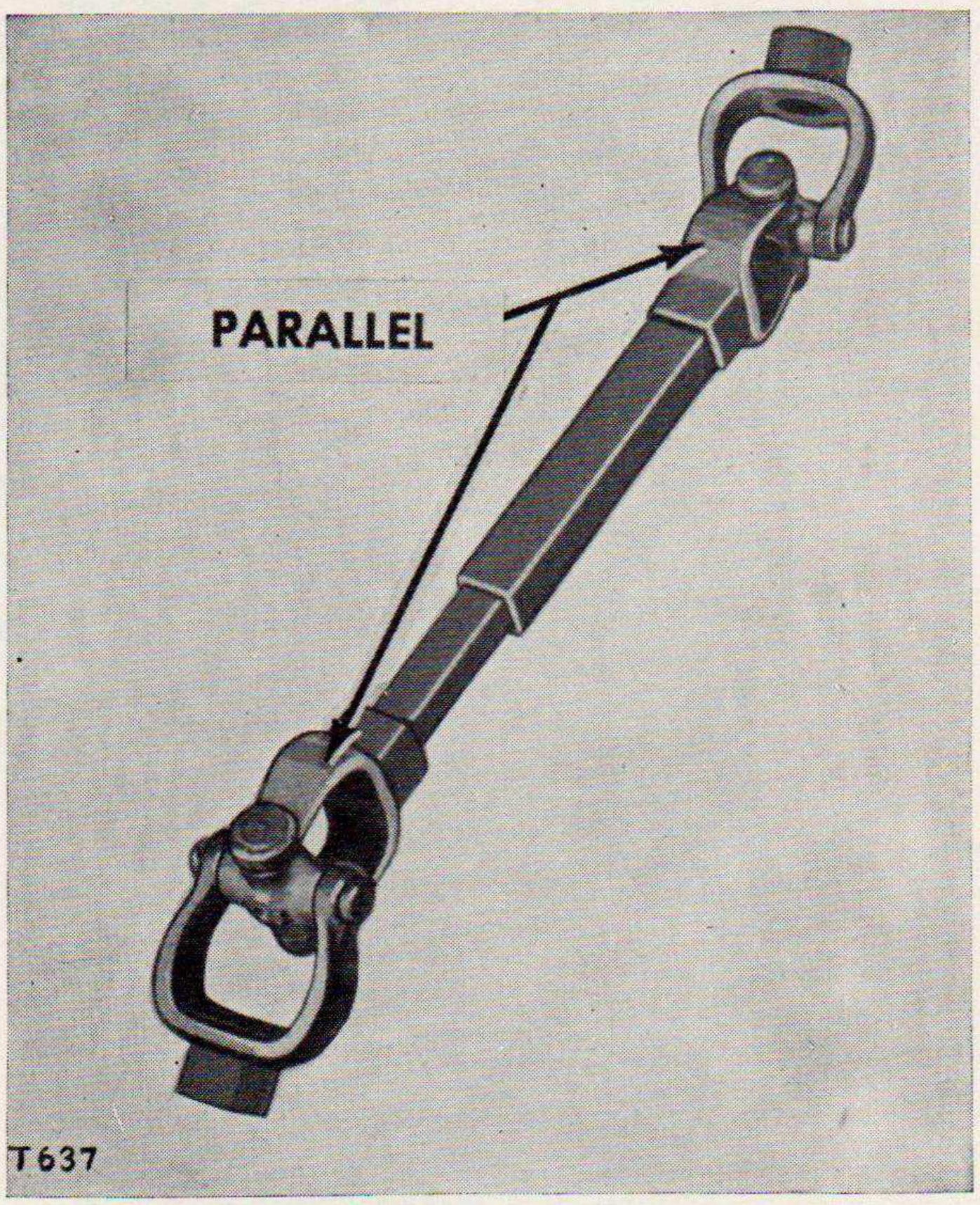


Figure 113. Universal joint alinement.

