WABCO

D TRACTOR-SCRAPER

service manual

WESTINGHOUSE AIR BRAKE COMPANY
CONSTRUCTION EQUIPMENT DIVISION

GENERAL INFORMATION

INDEX

FOREWORD

The Maintenance and Repair Manual is especially designed for use by mechanics. The material is arranged for easy reference and logical sequence of detail. The first section contains brief instructions on how to operate the machine, its specifications, and torque chart. (For a more complete explanation, refer to the Operator's Manual.)

The greater portion of the manual pertains to disassembly, service, and reassembly. Each major mechanical division is dealt with individually. For example: The disassembly, service, and reassembly of the radiator group is discussed as a unit. The same is true of the engine and engine accessories, the final drives and so on throughout the entire mechanical detail of the machine. Thus, if you have a repair problem on your machine, all material pertaining to that part or parts will be grouped together in one section, ready for your quick reference and use.

The illustrations used in this manual are typical of the component shown and do not necessarily refer to any one particular machine.

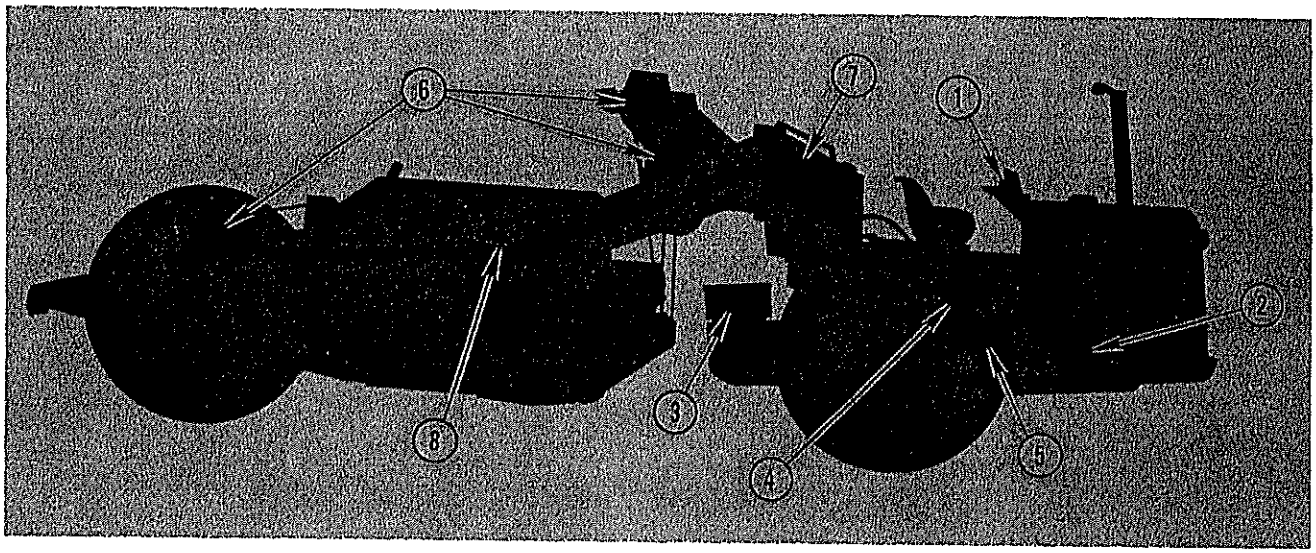


FIGURE A-3. ELECTRICAL SYSTEM

1. Instrument Panel
2. Rectifiers
3. Batteries
4. Transformer
5. Generator
6. Electric Motor
7. Switch Panel
8. Conductors

PREPARING NEW UNIT FOR OPERATION

GENERAL

Inspect machine thoroughly for external appearance and possible damage or theft during shipment. Report any damage or shortage to railroad or carrier.

Remove all processing, protective material or packing used to condition the machine for shipment. Detach tools or bundles wired to the machine. Check condition and amount of tools against packing list.

Check all lubrication points.

Check level of fuel oil in supply tank.

ENGINE AND ACCESSORIES

Fill radiator, check coolant. (Anti-freeze in winter.)

Check drive belt adjustments.

Drain off small amount of fuel from fuel filters to remove water or sludge.

Check oil level in air cleaner oil cup.

Check for water, oil, fuel or air leaks, before starting and during operation of engine.

Refer to engine manufacturer's manual for initial starting instructions.

Check engine shut-off control.

Start engine, observe operation. Check for any unusual noise or abnormal engine performance.

Check the engine oil pressure at oil pressure gauge.

Check the temperature of coolant at the temperature gauge.

TRANSMISSION

Check oil level.

Check clutch pedal for free play.

Check transmission for correct operation at all speeds.

FINAL DRIVES

Check oil level in final drive and ring gear compartments.

BRAKES

Check for air leaks in air brake lines.

Check brakes for proper operation.

WHEELS AND TIRES

Check tire pressure (at atmospheric temperatures). See Section "H" for correct tire pressures.

Check wheel bolts for tightness. Check each shift for first few days of operation and then intermittently thereafter.

ELECTRICAL SYSTEM

Check all electrical connections for tightness.

Check level of electrolyte in batteries.

Check specific gravity of battery electrolyte.

Check operation of lights, and accessories.

Turn on D.C. main switch and key switch. Ammeter should show a normal discharge, indicating that the generator is excited.

Check ammeter on instrument panel. The ammeter should show a charge with no load on the electrical system and the engine at high idle (D.C. main switch on).

Check operation of limit switches and A. C. electric motors.

Check for open breather hole in rectifier oil tank fill pipe cap.

MISCELLANEOUS

Check air pressure gauge on dash panel. For proper operation the air pressure should be from 90 to 120 pounds per square inch.

Hook up cables to trail units.

Check trail unit hitch bolts for tightness. Check each shift of operation for first few days and then intermittently thereafter.

OPERATING INSTRUCTIONS

The instructions which follow are intended to acquaint the mechanic with the instruments and controls and their proper use in operating the Model D Tournapull and trail units.

It is imperative that the mechanic understands the function and operation of each of the instruments and controls. The knowledge is essential for the proper maintenance and safe operation of the machine, which will give longer machine life and less down time.

Instrument Panel

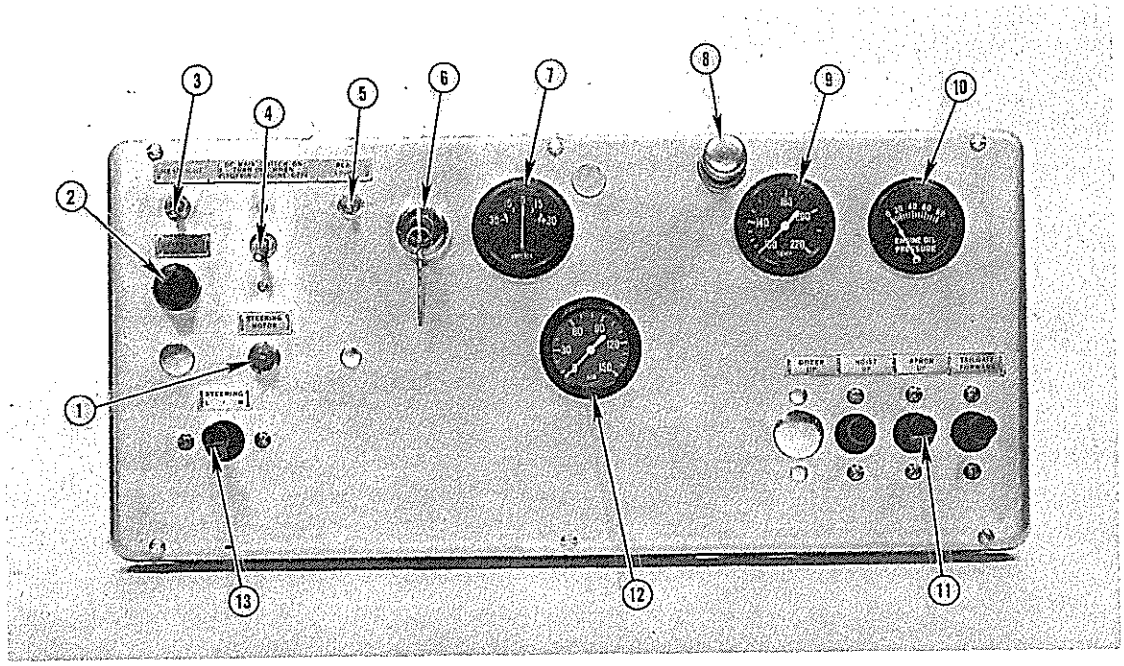


FIGURE A-4. INSTRUMENT PANEL

1. Steering Motor Warning Light
2. Cranking Motor Switch
3. Head Light Switch
4. D.C. Main Switch
5. Rear Light Switch
6. Key Switch
7. Ammeter
8. Panel Light
9. Temperature Gauge
10. Oil Pressure Gauge
11. Motor Control Switches
12. Air Pressure Gauge
13. Steering Motor Switch

STEERING MOTOR WARNING LIGHT

The steering motor warning light (1) remains on at all times unless the temperature of the steering motor exceeds the safe operation range. Should the light go off, allow a short interval for the motor to cool and the light to come on again before resuming operation. Should the light continue to go off at short intervals, the trouble should be located and corrected.

CRANKING MOTOR SWITCH

The cranking motor switch (2) opens and closes the circuit to the cranking motor solenoid. Press switch to operate the cranking motor. The cranking motor delivers the initial momentum to the engine necessary for its starting.

HEADLIGHT SWITCH

The headlight switch (3) controls headlights. The light switch is a two position, toggle-type switch. The switch is off when the toggle is down.

D.C. MAIN SWITCH

The D.C. main switch (4) opens and closes the 24 volt D.C. basic excitation circuit to the A.C. generator. When the toggle is up, the circuit is closed (on), when the toggle is down the circuit is open (off). The switch must be on before any of the A.C. electric motors can be operated. Open the switch when idling the engine for long periods to prevent unnecessary drain on the storage batteries.

REAR LIGHT SWITCH

The rear light switch (5) controls the light(s) on the trail unit. Lift the toggle up to turn on the light, push the toggle down to turn off the light.

KEY SWITCH

The key switch (6) opens and closes the 6 volt circuit to the cranking motor switch and the lubricating oil pressure switch. To start the engine, turn the switch to the on position completing the circuit to the cranking motor switch.

AMMETER

The ammeter (7) indicates the rate of charge or discharge of the storage batteries. At high idle with no load on the electrical system the ammeter should register a charge, when the D.C. main switch is on.

PANEL LIGHT

The panel light (8) is used for night time operation of the machine. The light is controlled by a

Steering and Braking

The Tournapull is steered by a reversible A.C. electric motor. This motor is controlled by the steering switch located in the lower left corner of the instrument panel.

The steering system is independent of the drive wheels and includes an A.C. electric motor, gear reduction box, and pinion mounted on the steering kingpin housing. A ring gear which is attached to the Tournapull is driven by the gear box pinion, turning the Tournapull to the right or left with respect to the kingpin housing and trail unit. Since steering clutches are not used, there is no reduction of power to either of the drive wheels in turning. Instead, the independent steering permits the differential to proportion full power to the drive wheels.

The Tournapull and trail unit are equipped with disc type air brakes. Two types of discs are used in this brake — internally splined steel discs secured to the stationary brake hub, and externally splined, lined discs which turn with the wheels. When the air is applied, the discs are forced together and the friction created between the discs slows up or stops the rotation of the wheels. The amount of pressure applied to the foot brake pedal determines the amount of pressure applied against the brake discs and thus the abruptness of the stop. Springs release the brake after the foot is removed from the brake pedal and the air pressure is released.

Changing Speeds

The Tournapull transmission has five forward speeds and one reverse speed.

First speed forward is to the extreme right and forward. The last small portion of the movement to the right must be made against spring pressure. This spring pressure helps the operator identify the position into which he is placing the shift lever. This spring resistance is also evident in positioning the lever for reverse.

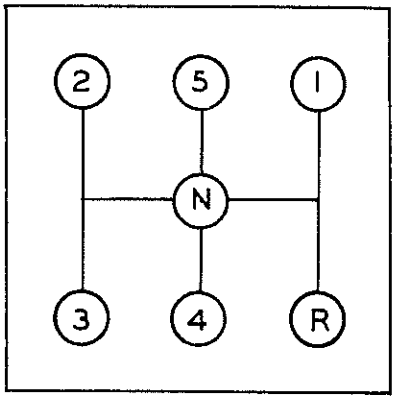


FIGURE A-9. TRANSMISSION LEVER POSITIONS

Second speed is to the left and forward; third, to the left and rear; fourth to the right and rear; and fifth, to the right and forward. For these four speeds do not attempt to overcome the spring pressure indicating the reverse speed or the 1st speed forward.

To shift into reverse, first bring the machine to a complete halt. Then move the lever to the extreme right position and back.

Always disengage the clutch completely before changing gears.

"Double clutch" when shifting to a higher speed or to a lower speed. To "double clutch" when shifting to a lower speed, depress the clutch pedal and shift the transmission into neutral. Engage the clutch (with transmission in neutral), accelerate the engine to a speed which corresponds to road speed in the lower gear. Disengage the clutch, shift transmission into the lower gear, then engage clutch and accelerate engine simultaneously. To "double clutch" when shifting to a higher speed, depress the clutch pedal and shift the transmission into neutral. Engage the clutch (with transmission in neutral). Disengage the clutch and shift transmission into higher gear, then engage clutch and accelerate engine simultaneously.

CAUTION: Drive down grades! Keep the transmission in gear and the clutch engaged. Coasting with the transmission in neutral will cause the mainshaft to spin at excessive speed far beyond the speed encountered during normal operation. The countershaft gears move at such a low speed in comparison to the mainshaft that they are unable to provide an oil circulating pump action adequate enough to supply the lubrication necessary for the mainshaft gear bushings. Bushing failure will probably result.

If the clutch is disengaged with the transmission in gear while the machine is coasting down grade, and then re-engaged again it will cause a sudden "slow-down" resulting in a shock load on the transmission gears, thus causing abnormal strain. Ultimate failure may result.

Do not ride the clutch pedal. Any pressure put on the clutch pedal lessens the engagement of the clutch and tends to create clutch slippage.

When shifting gears, always make sure that the transmission gears are in full mesh by moving the shift lever fully into its position.

For smoother operation of the machine progressive shifting is recommended.

TORQUE CHART

LOCATION	TORQUE
Arch Axle Locknut	1000 Ft. Lbs.
A.C. Generator Adaptor Hub Locknut	350 Ft. Lbs.
A.C. Generator Stator to Flywheel Housing Mounting Capscrews	40 Ft. Lbs.
A.C. Motor Brake Hub Nut (#1 Motor)	75 Ft. Lbs.
(#2 Motor)	300 Ft. Lbs.
A.C. Motor Bearing Retainer Nut (#1 Motor)	300 Ft. Lbs.
(#2 Motor)	350 Ft. Lbs.
Case Staybolts	190 Ft. Lbs.
Crane Axle Locknut	2000 Ft. Lbs.
Differential Pinion Bushing Capscrews	30 Ft. Lbs.
Differential Cage Capscrews	125 Ft. Lbs.
Electrotarder Grid Support Bolts	25 Ft. Lbs.
Final Drive Axle Locknut	3900 Ft. Lbs.
#1 Gear Box Output Gear Locknut	1000 Ft. Lbs.
#2 Gear Box 1st Reduction Gear Locknut	100 Ft. Lbs.
2nd Reduction Gear Locknut	200 Ft. Lbs.
Output Gear Locknut	2000 Ft. Lbs.
#3 Gear Box 1st Reduction Gear Locknut	100 Ft. Lbs.
2nd Reduction Gear Locknut	200 Ft. Lbs.
Output Gear Locknut	2000 Ft. Lbs.
Kingpin Bearing Retainer Nut	1300 Ft. Lbs.
Spiral Bevel Ring Gear Mounting Capscrews	190 Ft. Lbs.
Rear Dump Axle Locknut	1000 Ft. Lbs.
Steering Circle Gear Tapered Capscrews	285 Ft. Lbs.
Steering Circle Gear Flathead Capscrews	190 Ft. Lbs.
Scraper Axle Locknut	1000 Ft. Lbs.
Scraper Blade Bolts	265 Ft. Lbs.
Steering Trunnion Ball and Socket Capscrews	300 Ft. Lbs.
Transmission Adaptor Nuts	190 Ft. Lbs.
Transmission Adaptor Capscrews	60 Ft. Lbs.
Transmission Adaptor Bearing Retainer Nut	300 Ft. Lbs.
Transmission Adaptor Bearing Retainer Capscrews	15 Ft. Lbs.
Trail Unit Yoke Hitch Bolts	2000 Ft. Lbs.
Trail Unit Ball and Socket Capscrews	350 Ft. Lbs.
#1 Cable Drum Locknut	1000 Ft. Lbs.
Quick Release Cable Drum Locknut (Arch)	1000 Ft. Lbs.
Wheel Mounting Capscrews	550 Ft. Lbs.

Capscrews and Nuts

Size	Flat Head	Taperhead
1/4"	8 Ft. Lbs.	12 Ft. Lbs.
5/16"	15 Ft. Lbs.	25 Ft. Lbs.
3/8"	30 Ft. Lbs.	45 Ft. Lbs.
7/16"	50 Ft. Lbs.	75 Ft. Lbs.
1/2"	70 Ft. Lbs.	105 Ft. Lbs.
9/16"	90 Ft. Lbs.	135 Ft. Lbs.
5/8"	125 Ft. Lbs.	190 Ft. Lbs.
3/4"	190 Ft. Lbs.	285 Ft. Lbs.
7/8"	265 Ft. Lbs.	400 Ft. Lbs.
1"	360 Ft. Lbs.	540 Ft. Lbs.
1 1/8"	450 Ft. Lbs.	675 Ft. Lbs.
1 1/4"	580 Ft. Lbs.	870 Ft. Lbs.
1 3/8"	690 Ft. Lbs.	1000 Ft. Lbs.
1 1/2"	850 Ft. Lbs.	1275 Ft. Lbs.

REAR DUMP

OVERALL MEASUREMENTS (With Tournapull)
- Length (Traveling Position) ..... 24' 10"
- (Dump Position) ..... 21' 10"
- Width ..... 8' 0"
- Height ..... 9' 6"
- Wheelbase (Traveling Position) ..... 14' 6"
- (Dump Position) ..... 9' 8"

CAPACITY
- Tons 11
- Cubic Yards (Heaped - 2:1) 8
- (Struck) 7

BOWL
- Length ..... 10' 11"
- Width ..... 6' 0"
- Maximum Depth ..... 5' 3"

TIRES ..... 2 (18.00 - 25) 12 PR

GAUGE ..... 6' 3"

GROUND CLEARANCE (Rear Dump) ..... 24"

TURNING RADIUS (Minimum)
- (Body in Travel Position) ..... 12' 4"
- (Body in Dump Position) ..... 9' 4"

WEIGHT DISTRIBUTION	Loaded	Empty
Front Axle	50%	70%
Rear Axle	50%	30%

APPROXIMATE SHIPPING WEIGHT (Tournapull and Rear Dump) ..... 22,300 lbs.

CRANE

OVERALL MEASUREMENTS (With Tournapull)
- Length (Maximum) ..... 58' 10"
- (Minimum) ..... 27' 9"
- Height (Maximum) ..... 36' 6"
- (Minimum) ..... 11' 3¾"
- Width ..... 12' 8½"
- Wheelbase ..... 16' 0"

TIRES ..... 2 (18.00 - 25) 16 PR

GAUGE ..... 132½"

GROUND CLEARANCE (Crane) ..... 17"

MINIMUM TURNING RADIUS ..... 15' 2"

MAXIMUM LIFT ..... 35'

REACH AND LIFT CAPACITY (Behind Centerline of Crane Wheels)

0' to 8'	20,000 lbs.
10'	16,000 lbs.
12'	13,300 lbs.
15'	10,600 lbs.
20'	8,000 lbs.
25'	6,400 lbs.
30'	5,300 lbs.
35'	4,500 lbs.

APPROXIMATE SHIPPING WEIGHT (Tournapull and Crane) ..... 23,900 lbs.

LOGGING ARCH

OVERALL MEASUREMENTS (With Tournapull)	
Length (With blade)	25' 9"
Width	9' 2¾"
Height	10' 1¾"
Wheelbase	13' 6"
TIRES	2 (18.00 - 25) 16 PR
GAUGE	90"
GROUND CLEARANCE (Arch)	23"
WINCH	
Drum Size - Barrel Diameter	10¾"
Flange Diameter	20¾"
Barrel Length	10"
Flange Depth	5"
Capacity	366' of ¾"

AVAILABLE LINE PULL	Normal	Stall
Bare Drum	39,200 lbs.	61,500 lbs.
Full Drum	22,500 lbs.	35,400 lbs.

LINE SPEED (Normal Operating)	
Bare Drum	30 ft/min
Full Drum	53 ft/min
LINE PAY OUT (Full Drum and Synchronous motor speed)	70 ft/min
With Quick Release	Unlimited

COOLING, AIR, AND FUEL SYSTEMS

INDEX

COOLING, AIR, AND FUEL SYSTEMS

COOLING SYSTEM

The cooling system includes the fan and fan belts, radiator, thermostats, and water pump. Water is circulated by a centrifugal pump which pumps the water out of the radiator into the water inlet manifold, where it circulates around an oil cooler and passes into the engine water jacket and then into the water inlet manifold at the top of the cylinder head. There is a set of thermostats in the water outlet manifold which control the flow of water. Before the temperature of the water reaches 160° F., the thermostats stay closed and the water by-passes the radiator. When the temperature of the circulating water is approximately 160° F., the thermostats allow the water to flow through the water by-pass line into the inlet side of the water pump. When the temperature of the water exceeds approximately 160° F., the thermostats open and permit the flow of water into the radiator. Under normal operating conditions, the water temperature should range from approximately 160° to 185° F.

Water from the engine cooling system is also circulated through the air compressor head and block. Water lines are connected to the compressor on the end opposite the drive pulley.

The pressure type radiator cap permits any overflow by water expansion within the radiator to flow out through the overflow pipe.

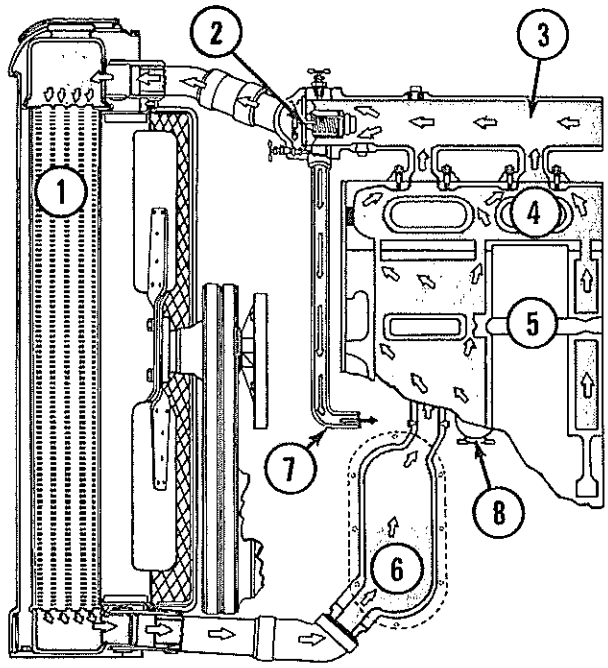


FIGURE B-1. COOLING SYSTEM

1. Radiator
2. Thermostat
3. Water Manifold
4. Cylinder Head
5. Block
6. Oil Cooler
7. To Water Pump
8. Water Pump

RADIATOR

Removal and Disassembly

Drain the coolant from the radiator and engine block. Disconnect the hoses at the radiator.

Remove the capscrews fastening the hood to the radiator shell. Prop up the hood, using blocks of wood between the underside of the hood and the top of the engine. The hood may be removed if desired.

If hood is removed, disconnect air line to horns.

Disconnect the leads to the headlights. Connectors are provided for easy disconnecting. Slide back the insulating tubes, move one half of the connector 90° out of line with the other half, and separate the two halves as shown in Figure B-3.

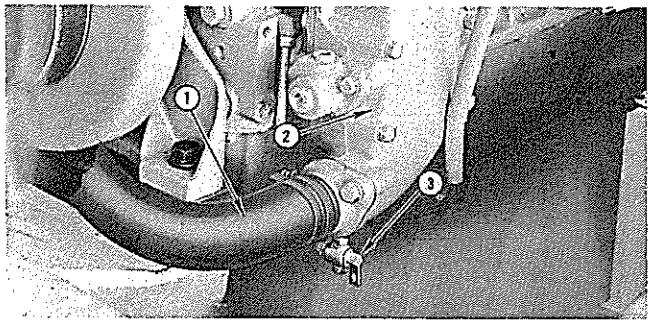


FIGURE B-2. LOWER RADIATOR HOSE

1. Hose
2. Oil Cooler
3. Drain

The connectors are located at the left headlight near the radiator end of the conduit carrying the headlight leads.

Remove capscrews and lockwashers securing radiator shell to the Tournapull case and the nut and washer from each rubber mount which fastens the radiator and shell together. Remove shell.

Remove the nut from stud at each corner of radiator core that fastens it to the case. Remove core.

Remove the four capscrews, lockwashers and nuts securing rubber mounts to the case and remove mounts.

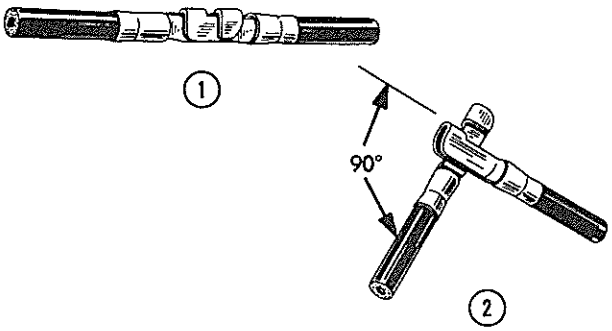


FIGURE B-3. KNIFE DISCONNECT

1. Connected
2. Disconnected

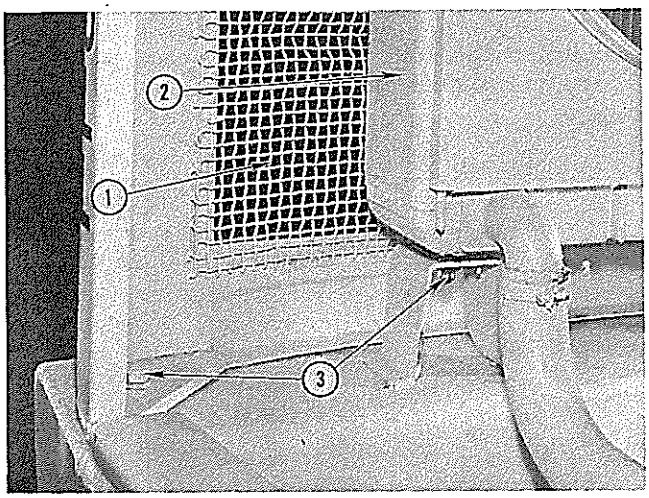


FIGURE B-4. MOUNTING BOLTS

1. Shell 2. Radiator 3. Bolts

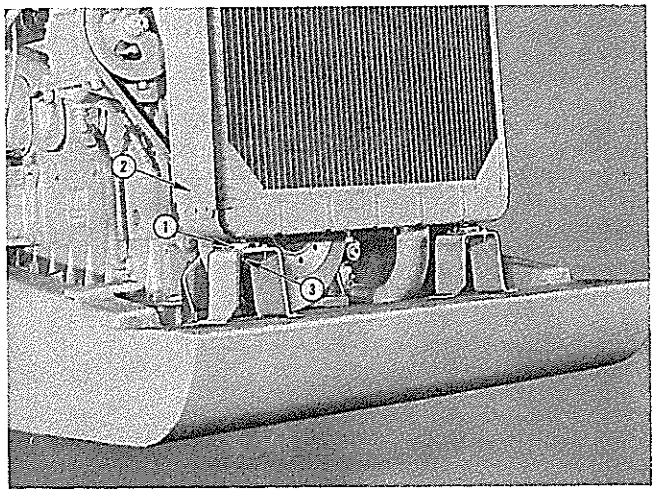


FIGURE B-5. RUBBER MOUNTS

1. Rubber Mount 2. Radiator 3. Stud

TEMPERATURE GAUGE

The temperature gauge is located on the instrument panel. It indicates the temperature of the coolant in the cooling system. If the temperature registers at a level in excess of the normal operating range, checks should be made to determine the trouble.

Should the gauge become inoperative, remove the nuts on the back of the instrument panel holding the gauge to its mounting bracket. Also loosen the nut holding the temperature gauge bulb in position in the engine block. Remove the gauge. A broken gauge should be replaced with a new one.

THERMOSTATS

Before installing the thermostats, examine for corrosion and replace if excessively corroded or if the frame is bent or damaged. Check for holes in the bellows. To test thermostats, suspend them in a vessel containing hot water with a thermometer and raise the temperature of the water. They should begin to open at the temperature corresponding with the mark on the thermostats. The degree difference between the start and fully opened point is about 10° F. If the thermostats do not function as above, replace.

Check the condition of neoprene seal and spring which prevents water from leaking to radiator when the thermostat is closed. Check by-pass vent holes.

Insert thermostats in water outlet manifold. Install housing over the studs, and tighten the holding nuts and lockwashers.

ANTI-FREEZE MIXTURES

Temperature Degrees	Permanent Anti-Freeze	Alcohol (Methanol Base)
+ 1	11 qts.	9 qts.
− 4	12 qts.	12 qts.
−15	14 qts.	15 qts.
−22	15 qts.	17 qts.
−35	17 qts.	20 qts.
−42	19 qts.	22 qts.

AIR SYSTEM

AIR CLEANERS

The air intake to the engine's manifold is connected to the discharge side of the air cleaner.

The dust laden air is drawn into the inlet cap through the openings around the outside of the bottom of the cap.

The inlet cap keeps fibrous materials such as chaff or lint from entering the main body of the air cleaner assembly. Air is combined with the oil, forming a spray, and drawn upward through the filter element in the cleaner body. Oil and dust particles are separated from the air in the filter element and drain back into the oil cup. Cleaned air is drawn into the engine's intake manifold.

Removal

Loosen the wing nuts at the bottom of the air cleaner assembly and remove the oil cup and disc. Loosen the hose clamps on the discharge pipe.

Take off the air cleaner mounting bands and remove the air cleaner as a unit. Place the air cleaner on a bench for further disassembly.

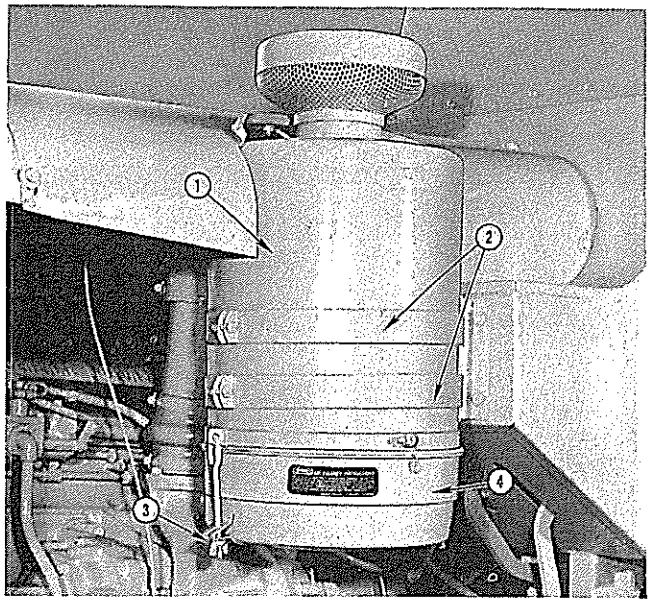


FIGURE B-6. AIR CLEANER

1. Air Cleaner
2. Mounting Bands
3. Wing Nut
4. Oil Cup

Remove the prefilter by pushing up slightly and turning to the left, then pull down. Loosen the clamp on the neck of the inlet cap and remove the cap.

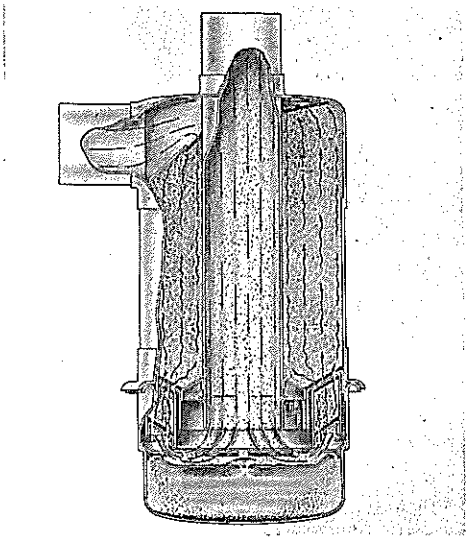


FIGURE B-7. FLOW OF AIR THROUGH AIR CLEANER

Service

After the unit has been disassembled, all parts can be cleaned and defective parts replaced. Empty the oil cup, clean and refill when the oil becomes too thick to spray readily or when one-fourth of the oil has been displaced by sediment.

Daily inspection is necessary to determine when any of these conditions have been reached.

Check the oil level at the beginning of each shift. Change oil every 5 shifts of operation (more often if necessary in extreme dusty conditions). Never use oil heavier than that used in the engine crankcase. The same weight is recommended. The oil should be up to the oil level mark on the disc. Raising the oil above this mark does not increase the efficiency and this practice should be avoided.

See Section "K" for air cleaner maintenance.

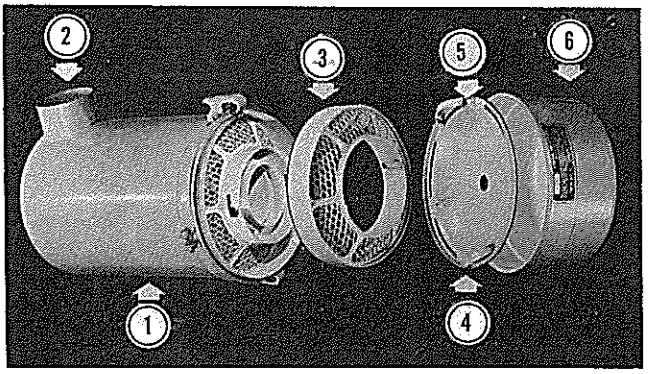


FIGURE B-8. AIR CLEANER, EXPLODED

1. Body
2. Discharge
3. Pre-Filter
4. Gasket
5. Disc
6. Oil Cup

AIR COMPRESSOR

Description

The compressor is of the two cylinder, single acting reciprocating type. The rated capacity of 7 ¼ cubic feet per minute is based on piston displacement when running at a speed of 1250 RPM.

Both the cylinder head and cylinder block are water cooled by the engine's cooling system.

Oil under pressure from the engine enters the compressor through a passage in the crankcase, and is fed to the connecting rod bearings through drilled holes in the crankshaft and to the wrist pin bearings through drilled holes in the connecting rods. The main bearings are ball bearings and are splash lubricated. Surplus oil returns to the engine gear housing through a line from the compressor base.

The compressor name plate is attached to the crankcase and includes the serial number, piece number and type of compressor.

Type U

Operation

The compressor runs continuously while the engine is operating. However, the actual compression of air is controlled by a governor which, acting in conjunction with the unloading mechanism in the compressor cylinder head starts or stops the compression of air by loading or unloading the compressor when the air pressure in the system reaches the desired minimum or maximum.

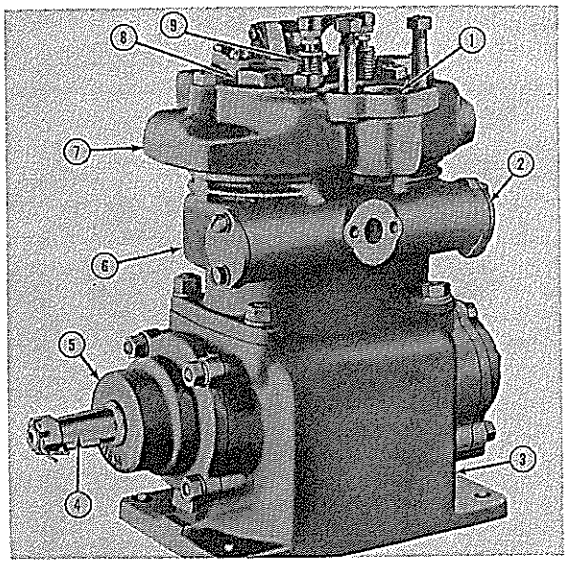


FIGURE B-9. AIR COMPRESSOR

1. Discharge Port
2. Air Strainer
3. Crankcase
4. Crankshaft
5. End Cover
6. Cylinder Block
7. Cylinder Head
8. Discharge Valve Cap Nut
9. Unloading Valve Spring

COMPRESSING AIR (Fig. B-10): During the downstroke of each piston, a partial vacuum is created above the piston and as the piston nears the bottom of its stroke, it uncovers the intake ports in the cylinder wall. Air then enters the cylinders above the piston after passing through the air cleaner, the intake manifold, and the intake ports in the cylinder wall.

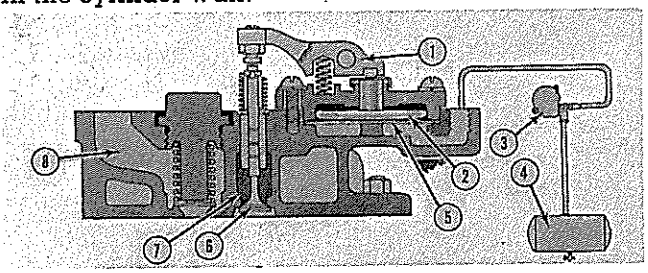


FIGURE B-10. COMPRESSING POSITION (LOADED)

1. Unloading Lever
2. Diaphragm Follower
3. Governor
4. Reservoir
5. Diaphragm
6. Unloading Valve
7. Valve Cavity
8. Discharge Port

As each piston begins its upstroke, it covers the intake ports in the cylinder wall and the air which has entered the cylinder is trapped above the piston. As the piston continues its upstroke, the air above the piston is compressed until the pressure lifts the discharge valve and the compressed air is discharged through the discharge line into the air tank.

As each piston starts its downstroke, the discharge valve above it returns to its seat preventing the compressed air from returning to the cylinder, and the same cycle is repeated.

NOT COMPRESSING AIR (Unloaded): When the air pressure in the air tank reaches the maximum setting of the governor, compressed air from the air tank passes through the governor into the cavity under the unloading diaphragms in the compressor cylinder head. This air pressure lifts the unloading diaphragm and one end of the unloading lever. The unloading lever then pivots on the unloading lever pin and the other end pushes the unloading valves off their seats (Fig. B-11).

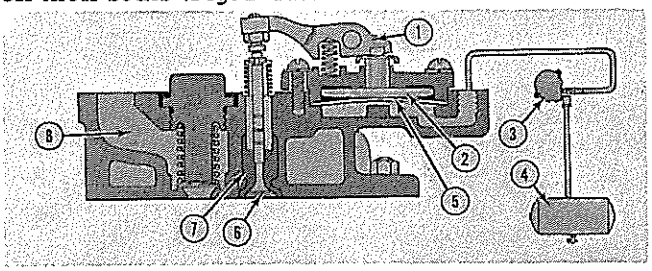


FIGURE B-11. NON-COMPRESSING POSITION (UNLOADED)

1. Unloading Lever
2. Diaphragm Follower
3. Governor
4. Reservoir
5. Diaphragm
6. Unloading Valve
7. Valve Cavity
8. Discharge Port

With the unloading valves off their seats, the unloading cavity forms a passage between the cylinders above the piston. Thus during the upstroke of each piston air merely passes back and forth through this passage and compression is stopped. When the air pressure in the reservoir drops to the minimum setting of the governor, the governor releases the air pressure from beneath the unloading diaphragm. The unloading valve springs then return the unloading valves to their seats and compression is resumed.

Removal

Drain the air system completely by opening the bleeder valve on the air supply tank.

Drain engine cooling system, compressor cylinder head and compressor block.

Disconnect air, water, and oil lines connected to the compressor.

Relieve tension on the compressor drive belt.

Remove compressor mounting bolts and remove compressor from machine.

Use a gear puller to remove the pulley from the compressor crankshaft after removing the crankshaft nut.

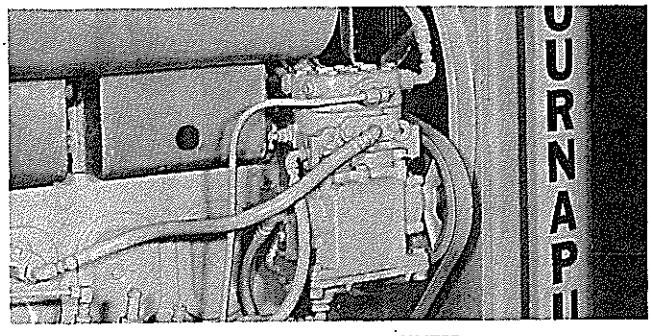


FIGURE B-12. AIR COMPRESSOR, MOUNTED

Disassembly

CLEANING BEFORE DISASSEMBLY: Remove all grease or dirt from exterior of the compressor by scraping. If necessary use cleaning solvent and a brush.

MARKING BEFORE DISASSEMBLY: The cylinder head, cylinder block and crankshaft of many compressors are designed so that the compressor can be assembled in several different ways to meet the installation requirements. In order to insure correct assembly, such parts should be marked before disassembly where necessary to show their correct position in relation to each other. This can be done best by making center punch marks in the related parts to act as guides during assembly.

The following parts should be marked:

Position of cylinder head in relation to cylinder block.

Position of air intake fitting in relation to cylinder block.

Position of cylinder block in relation to the crankcase.

Position of front end cover (drive end of the crankcase) in relation to the crankcase. (Make one punch mark on each.)

Position of rear end cover in relation to the crankcase. (Make two punch marks on each.)

All crankshafts are marked already with one punch mark on the throw nearest the drive end. Marking the crankcase with one punch mark at the drive end will permit the crankshaft to be positioned properly in the crankcase during assembly.

Remove unloading lever, unloading lever spring, and dust cover.

Remove all nuts from all cylinder head studs and lift off cylinder head (Fig. B-13). The cylinder head may have to be tapped lightly with a rawhide hammer to break the gasket seal.

Scrape cylinder head gasket off cylinder head and block.

Remove machine screws attaching unloading box cover to cylinder head. Lift off unloading box

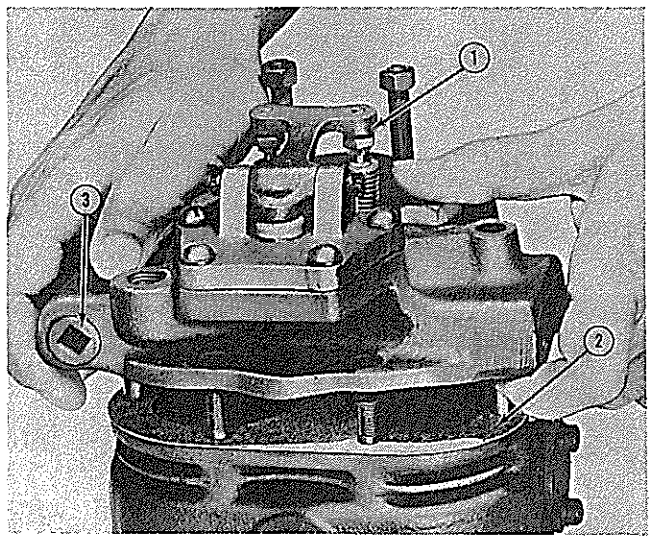


FIGURE B-13. REMOVING CYLINDER HEAD

1. Unloading Lever 2. Gasket 3. Drain Plug

cover and remove diaphragm follower and the two diaphragms.

Remove discharge valve cap nuts and lift out discharge valve springs and discharge valves.

Compress unloading valve springs by hand and remove spring retaining rings. Then remove un-

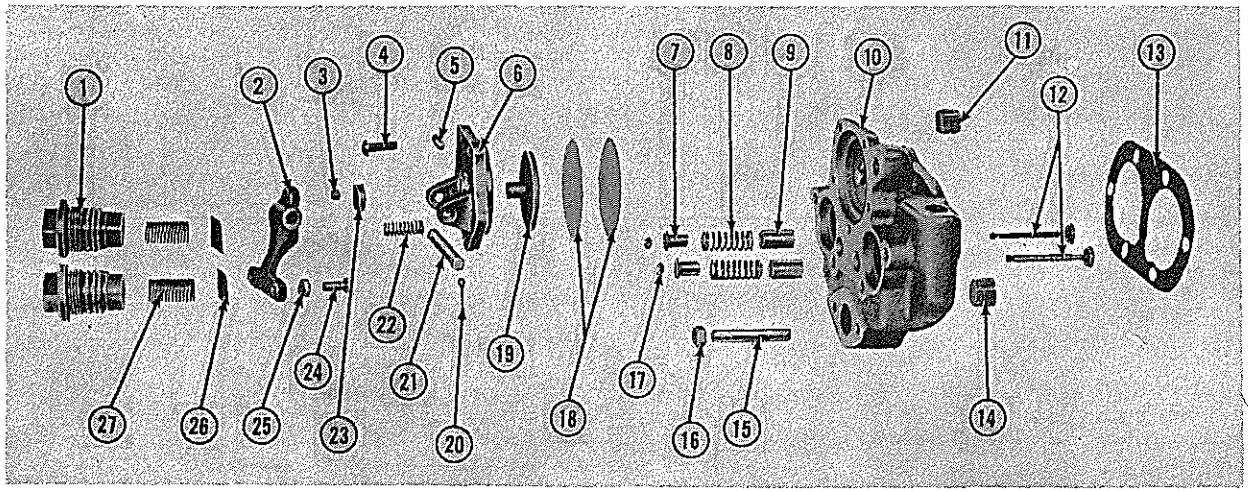


FIGURE B-14. CYLINDER HEAD, EXPLODED

1. Cap Nut
2. Unloading Lever
3. Button
4. Capscrew
5. Lockwasher
6. Box Cover
7. Stop
8. Unloading Valve Spring
9. Bushing
10. Body
11. Pipe Plug
12. Unloading Valves
13. Gasket
14. Plug
15. Stud
16. Nut
17. Washer
18. Diaphragm
19. Diaphragm Follower
20. Cotter Pin
21. Lever Pin
22. Lever Spring
23. Dust Cover
24. Adjusting Screw
25. Locknut
26. Discharge Valve
27. Discharge Valve Spring

loading valve stops and unloading valve springs. Remove unloading valves by pushing them out the bottom of the cylinder head body.

Remove cotter pins and slotted nuts from bolts securing connecting rod bearing caps to connecting rods (Fig. B-15). Lift out connecting rod bearing caps. Then push pistons, with connecting rods attached, out the top of cylinder block. Replace caps on each connecting rod to avoid damage to the bearings. The connecting rod caps and connecting rods are already marked with center punch marks to show the proper position of the caps.

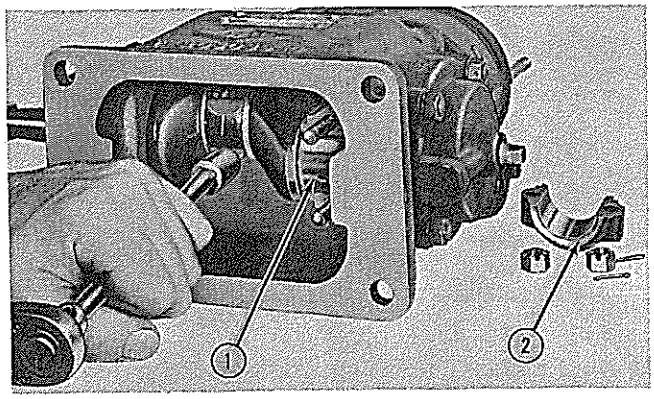


FIGURE B-15. REMOVING ROD BEARING CAPS

1. Connecting Rod Journal
2. Bearing Cap

Remove piston rings from each piston. If pistons are to be removed from connecting rods, remove the wrist pin lock wires from each wrist pin and press wrist pins from pistons and connecting rods.

Remove nuts from studs securing front or drive end cover to crankcase. Remove end cover with oil seal and gasket. If oil seal needs replacing, remove it from end cover.

Remove nuts from studs securing rear end cover to crankcase. Remove end cover, oil seal ring and gasket.

Some crankcases are fitted with a shoulder. This positions the crankshaft in the crankcase. In such cases, the crankshaft may be removed only through one end of the crankcase. Press crankshaft and ball bearings out of crankcase, then press ball bearings off crankshaft.

Remove intake manifold cover and gasket.

Remove nuts securing cylinder block to crankcase and remove cylinder block and gasket.

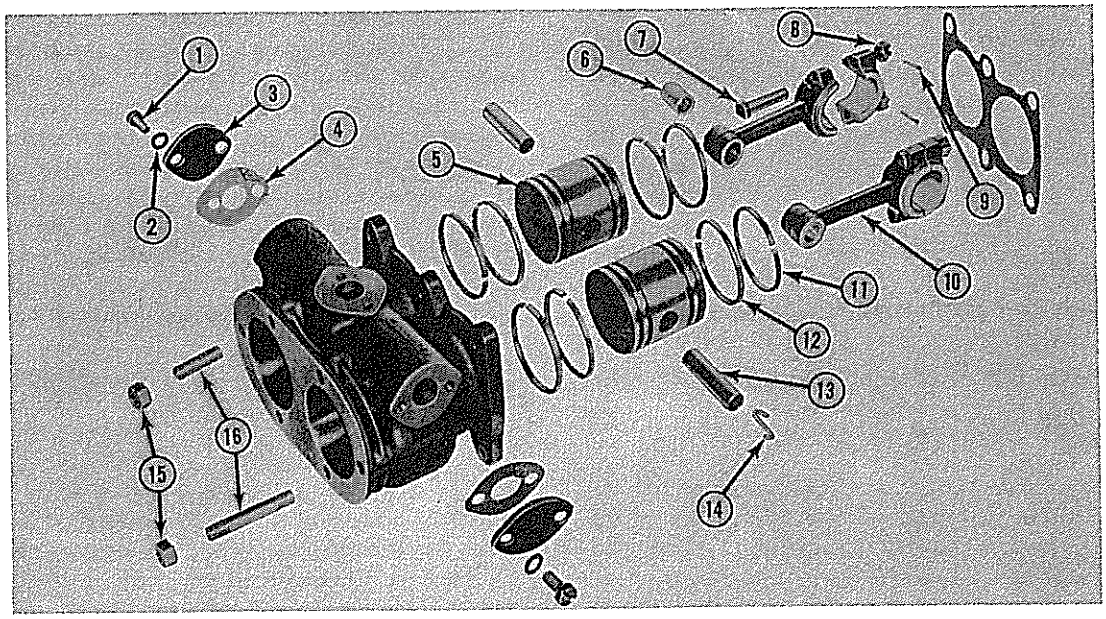


FIGURE B-16. CYLINDER BLOCK, EXPLODED

1. Capscrew
2. Lockwasher
3. Cover Plate
4. Gasket
5. Piston
6. Wrist Pin Bushing
7. Bolt
8. Nut
9. Cotter
10. Connecting Rod
11. Oil Ring
12. Compression Ring
13. Wrist Pin
14. Lockwire
15. Nut
16. Stud

Cleaning and Inspection of Parts

Clean all parts using cleaning solvent to remove all traces of dirt, oil and grease before inspection.

Put cylinder head body through a cleaning solvent to remove all carbon from discharge valve cavities and unloading valve cavity and to remove all rust and scale from water cavity. Use air pressure to blow dirt out of all cavities. Scrape carbon, dirt, and particles of oil gaskets from all surfaces.

Clean discharge valves (not worn excessively or damaged) by lapping them on a piece of crocus cloth on flat surface (Fig. B-18).

Clean thoroughly all oil passages through the crankshaft, connecting rods, crankcase, base plate and end covers. If necessary, probe oil passages with a piece of wire and flush with cleaning solvent.

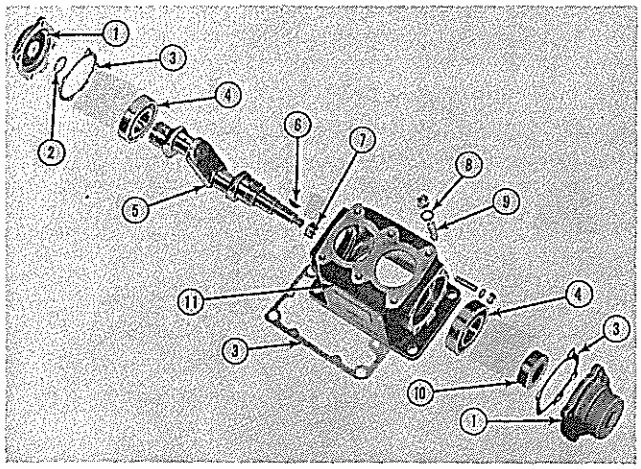


FIGURE B-17. CRANKCASE, EXPLODED

1. End Cover
2. Oil Ring
3. Gasket
4. Ball Bearing
5. Crankshaft
6. Key
7. Nut
8. Lockwasher
9. Stud
10. Oil Seal
11. Crankcase

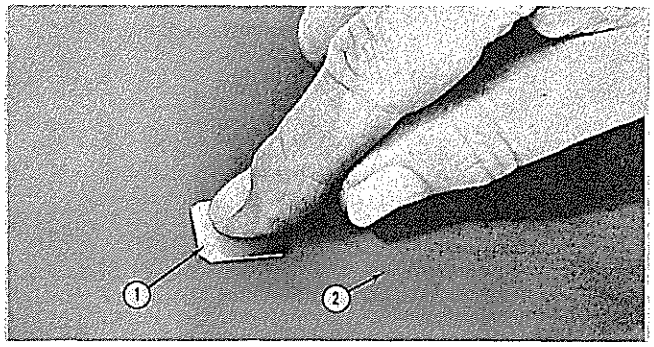


FIGURE B-18. LAPPING DISCHARGE VALVE

1. Discharge Valve
2. Lapping Plate

Put cylinder block through a cleaning solvent to remove all carbon and dirt from intake manifold and intake ports and to remove all rust and scale from water cavity.

All ball bearings must be washed thoroughly in cleaning solvent.

Inspect cylinder head body for cracks or breaks. Replace if any are found. Check condition of unloading diaphragm cavity in cylinder head. Replace cylinder head body if seat is pitted or damaged in any way.

Test water jacket, after cleaning, for leakage by using air pressure. This must be done by assembling the cylinder head body to the cylinder block. (The water jackets in both parts are checked at the same time.) Replace cylinder head body or the cylinder block if any leakage is found.

Check fit of unloading lever pin in unloading lever for excessive play. If pin or lever show signs of wear, either or both should be replaced.

Check unloading diaphragms and replace if any signs of wear or cracking are present. Check diaphragm seat on bottom of unloading box cover. Lap seat or replace cover if necessary.

Check condition of slot in unloading valve stems where the retaining washers contact the valve stems. Replace unloading valves if any evidence of wear is present. Check fit of unloading valve stems in unloading valve bushings. If excessive clearance is found, check unloading valve stems. Wear of the unloading valve stems must not exceed 0.002". This may be checked by comparing the diameter of the unloading valve stem and the unloading valve bushings, with the diameter of the stem where it does not engage the bushing. If there is excessive clearance between the unloading valves and the unloading valve bushings, or both must be replaced. If the unloading valve bushings are to be replaced, they may be removed by pressing them out through the top of the cylinder head.

Discard all used discharge valve springs and replace with new springs.

Inspect condition of discharge valves and discharge valve seats. If discharge valves are grooved deeper than 0.003" where they contact the seats, they should be replaced. If the discharge valve seats are worn excessively so there is no longer sufficient metal left to reclaim the seat by reaming, the cylinder head body should be replaced.

Check crankcase and end covers for cracks and broken lugs. Replace if any are found.

Check fit of oil seal ring in the ring groove. Ring must be a neat fit in the ring groove and have a 0.008" to 0.015" clearance at the gap when placed in the end bore of the crankshaft. Check lip of oil seal for wear. If worn thin or damaged, the oil seal must be replaced.

Check fit of bearings in crankcase. Bearings must be a light press fit. If the crankcase bearing bores are worn or damaged, the crankcase should be replaced.

A cylinder block with broken lugs or with cracks of any kind must be replaced.

Check cylinder bores for evidence of excessive wear, out-of-round, or scoring. Cylinder bores which are scored or out-of-round more than 0.003"

or tapered more than 0.003" should be rebored or honed oversize (Fig. B-19). Cylinder bores must be smooth, straight, and round and must be finished with a 320 grit hone. Clearance between pistons and cylinder blocks must be between 0.002" minimum and 0.004" maximum.

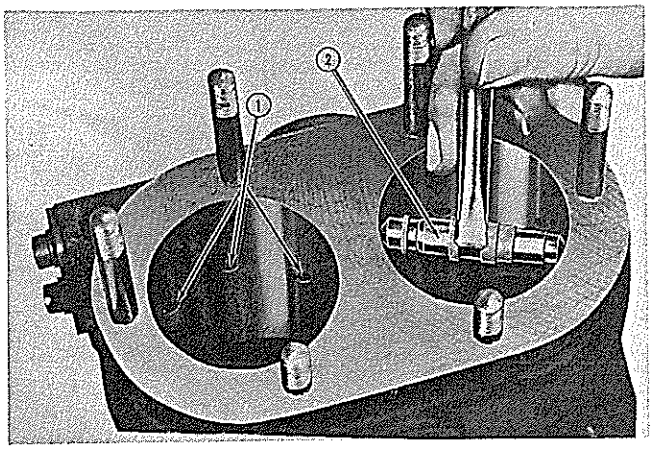


FIGURE B-19. CHECKING CYLINDER BORE
1. Intake Ports 2. Inside Micrometer

Inspect pistons for scores, cracks or damage of any kind. If scores or cracks are found, replace the piston. Check each piston with a micrometer in relation to the cylinder bore diameter to be sure the clearance is between 0.002" minimum and 0.004" maximum.

Check fit of piston rings in ring groove. The clearance between compression ring and ring groove and the ventilated oil ring and groove should be not less than 0.0015" nor more than 0.0025". Piston rings which have a gap of more than 0.0020" when positioned in the cylinder should be replaced (Fig. B-20). Clearance at the gap of new piston rings when installed in the cylinder must be not less than 0.010" nor more than 0.015".

Check fit of wrist pins in pistons and connecting rods. Wrist pins must be a light press fit in the pistons. If wrist pin is a loose fit in the piston, the wrist pin, piston, or both must be replaced. Check fit of wrist pin in connecting rod bushing by rocking the piston. If excessive clearance is apparent, replace wrist pin bushings in connecting rod. Wrist pin bushings should be reamed after being pressed in place. Discard all used wrist pin lockwires.

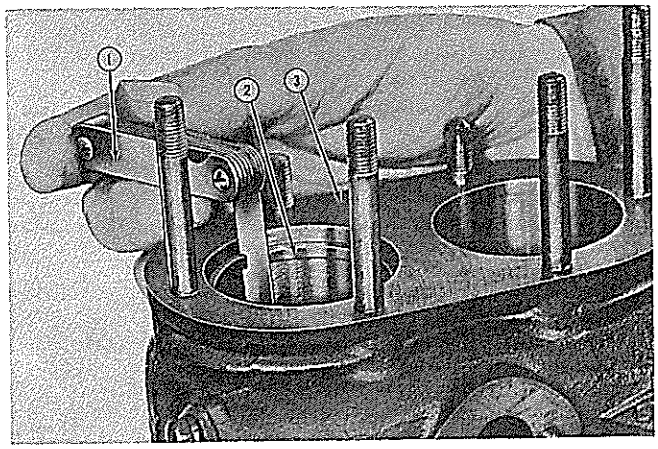


FIGURE B-20. CHECKING RING GAP
1. Feeler Gauge 2. Piston Ring 3. Cylinder Block

Inspect connecting rod bearings for proper fit on crankshaft journals. Also, check babbitt bearing for wear. If worn, cracked, or broken, the connecting rods must be re-babbitted or replaced. Clearance between the connecting rod journal and the connecting rod bearing must be not less than 0.001" and not more than 0.002".

Crankshaft journals which are more than 0.001" out-of-round or bruised must be reground. When regrinding, the fillets at the ends of the journals must be maintained. Connecting rods 0.010", 0.020", and 0.030" undersize are made for reground crankshafts. Screw threads, keyways, tapered ends and all ground and machined surfaces of the crankshaft must not be mutilated or excessively worn. Main bearing journals must not be worn too much to prevent the ball bearings being a light press fit. The oil seal ring groove in crankshaft must not be worn to prevent a good fit of the oil seal ring. Walls of the oil seal ring grooves must be square and have a good finish.

Check the ball bearings for wear or flat spots, if found, the bearings must be replaced.

Repairs

UNLOADING VALVES: Reseat unloading valves which are not too badly worn or pitted using grinding compound (grade 1000), reciprocating valve grinding tool, and driver (Fig. B-21). If the valve seats are badly pitted or worn, they must be reamed out. Valves must be ground to their seats and cleaned after grinding. After cleaning, install the unloading valves, unloading valve springs, spring seats, and retaining washers in the cylinder head (Fig. B-22), and test the unloading valves for leakage (Fig. B-23).

Test the unloading valves for leakage by clamping the cylinder head in a special fixture. Test with 100 pounds air pressure using soap suds.

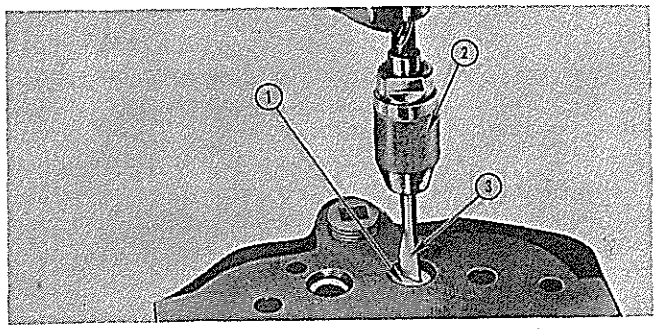


FIGURE B-21. RESEATING UNLOADING VALVES
1. Unloading Valve 2. Valve Grinding Tool
3. Driver Tool

Each unloading valve must be tested by applying soap suds to the exhaust port of the fixture while holding the other unloading valve down off its seat. Leakage in excess of a one inch soap bubble in three seconds for any one unloading valve is not permissible. If excessive leakage is found, again grind the leaking unloading valve to its seat.

DISCHARGE VALVES: If the discharge valve seats merely shown signs of slight scratches or are pitted, they can be reclaimed by using lapping

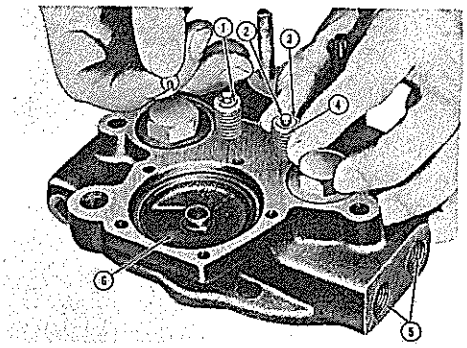


FIGURE B-22. INSTALLING UNLOADING VALVES

1. Retaining Washer
2. Unloading Valve
3. Unloading Valve Stop
4. Unloading Valve Spring
5. Water Connections
6. Unloading Diaphragm Cavity

discs or stone, driver and grinding tool. The valve seats must be cleaned after grinding.

After the discharge valves, discharge valve springs and cap nuts are installed, the discharge valve must be tested for leakage.

To test for leakage, apply 100 pounds air pressure through the discharge port of the cylinder head and apply soap suds to the discharge valve openings (Fig. B-24). Leakage in excess of a one inch soap bubble in one second is not permissible.

If excessive leakage is found, leave the air pressure applied and, using a fiber or hardwood dowel and a light hammer, tap the discharge valves off their seats several times to improve the seal between the valves and their seats. If the valves and valve seats have been reconditioned correctly, this will reduce the leakage.