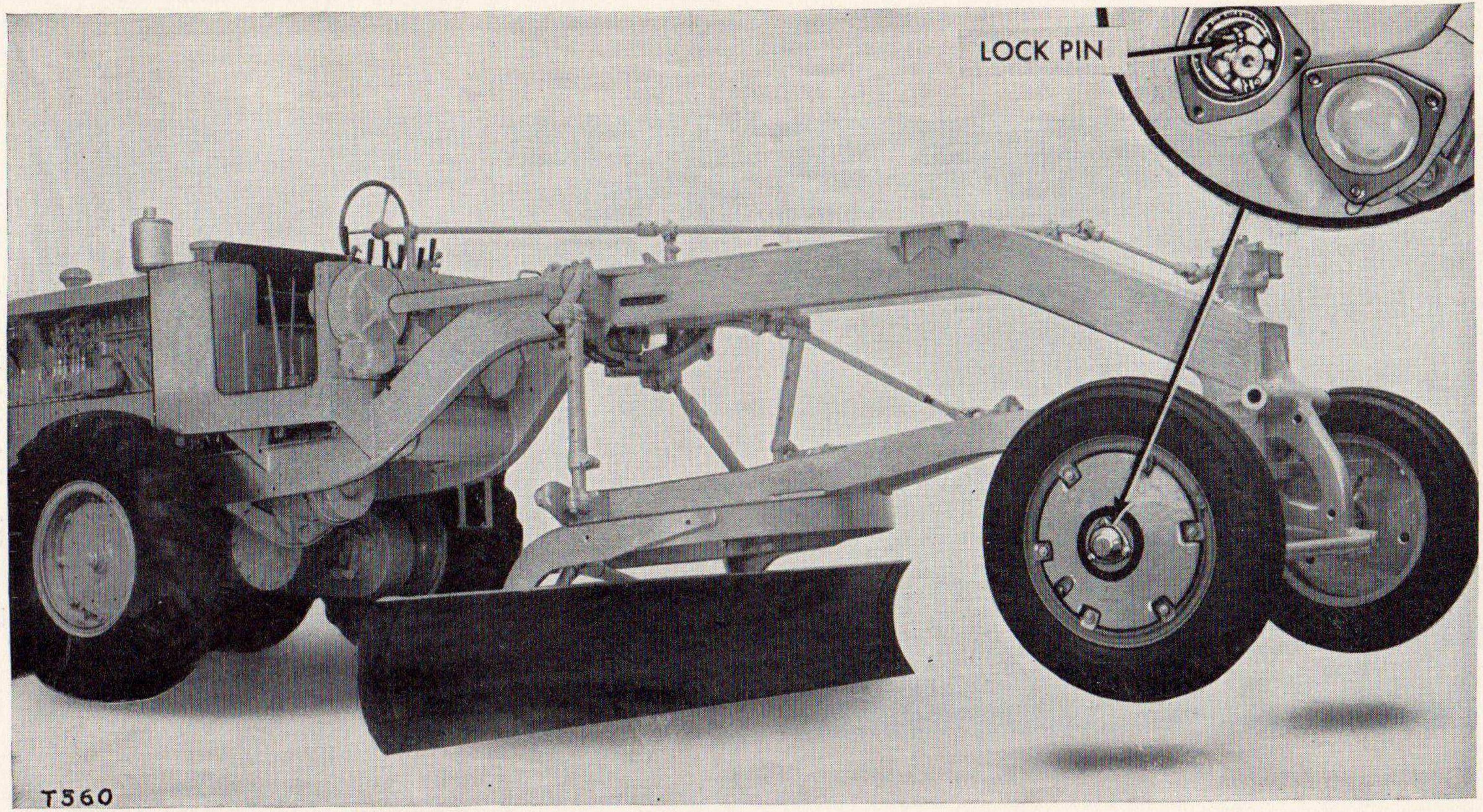


Figure 114. Raising the front wheels off the ground to adjust wheel bearings.

Section XXVII. FRONT AXLE AND STEERING MECHANISM

91. Description

The steering mechanism is the hand controlled type. A snubber assembly in the steering mechanism prevents a shock on the front wheels from spinning the steering wheel.

92. Maintenance

a. WHEEL BEARINGS. (See fig. 114.)

(1) *General.* The front wheels can be raised off the ground by operating the controls to lower the blade. Check the end play and adjust the wheel bearings if end play can be detected.

(2) *Adjusting procedure.*

(a) Raise the front wheels off the ground with a jack or by lowering the blade.

(b) Remove the hub cap and the adjusting nut lock pin.

(c) Tighten the adjusting nut with wrench No. 1D3363 until it locks the wheel when turned by hand.

(d) Turn the adjusting nut back one-sixth turn.

(e) Replace the lock pin and the hub cap.

b. FRONT WHEEL TOE IN ADJUSTMENT. (See fig. 115.)

(1) *General.* The front wheels should toe in (front of the wheels closer together than the rear) one-fourth inch. The adjustment is made by altering the length of the tie rod located directly behind the front axle.