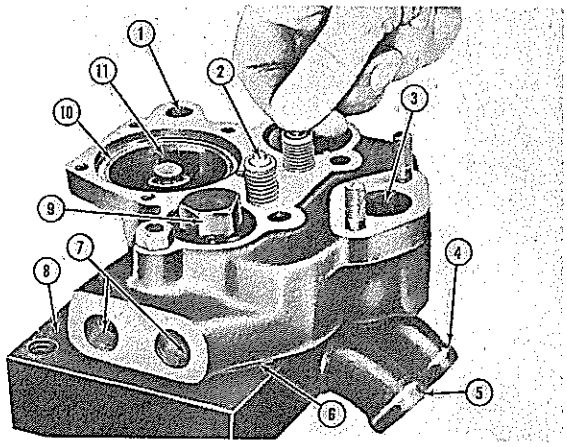


FIGURE B-23. TESTING UNLOADING VALVES

1. To Governor
2. Unloading Valve Stem
3. Discharge Port
4. Test For Leakage Here
5. Connect Air Supply Here
6. Gasket
7. Water Connections
8. Test Fixture
9. Discharge Valve Cap Nut
10. Seat
11. Unloading Diaphragm Cavity

Leakage tests must also be made by applying soap suds around the top of the discharge valve cap nuts. Leakage here must not exceed a one inch soap bubble in five seconds.

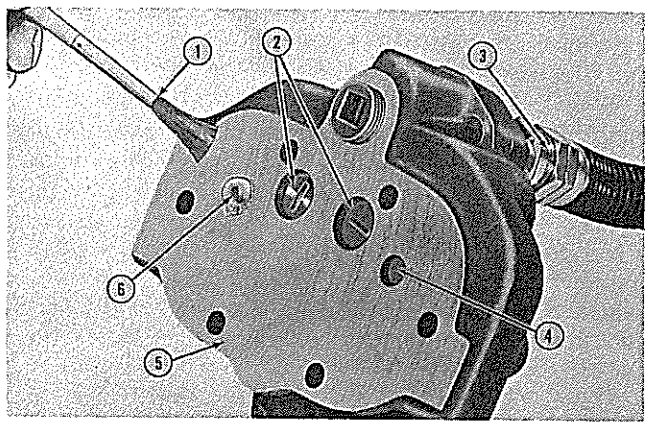


FIGURE B-24. CHECKING DISCHARGE VALVES

1. Brush
2. Unloading Valves
3. Discharge Port
4. Discharge Valve
5. Cylinder Head
6. Discharge Valve

Assembly

INSTALLING CYLINDER BLOCK: Place new cylinder block gasket in position over crankcase studs. Position cylinder block on crankcase in accordance with markings made before disassembly. Install nuts securing block to crankcase.

INSTALLING CRANKSHAFT: If the crankshaft is fitted with oil seal rings, install rings.

Position ball bearings and crankshaft in crankcase. Be sure the drive end of the crankshaft is positioned at the end of the crankcase which was marked with one punch mark before disassembly. If one end of crankshaft is counter-bored for holding bearing, be sure the crankshaft is entered through the correct end of the crankcase. Carefully press crankshaft and bearings into crankcase (Fig. B-24).

Install oil seal ring. Then position rear end cover over studs in crankcase being sure that the oil hole in the rear end cover lines up with the oil hole in the gasket and crankcase. Install nuts securing the end cover in place. Install pipe plugs in end cover oil openings which are not in use.

If front end cover oil seal has been removed from the end cover, press a new oil seal into the end cover. Install a new gasket. Carefully position the front end cover so as not to damage the oil seal and install nuts securing end cover in place.

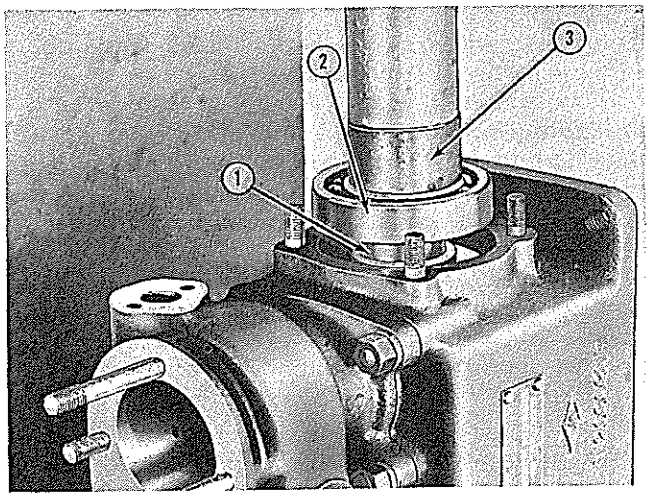


FIGURE B-25. INSTALLING CRANKSHAFT

1. Collar
2. Bearing
3. Crankshaft

ASSEMBLING PISTONS AND CONNECTING RODS: If wrist pin bushings have been removed from connecting rods, press new bushings into place making sure that the oil holes in the bushing line up with the oil holes in the connecting rods. Bushings must then be reamed, honed, or bored to provide between 0.005" and 0.001" clearance on the wrist pin. Position connecting rod in piston and press wrist pin into position. Keep lock wire hole in pin aligned with lockwire hole in piston. Install new wrist pin lockwire in wrist pin so that the end of the wire engages the hole in the piston. Do not use pistons in which the wrist pin is loose.

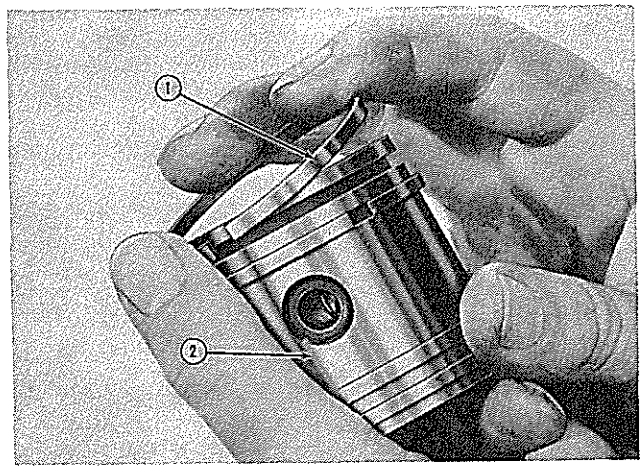


FIGURE B-26. INSTALLING PISTON RINGS

1. Piston Ring
2. Piston

Install piston rings by hand (Fig. B-26). Five rings are used in each piston and they must be installed in their proper location. Careful inspection is necessary to determine which side of the tapered ring has the largest diameter. Tapered oil rings are marked with a small diamond shaped trademark on the top side of the ring opposite the gap and must be installed with the trademark side of the ring toward the top of the piston. Compression rings are marked with a small diamond shaped trademark near the gap in the ring and can be installed with either side toward the top of the piston. Stagger the position of the gaps in the rings. See Figure B-27.

Before installing pistons and connecting rods, thoroughly lubricate pistons, piston rings, wrist pin

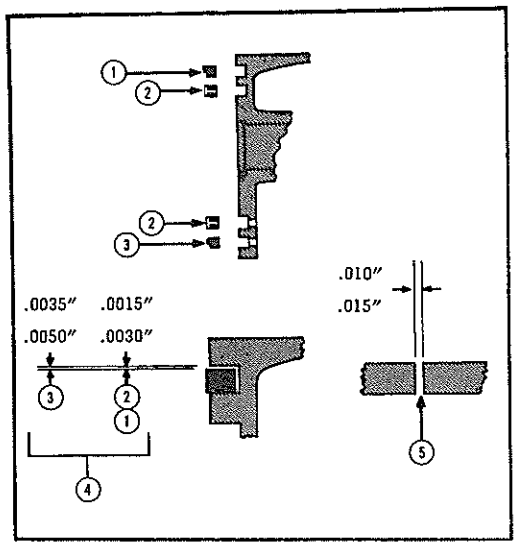


FIGURE B-27. PISTON RING POSITIONS

1. Compression Ring
2. Ventilated Oil Ring
3. Scraper Oil Ring
4. Correct Groove Clearance
5. Correct Gap Clearance in Cylinder

bearings, and connecting rod bearings with clean engine oil.

Turn crankshaft until No. 1 crankshaft journal is down. Remove bearing cap from No. 1 connecting rod leaving connecting rod bolts in the rod. Connecting rods are installed so that the center punch

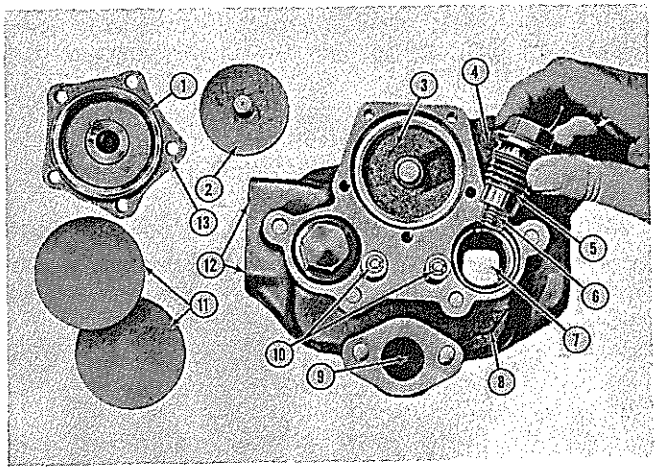


FIGURE B-28. POSITIONING DISCHARGE VALVES

1. Diaphragm Seat
2. Diaphragm Follower
3. Unloading Diaphragm Cavity
4. Diaphragm Cavity Port
5. Valve Cap Nut
6. Spring
7. Discharge Valve
8. Cylinder Head
9. Discharge Port
10. Unloading Valves
11. Unloading Diaphragms
12. Water Connections
13. Unloading Box Cover

markings on the connecting rods face the same side of the compressor as when disassembled.

Insert No. 1 connecting rod and piston through the top of No. 1 cylinder making sure the connecting rod bearing engages the connecting rod journal in the same position as that in which it was fitted.

Position and attach lower bearing cap to connecting rod and install two slotted nuts and cotter pins.

Install other piston and connecting rod in the same manner.

ASSEMBLING AND INSTALLING CYLINDER HEAD. If the unloading valve bushings have been removed, press new bushings into place, from the top of the cylinder head. Unloading valve bushings must be reamed after being pressed into place.

Insert each unloading valve into cylinder head body from bottom side. Place wooden block or nut under valve to keep it in position. Install unloading valve spring over each unloading valve and place unloading valve stop over each spring. Then compress each unloading valve spring by hand until spring retaining ring can be inserted over stop. (Fig. B-22).

Position each discharge valve on its seat through the opening in the top of the cylinder head as illustrated in Fig. B-28. Then position discharge valve spring and discharge valve cap nut by inserting them in cylinder head body over discharge valve. Tighten each discharge valve nut cap.

Position two unloading diaphragms in unloading diaphragm cavity in top of cylinder head body after lubricating the diaphragms with a thin coating of light engine oil. Place diaphragm follower in position on diaphragms with post upward. Place unloading box cover in position over diaphragm following post. Attach unloading box cover to cylinder head body with machine screws and lockwashers. Tighten all machine screws gradually and evenly.

Check for leakage past the unloading diaphragms by applying 100 pounds air pressure through the unloading diaphragm cavity port and applying soap suds all over the unloading box cover. Leakage in excess of a one inch soap bubble in three seconds is not permissible.

Place unloading lever spring in position on the unloading box cover and unloading lever. Install over spring. Insert unloading lever pin through unloading box cover and unloading levers. Install cotter pin in the ends of unloading lever pin.

Turn adjusting screws in unloading lever until clearance between the head of the adjusting screws and the end of the unloading valves is 0.010" minimum and 0.015" maximum. Tighten locknut when desired clearance is obtained. If there is too much clearance at this point, the unloading valves may not be opened sufficiently to unload the compressor. If there is no clearance, the unloading valves may be held open continuously and the compressor will not compress air.

Install a new cylinder head gasket. Position cylinder head on cylinder block in accordance with markings made before disassembly and install and tighten nuts on cylinder head studs.

INSPECTION OF REBUILT UNIT: Check to be sure all threaded openings to oil passages, such as may be found in the end covers or base plate, are properly plugged.

If the compressor is not to be installed immediately on a machine, plug the air connection to the unloading mechanism and the water connection to the cylinder head and cylinder block. Protect the discharge port against the entrance of dirt by fitting it with a temporary blanking cover.

Fit the ends of all the crankshafts with cotter pins, nuts and keys when such parts are required and then protect against damage during handling by wrapping with friction tape or some other similar material.

The unloading lever and valve mechanism must be well lubricated with lubricating oil.

Protect the open bottom against the entrance of dirt during handling or storage by installing a temporary cover.

Installation

Clean oil supply line to compressor and, if possible, run engine a few seconds to be sure the oil supply to compressor is flowing freely.

Clean oil return line and passage to be sure oil can return from the compressor to the engine crankcase.

Lubricate compressor cylinder walls and bearings with lubricating oil before placing compressor in position.

Inspect bore and keyways of pulley for wear or damage. Pulley must be a neat fit on the compressor crankshaft. Replace pulley if bore or keyway is damaged or worn.

Install pulley on compressor crankshaft being sure it properly contacts the shaft and does not ride the key. Tighten crankshaft nuts securely and install cotter.

Clean or replace any dirty air or water lines before connecting them to the compressor. Always use a new discharge fitting gasket.

Align compressor drive if necessary and tighten mounting bolts securely and evenly. Adjust belt tension (refer to Section K). Then, with compressor running, check for noisy operation and oil, water, or air leaks. Check the unloading valve for clearance. Test air system for serviceability.

NOTE: When connecting air inlet line to compressor, care should be taken not to crush fiber washer. Damage to washer may result in compressor pumping oil into the air tank.

TU-FLO 400
Operation

The compressor runs continuously while the engine is operating. However, the actual compression of air is controlled by a governor which, acting in conjunction with the unloading mechanism in the compressor cylinder block, starts or stops the compression of air by loading or unloading the compressor when the air pressure in the system reaches the desired minimum (90 pounds) or maximum (120 pounds) respectively.

COMPRESSING AIR: During the downstroke of each piston, a partial vacuum is created above the piston which unseats the inlet valve. Air then enters the cylinders above the piston after passing through the air cleaner, the intake manifold, and the intake ports.

As each piston begins its upstroke the air pressure on top of the inlet valve, plus the inlet valve return spring force, closes the inlet valve and air which has entered the cylinder is trapped above the piston. As the piston continues its upstroke, the air above the piston is compressed until the pressure lifts the discharge valve and the compressed air is discharged through the discharge line into the air tank.

As each piston starts its downstroke, the discharge valve above it returns to its seat preventing the compressed air from returning to the cylinder, and the same cycle is repeated.

NOT COMPRESSING AIR: When the air pressure in the air tank reaches the maximum setting of the governor, compressed air from the air tank passes through the governor into the cavity under the unloading pistons in the compressor cylinder block. This air pressure lifts the unloading pistons which in turn lift the inlet valves off their seats.

With the inlet valves held off their seats, the unloading cavity forms a passage between the cylinders above the pistons. Thus during the upstroke of each piston air merely passes back and forth through this passage and compression is stopped. When the air pressure in the air tank drops to the minimum setting of the governor, the governor releases the air pressure from beneath the unloading pistons. The unloading piston return springs then force the pistons down and the inlet valve springs return the inlet valves to their seats and compression is resumed.

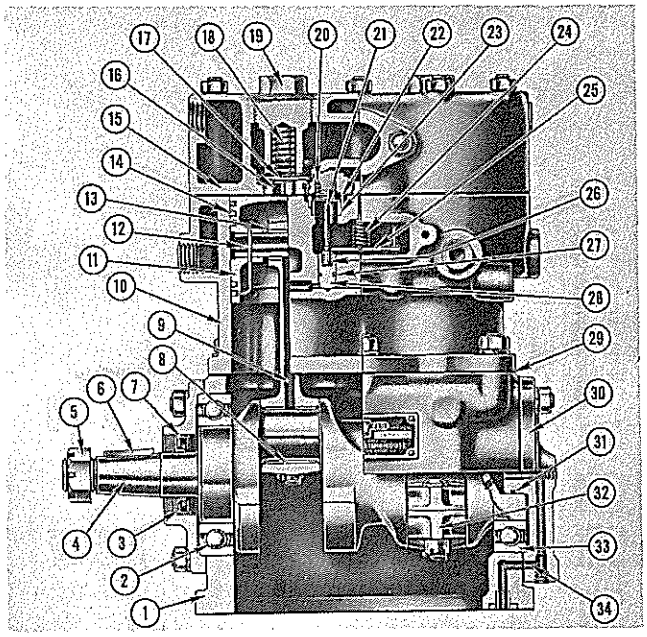


FIGURE B-29. TU-FLOW AIR COMPRESSOR

1. Crankcase
2. Bearing
3. Oil Seal
4. Crankshaft
5. Nut
6. Key
7. Front End Cover
8. Bearing Insert
9. Connecting Rod
10. Cylinder Block
11. Piston
12. Wrist Pin
13. Bushing
14. Piston Ring
15. Cylinder Head
16. Discharge Valve Seat
17. Discharge Valve
18. Discharge Valve Spring
19. Discharge Valve Cap Nut
20. Inlet Valve Spring
21. Inlet Valve
22. Inlet Valve Guide
23. Inlet Valve Seat
24. Unloader Spring
25. Unloader Spring Saddle
26. Unloader Plunger
27. Grommet
28. Unloader Piston
29. Gasket
30. End Cover
31. Oil Seal Ring
32. Cap
33. Bearing
34. Lube Oil Passage

Disassembly

Remove all grease or dirt from the exterior of the compressor by scraping. If necessary use cleaning solvent and a brush.

The cylinder head, cylinder block and crankshaft of many compressors are designed so that the compressor can be assembled in several different ways to meet the installation requirements. In order to insure correct reassembly, such parts should be marked before disassembly where necessary to show their correct position in relation to each other. This can be done best by making center punch marks in the related parts to act as guides during assembly.

The following parts should be marked:

Position of cylinder head in relation to cylinder block.

Position of air intake fitting in relation to cylinder block.

Position of cylinder block in relation to crankcase.

Position of front and end cover (drive end of crankcase) in relation to the crankcase. (Make one punch mark on each.)

Position of rear end cover in relation to the crankcase. (Make two punch marks on each.)

Marking the crankcase with one punch mark at the drive end will permit the crankshaft to be positioned properly in the crankcase during assembly.

Remove nuts from all cylinder head studs and lift off cylinder head. The cylinder head may have to

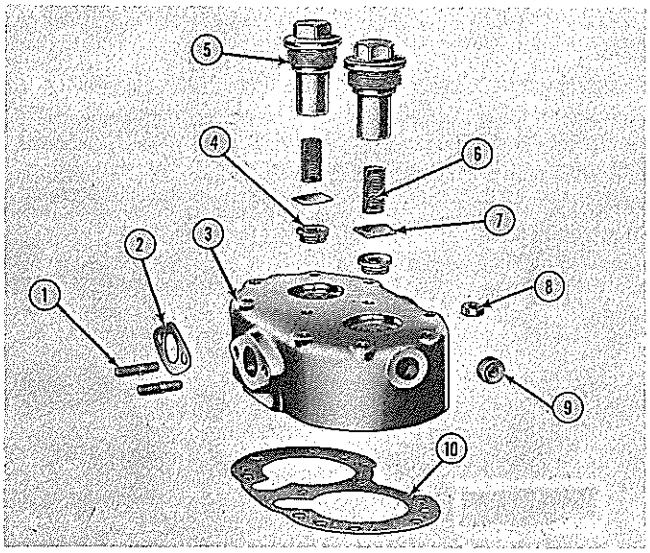


FIGURE B-30. CYLINDER HEAD, EXPLODED

1. Stud
2. Gasket
3. Cylinder Head
4. Discharge Valve Seat
5. Discharge Valve Cap Nut
6. Discharge Valve Spring
7. Discharge Valve
8. Nut
9. Pipe Plug
10. Head Gasket

be tapped lightly with a rawhide hammer to break the gasket seal.

Scrape cylinder head gasket off cylinder head and block.

Remove cotter pins and slotted nuts from bolts securing connecting rod bearing caps to the connecting rods. Lift out connecting rod bearing caps. Then push pistons, with connecting rods attached, out the top of the cylinder block. Replace caps on each connecting rod. They are already marked with center punch marks to show the proper position of the caps.

Remove piston rings from each piston. If the pistons are to be removed from connecting rods, remove wrist pin lockwires from each wrist pin and press wrist pins from pistons and connecting rods.

Remove nuts from studs securing front or drive end cover to crankcase. Remove end cover with oil seal and gasket. If oil seal needs replacing, remove it from end cover.

Remove nuts from studs securing rear end cover to crankcase. Remove end cover, oil seal ring and gasket.

Some crankcases are fitted with a shoulder. This positions the crankshaft in the crankcase. In such cases the crankshaft may be removed only through one end of the crankcase. Press crankshaft and ball bearings out of the crankcase, then press ball bearings off crankshaft.

When cylinder head is removed from cylinder block, the inlet valve springs and inlet valves should be removed.

Remove nuts securing cylinder block to crankcase and remove cylinder block and gasket.

Remove unloader spring and the unloader spring seat.

Remove unloader spring saddle, unloader plungers, and unloading pistons. Remove unloader piston grommets. Remove inlet valve seat bushing only if they are worn.

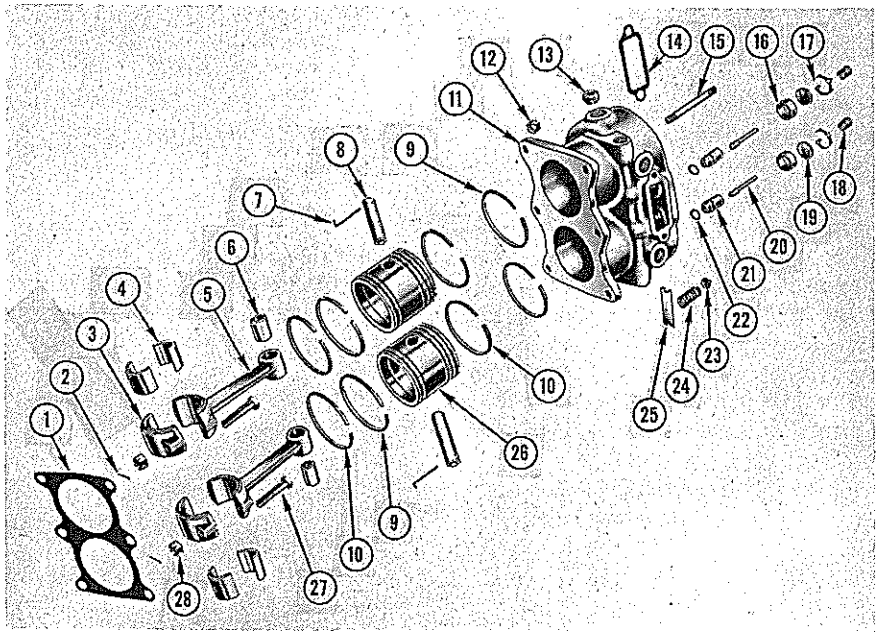


FIGURE B-31. CYLINDER BLOCK, EXPLODED

1. Gasket
2. Cotter
3. Rod Bearing Cap
4. Bearing Insert
5. Connecting Rod
6. Bushing
7. Lockwire
8. Wrist Pin
9. Piston Ring (Narrow)
10. Piston Ring (Wide)
11. Cylinder Block
12. Nut
13. Pipe Plug
14. Gasket
15. Stud
16. Inlet Valve Body
17. Inlet Valve Guide
18. Inlet Valve Spring
19. Inlet Valve
20. Unloader Plunger
21. Unloader Piston
22. Grommet
23. Unloader Spring Seat
24. Unloader Spring
25. Unloader Spring Saddle
26. Piston
27. Bolt
28. Nut

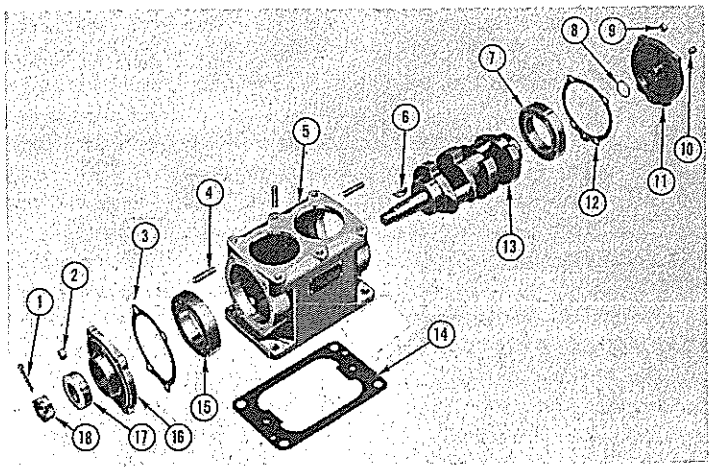


FIGURE B-32. CRANKCASE, EXPLODED

1. Cotter	4. Stud	7. Bearing	10. Pipe Plug	13. Crankshaft	16. End Cover (Front)
2. Nut	5. Crankcase	8. Oil Seal Ring	11. End Cover (Rear)	14. Gasket	17. Oil Seal
3. Gasket	6. Key	9. Nut	12. Gasket	15. Bearing	18. Nut

Cleaning and Inspection of Parts

Clean all parts thoroughly using cleaning solvent to remove all traces of dirt, oil and grease before inspection.

Put cylinder head body through a cleaning solution to remove all carbon from discharge valve cavity and to remove all rust and scale from water cavity. Use air pressure to blow dirt out of all cavities. Scrape carbon, dirt, and particles of old gaskets from all surfaces.

Clean discharge valves (not worn excessively or damaged) by lapping them on a piece of crocus cloth on a flat surface.

All ball bearings must be washed thoroughly in cleaning solvent. Inspect cylinder head body for cracks or breaks. Replace if any are found.

Test water jacket after cleaning for leakage, using air pressure. This must be done by assembling the cylinder head to the cylinder block. The water jackets in both parts are checked at the same time. Replace cylinder head body or the cylinder block if any leakage is found.

Discard all used discharge valve springs and replace with new ones.

Inspect condition of discharge valves and discharge valve seats. If discharge valves are grooved deeper than 0.003" where they contact the seats, they should be replaced. If the discharge valve seats are worn excessively so there is no longer sufficient metal left to reclaim the seat by using a lapping stone, the cylinder head body should be replaced.

Check crankcase and end covers for cracks and broken lugs. Replace if any are found.

Check fit of oil seal ring in the ring groove. Ring must be a neat fit in the ring groove and have 0.008" to 0.015" clearance at the gap when placed in the end bore of the crankshaft. Check lip of oil seal for wear. If worn thin or damaged, the oil seal must be replaced.

Inspect oil ring groove in end cover. If ring wear has formed a step pattern in the groove replace end cover or machine groove for next oversize oil seal ring.

Check fit of ball bearings in crankcase. Bearings must be a finger press fit. If the crankcase bearing bores are worn or damaged, the crankcase should be replaced.

A cylinder block with broken lugs or with cracks of any kind must be replaced.

Check fit of unloading pistons and piston grommets in cylinder block for excessive wear. New grommets should be installed, after which the unloading pistons should be a neat sliding fit in their bores.

The bores must not be scratched or damaged in any way which might accelerate grommet wear. Check the unloading piston return spring for permanent set. If the spring does not have sufficient tension to return the unloader piston to the unloader position, replace the spring.

Inspect condition of inlet valve and seats. If inlet valves are grooved deeper than 0.003" where they contact the seat they should be replaced. If the inlet valve seats are worn or damaged so that they cannot be reclaimed by facing or lapping, seats should be replaced.

Check cylinder bores for evidence of excessive wear, out-of-round, or scoring. Cylinder bores which are scored or out-of-round more than 0.002" or tapered more than 0.003" should be rebored or honed oversize. Oversize pistons are available 0.010", 0.020" or 0.030" oversize. Cylinder bores must be smooth, straight, and round and must be finished with a 320 grit hone. Clearance between pistons and cylinder bores must be 0.002" minimum and 0.004" maximum.

Inspect pistons for scores, cracks or damage of any kind. If scores or cracks are found, replace the

piston. Check each piston with a micrometer in relation of the cylinder bore diameter to be sure the clearance is between the 0.002" minimum and 0.004" maximum.

Check fit of piston rings in the ring grooves. Clearance between the ring and ring groove should be not less than 0.0015" nor more than 0.0030". Clearance at the gap of new piston rings when installed in the cylinder must not be less than 0.007" nor more than 0.019".

Check fit of wrist pins in pistons and connecting rods. Wrist pins must be a light press fit in the pistons. Check the fit of wrist pin in connecting rod bushing by rocking the piston. If excessive clearance is apparent, replace wrist pin bushings in connecting rod. Wrist pin bushings should be reamed after being pressed in place. Discard all used wrist pin lock wires.

Inspect connecting rod bearings for proper fit on crankshaft journals. Also check connecting rod bearings for wear. If worn, cracked or broken, the inserts must be replaced.

Connecting rod caps are not interchangeable. Position the caps so that the two locking slots are both located adjacent to the same capscrew.

Clearance between the connecting rod journals and the connecting rod bearing must be not less than 0.0003" or more than 0.0021" after rebuilding compressor.

Crankshaft journals which are more than 0.001" out-of-round or bruised must be reground. When regrinding, the fillets at the ends of the journals must be maintained. Connecting rods 0.010", 0.020" and 0.030" undersize are made for reground crankshafts. Screw threads, keyways, tapered ends and all ground and machined surfaces of the crankshaft must not be mutilated or excessively worn. Main bearing journals must not be worn too much to prevent the ball bearings from being a tight press fit. The oil seal ring groove in the crankshaft must not be worn so as to prevent a good fit of the oil seal ring. Walls of the oil seal ring grooves must be square and have a good finish.

Check the ball bearings for wear or flat spots. If found, the bearings must be replaced.

Repairs

DISCHARGE VALVES AND SEATS: If discharge valve seats merely show signs of slight scratches, they can be reclaimed by using a lapping stone, grinding compound, lapping disc, grinding tool and driver. If seats cannot be reclaimed, install new seats. After installing new discharge valves, discharge valve springs and discharge valve cap nuts, the discharge valve travel should be between 0.036" and 0.058".

To test for leakage apply 100 pounds of air pressure through the discharge port of the cylinder head and apply soap suds to the discharge valve openings in the floor of the cylinder head. Leakage should not exceed a one inch soap bubble in not less than five seconds.

If excessive leakage is found, leave the air pressure applied and using a fibre or hardwood dowel and light hammer, tap the discharge valves off their seats several times to improve the seal between the valves and their seats. If the valves and valve seats have been reconditioned properly this will reduce the leakage.

Leakage tests must also be made by applying soap suds around the discharge valve cap nuts, with air pressure applied as above. Leakage at cap nuts is not permissible.

INLET VALVES AND SEATS: If inlet valve seats show signs of slight scratches or wear they can be reclaimed by using a lapping stone, grinding compound, lapping disc, and valve grinding tool. If the seats cannot be reclaimed in this manner, they should be replaced. The dimensions from the top of the cylinder block to the inlet valve seat should not exceed 0.145". After installing new seats, the dimension should be 0.101" to 0.113".

Inlet valves not worn excessively or damaged, can be reclaimed by lapping them on a piece of crocus cloth on a flat surface.

UNLOADER PISTONS: The grommet or "O" ring in the unloader piston should be replaced. Be careful in reinstalling the unloader piston in the bore so that the grommet is not damaged or cut. When reinstalled the piston should be a neat sliding fit in its bore. It may be necessary to use air pressure, WITH CAUTION, at the governor port of the cylinder block to remove the unloader piston for inspection, after removing the unloader plunger and associated parts.

After assembly, unloader pistons should be tested by application of 100 pounds air pressure through governor line port. When coating unloader pistons with soap suds, leakage should not exceed a ½" soap bubble in not less than 5 seconds.

Assembly

INSTALLING CYLINDER BLOCK: Place new cylinder block gasket in position over crankcase studs. Position cylinder block on crankcase in accordance with marking made before disassembly. Install nuts securing block to crankcase.

INSTALLING CRANKSHAFT: If the crankshaft is fitted with oil seals, install rings.

Position ball bearings and crankshaft in the crankcase. Be sure the drive end of crankshaft is positioned at the end of the crankcase which was marked with one punch mark before disassembly. If one end of the crankcase is counterbored for holding bearing, be sure the crankshaft is entered through the correct end of the crankcase. Careful-

ly press crankshaft and bearings into crankcase.

Install oil seal ring. Then position rear end cover gasket over studs on rear of crankcase being sure that the oil hole in the rear end cover lines up with the oil hole in the gasket and crankcase. Install nuts securing the end cover in place. Install pipe plugs in end cover oil openings which are not in use.