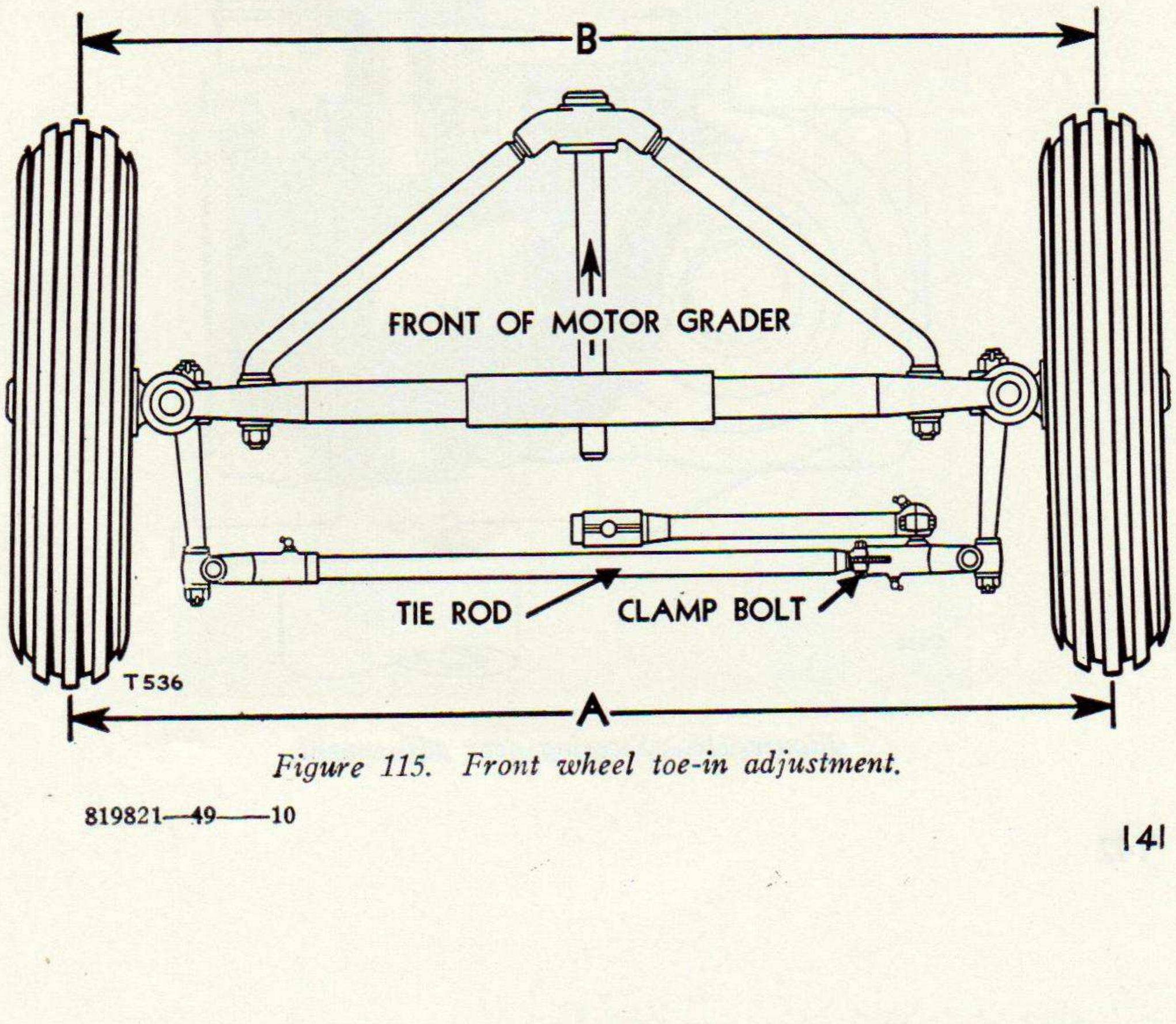


Figure 115. Front wheel toe-in adjustment.

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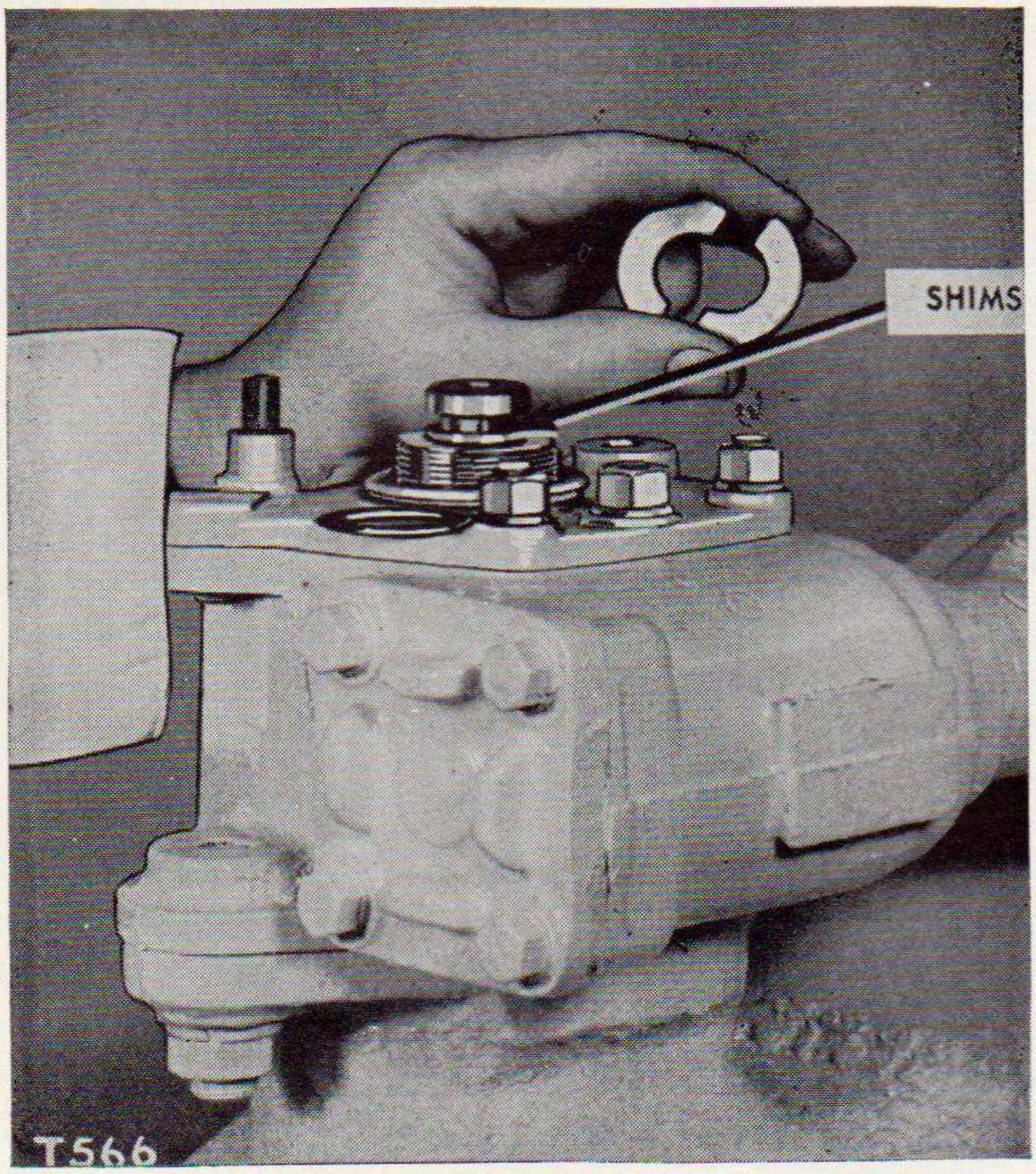