If front end cover oil seal has been removed from the end cover, press a new oil seal into the end cover. Install a new gasket. Carefully position the front end cover so as not to damage the oil seal and install nuts securing end cover in place.

ASSEMBLING PISTONS AND CONNECTING RODS: If wrist pin bushings have been removed from connecting rods, press new bushings into place making sure that the oil holes in the bushings line up with the oil holes in the connecting rods. Bushings must then be reamed, honed, or bored to provide between 0.0001" to 0.0006" clearance on the wrist pin. Position connecting rod in piston and press wrist pin into position. Keep lock wire hole in pin aligned with lockwire in wrist pin so that the end of the wire engages the hole in the piston. Do not use pistons in which the wrist pin is loose.

Install piston rings by hand. Four rings are used in each piston and they must be installed in their proper location. Careful inspection is necessary to determine which side of the tapered oil ring has the largest diameter. Tapered oil rings are marked with a small diamond shaped trademark on the top side of the ring opposite the gap and must be installed with the trademark side of the ring toward the top of the piston. Compression rings are marked with a small diamond shaped trademark near the gap in the ring and can be installed with either side toward the top of the piston. Stagger the position of the gaps in the rings.

Before installing pistons and connecting rods, thoroughly lubricate pistons, piston rings, wrist pin bearings, and connecting rod bearings with clean engine oil.

Turn crankshaft until No. 1 crankshaft journal is down. Remove bearing cap from No. 1 connecting rod leaving connecting rod bolts in the rod. Connecting rods are installed so that the center punch markings on the connecting rods face the same side of the compressor as when disassembled.

Insert No. 1 connecting rod and piston through top of No. 1 cylinder making sure the connecting rod bearing engages the connecting rod journal in the same position as that in which it was fitted.

Position and attach lower bearing cap to connecting rod. The cap is in the correct position when the two locking slots in the inserts and in the rod and cap are both located adjacent to the same connecting rod. Install two slotted nuts and cotters.

Install other piston and connecting rod in the same manner.

ASSEMBLING AND INSTALLING UNLOADER PISTON. Lubricate the unloader piston cavity in the cylinder block and also the unloader piston and unloader piston grommet with clean engine oil. Install unloader piston grommet on unloader piston. Install unloader pistons and unloader plungers through the top of the cylinder block taking care to avoid cutting the unloader piston grommets on the block. Install unloader spring saddle on unloader plungers. Install spring seat in top of cylinder block strainer opening and place unloader spring between spring guide and spring saddle. Install inlet valve guides if they have been previously removed.

ASSEMBLING AND INSTALLING CYLINDER HEADS. Install discharge valves in the cylinder head. Install discharge valve spring and discharge valve cap nut.

Install inlet valves and inlet valve springs in cylinder block. Place new cylinder head gasket on block. Carefully align inlet valve springs with inlet valve guides in cylinder head and secure head to block by tightening cylinder head nuts evenly.

Inspection and installation for this type air compressor is the same as for the Type "U" air compressor. See page B-12.

AIR COMPRESSOR GOVERNOR

The air compressor governor has been inserted into the air supply system to control the amount of air contained in the reservoir tank.

Although compressor runs continuously during engine operation, actual compression of air takes place only when the air tank pressure falls below minimum requirement. After pressure has again been built up to the maximum setting, the governor acting in conjunction with the compressor unloading mechanism halts further compression of air.

Removal and Disassembly

Bleed the air from the air supply tank. Disconnect line at side of governor. Unscrew the governor from the pipe fitting on the top of the air supply tank. Release the nut which locks the adjusting screw in place and then back out screw from sleeve (Fig. B-33).

Lift spring and plunger from sleeve (Fig. B-34). Loosen the sleeve collar until it is entirely free of the governor body, permitting removal of sleeve

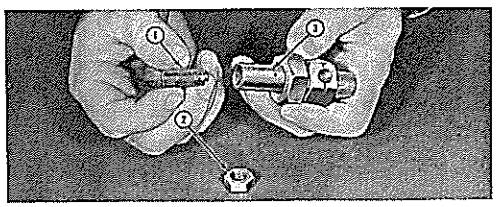


FIGURE B-33. REMOVING ADJUSTING SCREW

1. Adjusting Screw 2. Locknut 3. Sleeve

(Fig. B-35).

The end of the sleeve is a snug fit in the governor body but can be removed by hand. Sleeve must not be pried or forced free of its seat. After sleeve has been removed, exposed ball check and shim may then be removed (Fig. B-36).

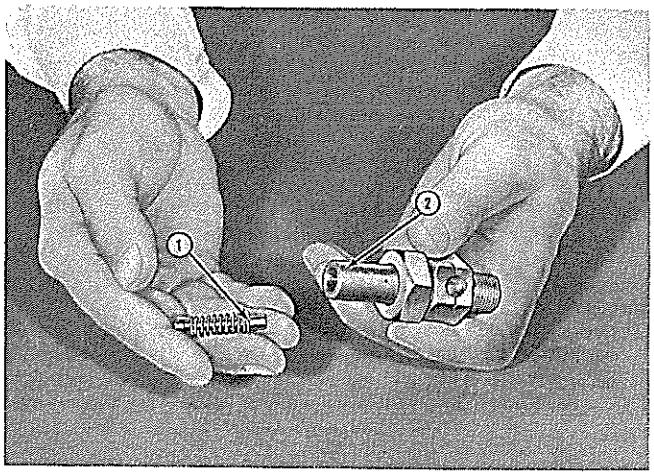


FIGURE B-34. REMOVING SPRING AND PLUNGER

1. Spring and Plunger
2. Sleeve

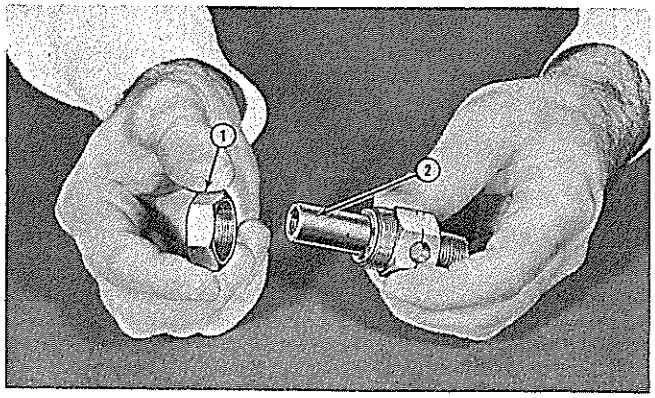


FIGURE B-35. REMOVING COLLAR

1. Collar
2. Sleeve

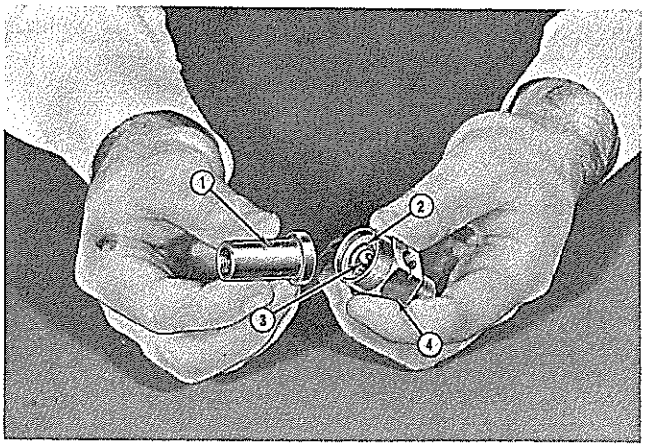


FIGURE B-36. SLEEVE REMOVED

1. Sleeve
2. Shim
3. Ball Check
4. Governor Body

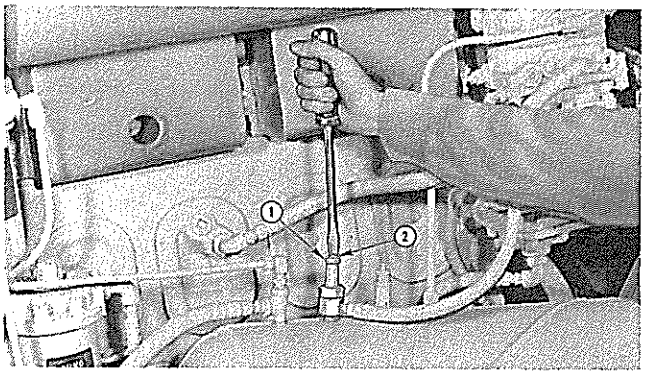


FIGURE B-37. ADJUSTING GOVERNOR

1. Locknut
2. Adjusting Screw

Reassembly

Replace ball check and shim in governor body.

Fit sleeve into governor body.

Place collar over sleeve and screw down on the governor body.

Replace spring, and plunger into sleeve with the largest end of the plunger toward the ball check.

Replace adjusting screw and locknut.

Adjustment

Re-install the governor on the machine. Do not connect line to the compressor unloader. Operate the engine until the air pressure in the supply tank reaches the maximum setting (120 p.s.i.). Refer to air pressure gauge on instrument panel for air pressure. The valve should open at this point and exhaust air through the port in the side of the governor body.

If air should exhaust before the limit is reached, loosen locknut and screw in the adjusting screw. If air exhausts after the proper pressure is reached, screw the adjusting screw out, releasing some of the spring pressure against the ball. When the proper adjustment has been obtained, lock the adjusting screw into place with the locknut. See Fig. B-37.

QUICK RELEASE VALVE

The purpose of the quick release valve is to reduce the time required to release the brakes by hastening the exhaust of air pressure from the brake diaphragm.

The valve consists of a body containing a spring loaded diaphragm so arranged as to permit air pressure to flow through the valve in one direction but, when the supply pressure is reduced, the air which has passed through the valve is permitted to escape through the exhaust port.

The quick release valve assumes three positions during normal operation. These three positions are:

the applying position, when air pressure is passing through the valve into the brake; the holding position, when pressure is held in the brake; and the releasing position, when the brake is being exhausted.

When air pressure from the brake valve enters the top connections of the valve, the diaphragm moves down and closes the exhaust port. Air pressure then deflects the outer edges of the diaphragm downward and flows out the side connections to the brakes.

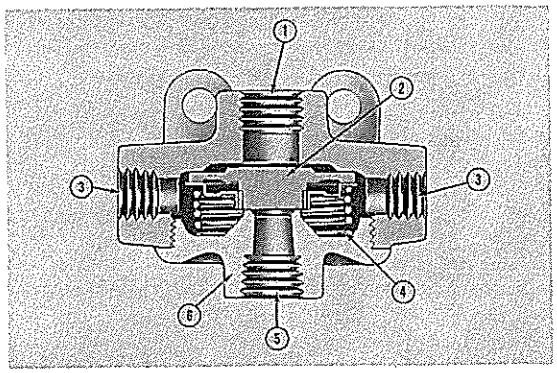


FIGURE B-38. QUICK RELEASE VALVE, SECTIONAL

1. Inlet Port
2. Diaphragm
3. Outlet
4. Spring
5. Exhaust
6. Cover

As soon as the brake chamber pressure below the diaphragm equals the brake valve pressure above the diaphragm, the force of the spring below the diaphragm forces the outer edge of the diaphragm back up against the body, although the center of the diaphragm keeps the exhaust port closed. This is the holding position.

If the brake valve pressure on top of the diaphragm is released, the brake chamber pressure below the center of the diaphragm raises it, then opens the exhaust port and permits the brake air pressure to be released through the exhaust port.

If the brake valve pressure on top of the diaphragm is only partially released, the diaphragm assumes its holding position as soon as the pressures above and below it are equalized.

In this manner, the quick release valve reacts to pass any increased brake valve pressure through it to the brakes, or quickly releases the brake air pressure when the brake valve pressure is reduced and thus maintain the same pressure in the brakes as the brake valve is delivering.

Removal and Disassembly

The machine is equipped with a quick release valve for each wheel brake.

On the Tournapull the valves are mounted on the main case. The trail unit valves are mounted on the frame near the wheels.

To remove the quick release valve, disconnect the tubing, remove the two capscrews and remove the valve from the machine.

Remove all dirt and grease from exterior of the valve using cleaning solvent and a brush.

Unscrew the cover, lift out diaphragm spring, diaphragm spring seat, and diaphragm.

Inspect exterior of valve for broken or damaged parts. All broken or damaged parts must be replaced.

Examine all metal parts and wash in cleaning solvent.

Examine diaphragm for signs of cracking, wear or damage. Carefully examine the lower face of the diaphragm which contacts the exhaust port seat in the cover for sign of pitting or grooving. Replace diaphragm if any of these conditions are found.

Reassembly

To reassemble quick release valve, install diaphragm into diaphragm spring seat. Replace the diaphragm spring and seat into body.

Install valve on machine, reconnect air lines.

With brake applied, coat the exhaust port with soap suds to detect leakage. Leakage in excess of a one inch soap bubble in one second is not permissible.

AIR TANK

The air tank is located on the right side of the Tournapull front case.

A bleeder valve is located on the bottom of the tank. Air pressure forces any moisture present out through the bleeder valve. The air tank should be drained of all collected condensation as part of the daily preventive maintenance program.

The tank itself requires little attention because of the all welded, sheet steel construction. Care should be exercised, however, to prevent bending or breaking the inlet and outlet lines and fittings.

A safety valve is mounted on the tank and is set to open at 150 lbs. per square inch.

Should the air pressure in the supply tank rise to a point above the setting of the safety valve, the pressure will force the ball, against the spring, from its seat and allow the air to flow around the ball and out through the exhaust port. As soon as the pressure is reduced to the setting of the valve, the spring forces the ball back on its seat, stopping the exhaust.

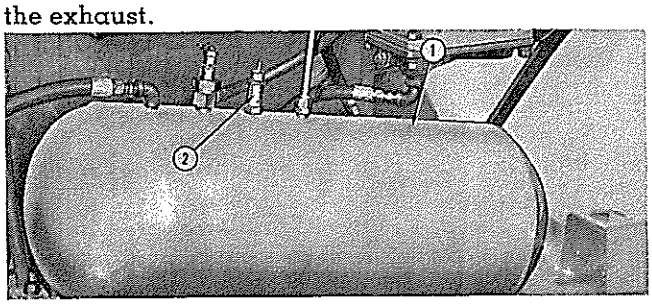


FIGURE B-39. AIR TANK

1. Air Tank
2. Safety Valve

BRAKE APPLICATION VALVE

The operation of the hand and foot application brake valves are the same except for the method of application.

Turning the handle of the hand valve moves the actuating cam down, while foot pressure moves the cam down in the foot valve.

As the application handle is moved in a clockwise, or downward direction, the actuating cam moves downward carrying with it the spring retainer, metering spring, and the metering piston assembly thereby seating the metering piston assembly on the exhaust valve insert and closing the exhaust to atmosphere. As further movement takes place, the valve stem moves downward, unseats the inlet valve insert and allows air pressure to enter the application side of the brake system.

When the desired rate of deceleration has been reached and the movement of the application handle is stopped, reaction or balance occurs in the valve mechanism. That is, the applied air pressure below the metering piston assembly forces the assembly upward, compresses the metering spring and allows the intake valve to close. Thus both inlet and exhaust valves are closed and the applied air pressure is held constant until the application handle or treadle is moved to released position or until additional air pressure is admitted to the application side of the valve by further clockwise or downward movement of the application handle or treadle.

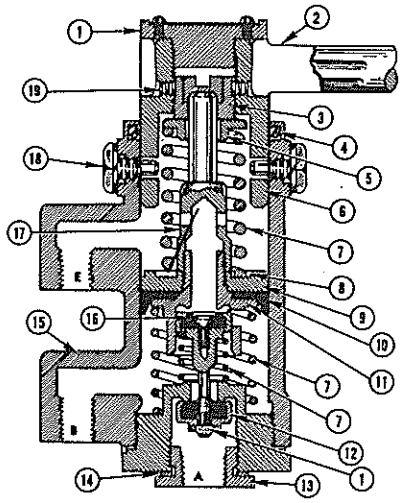


FIGURE B-40. HAND METERING VALVE

1. Nut
2. Handle
3. Guide
4. Grommet
5. Retainer
6. Cam
7. Spring
8. Washer
9. Piston
10. Cup
11. Spreader
12. Stem
13. Cap
14. Gasket
15. Body
16. Screw
17. Rod
18. Pin
19. Setscrew

Removal and Disassembly

Drain air tank and bleed the air system. Disconnect air lines at the brake valve. Remove the mounting bolts.

Remove the valve from the machine and clamp in a vise. Remove the inlet plug, plug gasket, inlet cap and cap gasket. The metering piston return spring may then be removed from the valve housing.

Place the inlet cap in a vise and remove the small hex nut which locks the inlet body to the exhaust valve body and stem. Insert a bit of a small screwdriver between inlet valve body and the wall of the inlet cap. Unscrew the stem from the inlet valve body. The inlet and exhaust valve spring may be removed. Remove the screw which retains the insert. Remove the inserts.

Remove application handle retaining nut and handle. Insert a drift through the opening in the actuating cam and push the metering piston assembly out through the lower opening in the valve housing. The metering spring, metering spring retainer and the metering spring washer may be removed. Insert a suitable drift through the exhaust holes in the piston rod and a piece of flat bar stock through the slots in the piston cup spreader and unscrew the two parts. Leave the bar stock in position. Engage the two slots in the piston and unscrew the two parts. The piston cup may now be removed.

Remove the actuating cam pins from the valve housing and push the actuating cam from the valve housing.

Remove the "O" ring. Remove the adjusting set screws and unscrew the adjusting nut from the actuating cam.

Adjusting and Testing

Reassemble the valve by reversing the disassembly procedure.

The valve can be adjusted either on or off the machine. In either case air pressure must be available. See Figure B-40.

Remove the application handle retainer nut and application handle. Be sure application handle is in released position before removal.

Loosen adjustment setscrews until the adjusting nut and piston guide can be rotated.

Disconnect application line at port "B".

Apply air pressure at port "A".

Using a broad blade screwdriver or other suitable tool, move the adjusting nut and piston guide downward until an air leak develops at port "B".

Turn adjusting nut and piston rod guide in opposite direction 1½ turns. Tighten adjustment setscrews. Make sure setscrews contact flats on the adjusting nut and piston rod guide. Replace application handle and handle retainer nut.

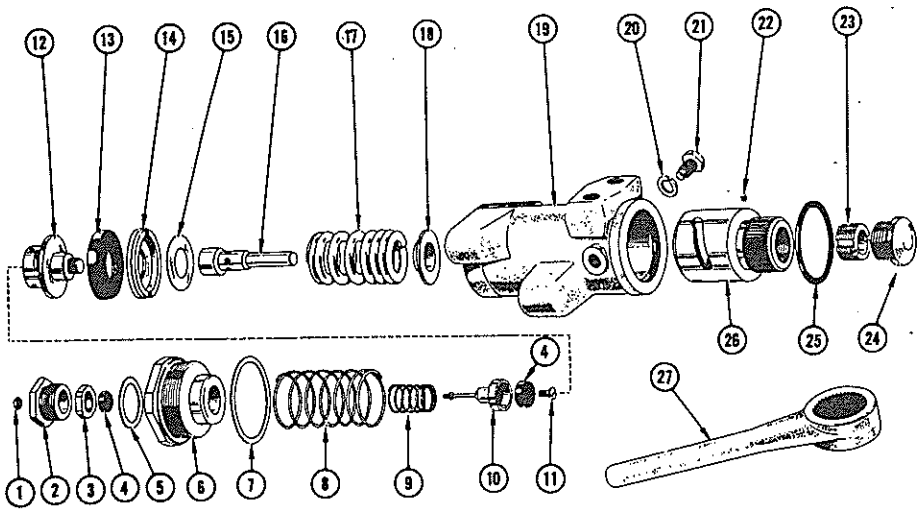


FIGURE B-41. METERING VALVE, EXPLODED

1. Nut
2. Plug
3. Body
4. Insert
5. Gasket
6. Cap
7. Gasket
8. Spring
9. Spring
10. Stem
11. Screw
12. Spreader
13. Cup
14. Piston
15. Washer
16. Rod
17. Spring
18. Retainer
19. Housing
20. Lockwasher
21. Pin
22. Setscrew
23. Guide
24. Button
25. "O" Ring
26. Cam
27. Handle

With the application handle in the released position and air pressure at port "A", there should be no leakage through ports "B" and "E". A leak at either of these ports indicates leakage at the valve insert caused by dirt, damaged or worn insert, damaged or worn insert seat, or a bent exhaust valve stem.

With the application handle in the applied position, air pressure present at port "A", and with port "B" plugged, there should be no leakage at port "E". A leak at port "E" indicates leakage at the exhaust valve insert caused by dirt, damaged or worn insert, damaged or worn insert seat, or a bent exhaust valve stem. This could also be caused by a damaged or worn piston cup.

Replace valve on machine and reconnect air lines.

Install an air gauge on the application side of the system. With the brakes fully applied, the instrument panel gauge and the gauge in the application side of the system should have approximately the same reading. See Figure B-42.

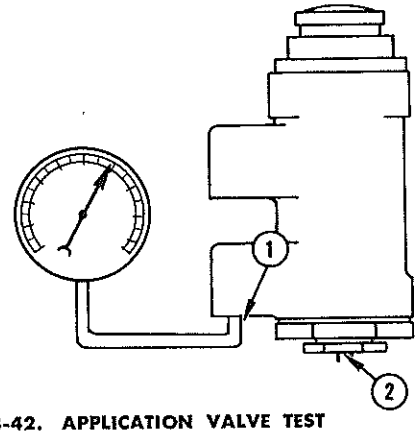


FIGURE B-42. APPLICATION VALVE TEST

1. Application
2. Intake

FUEL TANK

The fuel supply system cleans, contains, prepares and controls the flow of fuel oil to the engine. The use of a good grade fuel oil and proper care of the fuel filters are one of the important factors of engine care and maintenance. Buy clean fuel and keep it stored in a clean place.

Dirty fuel may contain solid material which may be abrasive. If some of this material reaches the fuel injection equipment, the finely finished surfaces will become damaged and the fuel injection equipment will no longer function properly.

Under such conditions, the engine will begin to show symptoms of loss of power, incomplete combustion, hard starting, missing and other forms of erratic operation.

Keep all fuel lines tight and free from leaks. Replace oil filter elements periodically. Refer to Sec-

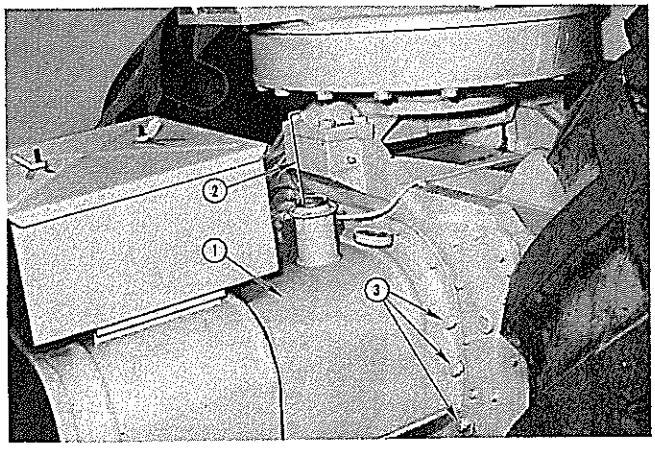


FIGURE B-43. FUEL TANK

1. Tank
2. Dip Stick
3. Spacers

tion "K" of this manual.

The filter unit included in the tank filler assembly removes any large foreign particles which may be present in the fuel used to fill the tank. Inspect the filter screen and clean with solvent periodically. Any large openings reduce the efficiency of the unit and should be corrected. If the filter unit cannot be repaired it should be replaced.

The fuel tank should be drained periodically to remove any sediment or condensate which may be present.

A dip stick is located inside the filler neck to measure the amount of fuel oil present in the tank.

Removal

Remove drain plug and drain lubricant from the main case. Disconnect battery cables and remove batteries from battery box.

Remove drain plug and drain fuel tank.

Disconnect fuel lines at fuel tank.

Support fuel tank and battery box with sling. Remove capscrews securing fuel tank to rear of main case. Pull fuel tank and gasket from main case.

NOTE: When reassembling fuel tank to main case, be sure to replace the five spacers over capscrews. Two go on the left side of fuel tank and three on the right side.

TROUBLE SHOOTING

Air Compressor

TROUBLE: Compressor fails to maintain adequate pressure in air system.

CAUSE: Dirty air cleaner.

REMEDY: Remove air cleaner. Clean all parts in cleaning solvent. Refill cup and replace on machine.

CAUSE: Excessive carbon in compressor cylinder head or discharge line.

REMEDY: Clean head and line of carbon and replace if necessary.

CAUSE: Discharge valves leaking.

REMEDY: Repair or replace compressor cylinder head if excessive leakage is found.

CAUSE: Excessive wear.

REMEDY: Disassemble compressor and replace worn parts.

CAUSE: Drive belt slipping.

REMEDY: Replace pulley if worn. Tighten or replace belt.

CAUSE: No clearance at compressor unloader valves.

REMEDY: Adjust clearance to 0.010" minimum to 0.015" maximum. Clearance can be checked only when the compressor is loaded. (Type U compressors only).

CAUSE: Unloading valve stuck open.

REMEDY: Check condition of unloading valves. If slot at end of stem or stem is worn, replace valve. If there is excessive clearance between the unloading valve stems and the unloading valve bushings, both may have to be replaced.

CAUSE: Excessive leakage of unloading valves.

REMEDY: Unloading valves pitted or worn must be ground to their seats. If valve seats are too badly pitted or worn, unloading valve and valve bushing must be replaced.

TROUBLE: Compressor passes excessive oil.

CAUSE: Excessive wear.

REMEDY: Replace compressor or worn parts.

CAUSE: Oil return line to engine crankcase plugged.

REMEDY: Remove line and clean.

CAUSE: Compressor crankcase flooded.

REMEDY: Remove oil return line and clean.

CAUSE: Oil ring impropely installed.

REMEDY: Remove pistons and re-install or replace rings.

TROUBLE: Noisy operation.

CAUSE: Loose drive pulley.

REMEDY: Tighten or replace pulley.

CAUSE: Excessive carbon in cylinder head or discharge line.

REMEDY: Clean head and line of carbon. Replace if necessary.

CAUSE: Worn or burned out bearings.

REMEDY: Replace bearings.

CAUSE: Excessive wear.

REMEDY: Replace compressor or worn parts.

TROUBLE: Compressor does not unload.

CAUSE: Defective unloading diaphragms.

REMEDY: Replace worn diaphragms.

CAUSE: Excessive clearance at unloading valves.

REMEDY: Adjust clearance from 0.010" minimum to 0.015" maximum. (Type "U" compressors only.)

CAUSE: Unloading cavity plugged with carbon.

REMEDY: Remove piston head, disassemble and clean.

CAUSE: Unloading mechanism binding or stuck.

REMEDY: Disassemble and clean all parts with a cleaning solvent. Replace all parts.

Treadle Valve

TROUBLE: Brakes gradually apply themselves with no foot pressure on treadle.

CAUSE: Incorrect exhaust valve adjustment preventing the valve from opening and the inlet valve from closing.

REMEDY: Adjust the exhaust valve.

TROUBLE: Brakes release slowly when foot pressure is removed.

CAUSE: Incorrect pedal linkage adjustment preventing the valve from returning to full release position.

REMEDY: Correct pedal linkage adjustment.

CAUSE: Insufficient clearance between the exhaust valve and its seat.

REMEDY: Adjust the exhaust valve.

CAUSE: Piston sticking in the valve body.

REMEDY: Clean and lubricate the valve and spring.

TROUBLE: The valve will not balance or hold the pressure constant.

CAUSE: Weak inlet return spring.

REMEDY: Replace spring.

CAUSE: Inlet valve pilot is sticking on its guide in valve cap.

REMEDY: Remove cap and clean the guide and valve pilot.

CAUSE: Broken metering spring.

REMEDY: Replace spring.

TROUBLE: Air brake not functioning properly.

CAUSE: Leaks in air system.

REMEDY: Check entire system and all connections for leaks.

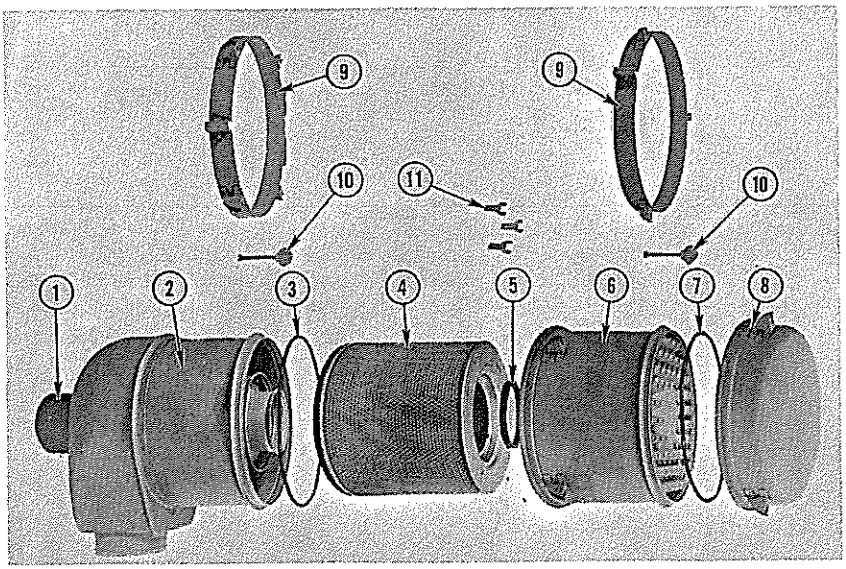
DRY TYPE AIR CLEANER

The dust laden air is drawn into the air chamber of the cleaner which is a common entrance to the cyclone tubes, and is rotated downward by the helix shaped vanes, to create a centrifugal force on the dust particles.

The air spirals down into the tapered section of the tube and reverses direction at the bottom. As the air reverses direction, dust particles are thrown into the dust cup by the centrifugal force.

The partially cleaned air then moves up through the center of the cyclone tubes into an upper chamber where it is then drawn through the filter cartridge into the engine's intake air system.

A service indicator on the engine intake air tube indicates the need for filter cartridge service. As the filter becomes dirty, the additional vacuum, created by the engine's demand for air, causes the indicator float to rise.



DRY TYPE AIR CLEANER

1. Air Intake Tube
2. Dry Filter Housing
3. Gasket
4. Dry Filter
5. Gasket
6. Cyclone Tubes
7. Gasket
8. Dust Collector Cup
9. Mounting Bands
10. Wing Nut and Stud
11. Filter Wing Nuts

Service

Daily inspection of the dust collector cup is necessary to determine if service is necessary.

Do not remove collector cup or otherwise service air cleaner while engine is operating.

Loosen the four wing nuts securing the dust cup to the air cleaner body. Swing nuts and bolts away from cup, lower and remove cup.

Wipe out cup and gasket with a clean rag. Do not use oil, gasoline, or oily waste. Inspect gasket; if it shows signs of wear, damage, or leaks, it must be replaced.

Remove the dust cup and tube section. Inspect both ends of tube section. Light should be visible through each tube. Use a stiff fiber brush or compressed air to remove any accumulated dust from in or around the tubes. Replace gaskets if necessary. Do not apply heat of any kind to the tubes.

Service the filter cartridge when, with the engine shut off, the red restriction indicator stays up. After filter has been serviced, return the indicator to the down position by pushing up on the indicator stem.

Although a paper filter is normally considered as being expendable, careful and proper cleaning can increase its life. Listed below are two methods for cleaning filter cartridges. The first method is recommended for effective cleaning. As an alternate to the first method, method number two may be used in cases where the inlet air contains substantial amounts of carbon or oil fumes, the dust cake on the filter cartridge may be difficult to clean off.

METHOD #1

Direct a jet of dry, clean air against downstream or clean air side of the filter cartridge. Move the air jet up and down the pleats, while slowly rotating the cartridge.

Exercise extreme caution so that paper is not ruptured by nozzle or air jet. Direct the air jet in the direction opposite that of normal air flow.

METHOD #2

Cartridges may be cleaned by washing with water and a good household non-sudsing detergent. Warm water (120° to 140° F.) is desirable, however, it is not necessary. If a hose is used to wash or rinse the cartridge, be careful not to rupture the paper with the water jet. A maximum water line pressure of 40 p.s.i. is recommended. Flush the cartridge until drain water becomes clean. Air dry thoroughly before replacing in filter body. It is desirable to have a spare cartridge to use while present unit is being cleaned.