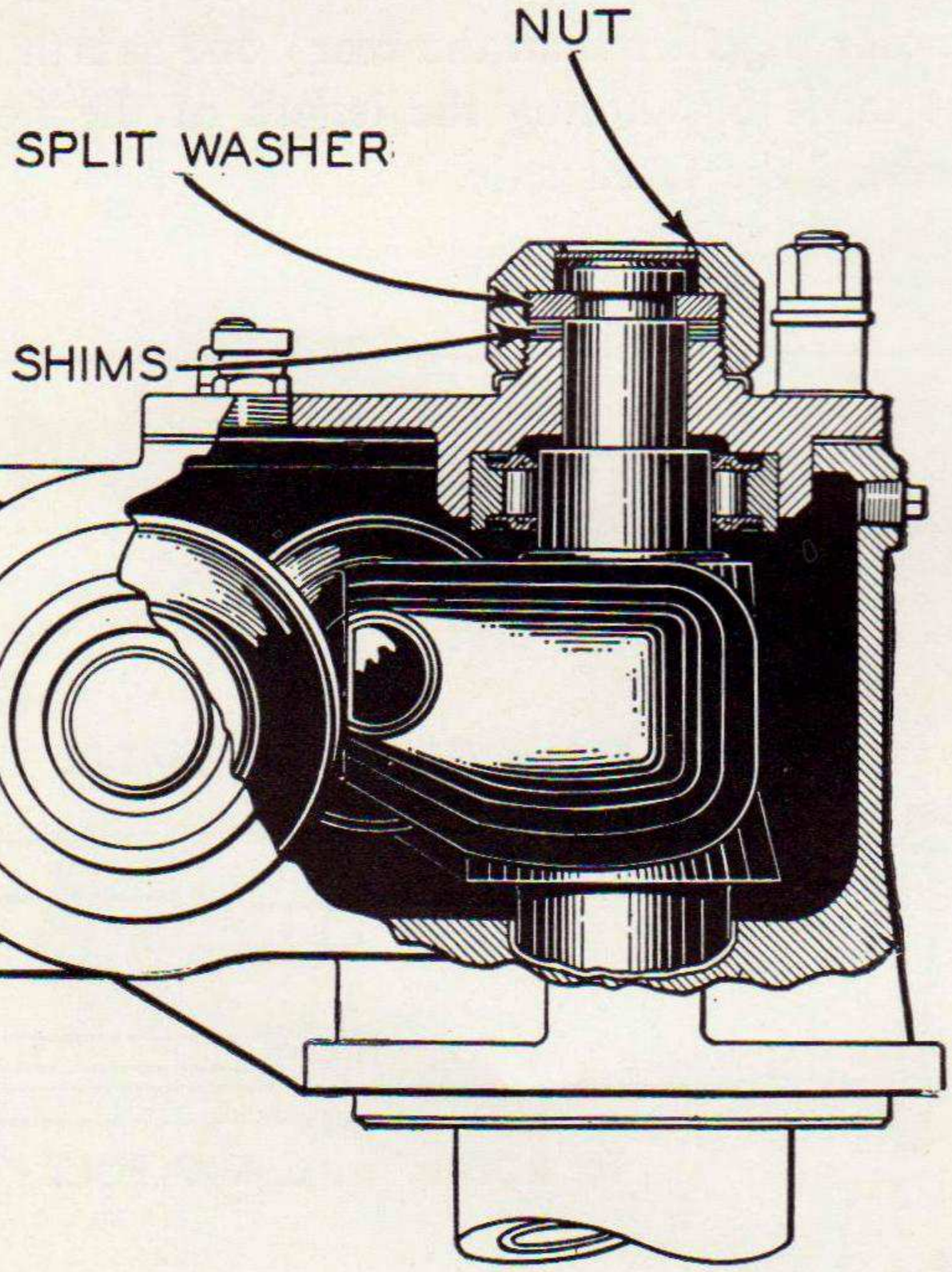

Figure 116. Steering gear adjustment.

(2) *Checking procedure.*

(a) Drive the motor grader on a smooth level surface.

(b) Make a mark on the center of the tread of each front tire at hub height at the rear of the tires.

(c) Measure the distance between these two marks.

(d) Drive the motor grader forward to put the marks at hub height at the front of the tires.

(e) Measure the distance between the two marks at the front. The distance in front (B) should be one-fourth inch less than the distance in back (A).

(3) *Adjusting procedure.* (See fig. 115.)

(a) Loosen the clamp bolt on the tie rod, located on the right end of the tie rod.

(b) Turn the tie rod counterclockwise to increase the "toe in".

(c) Tighten the clamp bolt.

93. Steering Gear Adjustment (See fig. 116.)

a. GENERAL. The slack in the steering gear may be eliminated by removing shims under the split washer on the upper end of the ball arm shaft.

b. PROCEDURE.

(1) Remove the lock and nut on top of the steering gear assembly.

(2) Remove the split washer.

(3) Remove only enough shims to take up the slack. The nut should fit firmly and the steering mechanism should work freely after the adjustment.

(4) Replace the nut and lock.

Section XXVIII. BLADE AND CIRCLE

94. Description

The blade is mounted on a circle capable of being fully revolved. The blade has reversible, replaceable end bits, which protect the corners of the main replaceable cutting edge. The circle is mounted on a double drawbar and is fully power controlled and operated.

95. Care

a. If the machine is to be parked for a few days the blade surface should be protected from rust, by coating it with heavy grease after it has been cleaned. Rust can be removed by using a solution of one part muriatic (commercial hydrochloric) acid and three parts water. After removing the rust, rinse the blade with clear water to remove the acid. Lye can be used for mild cases of rust.

b. End bits, when worn or broken, may be turned over and changed to opposite ends of the blade.

96. Circle Adjustment

a. Vertical Adjustment.

(1) *General.* If the circle and guide shoes become worn the blade will "chatter" (vibrate up and down during operation). Adjustment for this wear can be made by removing shims from between the circle shoes and the circle support.

(2) *Adjustment procedure.* (See fig. 117.)

(a) Lower the blade to the ground.

(b) Remove the circle shoe bolts.

(c) Remove shims as necessary.

(d) Replace the circle shoe bolts.

(e) Revolve the circle using the power control to make sure the circle does not bind at any point.

b. Adjustment to Eliminate Side Play. (See fig. 117.)

(1) Lower the blade and let it rest lightly on the ground.

(2) Loosen the circle shoe bolts and the lock nuts on the adjusting screws located under the circle support.

(3) Turn the adjusting screws down tight and back off until the circle turns freely. Both guides must be adjusted an equal amount, otherwise the circle will bind at the front.

(4) Tighten the lock nuts and the circle shoe bolts.

(5) Revolve the circle using the power control to make sure the circle does not bind at any point.

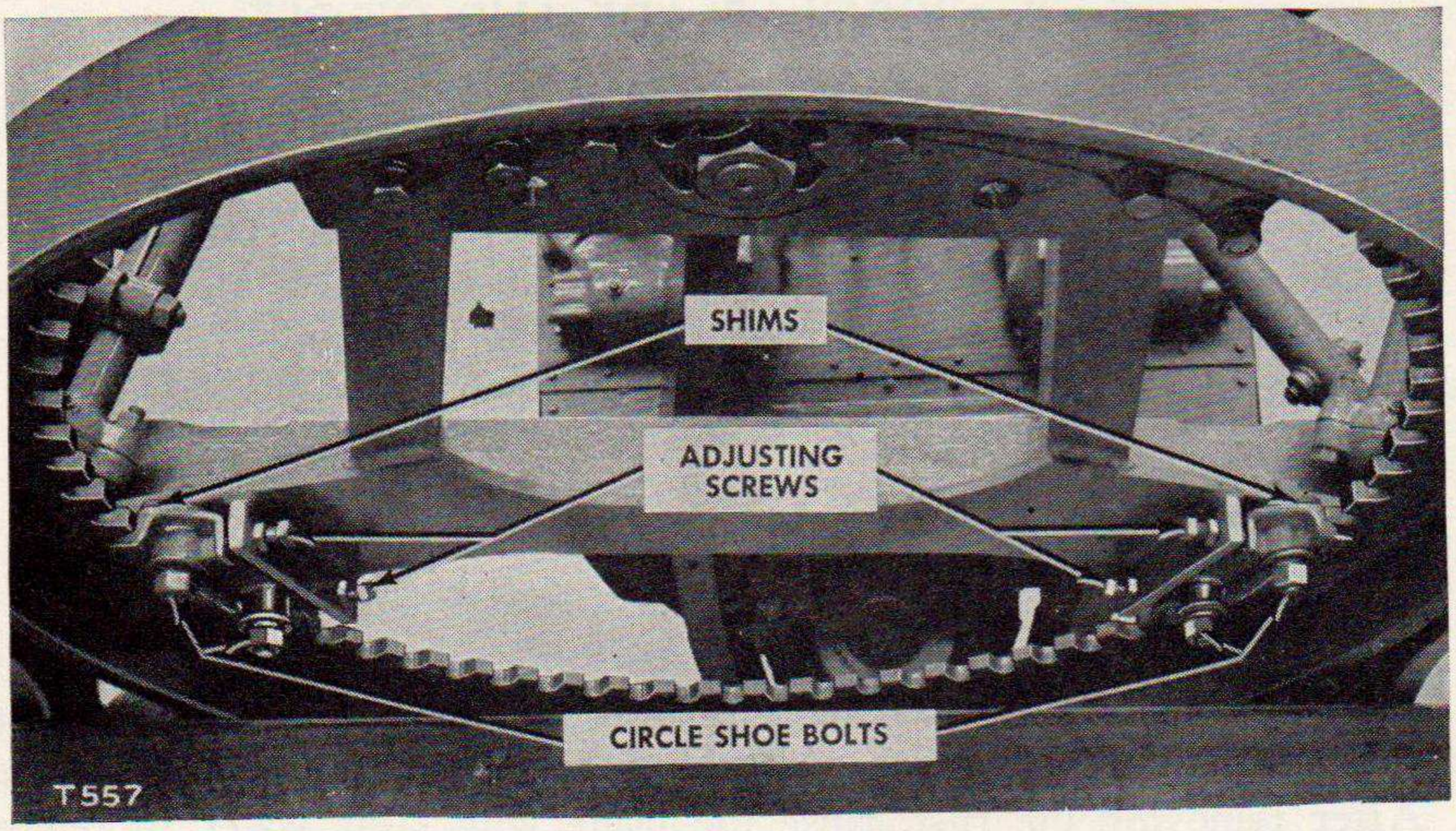

Figure 117. Circle adjustment.

Section XXIX. TIRES

97. General

If high pressure tires are used in front they should be inflated to 70 pounds. If low pressure tires are used in front inflate to 28 to 30 pounds. The rear or low pressure tires should be inflated to 28 to 30 pounds. In snow or sand it is permissible to inflate the rear tires to only 20 to 22 pounds pressure for additional traction.