After cleaning cartridge, inspect for damage or rupture. Place a bright light bulb inside the cartridge. Inspection of the cartridge on the outside will disclose any holes where light shines through. Replace cartridge, if any holes are present.

Cartridge should be replaced every 1000 hours, or as determined by the condition of the cartridge.

To remove filter cartridge, loosen clips fastening cover to body, and lift off cover. Remove wing bolt holding filter cartridge in position and lift out cartridge.

Inspect gaskets and replace if they show any signs of leaks or are damaged in any way.

Install new or cleaned cartridge, replace wing bolt and tighten until unit cannot be rotated. Replace cover and gasket. Fasten clamps.

Check connections between air cleaner and engine. Make sure they are air tight.

ENGINE AND COCKPIT

INDEX

ENGINE AND COCKPIT

ENGINE

Removal

Open drain cocks and drain coolant from radiator and engine block.

Disconnect battery ground.

Remove hood, radiator and cockpit. (See page C-4 for cockpit removal.)

Disconnect cable leads from terminals on rectifier tank lid.

Disconnect air lines from air supply tank. Remove air tank mounting bolts and lift air tank from Tournapull case.

Attach chain hoist to lifting eyes on engine and take up slack. Remove front and rear engine mounting bolts. Keep shims and spacers together as they are removed. They are to be reinstalled in the same place if installing the same engine.

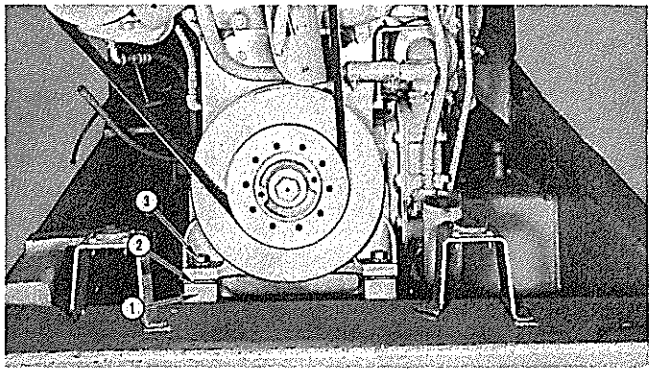


FIGURE C-1. FRONT ENGINE MOUNT

1. Spacer 2. Shims 3. Mounting Bolts

Now move to the point where the transmission bell housing is secured to the generator end bell. Place block under transmission to prevent its dropping when engine is removed. Remove the capscrews securing the two units together. Raise the engine slightly and at the same time pry generator end bell away from the transmission bell housing. Care must be taken to see that the transmission drive shaft is free of the splined hub in the clutch disc before raising the engine too high.

As engine is hoisted up from the case, check to be sure all leads and tubing have been disconnected.

Place engine and generator on stand or blocks to permit further disassembly.

The engine, generator, clutch and transmission may be removed as one unit by following the instructions given below.

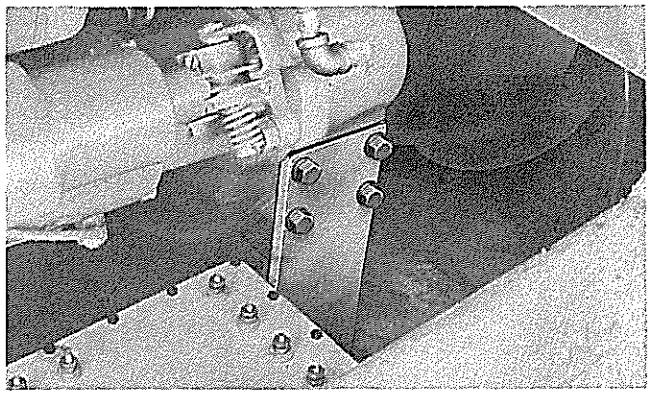


FIGURE C-2. REAR ENGINE MOUNT

Proceed as described above up to the point of removing the capscrews securing the generator end bell to the transmission bell housing.

Drain lubricant from final drive compartment. Remove fuel tank, battery box, final drive pinions and differential.

From inside main case, remove the eight jam nuts and the eight nuts securing the transmission adaptor to the main case.

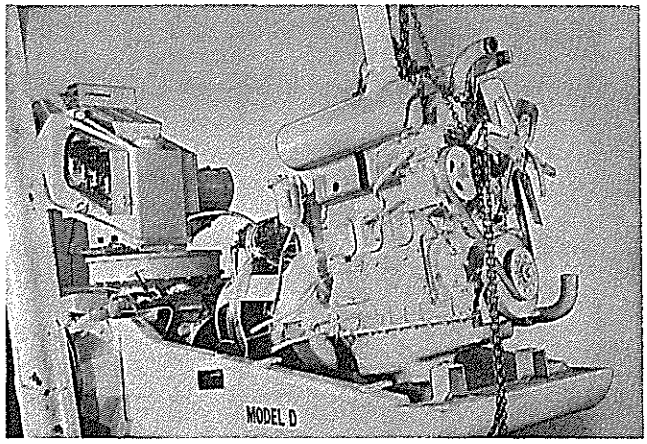


FIGURE C-3. REMOVING ENGINE

Raise engine slightly, pry transmission away from main case until pinion is clear of case. Raise engine and pull forward out of case. Place on a stand or blocks for further disassembly.

For engine disassembly and repair, refer to engine manual.

Installation

Clean outside of engine thoroughly to remove accumulated coating of dirt and oil. Clean all engine mounts and shims, transmission bell housing and generator end bell.

Clean face of transmission and boss of main case. Spread a thin coating of Permatex on boss of case. Install transmission into case. Secure by replacing nuts and jam nuts securing adaptor to rear case.

Install engine, generator and clutch into the case as a unit. Attach chain hoist to lifting eyes on engine, and hoist into position.

Line up flywheel clutch disc hub with the clutch shaft on front of transmission, rotating shaft if nec-

essary to align splines on shaft and in hub of clutch disc. Then move engine to the rear until the clutch shaft is inserted into the clutch pilot bearing in flywheel, and generator end bell is positioned against transmission bell housing.

If the same engine is being reinstalled, replace the same shims and engine mount spacers beneath the front engine supports in their original positions. This is necessary to insure proper alignment.

If a replacement engine is being installed, position a dial indicator on the case with its staff on transmission bell housing and set at a reading of "0". This must be done before installing engine in case. After engine is installed, this reading must still be "0", indicating no change in position of transmission. See Fig. C-4.

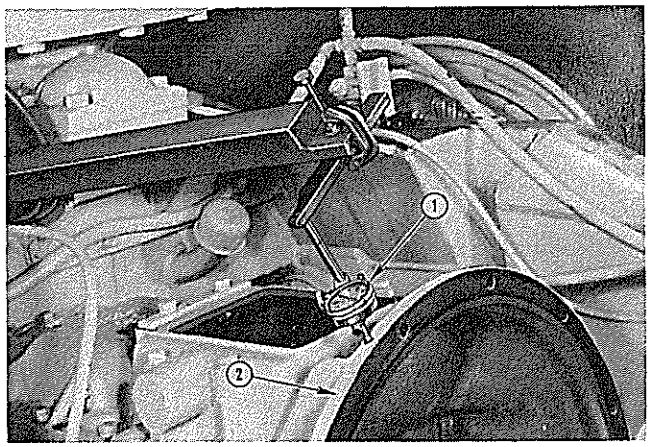


FIGURE C-4. DIAL INDICATOR IN POSITION

1. Dial Indicator
2. Bell Housing

Now place engine in case as described above. Place front engine support spacers beneath engine mounts. Carefully support the engine with the chain hoist so that the engine weight is not on the clutch shaft or transmission. Maneuver engine back into case until transmission bell housing and generator end bell are approximately 0.010" apart. (Check with feeler gauge.) Use four equally spaced capscrews to hold them in position.

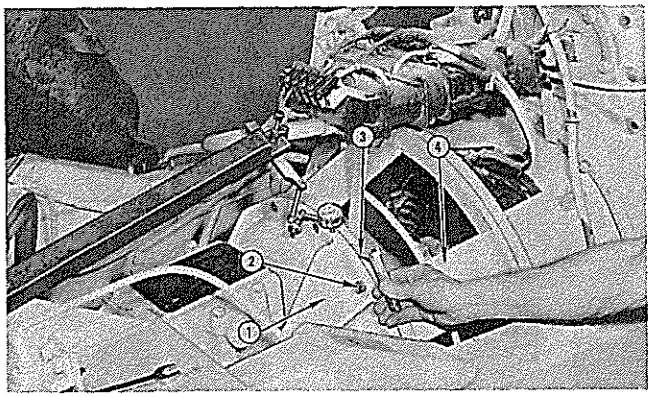


FIGURE C-5. CHECKING SPACE BETWEEN END BELL AND BELL HOUSING

1. Bell Housing
2. Capscrew
3. Feeler Gauge
4. End Bell

Check space beneath front engine mounting brackets with feeler gauge for approximate number of shims required. Insert shims and pull down capscrews to proper torque. Again using feeler gauge check the space between the transmission bell housing and the generator end bell at both top and bottom. Add or take away shims necessary to obtain identical readings, then loosen the capscrews in the engine mounts.

Tighten the four capscrews at the rear mounting plates on each side of the engine. Check space between transmission bell housing and generator end bell at each side with a feeler gauge. The two horizontal readings must be the same.

A variation of more than 0.002" plus or minus between the two vertical readings is not permissible. This also pertains to the horizontal readings. After proper adjustment has been obtained, loosen capscrews.

Insert capscrews fastening the transmission bell housing and the generator end bell together and tighten. Now tighten front and rear engine mounting bolts.

Complete reassembly of machine.

To replace engine, generator, clutch and transmission as a unit it is first necessary to assemble them to each other.

Clean face of transmission and boss of main case. Spread thin coat of Permatex on boss of case.

Attach chain hoist to lifting eyes on engine and hoist into position in main case.

Replace same shims and engine mount spacers beneath front engine supports in their original positions.

Secure transmission adaptor to the case with capscrews and nuts.

Replace and tighten rear engine mounting capscrews. Tighten front engine mounting bolts.

Complete reassembly of machine.

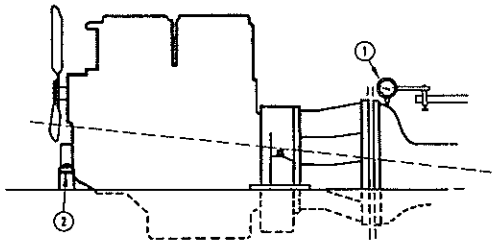


FIGURE C-6. ENGINE TOO HIGH IN FRONT

1. Dial Indicator
2. Take Out Shims

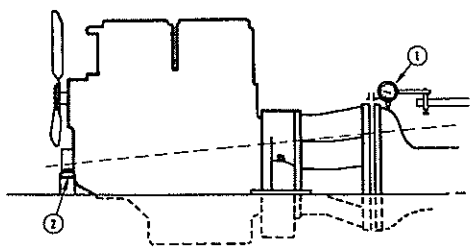


FIGURE C-7. ENGINE TOO HIGH IN REAR

1. Dial Indicator
2. Add Shims

COCKPIT

Removal

Disconnect headlight wires and free from clamps on underside of hood. Remove rain cap from exhaust stack or remove exhaust stack. Disconnect air line to air horns. Remove capscrews securing hood to radiator shell and cockpit. Remove hood.

Disconnect air cleaner discharge hose.

Remove capscrews, lockwashers, and nuts securing the foot plates to the brake and clutch pedal shafts. Remove foot plates.

Disconnect throttle linkage from underside of foot pedal.

Bleed the air system and disconnect the air gauge air line from the bottom of the foot brake application valve.

Disconnect engine emergency shut-down control from lever on engine air box. Disconnect heat indicator bulb and oil pressure switch hose from engine.

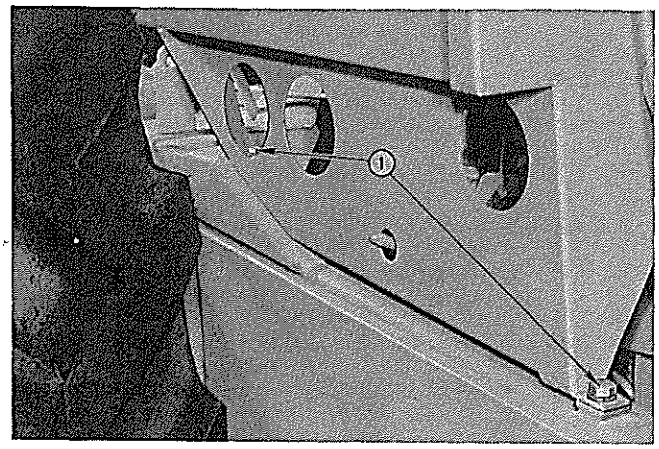


FIGURE C-8. COCKPIT MOUNTING BOLTS

1. Mounting Bolts

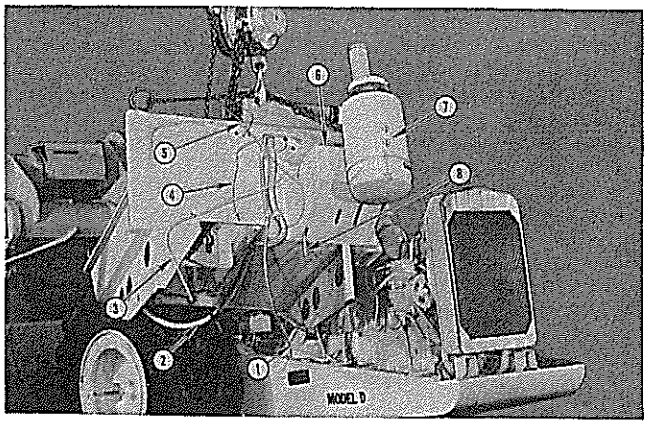


FIGURE C-9. COCKPIT, REMOVED

1. Headlight Wires
2. Electric Cable
3. Fuel Filter Line
4. Heat Indicator Bulb
5. Emergency Shut Down Control
6. 6 Volt Battery Tap
7. Air Cleaner
8. Foot Throttle

Disconnect cranking motor switch to cranking motor solenoid lead at the cranking motor.

Disconnect cable (instrument panel to transformer to main switch box) from cable clamps under cockpit and from terminals on transformer and in switch box.

Disconnect battery cable and 6 volt tap wire from cable clamps under cockpit.

Fasten hoist to cockpit. Remove the four mounting bolts securing the cockpit to the case. Raise cockpit slowly and at the same time check to be sure all wires, cables, or controls have been disconnected. Guide cockpit over transmission shift lever.

Place cockpit on blocks to prevent damaging any dangling controls, cables or tubing.

A.C. GENERATOR

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A.C. GENERATOR
Removal and Disassembly

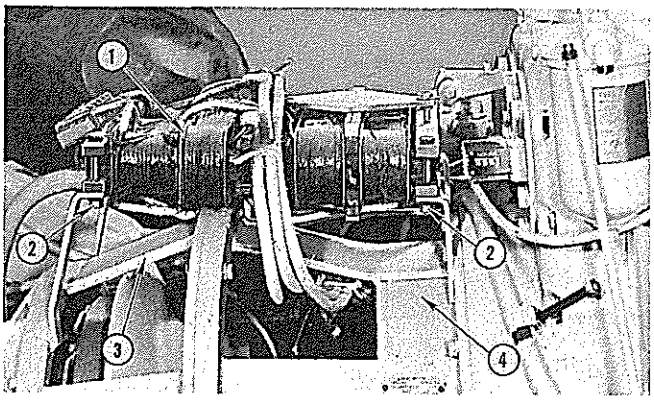


FIGURE D-1. A.C. GENERATOR AND TRANSFORMER

1. Transformer
2. Mounting Bolts
3. End Bell
4. Stator

Remove engine, generator, and flywheel clutch from the case as a unit. Refer to Section "C" of this manual.

Remove the clutch assembly and secondary flywheel. Refer to Section "E" of this manual.

Disconnect the two leads to the generator brush holders. Disconnect one at the end bell and the other at the transformer terminal strip.

Remove the socket head locking setscrew from the generator locknut (Fig. D-2). Now remove the generator locknut with a special wrench and extension handle.

Disconnect A.C. leads from the transformer terminal strip. The A.C. leads to the generator must be separated from the transformer with a soldering iron.

Remove transformer mounting bolts (see Fig. D-1) and remove transformer.

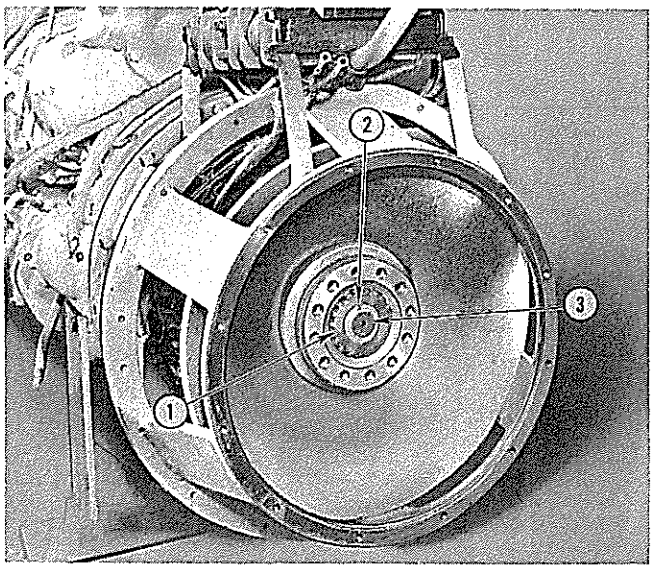


FIGURE D-2. ROTOR SHAFT LOCKNUT

1. Locknut
2. Setscrew
3. Rotor Shaft

Remove the capscrews securing the generator end bell to the generator stator and separate the two units (Fig. D-3). Press out the adaptor, bearing, piston rings and retainer from the bore of the end bell as a complete unit.

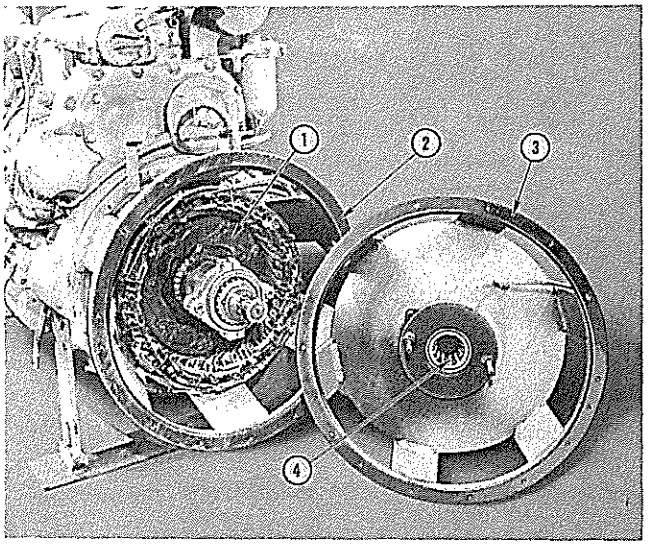


FIGURE D-3. END BELL, REMOVED

1. Rotor
2. Stator
3. End Bell
4. Adaptor

Remove piston rings from grooves in the adaptor hub and slide retainer ring and bearing from hub.

Attach sling to generator stator and end bell. Remove capscrews securing stator to engine flywheel housing (Fig. D-4). Pull stator away from rotor, taking care not to damage windings.

Remove the rotor by backing out capscrews after cutting lockwires. To prevent damage to the rotor windings, sling rotor to keep it from dropping to the

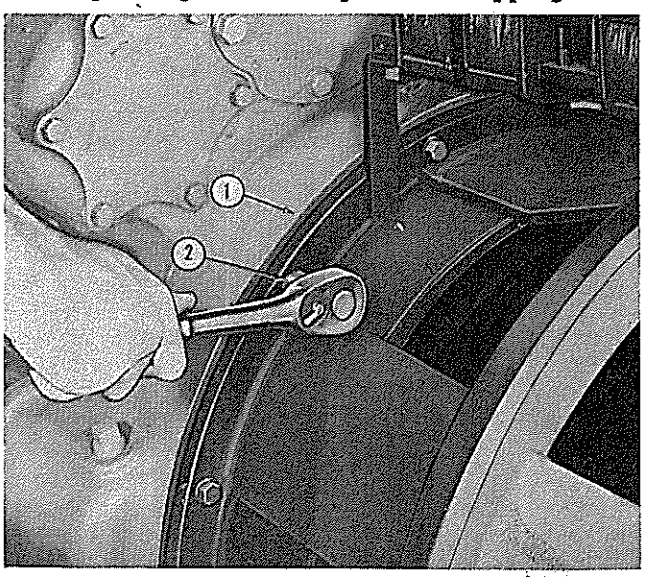


FIGURE D-4. REMOVING CAPSCREWS

1. Flywheel Housing
2. Capscrew

floor when removed (Fig. D-5). Take capscrews only half way out, pull on rotor, then take the capscrews out completely. CAUTION: Tape threads on end of rotor shaft to prevent damage to them.

NOTE: Stator, end bell, and transformer may be separated from engine as one unit. Remove setscrew and locknut from rotor shaft. Attach rope sling to stator and end bell. Remove capscrews securing stator to engine flywheel housing. Pull stator and end bell away from rotor, taking care not to damage windings.

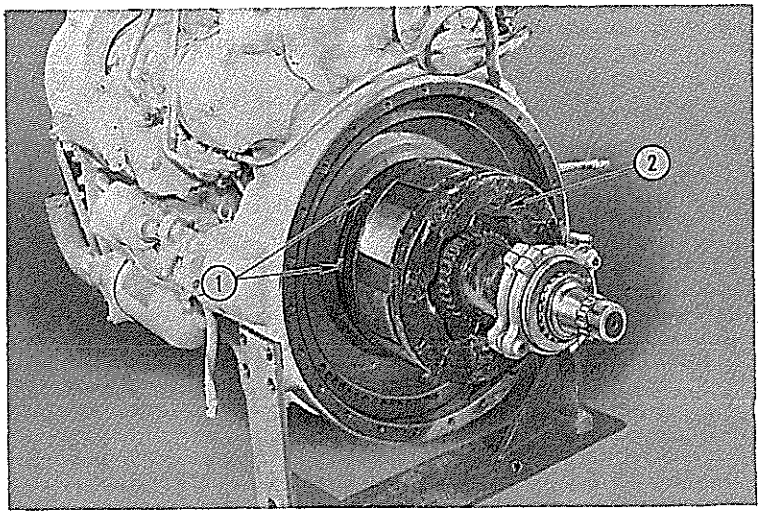


FIGURE D-5. GENERATOR ROTOR

1. Mounting Capscrews
2. Rotor

Reassembly

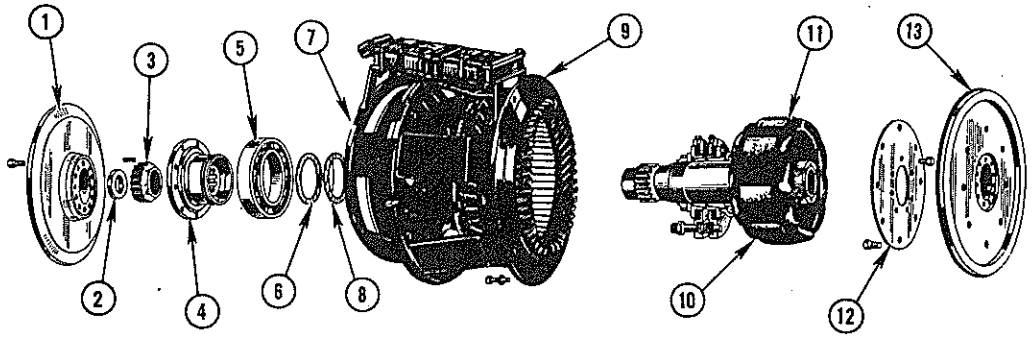


FIGURE D-6. A.C. GENERATOR, EXPLODED

1. Secondary Flywheel
2. Pilot Bearing
3. Locknut
4. Adaptor
5. Bearing
6. Retainer
7. End Bell
8. Piston Ring
9. Stator
10. Brush Ass'y.
11. Rotor
12. Coupling Plate
13. Flywheel

Inspect the stator windings. Remove any accumulation of grease and dirt with a low pressure siphon hose and a cleaning fluid, such as carbon tetrachloride. After the windings have been washed down with the cleaning fluid, blow off the excess with compressed air. Check generator grease tube to be sure it is open.

Install rotor on engine flywheel and secure with capscrews and lockwashers. Torque capscrews to 190 ft. lbs. Replace lockwires.

Replace the stator over rotor and secure to flywheel housing with capscrews and lockwashers. Torque 3/8" NC capscrews to 30 ft. lbs. If equipped with 7/16" NC capscrews, torque to 50 ft. lbs.

Install and secure end bell to generator stator with capscrews and lockwashers. Torque to 30 ft. lbs. Reconnect leads to generator brush holders. See page D-4 for brush holder service.

Repack ball bearing with high temperature ball bearing grease.

Install the ball bearing onto the hub of the adaptor structure. Slide the retainer ring onto the hub until it has passed the piston ring grooves (beveled edge of ring away from adaptor). Place the two piston rings in the grooves of the hub. Compress the rings and position the retainer ring over them, thus holding them in the compressed position.

Now start the adaptor hub into the bore of the end bell. This will force the retainer ring back, freeing the piston rings in the bore of the end bell.

Assemble the adaptor on rotor shaft and torque the locknut to 1000 ft. lbs. Replace socket head setscrew.

Complete reassembly of unit.

After reassembly use a feeler gauge to check the air gap between the rotor and stator. The gap must be the same all around the circumference of the rotor and stator. Proper gap is from 0.020" to 0.040".

BRUSH HOLDER

Two aluminum brush holders hold the segments of the generator brushes. The holder farthest from the engine is grounded to the generator end bell. The remaining holder is insulated from the holder studs by insulating bushings. This insulated holder is connected to the terminal strip on the generator stator.

Each split type holder is composed of two half rings, held together by capscrews. Two clips are inserted between the two halves, extending slightly into the counterbore which holds the brush segments, preventing them from turning in the holder.

The brushes are made of graphite carbon. Non-adjustable springs between the brush holders give the required brush pressure as the brush makes side contact with the rotor slip rings.

The generator brushes should be inspected for wear when the generator is disassembled. The brushes are 3/8" thick when new and should be discarded when one half of the brushes have worn away.

Disassembly

Remove the socket head capscrews holding the two pairs of brush holder half rings together (Fig. D-7).

Remove the half rings, brush segments and springs from around the rotor shaft.

The brush segments, tension springs, half rings, clips and bushings may now be separated (Fig. D-8).

Check for grounds or shorts between the brush holders or between brush holder and the frame of the machine. Be sure the insulated bushings are not crushed or broken.

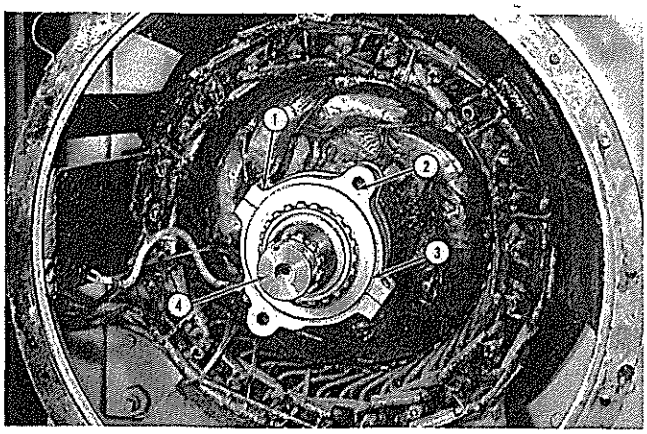


FIGURE D-7. REMOVING BRUSH HOLDERS

1. Capscrew
2. Half Ring
3. Brush
4. Rotor Shaft

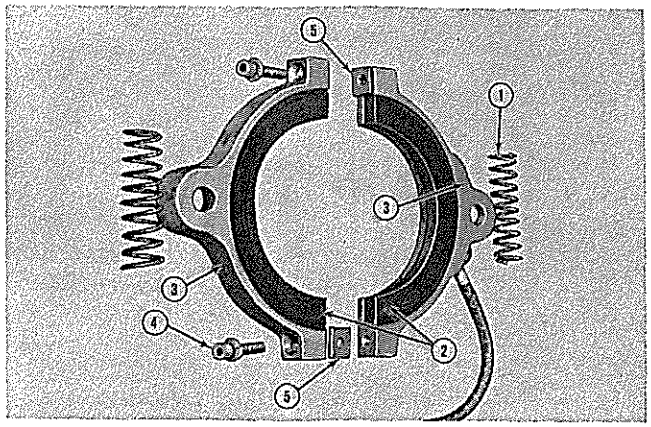


FIGURE D-8. BRUSH HOLDER, REMOVED

1. Spring
2. Brush Segments
3. Half Ring
4. Capscrew
5. Clip

Reasssembly

To replace the brush holder assembly, assemble the two top half rings, brush segments and tension spring. Compress spring by squeezing half rings together and place over rotor shaft between the rotor slip rings, separated by the center insulating washer.

Assemble bottom half rings in the same manner. Place clips on bottom half rings, compress spring and place over bottom of rotor shaft.

Replace socket head capscrews and lockwashers.

RECTIFIERS

Removal and Disassembly

The two rectifiers used in the electrical system are contained in an oil filled steel box. The box is located in the left side of the engine compartment.

Disconnect wires to rectifier terminals on the outside of rectifier box lid (Fig. D-9).

Remove the capscrews securing the lid to the

rectifier box; remove lid, with rectifiers attached, and gasket from box (Fig. D-10).

Disconnect wires from terminals on rectifiers. Mark each, as they are removed, to facilitate reassembly.

Loosen nuts on each end of rectifier mounting bolt. Slide rectifier from between mounting bracket (Fig. D-11).

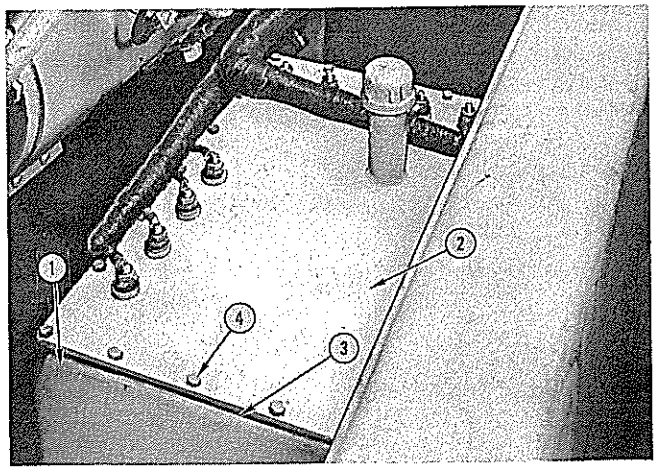


FIGURE D-9. RECTIFIER TANK LID

1. Tank
2. Lid
3. Gasket
4. Capscrew

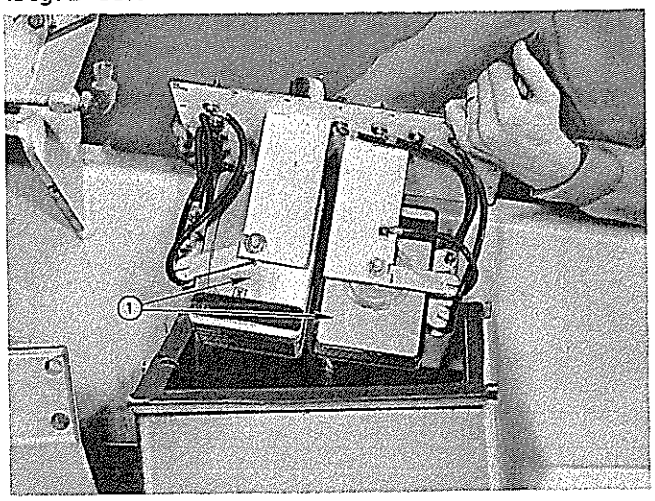


FIGURE D-10. REMOVING LID

1. Rectifiers

Reassembly

The rectifiers should never be interchanged. Replacement must always be made with a rectifier with the same number of plates and stacked in the same way as the one being replaced.