98. Care

Test the air pressure every 64 hours and examine the tires for cuts, breaks and sharp objects which might work into the casing and puncture the tube.

99. Removal

a. Remove Tire and Rim from the Wheel.

(1) *Raise the wheel off the ground.* Raise the rear wheel with a jack. The front wheels can be raised by lowering the blade.

(2) *Remove the nuts and clamps.* Remove the nuts with wrench No. 2B5622 using tool No. 2B5623 for a handle.

(3) *Lift off the tire and rim.*

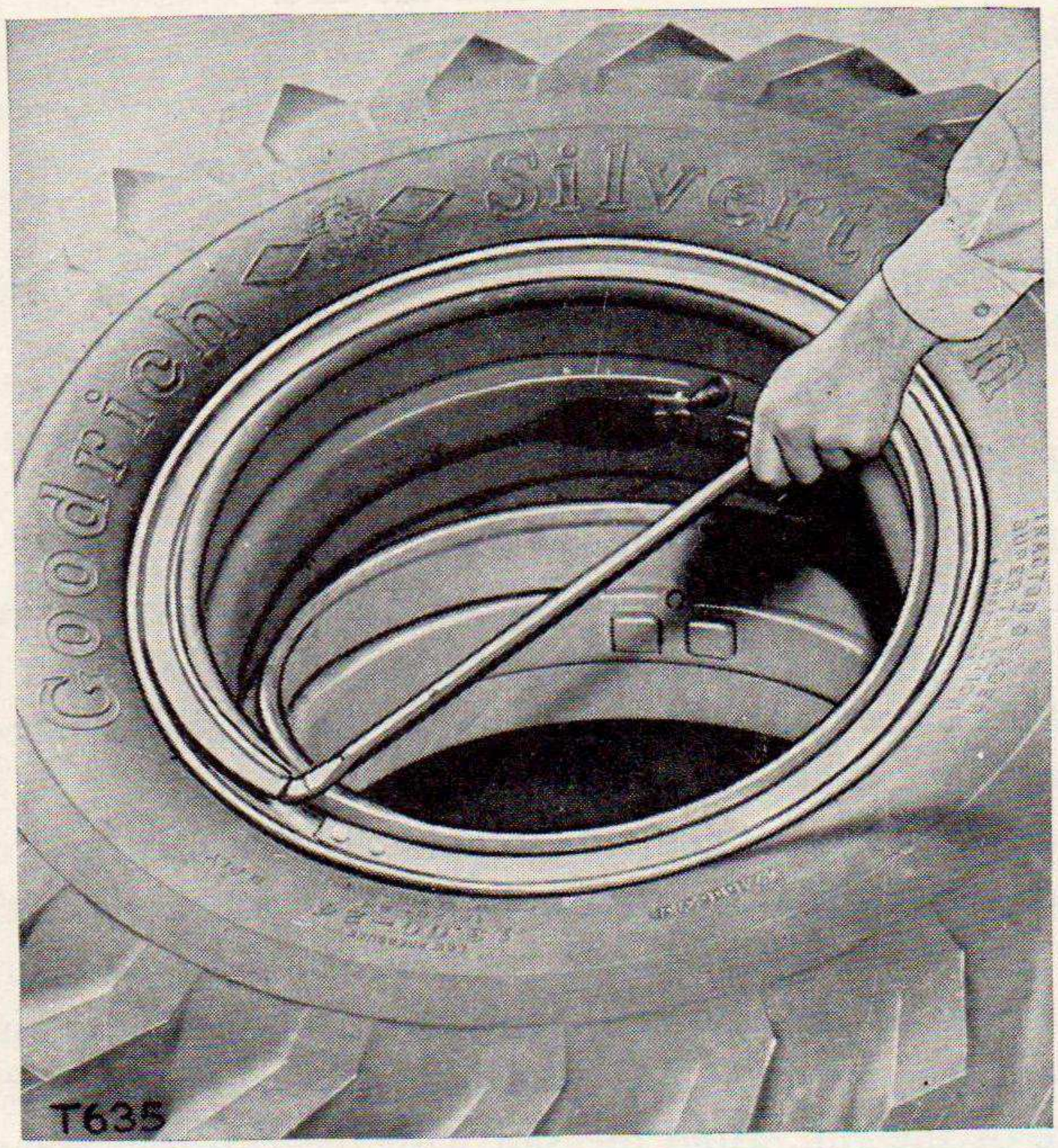

Figure 118. Removing lock ring.

Figure 119. Safe position for inflating tires.

b. Remove Tire from the Rim. (See fig. 118.)

(1) *Deflate tire.* Deflate the tube in the tire.

(2) *Remove lock ring.* Insert the point of the tire tool No. 2B5623 in the ring slot and pry the lock out of the groove and remove the side and lock ring. The lock ring is pinned to the side ring and both rings will come off together.

(3) *Lift off the tire.* The tire, tube, and flap can be lifted off together.

100. Installation

a. Installing Tire and Tube on Rim.

(1) Put the tire, tube and flap on the rim. The way the rear tire is put on the rim will determine the direction in which the arrow points. Place the tire on the rim so the (traction wheel) arrow points in the direction of forward rotation.

(2) Place blocks under the rim to hold the tire off the ground.

(3) Place the half of the ring opposite the slot into position below the groove in the rim and force the side ring to stretch over the edges of the rim at the cut out portion of the ring.

(4) Insert the rim tool No. 2B5623 in the slot and pry over the edge of the rim. Hold the slot with the rim tool and strike the ring with a hammer to force it into position.

Warning: To avoid the possibility of personal injury while inflating tires, a safe position should be taken. (See fig. 119.) Stand near the tread to be in the clear should the tire fail or the locking ring be forced from the rim.

(5) Inflate with a small amount of air until the ring moves against the rim bead. Strike the lock ring with a hammer to centralize it on the rim and against the bead. See that the ring lies evenly under the rim bead before inflating to full pressure.

b. INSTALL THE TIRE AND RIM ON THE WHEEL.

(1) Place the rim on the wheel locating the valve stem in the cut out section provided between two of the clamps. The arrow on the side of the rear tire should point in the forward direction for maximum traction.

(2) Replace the clamps and nuts. Adjust the tire rim lugs to reduce tire wobble and eccentricity to 1/8 inch or less. This can be accomplished by loosening or tightening lugs to shift the tire and rim "in and out" or "up and down". Follow this same procedure when mounting a tire to insure proper tire alignment and maximum tire life.

Note. The four drive wheels on this machine are tied together through the chain drive. Therefore, the rear axle and each wheel must make the same number of revolutions per mile when operating in a straight line. Consequently, it is important in replacing tires, either singly or otherwise, that the tires have the same outside diameter as the tires with which they are to be used. Although tires may be of the same nominal size, for example, 13.00 x 24, the outside diameter due to differences in tire construction between brands of tires and between styles of treads, may be sufficient so that tires of different style or make may not run properly together. Thus, a tire of a different style or make might slip and show signs of rapid wear due to a difference in size.

PART FOUR

AUXILIARY EQUIPMENT

Section XXX. AUXILIARY EQUIPMENT

101. General

The description and operation of auxiliary equipment is covered in section IX.

APPENDIX I

SHIPMENT AND STORAGE

1. Shipment

a. GENERAL. The usual means of shipping a motor grader is by flat car. However, a truck or trailer of sufficient length can be used. The following steps can be used for a truck or trailer as well as for a flat car. The motor grader has a high speed of 15.2 mph which makes it practical to transport it on its own power except for long distances.

b. DOMESTIC SHIPPING. (See fig. 120.)

(1) *Place the machine square on car floor.*

(2) *Install locking cap screw in leaning wheel mechanism.*

(3) *Place the throttle control lever in shut-off position.*

(4) *Place the compression release in run position.*

(5) *Shift the transmission in first speed.*

(6) *Apply the hand brake.*

(7) *Cover the exhaust pipe.*

(8) *Place chocks in front of front wheels and back of rear wheels.* Place chocks as close together as possible in such a position to prevent any forward or backward motion of the machine. Care must be taken to shape the chocks and place them to fit the contour of the tire it contacts. Fasten the chocks to the car floor with spikes or some equally effective method.