Replace rectifier in mounting brackets on the lid and replace and tighten lockwashers and nuts on mounting bolts.

The following guide may be used for reconnecting leads to rectifier terminals.

The three A.C. terminals are color coded yellow and are not connected by a terminal bar.

The D.C. positive terminal is color coded red and is always connected to brass collector ring on one end of the rectifier. It is in between the three A.C. terminals and the D.C. negative terminal.

The D.C. negative terminal is color coded black and is on the opposite side of the A.C. terminals, across from the D.C. positive terminal.

Replace rectifiers in box and complete reassembly.

Refer to Section "L" of this manual for type and amount of oil for rectifier box.

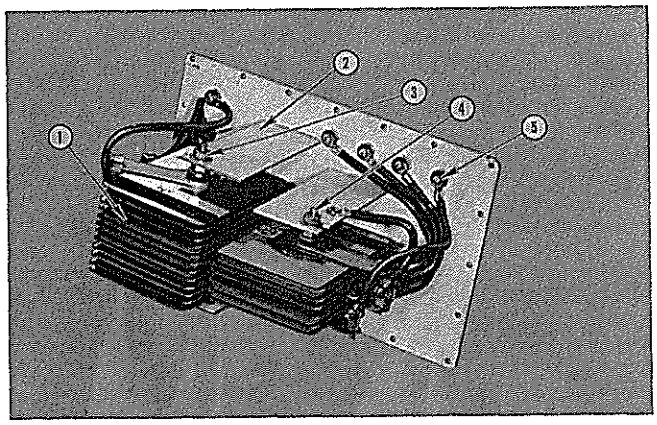


FIGURE D-11. RECTIFIER MOUNTING

1. Rectifier
2. Bracket
3. Nut
4. Mounting Bolt
5. Terminals

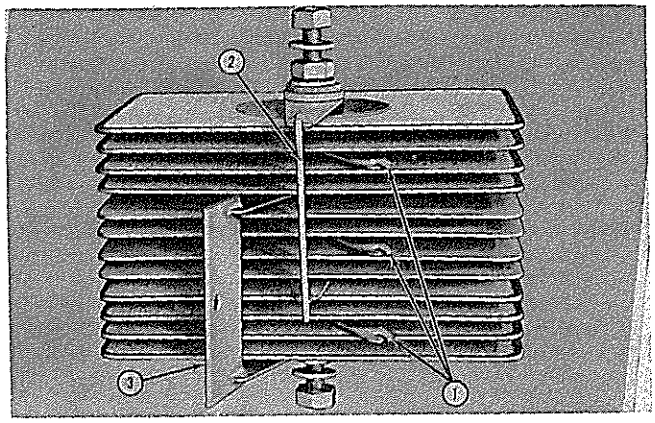


FIGURE D-12. RECTIFIER

1. A.C. Terminals
2. D.C. Negative Terminals
3. D.C. Positive Terminals

TRANSFORMERS

Removal

Disconnect leads from transformer terminal strip. Disconnect leads from rectifier box terminals. Disconnect main leads from generator to transformer at soldered connections.

Remove nuts from transformer mounting bolts and lift transformer from bracket. Pull transformer and cables from machine (see Fig. D-13).

Replacement

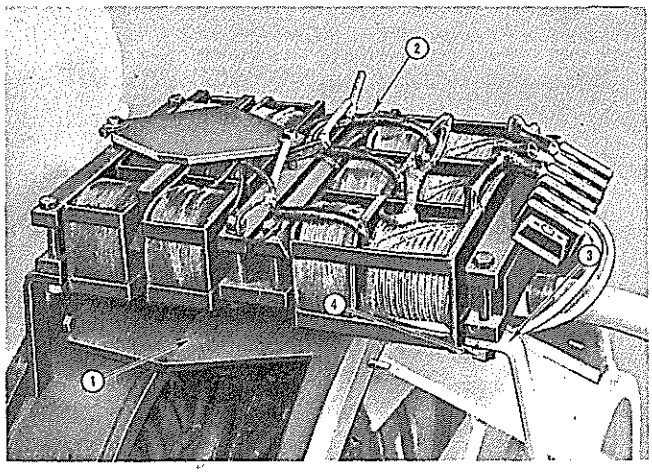


FIGURE D-13. TRANSFORMER

1. Generator
2. Transformer
3. Mounting Bracket
4. Capscrews

CONSTANT VOLTAGE TRANSFORMER

Separate generator, and main and constant voltage transformer primary winding leads by heating the splices (Fig. D-14).

Disconnect the primary leads at the transformer terminal strip. Remove terminal strip mounting screws and remove strip from transformer frame (Fig. D-15).

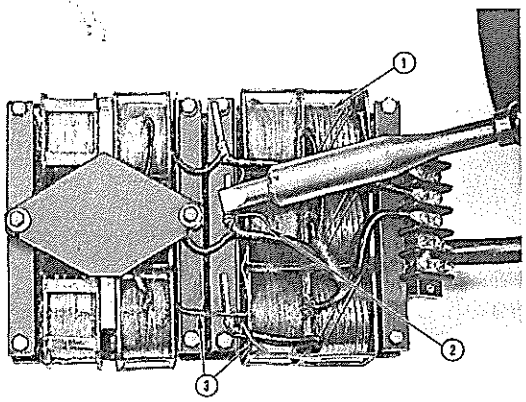


FIGURE D-14. DISCONNECTING PRIMARY COIL LEADS

1. Constant Voltage Transformer
2. Reactor Leads
3. Primary Coil Leads

Turn transformer assembly over and strip insulation from the point where the three secondary winding leads join the leads from the multiple cable. Slide insulating sleeves along wire until the splices are exposed. Heat splices with soldering iron until wires can be separated (Fig. D-16).

Remove the two capscrews from the connecting bar (Fig. D-17), remove bar and separate the transformer units (Fig. D-18).

MAIN TRANSFORMER

Disconnect the main transformer primary coils leads from the primary windings of the constant voltage transformer as shown in Fig. D-14.

Turn the transformer assembly over and strip insulation from the three spliced connections of the main transformer secondary windings at the point where they join the three leads from the multiple cable. Slide insulating sleeves from splices and heat with soldering iron until wires can be separated (Fig. D-19).

Remove capscrews from each end of connecting bar. Remove the capscrew securing adjusting plate to connecting bar. Loosen the other capscrew until plate can be moved aside. Remove bar and separate the transformers.

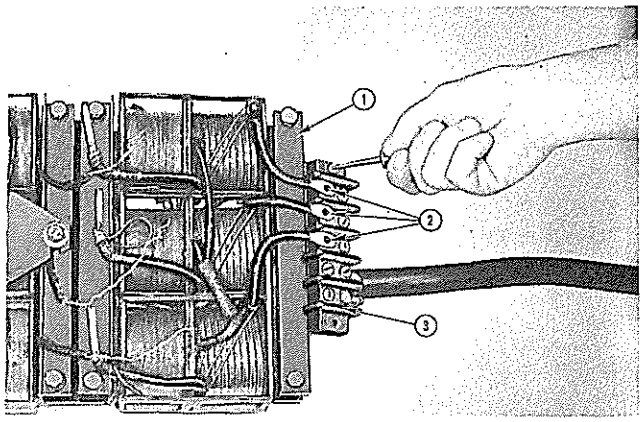


FIGURE D-15. REMOVING TERMINAL STRIP

1. Constant Voltage Transformer
2. Primary Leads
3. Terminal Strip

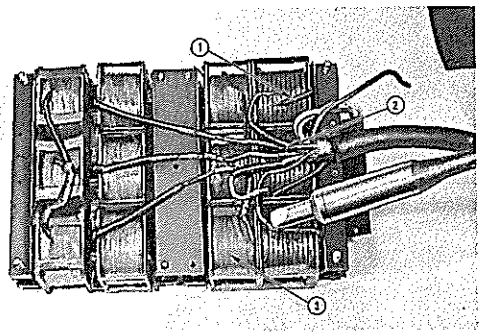


FIGURE D-16. DISCONNECTING SECONDARY LEADS

1. Insulating Sleeves
2. Secondary Windings
3. Constant Voltage Transformer

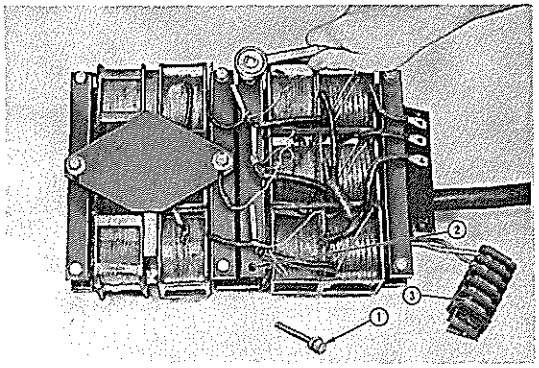


FIGURE D-17. REMOVING CONNECTING BAR

1. Capscrews
2. Connecting Bar
3. Terminal Strip

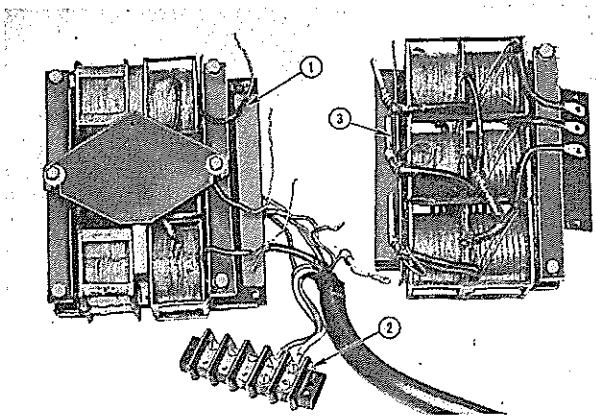


FIGURE D-18. TRANSFORMERS, SEPARATED
1. Main Transformer 2. Terminal Strip
3. Constant Voltage Transformer

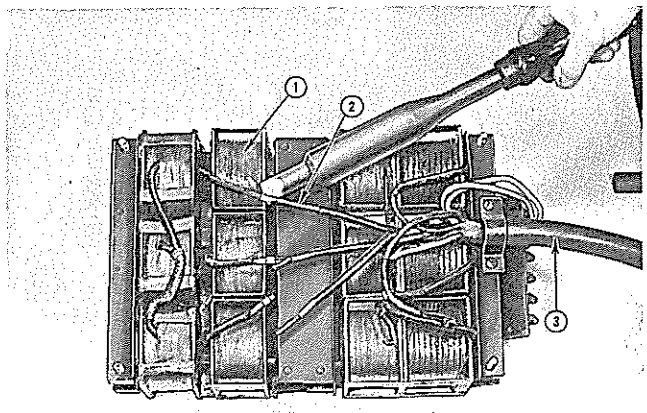


FIGURE D-19. DISCONNECTING SECONDARY LEADS
1. Main Transformer 2. Secondary Leads
3. Multiple Lead Cable

Reassembly

To reassemble transformers, reverse the disassembly procedure.

When reconnecting leads, be certain all wires have been scraped clean. After splicing leads together, solder each connection to insure a good connection.

Slide insulating sleeves over splices and secure sleeve into place with glass fiber tape. Paint all insulated connections with gyptol solution or its equivalent.

Replace transformer assembly on machine and secure with nuts and lockwashers. Reconnect electric cables.

BATTERIES

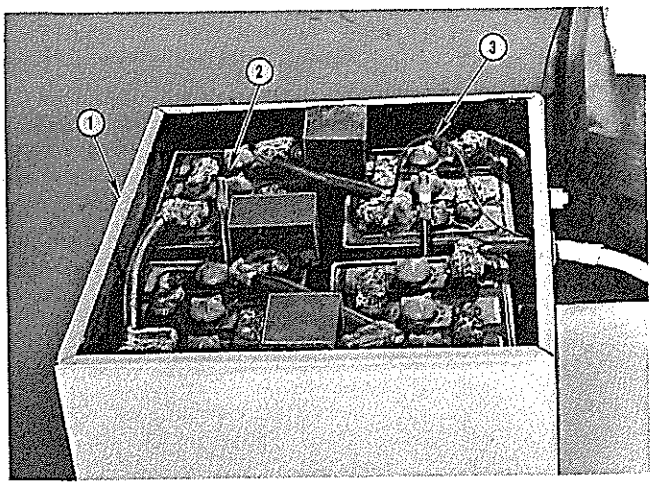


FIGURE D-20. BATTERY BOX
1. Battery Box 2. Battery
3. 6 Volt Tap

The Model D Tournapull is equipped with four 6 volt batteries connected in series to provide the 24 volts D.C. necessary for operation of the cranking motor, and initial excitation of the A.C. generator. A 6 volt D.C. tap runs from the negative terminal of the first battery from the ground to the instrument panel. This tap provides the current necessary for operation of the instruments, lights and accessories.

The batteries are mounted in a box on top of the fuel tank.

Always operate the batteries at or near full charge and keep the electrolyte at the proper level. A battery half charged or less cannot be depended upon for starting and wears out rapidly. A low battery usually indicates that the charging system is out of adjustment.

Keep the electrolyte above the plates so the battery can produce its full capacity and not be damaged by overheating. Maintain battery water level from the top of the plates to 3/8" above the plates.

Distilled water (never boiled or filtered) or water from local sources approved by the battery manufacturer should be used for filling storage batteries.

The best time to add water is just prior to operation. This insures a good mixture between the water and electrolyte. The water will stay on top in cold weather and freeze at about 32° F., unless it is thoroughly mixed.

The batteries should be kept clean and dry. Dirt and dampness furnish a path for electricity to leak away. Connections must be clean and tight to reduce resistance to the flow of current.

Dirt should be brushed off with a stiff bristle (non-metallic) brush. Wipe with a cloth wet with ammonia or bicarbonate of soda (one pound of soda to a gallon of water). Wash off with water. Examine vent plugs to see if the gas escape holes are clean afterwards.

Corrosion should be removed by scraping or with a stiff bristle (non-metallic) brush. Wash with ammonia or soda solution. After rinsing with clear water and drying, a thin coating of terminal grease or vaseline should be applied to the terminals.

Refer to Section "L" of this manual for more complete information on testing the batteries.

FLYWHEEL CLUTCH

INDEX

FLYWHEEL CLUTCH

Function

The flywheel clutch is a single plate, dry disc type, and being self compensating does not require periodic adjustment. The cover plate and pressure plate are interlocked by means of indented portions on the cover plate registering in spaces between the drive bosses on the pressure plate to permit engaging movement of the pressure plate.

Pressure springs exert pressure on the pressure plate to create the necessary friction with the driven plate. This pressure may be relieved from the driven plate by actuating the release levers. The driven plate is not connected with the cover plate or the pressure plate but slides over a limited area of the transmission mainshaft by means of a splined hub. As the pressure plate is engaged it applies pressure uniformly against the driven plate facings, thus locking the pressure plate and flywheel together through friction of the driven plate. The clutch thus revolves as a unit to rotate the transmission mainshaft, transferring engine rotation to the ring gear through the spiral bevel pinion.

As the clutch pedal is pushed downward, the release bearing moves forward against the release levers of the clutch and further travel actuates the release levers and releases the pressure plate, disrupting the flow of power at this point.

Removal

Remove hood and radiator. Remove capscrews securing generator end bell to transmission bell housing. Pull engine, generator, and clutch from Tournapull case as a unit (see Section "C"). Place on stand for further disassembly.

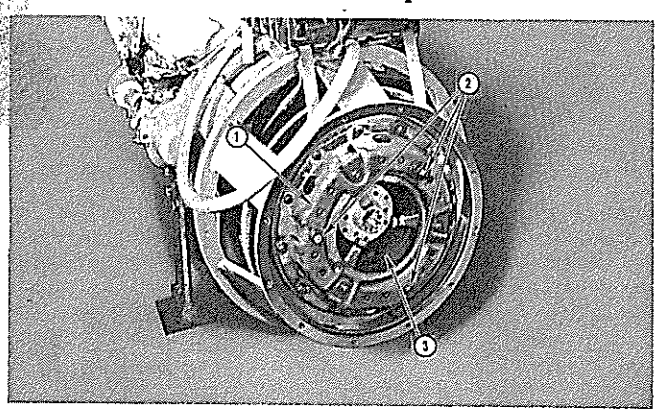


FIGURE E-1. HOLD DOWN BOLTS

1. Cover Plate
2. Hold Down Bolts
3. Pressure Plate

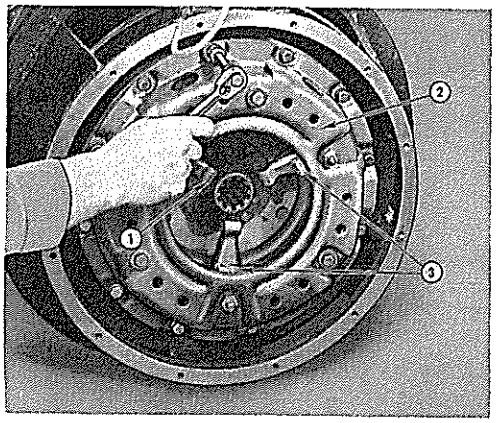


FIGURE E-2. WOOD BLOCKS IN POSITION

1. Release Lever
2. Cover Plate
3. Block

Insert three 3/8" x 16 N.C. capscrews, 2 1/2" long, in the three holes in the clutch cover plate (Fig. E-1). Relieve the pressure between the pressure plate and the clutch plate by tightening the capscrews a few turns.

NOTE: If capscrews are not available insert small blocks of wood about 3/8" thick between rim of cover plate and each release lever (Fig. E-2). This will hold the clutch springs partially compressed and permit easier removal of the cover plate.

If same cover plate and flywheel are to be rein-

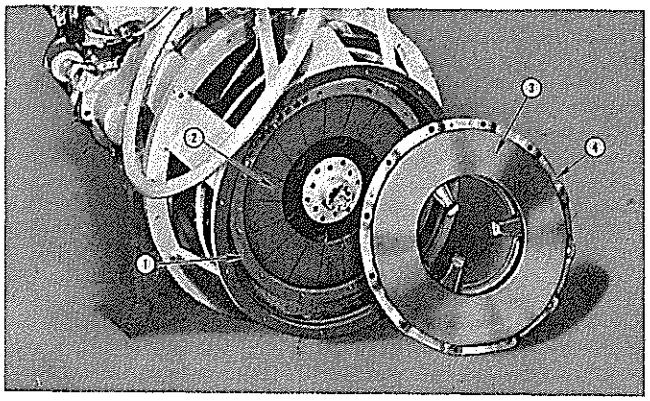


FIGURE E-3. COVER AND PRESSURE PLATE REMOVED

1. Flywheel
2. Clutch Plate
3. Pressure Plate
4. Cover

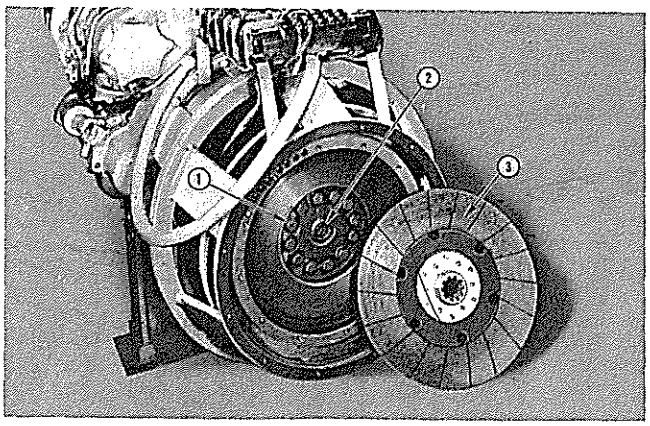


FIGURE E-4. CLUTCH PLATE REMOVED

1. Flywheel Mounting Capscrews
2. Pilot Bearing
3. Clutch Plate

stalled, punch mark them to insure their being reassembled in the same relative positions.

Remove capscrews from around circumference of cover plate (Fig. E-3), and lift off cover plate, and pressure plate with levers and springs.

Punch mark pressure plate and cover plate to insure reassembly in same positions.

Pull clutch plate from flywheel (Fig. E-4).

Take out capscrews and remove secondary flywheel (if necessary).

Check condition of pilot bearing in secondary flywheel.

Disassembly

Position three steel blocks 3/8" square, on arbor or drill press table to keep the clutch pressure plate raised. Place cover plate and pressure plate assembly in the arbor or drill press, over the steel blocks, with cover plate up. Lay a heavy block of wood or a piece of steel across the cover plate as shown in Fig. E-5). The block should be long enough to reach across the entire top of the cover plate and narrow enough to prevent interference with the tips of the release levers.

NOTE: If a suitable press is not available, an alternative would be the use of a 5/8" bolt, at least 8" long, extending up through a hole in the work bench through the center of the clutch and through a heavy block of wood lying across the top of the clutch. Then by drawing down on the nut on the bolt, the assembly may be compressed or released very gradually. The three steel blocks must be positioned as with the press.

Using either the press or the bolt, compress the assembly slightly and remove the lever adjusting screw locknuts.

With a screw driver turn each lever adjusting screw down (clockwise) a few turns, after which release the spring tension a small amount, repeating these operations until each of the lever adjusting screws are entirely free from the cover plate. Release remaining spring tension and lift cover plate from pressure springs.

Pressure springs may now be removed. Then remove release levers after extracting cotter pins and lever pins (Fig. E-6).

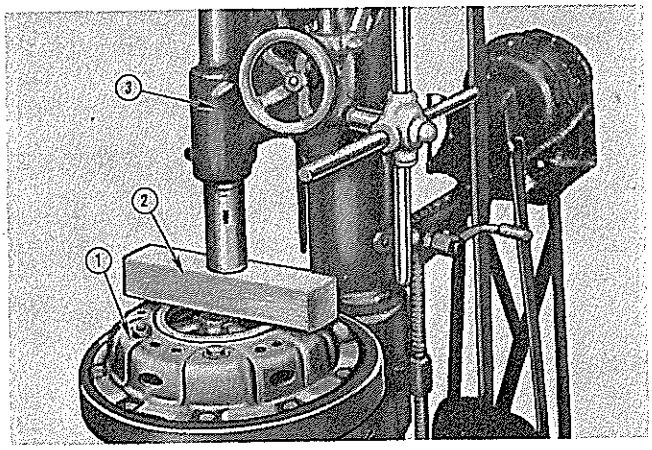


FIGURE E-5. RELEASING SPRING PRESSURE
1. Clutch Cover 2. Block 3. Press

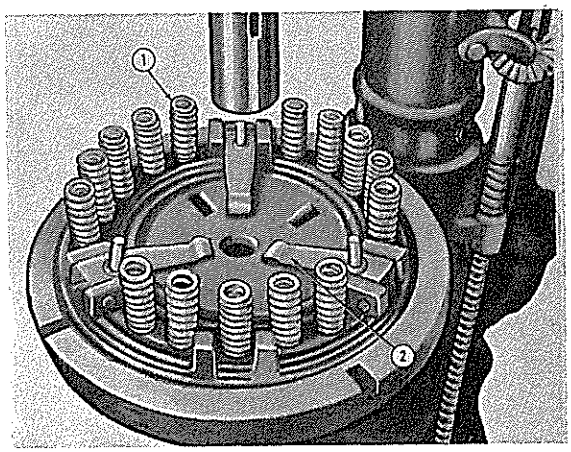


FIGURE E-6. COVER REMOVED
1. Pressure Springs 2. Release Levers

Reassembly

With the clutch entirely dismantled all parts should be inspected carefully for defects, and replacement made of any parts which show wear.

It is always advisable to replace pressure springs when the clutch is dismantled after considerable service or if there has been any great amount of slippage creating excessive heat, which may cause springs to lose their initial strength.

The pressure plate should be replaced if cracked, heat checked, or warped by excessive heat from slippage. Check for wear at lever pin holes in support bosses, also for wear on inside of drive bosses contacted by indentations of cover plate.

If the engaging surface of the clutch pressure plate should become warped or excessively checked from wear or heat, it is recommended that the pressure plate be replaced. However, in the event that the part is not immediately available, it is permissible, as a temporary measure, to machine off the engaging surface to obtain full contact with the lined disc.

The maximum amount of stock that can be removed from the face of the clutch pressure plate is 1/16". When the face is machined off, washers or shims the same thickness as the amount machined off the pressure plate, should be added under the springs to compensate for the loss of height. For instance, if 0.015" is taken off the pressure plate, 0.015" in shims should be added under the springs.

If necessary, the clutch engaging surface of the flywheel can also be machined off to eliminate warpage or heat checks. If the flywheel is the fabricated type and is glazed, a regular machine tool may not cut through the glaze and it may be neces-

sary to do the work on a grinder. The maximum amount of stock that should be removed from the flywheel is also 1/16".

After machining the engaging surface, the clutch assembly mounting surface of the flywheel must be machined off an equal amount so that the clutch assembly will be properly positioned in relation to the flywheel.

In the machining operation use extreme care to leave a 1/64" radius at the junction of the clutch contact surface and clutch assembly mounting stock of the flywheel, as shown in Fig. E-7.

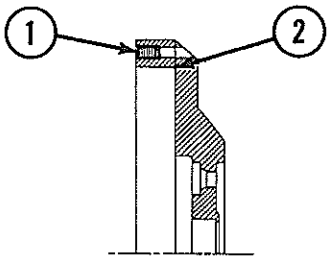


FIGURE E-7. CLUTCH FLYWHEEL

1. Clutch Mounting Surface
2. 1/64" Radius

If the flywheel body is badly warped, it will be unusable but if only slightly warped, the engaging surface can be reworked but it will also be necessary to static balance the flywheel after machining as it will have a whipping action if it is unbalanced. This, of course, would be transmitted to the generator and engine causing premature wear and failure to their component parts.

Cover plate should be replaced if damaged or distorted. Check for wear at indentations which register between drive bosses on pressure plate, also check for defective threads in holes accommodating release lever adjusting screws.

Replace lever pins which show wear. Apply a small amount of heavy oil or grease to shank of pin.

Release lever is serviced as a sub-assembly only, comprised of release lever spring and lever spring retaining pin. Replace release lever assemblies which show signs of wear where contacted by release bearing, worn threads on adjusting screw, or where binding appears to be present which retards free back and forth movement of adjusting screw. A small amount of heavy oil or grease should be applied to lever around the base of adjusting screw. If release levers are badly worn on tips, be sure to check for a sticking clutch release bearing. Replace any adjusting screw locknuts which have damaged threads.

Mount release lever assemblies to pressure plate with release lever pins and insert cotter pins. Place pressure plate with assembled release levers on three equally spaced steel blocks 3/8" thick so that pressure plate will be high enough from surface of the press plate or bench to permit proper assembly with cover plate and other parts.

Place pressure springs in position on the pressure plate as shown in Fig. E-5.

Next lay cover plate over springs, being sure to line it up properly so that all springs are seated on bosses of pressure plate and around indentations on top of cover plate. At this point also line up punch marks on cover plate and pressure plate.

Now compress the assembly slowly, lining up the lever adjusting screws with the threaded holes in the cover plate. Be sure that the indentations inside the cover plate freely enter the spaces between the drive bosses on the pressure plate. Compress sufficiently to permit threading each adjusting screw a short distance up into threaded holes of cover plate. Continue to compress assembly a small amount and turn up adjusting screws into cover plate a few turns, each one the same amount until the adjusting screws project up through the back plate about 1/2". Hold assembly compressed and turn on lock nuts, but do not tighten.

Depress the levers several times to insure all functional parts settling into the correct operating position.

Before releasing the press, either insert the 3/8" x 16 NC capscrews in the cover plate or place the three blocks of wood between the release levers and the cover plate to hold the clutch release springs partially compressed. Release pressure from clutch.

Mount clutch cover plate and pressure plate on flywheel using three pieces of 7/16" key stock placed under each lever and between the pressure plate end the flywheel (in place of the driven plate).

Turn down mounting capscrews evenly, a few turns at a time, until the clutch assembly is tight against flywheel.

Remove wood blocks from between release levers and clutch cover plate, or the capscrews holding the spring compressed (whichever was used). Place a steel rule or straight edge across the top of the cover plate and turn each lever adjusting screw in the proper direction to bring distance from the tip of lever to bottom of straight edge to 27/32".

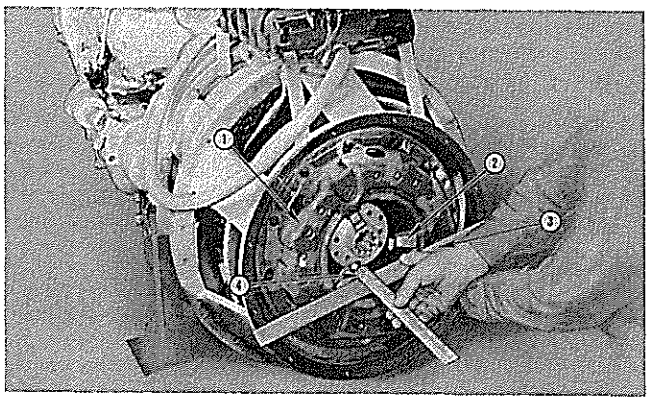


FIGURE E-8. ADJUSTING CLUTCH

1. Cover
2. Release Lever
3. Straight Edge
4. 27/32"

Tighten each locknut to lock the adjusting screw in position. Work levers manually a few times to be sure they are not binding. Be sure that all release levers are adjusted uniformly. Recheck distance after tightening locknuts.

Replace wood blocks between clutch cover plate and release levers. Remove cover plate and pressure plate from flywheel. Remove three pieces of bar stock. Replace driven plate and install the clutch on flywheel. Align punch marks on cover plate and flywheel. Use bar guide (Fig. E-9), if available in aligning driven plate. Secure cover to flywheel tightening capscrews evenly.

Reinstall engine, generator and clutch into case. Complete reassembly of machine.

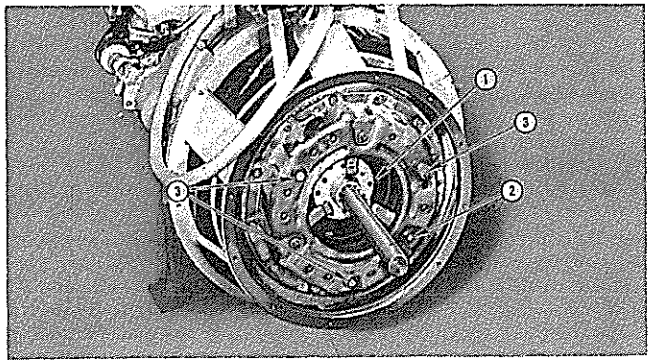


FIGURE E-9. ALIGNING CLUTCH DISC

1. Clutch Plate
2. Bar Guide
3. Hold Down Bolts

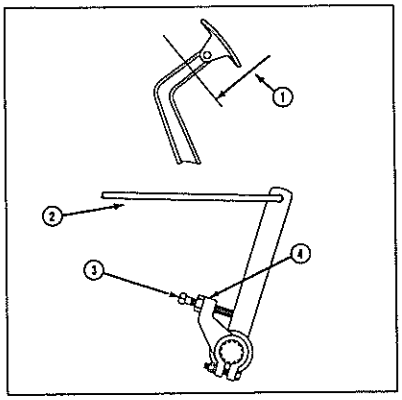


FIGURE E-10. ADJUSTING CLUTCH PEDAL

1. Free Play
2. To Clutch Pedal
3. Setscrew
4. Locknut

Clutch Pedal Adjustment

Clutch pedal movement is adjusted by moving the setscrew on the clutch release lever either in or out.

The clutch pedal should have approximately 1½" free movement (downward) before beginning to disengage the clutch.

Loosen the locknut and turn setscrew either in or out to obtain the proper pedal movement. Tighten locknut after obtaining proper adjustment.

The 1½" free movement will result in approximately 1/16" clearance between the face of the release bearing and the tips of the release levers. This measurement is important to prevent clutch slippage and damage to release bearing and levers.

TROUBLE SHOOTING

TROUBLE: Slipping.

CAUSE: Improper pedal adjustment.
REMEDY: Adjust to provide free pedal travel of 1" to 1½".

CAUSE: Oil soaked clutch facings, badly worn or damaged facings.
REMEDY: Replace driven plate.

CAUSE: Sticking pressure plate.
REMEDY: Check release levers for free action, also check fit between the cover plate indentations and drive bosses on pressure plate.

CAUSE: Weak pressure springs.
REMEDY: Replace pressure springs.

CAUSE: Sticking release sleeve, sticking cross shaft on which release yoke is mounted, or retarded return travel of clutch pedal.
REMEDY: Clean and lubricate bearing surfaces on release sleeve and cross shaft. Check clutch pedal movement and pedal return spring.

CAUSE: Distorted pressure plate.
REMEDY: Replace pressure plate:

CAUSE: Defective, worn or glazed clutch facings.
REMEDY: Replace driven plate.

CAUSE: Sticking pressure plate.
REMEDY: Check release levers for free action, also check fit between cover plate indentations and drive bosses on pressure plate.

TROUBLE: Chattering

CAUSE: Bent or badly worn driven plate.
REMEDY: Replace driven plate.

CAUSE: Oily clutch facings or facings which have become flaky from heat.
REMEDY: Replace driven plate.

TROUBLE: Dragging

CAUSE: Excessive free travel of clutch pedal. Badly worn levers or other release mechanism parts. Defective or damaged splines.
REMEDY: Adjust clutch pedal travel to 1½". Replace worn parts.

CLUTCH (Rockford 15")

Adjustment

The 15" Rockford clutch assembly is a single plate, dry disc type, pre-set at the factory and is self-adjusting to compensate for lining wear. The clutch pedal linkage must be adjusted periodically to maintain correct free pedal travel of 1½ inches.

Engaging screws located in the ends of the lever assemblies (or fingers) have tapered threads and are pre-set at the factory.

If one of these screws should become loose, it will be necessary to turn it further into the lever until it is once again tight. Using a dial indicator, check to make certain that the engaging surfaces of all three screws are on an even plane within .020". If this reading is not obtained, turn the screw (or screws) in until proper adjustment has been made. **Never back out** screws, as they will become loose and work out of the lever.

When installing a new lever assembly, follow the above procedure to assure uniform engagement and release of clutch.

For the function, removal, disassembly, reassembly, and pedal adjustment of this clutch, refer to page E-5.

TRANSMISSION

INDEX

TRANSMISSION

The transmission is a selective gear type, providing five forward speeds and one in reverse. The gear sets constituting the three top speeds are of the helix type and operate constantly in mesh. The different speeds are engaged by sliding clutch gears which require a relatively short shift. First, second, and reverse speed gears are of the straight spur type requiring a slightly longer shift for complete engagement.

The engaging ends of all shifting members are bullet form chamfered to prevent chipping and to facilitate shifting. All gears and shafts are made of heat treated, high grade alloy steel.

REMOVAL

Remove hood, radiator and cockpit. Drain lubricant from final drive compartment and remove fuel tank and battery box.

Remove engine, generator, clutch, and transmission as a unit (see Section "C"). Place on stand for further disassembly.

Support transmission with chain hoist. Remove capscrews securing transmission bell housing to generator end bell. Pull transmission straight away from generator. Care must be taken to see that the transmission drive shaft clears the clutch disc. Position transmission on stand or bench for further disassembly.

DISASSEMBLY

Drain lubricant from transmission case. Clean exterior of case thoroughly. It is important that no dirt or foreign matter be allowed to enter the case. Dirt is particularly harmful to bearings, sleeves, and bushings.

Adaptor

Remove setscrew locking pinion retainer nut in place on transmission mainshaft (Fig. F-1). Using the special wrench provided in the tool kit, back the retainer nut from the mainshaft. Remove spacer from inside pinion.

Pull pinion from adaptor. As pinion is withdrawn, the outer bearing cone and spacer will remain on pinion hub. Remove spacer and bearing cone from pinion hub.

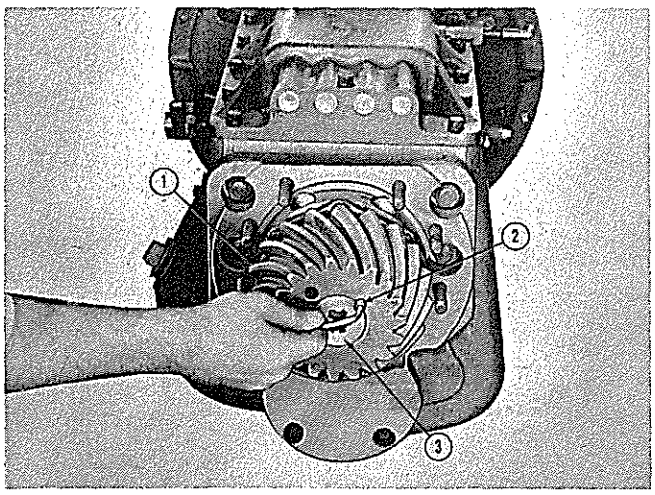


FIGURE F-1. REMOVING SETSCREW

1. Pinion 2. Setscrew 3. Retainer Nut

Remove the four capscrews and ferrules, and the four nuts securing the adaptor to the transmission case. Remove adaptor and gasket.

Remove capscrews securing bearing retainer to adaptor, and remove retainer. Press inner bearing cone and bearing cup from bore of adaptor.

Remove bushing and double oil seal from over transmission mainshaft.

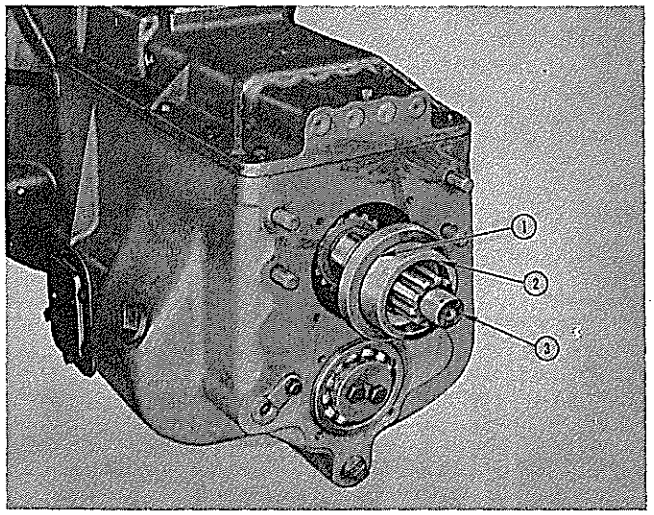


FIGURE F-2. REMOVING SPACER

1. Oil Seals 2. Spacer 3. Mainshaft

Transmission

SHIFT LEVER

Shift the transmission into neutral position. Remove capscrews by which shift lever assembly is attached to the shifting bar housing, and lift off shift lever assembly.

Remove ball from upper end of lever. Remove machine screw and lockwasher by which the boot and dust bell are attached to shift lever and force the dust bell upward and off the lever.

Place the shift lever housing in a vise with bottom of housing up. Remove shift lever tension spring by twisting a heavy screw driver between it and the housing. The spring will be forced from under the retaining lugs cast into the housing (Fig.

F-3).

Remove nut and washer from the shift lever pivot pin and remove pin. Remove the tension spring washer and withdraw gear shift lever from housing.

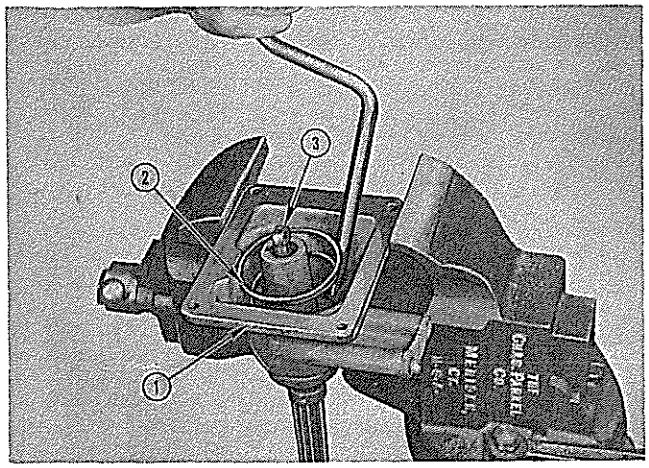


FIGURE F-3. REMOVING TENSION SPRING

1. Housing 2. Spring 3. Lever

SHIFTING BAR HOUSING

Remove the capscrews by which the assembly is attached to the transmission case. Lift the assembly from the case.

Make sure the assembly has been shifted into neutral position. This position can be identified by perfect alignment of the lever slots in the yokes and blocks (Fig. F-4).

Remove the tension spring cover and springs. Then turn the assembly with the yokes upward and jar on the floor to remove the steel balls assembled under the poppet springs.

Place the assembly in a vise with the reverse yoke uppermost and cut the lockwires. Remove lock screws from shifting yokes and bars (Fig. F-5).

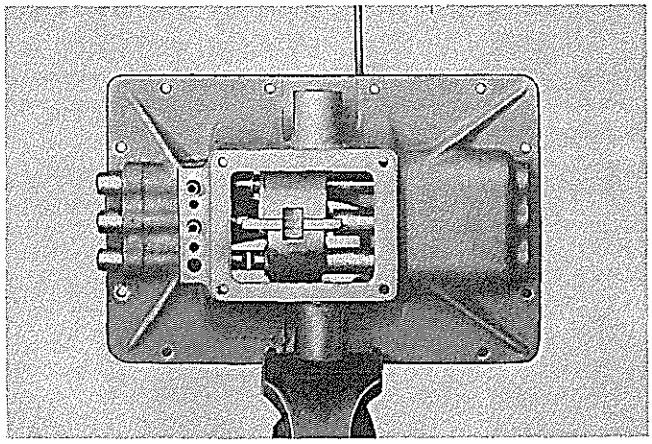


FIGURE F-4. TRANSMISSION IN NEUTRAL

Start with the upper bar and remove shifting bars in order through rear end of the housing. The welsh plugs assembled in the yoke bar holes will be driven out from the housing as the bars emerge.

NOTE: With spring tension removed from the shift-

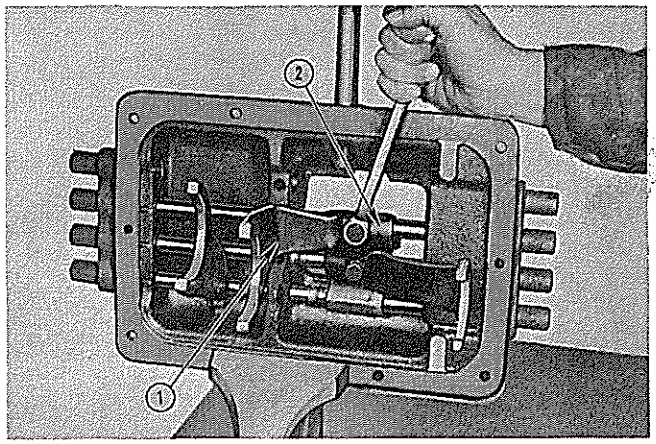


FIGURE F-5. REMOVING LOCK SCREWS

1. Shift Yoke 2. Yoke Bar

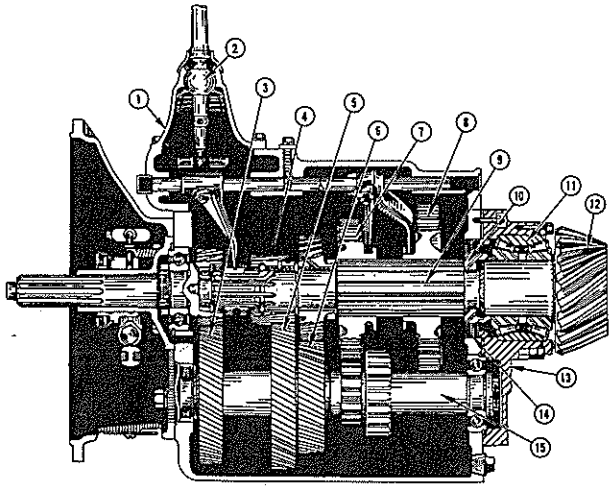


FIGURE F-6. TRANSMISSION AND ADAPTOR

1. Housing
2. Shift Lever
3. Countershaft Drive Gear
4. Mainshaft 4th Speed Gear
5. Countershaft 5th Speed Gear
6. Countershaft 3rd Speed Gear
7. 2nd Speed Sliding Gear
8. 1st Speed Sliding Gear
9. Mainshaft
10. Spacer
11. Bearing
12. Pinion
13. Adaptor
14. Oil Seal
15. Countershaft

ing bars, it may be necessary to move them by hand to the neutral position before the upper bar will move. This procedure may be necessary as each successive bar, except the last, is started from the housing.

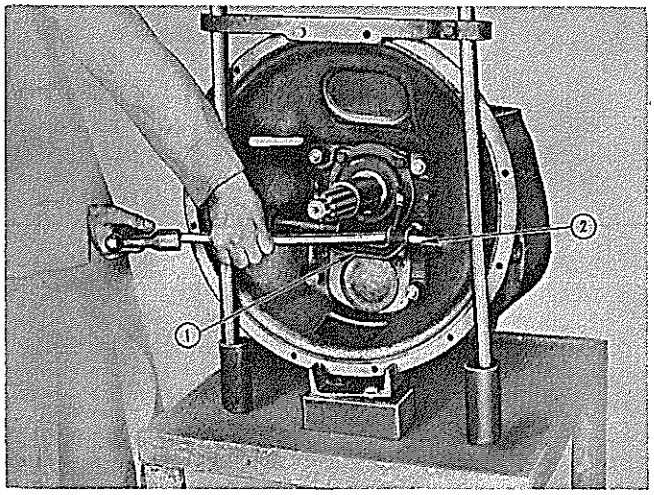


FIGURE F-7. REMOVING CLUTCH RELEASE
1. Clutch Release Yoke 2. Release Shaft

CLUTCH SHAFT AND DRIVE GEAR

Remove clutch release mechanism (Fig. F-7). Remove attaching capscrews and withdraw gear bearing cover. Do not loosen the tension spring clips which are assembled to the two upper screws.

Now, withdraw the drive gear, drive gear bearing and bearing as a unit (Fig. F-8).

Mount the gear in a vise with copper jaws. Remove bearing retaining nut. Jar or press bearing from gear shaft.

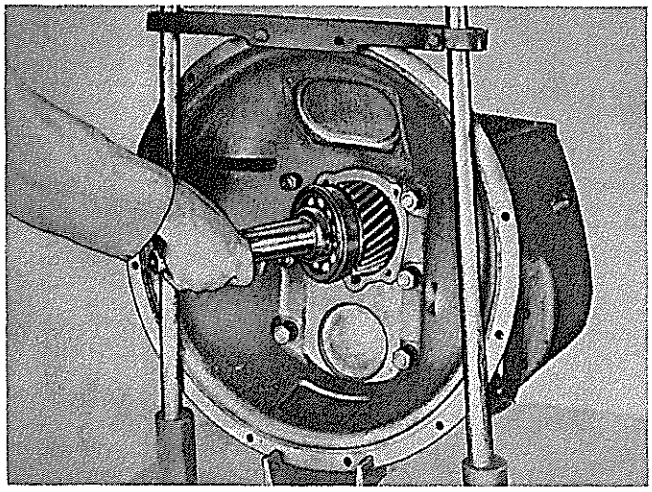


FIGURE F-8. REMOVING GEAR AND BEARING

MAINSHAFT ASSEMBLY

Shift the transmission into two speeds at once to keep the gears from turning and remove the two capscrews from the countershaft rear bearing retainer plate. Remove the retainer plate.

Pull the mainshaft assembly to the rear, tilt and remove it through the top of the case, leaving the sliding gears inside (Fig. F-9).

Remove loose sliding gears freed by removal of the shaft.

Mount the mainshaft in a vise with copper jaws. Remove pilot bearing and sliding clutch gear. Drive against the sliding clutch with a brass drift or soft hammer to free the bearing.

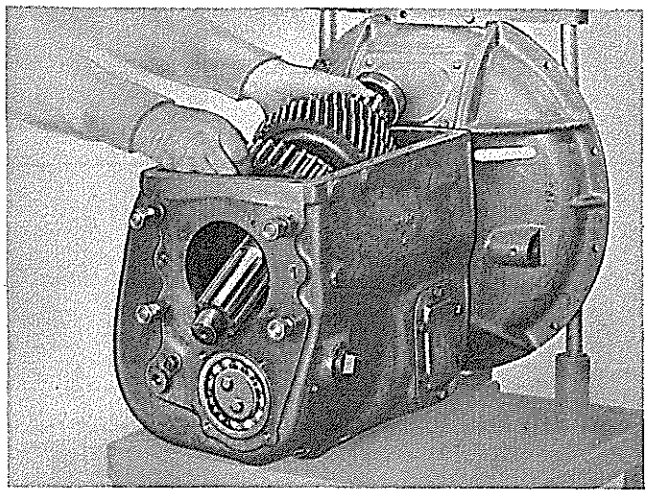


FIGURE F-9. REMOVING MAINSHAFT

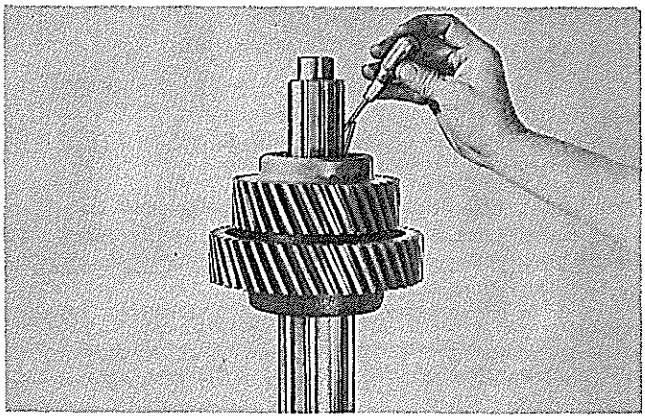


FIGURE F-10. REMOVING KEY

Pry the mainshaft gear washer key from its keyway between the splines on the pilot end of the mainshaft (Fig. F-10). Turn mainshaft gear washer in its groove until the lugs on its inside diameter line up with the grooves in the shaft and remove washer (Fig. F-11).

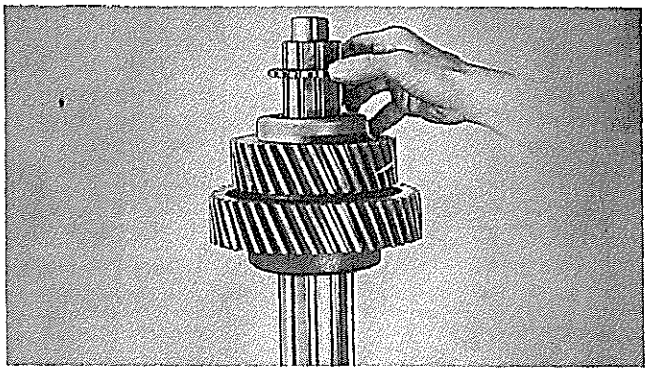


FIGURE F-11. REMOVING WASHER

Pull mainshaft gear and bushing from mainshaft.

Remove the assembly from the vise and remove the fourth speed gear sleeve from the mainshaft. Pry the sleeve key from the mainshaft. Jar the pilot end of the mainshaft against a wood block placed on the floor until the gear and bushing clears the sleeve seat on the mainshaft.

REVERSE GEARING

Remove lock from reverse idler gear shaft. Pull shaft from case and lift reverse gear and bearings

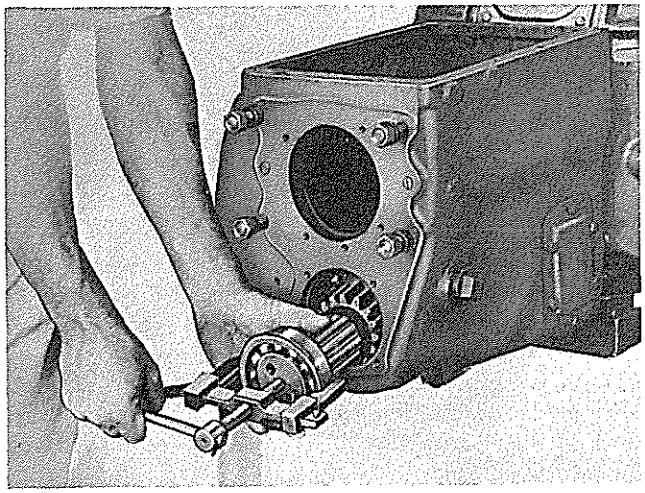


FIGURE 12. REMOVING REAR BEARING

from inside case.

NOTE: A simple puller for the reverse gear shaft may be constructed from a short piece of pipe, the inside diameter of which is slightly larger than the projecting end of the shaft: A long bolt having threads of the same number and size as those tapped into the hole in the reverse gear shaft; and a nut for the bolt and a flat piece of steel having a hole in its center sufficiently large to permit passage of the bolt. The nut is turned onto the bolt and the bolt is then passed through the plate and pipe, in that order, and turned into the reverse gear shaft. The nut is then tightened against the plate with the result that a pulling action is exerted against the shaft with the transmission case acting as a base through the pipe and plate.

COUNTERSHAFT

Attach puller to countershaft rear bearing and pull bearing (Fig. F-12).

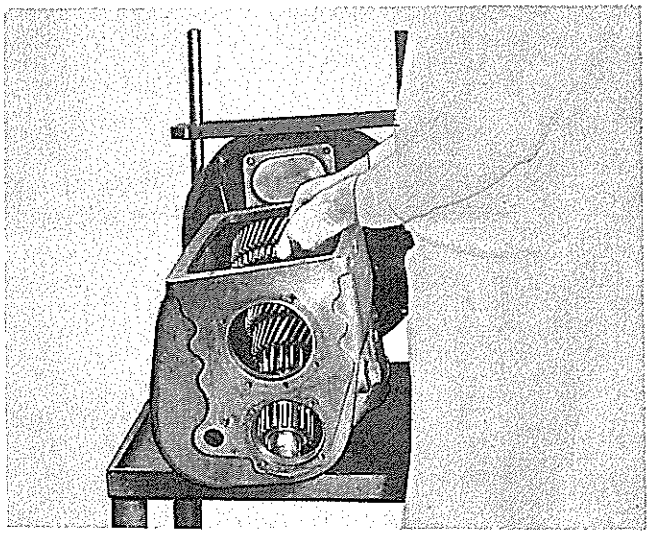


FIGURE F-13. REMOVING COUNTERSHAFT

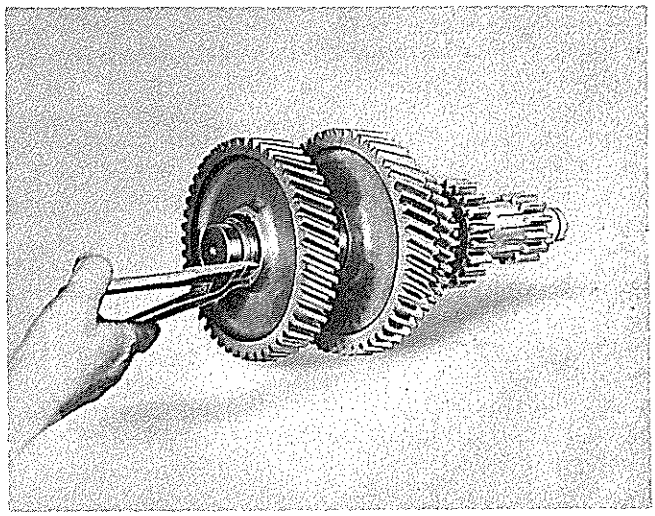


FIGURE F-14. REMOVING SNAP RING

Tilt countershaft and remove through opening at top of case as shown in Fig. F-13.

Remove capscrews securing countershaft front bearing cover to case. Remove bearing cover and countershaft front bearing.

Remove countershaft front bearing spacer, and snap ring (Fig. F-14). Press gears and spacer from shaft one at a time. Remove key from countershaft after removing each gear.

REASSEMBLY

Transmission

All bearings, thrust washers, bushings and splines should be lubricated with a light gear oil before reassembling to prevent scoring. All parts should move freely after being assembled in their proper places.

Make sure bearings are a press fit on shafts and that the outer races of these bearings fit tightly in their bores. The transmission case should be drained carefully and washed out before parts are installed. The bearings should be washed in a pressure bearing washer and examined for defects. Replace if necessary and lubricate. Examine teeth on all gears carefully. Cracked or chipped teeth, or spots where case hardening is worn through, renders gears unfit for further use and where this condition exists, the gears should be replaced.

Inspect splines on mainshaft and on main drive gear for evidence of wear. If the sliding gears or clutch hub have brinelled into the sides of the splines, replace the shaft.

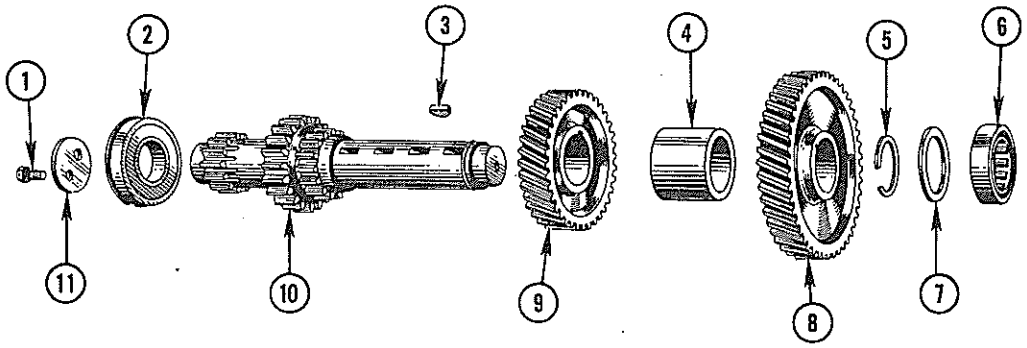


FIGURE F-15. COUNTERSHAFT, EXPLODED

1. Capscrew
2. Bearing
3. Key
4. Spacer
5. Snap Ring
6. Bearing
7. Front Bearing Spacer
8. Drive Gear
9. 3rd Speed Gear
10. Countershaft
11. Bearing Retainer

Inspect mainshaft thrust washer. If it is scored or worn down to permit excessive end play, worn parts should be replaced.

Inspect reverse idler shaft and bearings, and if found worn, they should be replaced.

Do not remove the clutch housing from transmission unless absolutely necessary. If it is detached, extreme care should be taken during reassembly to maintain the alignment between its machined face and the mainshaft bores in the case.

Replace bushings in mainshaft gears having excessive radial clearance. The following instructions will apply to installation of replacement bushings. Remove old bushings. Clear bore of gear carefully and remove all burrs. Lubricate outside diameter of bushings and inside diameter of gear. Carefully press bushing fully onto gear. Face off any projecting ends of the bushing. Drill oil holes in bushing, working through holes in gear. Remove all burrs resulting from drilling operations and break all sharp edges on ends of bushing with a bearing scraper.

Check all gaskets thoroughly and replace those damaged. Use gasket cement when reinstalling all parts which utilize gaskets.

COUNTERSHAFT

Install the gears and spacer in the same order as removed. Install new snap ring and reassemble the front bearing spacer. Now install countershaft front bearing cover, drawing capscrews up tightly. Install countershaft front bearing in bore of case. Lower the assembly into the case and insert front end of shaft into the front roller bearing. Install countershaft rear bearing.

REVERSE GEARING

To install, place the roller bearing and spacer in bore of the gear with the spacer between the bearings. Lower the reverse gear into the case with the chamfered teeth to the rear.

Install reverse idler shaft and drive it into the case, through the bearings and spacer. Replace the shaft lock and tighten the capscrew and lockwasher securing it.

MAINSHAFT

Mount the mainshaft in a vise equipped with copper jaws. Clean and oil the large mainshaft gear seat and install gear with external clutching teeth to the rear of the mainshaft.

Install fourth speed gear sleeve key and sleeve. Replace third speed gear over mainshaft and

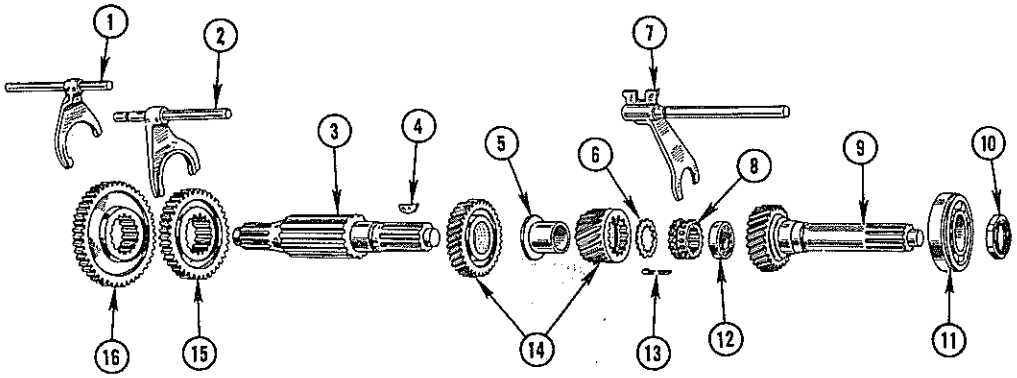


FIGURE F-16. MAINSHAFT, EXPLODED

1. 1st and Rev. Shift Yoke
2. 2nd and 3rd Shift Yoke
3. Mainshaft
4. Key
5. 4th Speed Gear Sleeve
6. 4th Speed Gear Washer
7. 5th Speed Shift Yoke
8. Mainshaft Sliding Clutch
9. Drive Shaft
10. Locknut
11. Bearing
12. Pilot Bearing
13. Key
14. Bushed Gear
15. 2nd Speed Sliding Gear
16. 1st Speed Sliding Gear

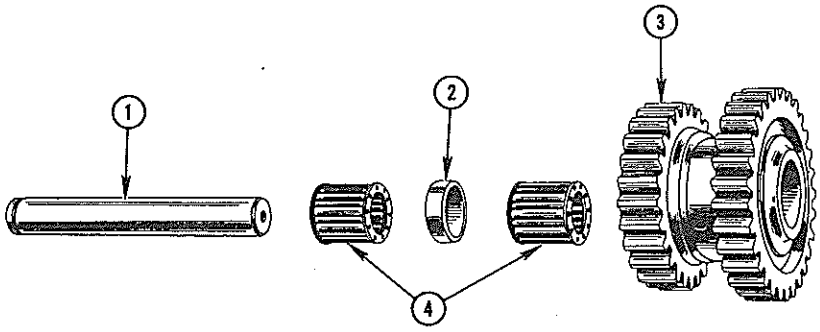


FIGURE F-17. REVERSE IDLER SHAFT, EXPLODED

1. Reverse Idler Shaft
2. Spacer
3. Reverse Gear
4. Bearing

sleeve. Install splined washer over mainshaft and into the third speed gear. Turn the washer in the groove until the lugs on its inside diameter are under the projecting splines. Install the washer key in its keyway between the splines. Install sliding clutch with the counterbore toward the bushed gears. Install the mainshaft pilot bearing. Check endplay of bushed gears by placing mainshaft upright in a vise. Position dial indicator so that indicator pad is against gear. Set dial at "0", lift up on gear to check endplay. It should be 0.006" minimum to 0.023" maximum.

Replace first and second speed sliding gears in the case. The yoke slot in the first speed gear should face the front of the transmission and the yoke slot in the second speed gear to the rear. Lower the mainshaft assembly into the case and thread the lower end into the two sliding gears. Lower the mainshaft assembly until both sliding gears are reseated on the shaft and the rear end of the shaft projects through the rear bearing bore.

Engage the teeth of the helical gears on the mainshaft with the teeth of those on the countershaft. Engage two ratios and reinstall bearing retainer plate at rear end of countershaft. Pull capscrews up tightly and replace lockwire.

CLUTCH SHAFT AND DRIVE GEAR

Press drive gear into the bearing. Install bearing locknut and peen into milled notches in the drive gear. Assemble the drive gear with bearing and nut attached in bore of case. Install the drive gear bearing cover and pull up tight with attaching capscrews. Replace the clutch release mechanism.

SHIFTING BAR HOUSING

Install shifting bars, blocks and yokes in the same order as removed, at the same time replacing in their proper position, the interlock pin and balls which prevent movement of remaining shifting bars after one has been shifted. Turn the yoke and screws tightly into place and wire securely. Install the steel balls and over them replace the yoke bar tension springs. Install the cover over the yoke bar tension springs.