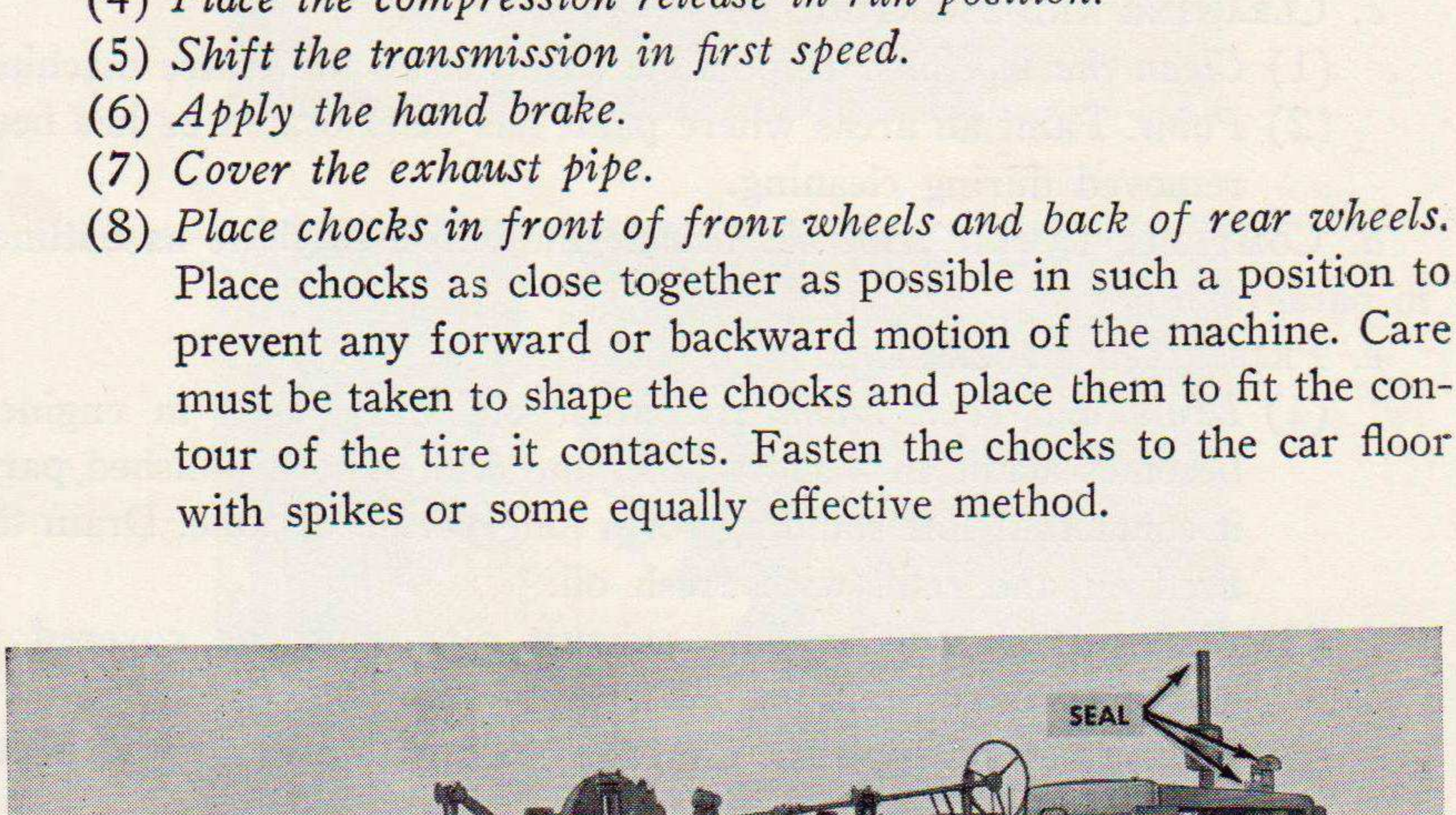

Figure 120. Blocking motor grader for shipment.

(9) *Place chocks along the outside edge of tires.* Two 2-inch by 4-inch timbers, shaped to fit the contour of the tires, along the outside edge of each tire fastened to the car floor with spikes will prevent any side motion of the machine.

(10) *Protect cooling system from freezing.* Drain the cooling system or protect it with antifreeze solution as directed in paragraph 25*b*.

c. EXPORT. See TM 5–1018 (Tentative Supplement), Preparation of Corps of Engineers Equipment for Export—Grader, Road, Motorized Diesel Engine-Driven, 12 Ft. Moldboard, Caterpillar, Model 12.

2. Limited Storage

a. GENERAL. If a machine is to be stored or left standing for a long period of time, the following steps should be taken to prevent damage to the machine, or trouble when it is again placed into operation.

b. INSPECTION AND REPAIR. Carefully inspect and repair or replace any worn or defective parts that may cause damage to the machine during storage, or impair its efficiency.

c. CLEANING AND PAINTING.

(1) *Clean the machine.* If possible steam clean the entire machine.

(2) *Paint.* Paint all areas where paint has deteriorated or has been removed during cleaning.

d. COMPLETE LUBRICATION. Lubricate the entire machine as outlined in paragraph 35.

e. PRESCRIBED PROCESSING.

(1) *Drain and refill crankcase.* Most oil, when used in engines, becomes acidic in a short time, and will etch all polished parts it contacts if left standing for a long period of time. Drain the used oil and refill with fresh oil.

(2) *Cover exhaust pipe.* The exhaust pipe must be covered to exclude snow or rain.

(3) *Protect blade from rust.* Coat the blade with a coating of heavy grease.

(4) *Drain all the gasoline from starting engine.* Drain the starting engine gasoline tank and let the starting engine burn the gasoline out of the carburetor. This will prevent gum deposits in the system.

(5) *Fill fuel tank.* Fill the Diesel engine fuel tank with Diesel fuel. This drives out all moisture-laden air and prevents condensation from taking place inside the tank.

(6) *Check storage battery.* Check the storage battery with a hydrometer and recharge it if the reading is 1.225 or lower. Clean the outside of the battery and cover all terminals with grease.

(7) *Drain cooling system or protect it with antifreeze.* If tem-

perature is below freezing or if freezing weather is expected before the machine is used again, drain the system, (see par. 63) or protect it with antifreeze. (See par. 25.)

(8) *Renew oil film on cylinder walls and bearings.* Start both starting engine and Diesel once every two weeks and let run until they are warm.

3. Dead Storage

Refer to TM 5–9715, Preparation of Corps of Engineers Equipment for Storage.

Caution: Do not place anything on the floor that will contact the tires en route.

4. Hoisting the Motor Grader

a. General. If the motor grader is to be moved or loaded with a hoist or crane, the equipment necessary is at least an eleven-ton hoist and four ¾-inch cables. The cables must be long enough to clear the cab, if the machine is equipped with one, and of equal length. A strong hook or clevis on the end of each to hook into the lifting eyes on the machine. The lifting eyes in front are located on the frame above the blade and circle and the rear ones are located on each of the tandem drive housings between the drive wheels.

APPENDIX II

REFERENCES

1. Preparation for Export Shipping

Preparation of Corps of Engineers Equipment for Oversea Shipment	TB 5–9711–1
Preparation of Corps of Engineers Equipment Export—Grader, Road, Motorized, Diesel Engine-Driven, 12-Ft. Moldboard, Caterpillar, Model 12	TM 5–1018 (Tentative Supplement)
Preparation for Export Spare Parts for Corps of Engineers Equipment	TB 5–9713–1

2. Dead Storage

Preparation of Corps of Engineers Equipment for Storage	TM 5–9715

3. Technical Publications

Repair Instructions (see par. 1, this manual).	TM 5–1018 (23 Mar 44)
Lubrication Instructions	LO 5–1018
Preventive Maintenance Services	TB 5–1018–1
Modification Work Orders	MWO ENG 1999–1 and MWO ENG 1999–2

4. Supply Catalogs

Organizational and Higher Echelon Spare Parts	ENG 7–G69
Illustrated Parts Catalog for Caterpillar Diesel No. 12 Motor Grader (see par. 1, this manual)	TM 5–1018 (23 Mar 44)

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