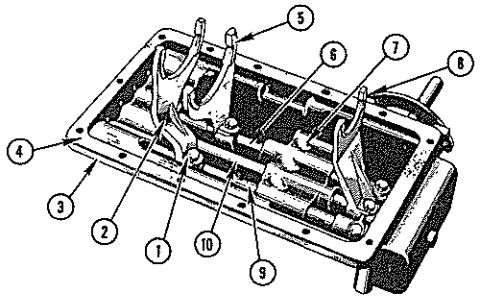


FIGURE F-18. SHIFT BAR HOUSING

1. Lockscrew
2. 1st and Rev. Shift Yoke
3. Housing
4. Gasket
5. 2nd and 3rd Shift Yoke
6. 2nd and 3rd Yoke Bar
7. Steel Ball
8. 4th and 5th Shift Yoke
9. 4th and 5th Yoke Bar
10. 1st and Rev. Yoke Bar

NOTE: After each bar and corresponding yoke or block has been assembled, it may be necessary to move it to the neutral position before the next bar can be installed. After all parts are replaced, make sure the assembly is shifted into the neutral position. Now, move all engaging members of the transmission to the neutral position. Install cover making sure that the shifting yokes enter the yoke slots of the sliding gears. Replace capscrews and tighten evenly.

GEAR SHIFT LEVER

Mount the housing in a vise with large opening upward making sure that the gear shift lever pivot pin is in place and securely tightened.

Install the shift lever so that the slot in the side of the pivot ball engages the pivot pin in the housing. Install tension washer and spring in the order named. Remove the partially completed assembly from the vise and install dust cover and grip. Tighten securely the screw by which the dust cover is attached.

Shift the transmission into the neutral position and place the assembly on the transmission making sure the lower end of the lever enters the lever notch milled into the yokes. Replace capscrews and tighten securely.

Adaptor

Install bushing and oil seals over transmission mainshaft. Lip of inside oil seal must be pointing in; lip of outside oil seal must be pointing out.

Replace adaptor gasket and adaptor on transmission and tighten capscrews and nuts. Torque 5/8" nuts to 190 ft. lbs. It will be necessary to replace the four ferrules in the tapered seats of the countersunk capscrew holes when reassembling the transmission and adaptor.

Some ring gear and pinion sets may require the use of shims with the pinion to obtain the correct mounting distance setting.

The mounting distance will be etched on the end of the pinion preceded by the letters MD and the symbol (—), as examples; (MD —0.016) (MD 0.000). Adding shims, to total the dimension marked on the end of the pinion, between the rear of the pinion and the front of the bearing cone, will properly adjust the pinion so that it will be correctly positioned. The shims are 0.004" thickness.

The proper number of shims required are included when installing ring gear and pinion sets in machines at the factory. If a ring gear and pinion set which has shims is removed for any reason, the same shims, or the same number of shims must be used if the set is reinstalled.

Ring gear and pinion sets furnished on parts orders will have the proper number of shims included. However, when installing a pinion in a transmission adaptor, double check the MD marking to make certain the correct number of shims are installed.

Place inner bearing cone, bearing cup, and spacer into adaptor bore. See note below. Replace bearing retainer on adaptor and secure with capscrews and lockwashers. Torque capscrews to 15 ft. lbs.

Place over bearing cup on pinion hub. Insert pinion hub and bearing, over mainshaft, into adaptor.

Replace spacer and retainer nut over end of mainshaft. Tighten nut to 300 ft. lbs. torque, using special wrench. Replace locking setscrew. Centerpunch the outer edge of setscrew lightly to prevent its working out of retainer nut.

NOTE: The double row, tapered roller bearings used in this machine have the required amount of lateral (end play) built in during the assembly process by the bearing manufacturer. These bearings are made up in matched sets. Each set includes two bearing cones, a cup, and a ground spacer located between the two cones.

The bearings must be kept in matched sets and parts of one set are NOT interchangeable with any other set. Keep the parts of each set together and install in the same bore from which they were removed.

Each set is identified by a code number, the same code number is etched on the faces of cones and the cup and also on the spacer. All parts having the same code number of parts of the same bearing set.

Some bearings will have identifying letters in addition to the set number. Bearings which have letters in addition to the code must be installed with the "A" cone in the "A" side of the cup and the "C" cone in the "C" side of the cup.

Those bearings without letters have been manufactured so that the cones can be used in either side of the cup without affecting the accuracy of the end play setting.

The bearing cones may be heated in oil to facilitate installation.

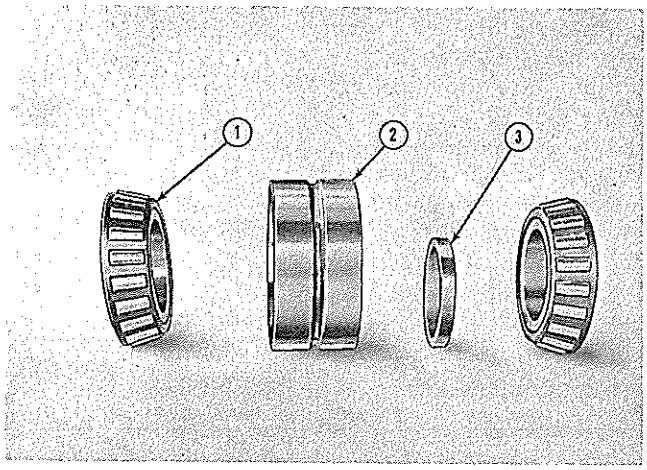


FIGURE F-19. MATCHED BEARING SET
1. Cone 2. Cup 3. Spacer

INSTALLATION

Attach hoist to transmission and raise until transmission shaft is in line with hub of clutch disc.

Move transmission forward, engaging splines on transmission shaft with splines in clutch disc hub.

Replace capscrews securing transmission bell housing to generator end bell.

Replace engine, generator, clutch and transmission in Tournapull case and complete reassembly of machine.

Refer to Section "G" of this manual for procedure on adjusting back lash.

Fill transmission with correct amount and type of lubricant. See Section "K" of this manual.

TROUBLE SHOOTING

TROUBLE: Difficult gear shifting

CAUSE: Transmission oil heavier than that which is recommended.

REMEDY: Drain and flush transmission and fill to level plug with recommended weight and type of lubricant.

CAUSE: Shifting yoke slots worn.

REMEDY: Replace shifting yokes.

CAUSE: Gear shift lever worn.

REMEDY: Replace shift lever.

TROUBLE: Transmission gear interference.

CAUSE: Shifting yokes may be sprung.

REMEDY: Replace shifting yokes.

CAUSE: Transmission shafts have excessive end play.

REMEDY: If end play is in mainshaft, adjust mainshaft bearings. If end play is in countershaft, correct end play by tightening bearing locknut, replacing bearings, etc., depending upon need.

CAUSE: Small interlock pin or balls in shifting bar housing worn, broken or omitted when transmission was last assembled.

REMEDY: Assemble new interlock pin or balls in shifting bar housing.

TROUBLE: Transmission won't stay in gear.

CAUSE: Small steel balls and springs omitted from above shifting bars in shifting bar housing.

REMEDY: Install balls and springs in position in shifting bar housing.

CAUSE: Operator not moving gear shift lever fully into gear.

REMEDY: Move gear shift lever all the way forward or to the rear when shifting gears.

TRANSMISSION

FULLER 5G-720

The transmission is a selective gear type, providing five forward and one reverse speed. The gear sets are of the straight spur type, and through the use of a clutch brake geared to the countershaft, permit easier and faster shifting without the loss of machine momentum. Operation of this air actuated brake is controlled by a pre-select button mounted below the instrument panel. (Fig. S-1).

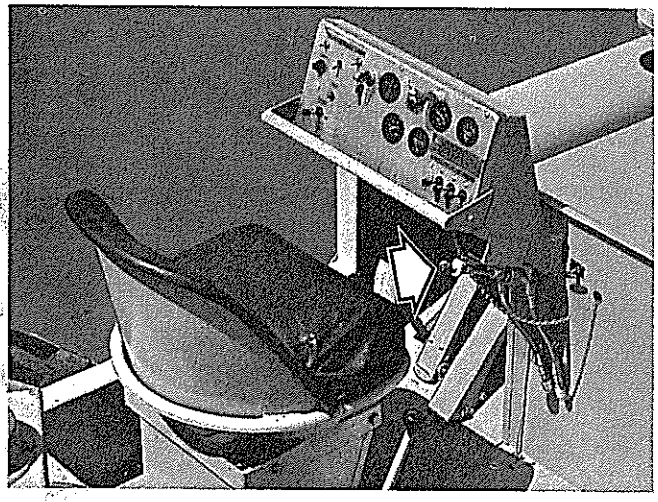


FIGURE S-1. PRE-SELECT BUTTON

When up shifting, pre-select button is depressed and air enters the line up to the trigger valve. This valve is normally closed when transmission is in gear. As shift lever is moved into neutral position, the trigger valve opens, releasing air to and actuating the clutch brake.

Application time of the brake is regulated automatically by a tripping valve and surge chamber located in the lines between the trigger valve and the clutch brake. The surge chamber, due to its physical proportion, causes a time lag in the build up of line pressure returning to the tripping valve. The tripping valve closes the pre-select valve and in turn discharges the system, releasing the clutch brake.

Following are some suggested practices for the operator when shifting from one gear to another. The actual shifting procedure to be followed depends upon the operator's technique which will improve with practice.

Always disengage the clutch completely before changing gears.

A clutch brake is mounted on the transmission countershaft to aid in shifting gears. This clutch brake is to be used only when shifting the transmission into a higher gear. Do not use when down shifting.

To shift out of neutral into 1st speed forward or reverse, use the following procedure. Depress the clutch pedal to disengage the flywheel clutch. Push in on the clutch brake pre-select button. Shift the transmission into 1st or reverse immediately after pushing in on the pre-select button, then release the clutch pedal. This is necessary as the clutch brake is only applied momentarily while the transmission is in neutral.

To up shift to a higher travel speed, use the following procedure. Push in on the clutch brake pre-select button. Depress clutch pedal. Shift the transmission shift lever into the desired position, and release the clutch.

To down shift to a lower travel speed, it is necessary to "double clutch" as described on page A-8.

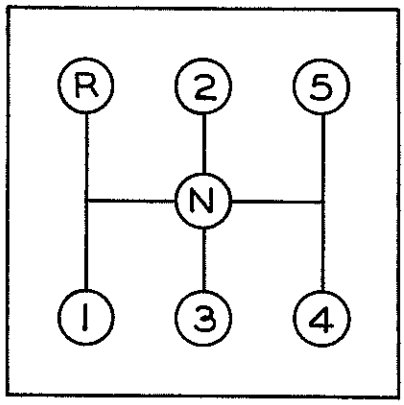


FIGURE S-2. SHIFTING DIAGRAM

The shifting diagram (Fig. S-2) shows the various positions of the gear shift lever used to obtain the different gear ratios.

Removal

Remove hood, radiator and cockpit. Drain the lubricant from final drive compartment and remove fuel tank and battery box.

Remove engine, generator, clutch, and transmission as a unit (see Section "D"). Place on stand for further disassembly.

Support transmission with chain hoist. Remove capscrews securing the transmission bell housing to generator end bell. Pull transmission straight away from generator. Care must be taken to see that the transmission drive shaft clears clutch disc. Position transmission on stand or bench for further disassembly.

Drain lubricant from transmission case. Clean exterior of case thoroughly. It is important that no dirt or foreign matter be allowed to enter the case. Dirt is particularly harmful to bearings, sleeves and bushings.

Disassembly

ADAPTOR

Remove setscrew locking pinion retainer nut in place on the transmission mainshaft (Fig. S-3). Using the special wrench provided in the tool kit, back the retainer nut from the mainshaft. Remove spacer from inside the pinion.

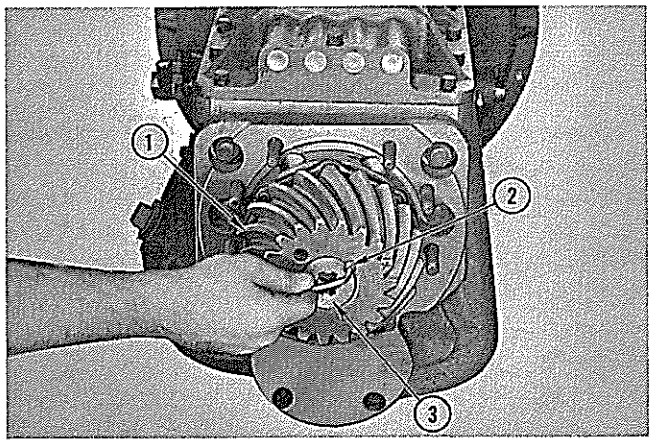


FIGURE S-3. REMOVING SETSCREW
1. Pinion 2. Setscrew 3. Retainer Nut

Pull pinion from adaptor. As pinion is withdrawn, the outer bearing cone and spacer will remain on pinion hub. Remove spacer and bearing cone from pinion hub (Fig. S-4).

Remove the four capscrews and ferrules, and the four nuts securing the adaptor to the transmission case. Remove adaptor and gasket.

Remove capscrews securing bearing retainer to adaptor, and remove retainer. Press inner bearing cone, bearing cup, and double oil seal from bore of adaptor (Fig. S-5).

Remove spacer from transmission mainshaft.

SHIFT LEVER

Shift the transmission into neutral position. Remove capscrews by which shift lever assembly is attached to the shifting bar housing and lift off shift lever assembly.

Remove knob ball from upper end of lever. Remove the machine screw and lockwasher by which the boot and dust bell are attached to shift lever and force the dust bell upward and off the lever.

Place the shift lever housing in a vise with bottom of housing up. Remove the shift lever tension spring by twisting heavy screwdriver between it and the housing. The spring will be forced from under the retaining lugs cast into the housing (Fig. S-6).

Remove the nut and washer from shift lever pivot pin and remove pin. Remove tension spring washer and withdraw gear shift lever from housing.

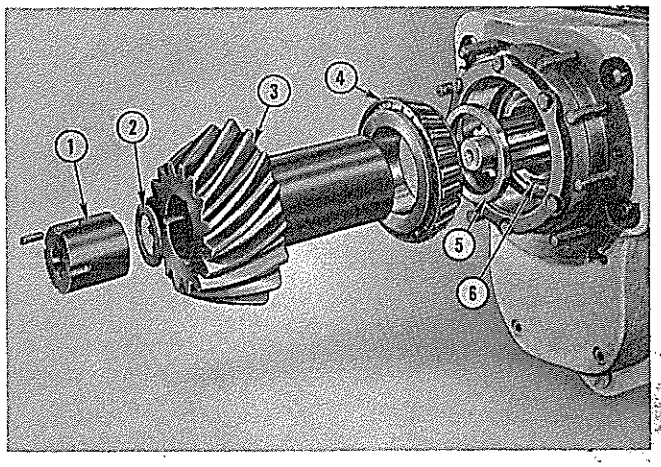


FIGURE S-4. PINION REMOVED
1. Retainer Nut
2. Washer
3. Pinion
4. Outer Bearing Cone
5. Spacer
6. Inner Bearing Cone

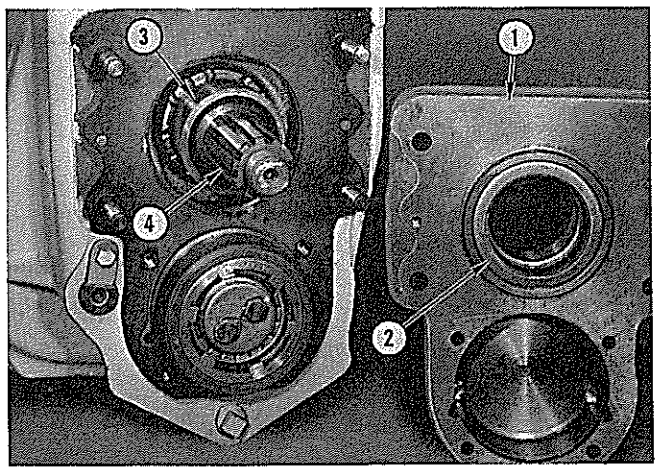


FIGURE S-5. REMOVING ADAPTOR
1. Adaptor
2. Oil Seals
3. Spacer
4. Mainshaft

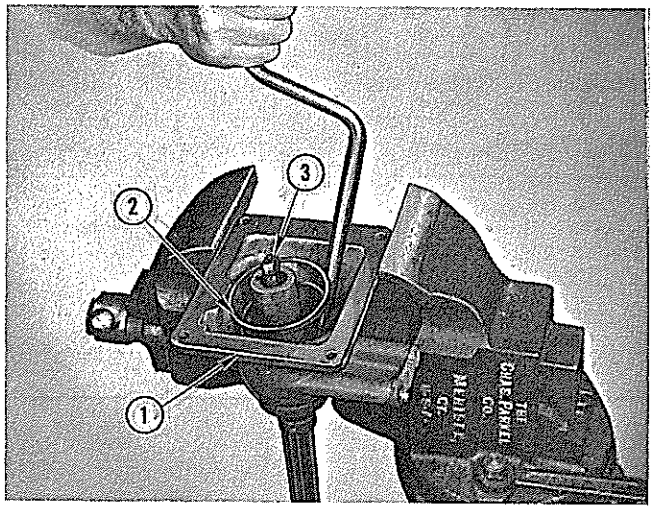


FIGURE S-6. REMOVING TENSION SPRING
1. Housing 2. Spring 3. Lever

SHIFTING BAR HOUSING

Disconnect hoses from surge chamber, clutch brake and trigger valve. Remove capscrews securing the trigger valve to housing and remove valve (Fig. S-7).

Remove the capscrews by which the shifter bar housing is attached to the transmission case and remove surge chamber. Lift shifter bar housing assembly from the case.

Make sure the assembly has been shifted into neutral position. This position can be identified by perfect alignment of the lever slots in the yokes and blocks.

Remove the tension spring cover and springs. Turn the assembly over to remove poppets (steel balls) assembled under the poppet springs (Fig. S-8).

Place the assembly in a vise with the first and reverse yoke uppermost and cut the lockwires. Remove the lockscrews from shifting yokes and bars.

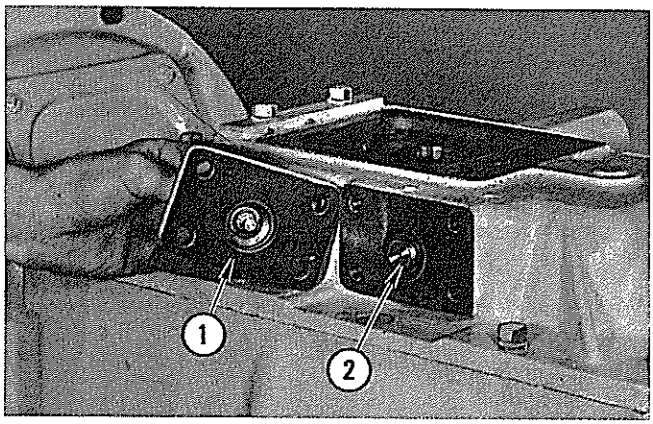


FIGURE S-7. REMOVING TRIGGER VALVE
1. Trigger Valve 2. Actuating Plunger

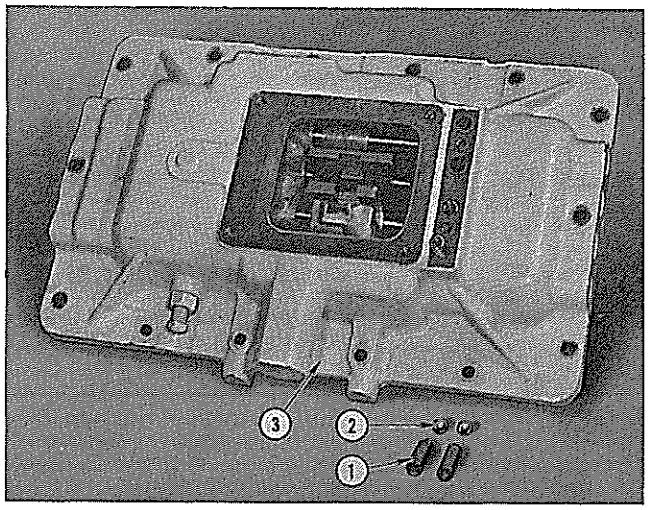


FIGURE S-8. REMOVING POPPET SPRINGS AND BALLS
1. Springs 2. Steel Balls 3. Shifter Housing

Remove the welch plugs, and starting with the first and reverse yoke bar, remove the shifting bars, yokes, and blocks in order (Fig. S-9). As each successive bar is removed, it will be necessary to locate the trigger valve actuating plunger so that the bar is free to move. This is done by pushing in, against spring tension, on the plunger located on the outside edge of the housing. When removing fourth and fifth speed shifter bar, use care so that the small interlock pin in this bar does not drop out. Remove the trigger valve actuating plunger.

After all the shifter bars have been removed, two steel balls may be removed from the interlock cross hole in the housing.

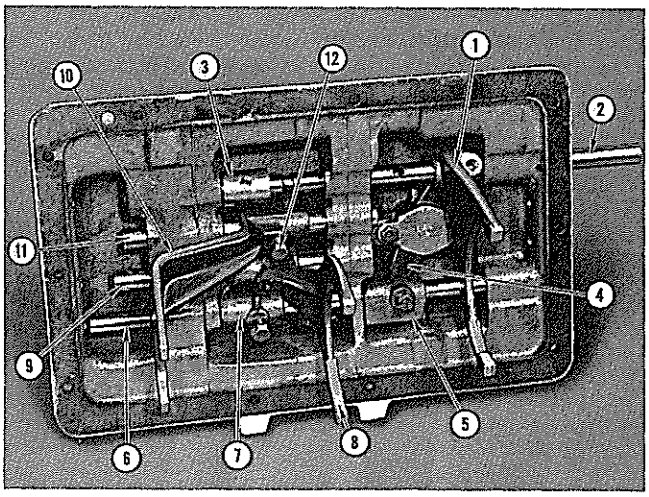


FIGURE S-9. REMOVING SHIFTER YOKES AND BARS
1. 1st and Reverse Yoke
2. 1st and Reverse Yoke Bar
3. 1st and Reverse Yoke Bar Block
4. 1st and Reverse Cross-over Lever
5. 1st and Reverse Cross-over Shifter Block
6. 1st and Reverse Shifter Bar
7. 1st and Reverse Shifter Block
8. 2nd and 3rd Yoke
9. 2nd and 3rd Yoke Bar
10. 4th and 5th Yoke
11. 4th and 5th Yoke Bar
12. Lockscrew

CLUTCH SHAFT AND DRIVE GEAR

Remove clutch release mechanism. As the shaft is driven out, two keys must be removed from the shaft before removing shaft from housing (Fig. S-10). Remove capscrews and withdraw gear bearing cover. Remove oil seal from cover only if damaged. Drive gear and drive gear bearing can then be removed as a unit.

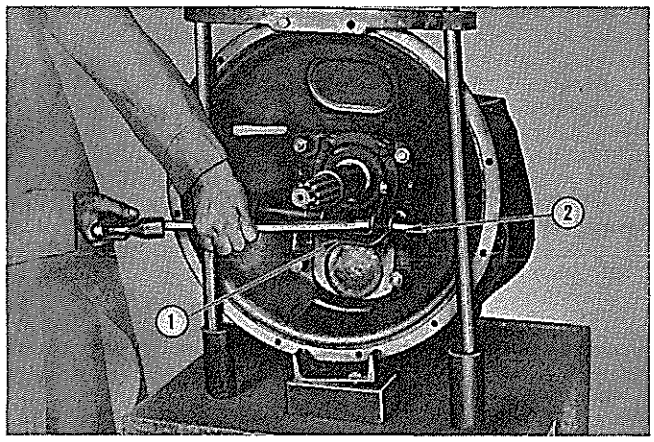


FIGURE S-10. REMOVING CLUTCH RELEASE

1. Clutch Release Yoke
2. Release Shaft

Mount the gear in a vise with copper jaws. Remove the bearing retaining nut and press the bearing from gear shaft. (Fig. S-11). Use special tool provided for removal of **lefthand** threaded nut. Examine piston rings in nut and replace if worn or damaged.

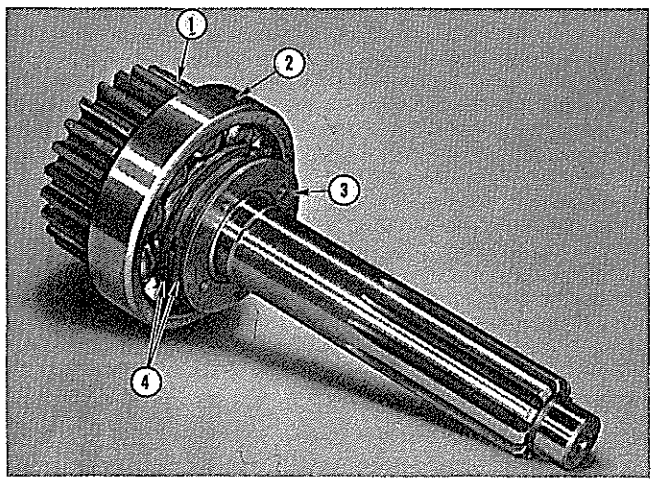


FIGURE S-11. CLUTCH SHAFT AND DRIVE GEAR

1. Drive Gear and Shaft
2. Bearing
3. Nut
4. Piston Rings

MAINSHAFT ASSEMBLY

Shift the transmission into two speeds at once to keep the gears from turning. Cut lockwire and remove two capscrews from the countershaft rear bearing retaining plate and remove plate (Fig. S-12).

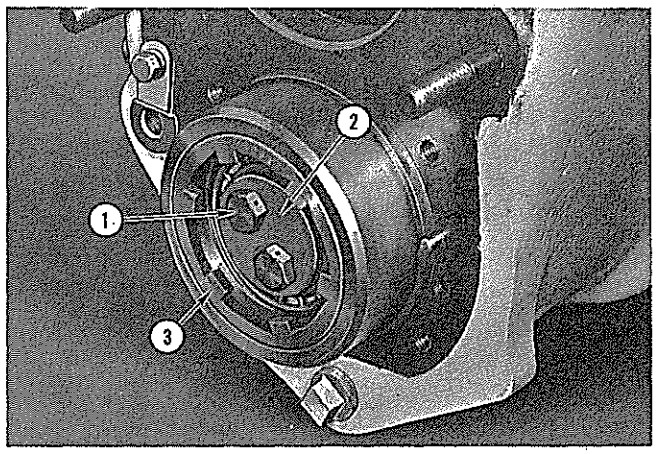


FIGURE S-12. RETAINING PLATE AND CAPSCREWS

1. Capscrews
2. Retaining Plate
3. Bearing Retainer Nut

Pull mainshaft assembly to the rear, tilt and remove it through top of case. Remove two sliding gears from rear of shaft.

Mount the mainshaft assembly in a vise with copper jaws. Remove pilot bearing, slots are provided for puller use in the splines of the mainshaft. Remove sliding clutch gear (Fig. S-13).

To remove the overdrive gear from mainshaft, pry the key from its keyway between the splines, on the pilot bearing end of the mainshaft. Rotate the splined washer in its groove on mainshaft until the splines on its inner diameter line up with the splines on the shaft. Slide the washer out, turning the overdrive gear so that the splines on the outer diameter of the washer clear the clutching teeth on the inside of the gear. Slide the washer from the mainshaft and remove the overdrive gear.

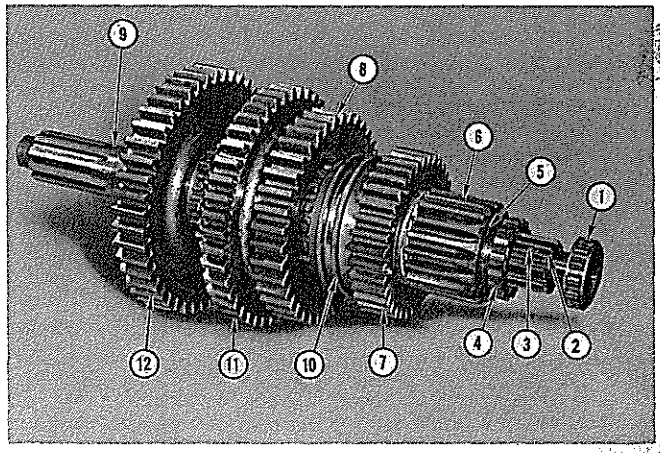


FIGURE S-13. REMOVING MAINSHAFT PILOT BEARING

1. Pilot Bearing
2. Slot for Puller
3. Key
4. Sliding Gear
5. Splined Washer
6. Mainshaft 4th Speed Gear
7. Mainshaft 3rd Speed Gear
8. Mainshaft 2nd Speed Gear
9. Mainshaft
10. Mainshaft 2nd and 3rd Speed Shifting Gear and Collar
11. 1st and Reverse Sliding Gear
12. Mainshaft 1st Speed Gear

Pull third speed gear from the mainshaft, overdrive gear flanged sleeve will come off with it.

Remove second and third speed clutch collar. Pull second speed gear from mainshaft, third speed gear sleeve and second and third speed clutch gear come off at the same time. Remove key from the mainshaft.

REVERSE GEARING

Remove lock from reverse idler gear shaft. Attach a puller to end of shaft and pull shaft free of reverse gear and bearing assembly inside case.

A simple puller for the reverse gear shaft may be constructed from the following pieces of material. A short piece of pipe, the inside diameter of which is slightly larger and longer than the projecting end of the reverse shaft; a long bolt having the same thread as the ones in the end of the shaft; a nut for the bolt; and a flat piece of steel having a hole in its center sufficiently large to permit passage of the bolt. Place the pipe over shaft with flat piece of steel on top of it. Turn the nut onto bolt and pass bolt through hole in the flat steel plate,

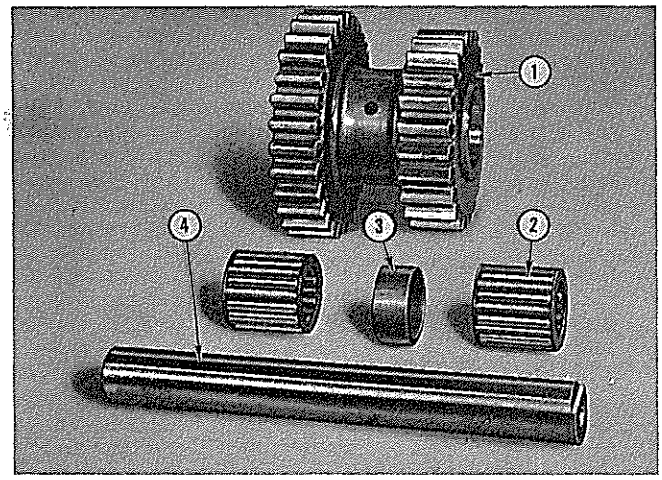


FIGURE S-14. REVERSE IDLER GEAR ASSEMBLY

1. Gears
2. Bearings
3. Spacer
4. Shaft

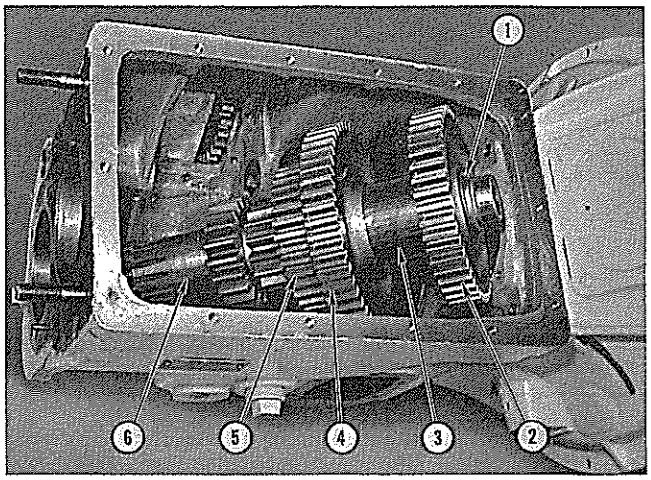


FIGURE S-15. REMOVING COUNTERSHAFT

1. Snap Ring
2. Drive Gear
3. Spacer
4. Overdrive Gear
5. Third Speed Gear
6. Countershaft

through the pipe and thread into the reverse gear shaft. The nut is then tightened against the plate with the result that a pulling action is exerted against the shaft with the transmission case acting as a base. Turn down nut until shaft may be drawn from gear and bearings. Remove gear, bearings, and spacer from transmission case (Fig. S-14).

COUNTERSHAFT

Remove large retaining nut from countershaft rear bearing adaptor, and remove adaptor from the transmission case (Refer to Fig. S-12). Remove bearings from adaptor only if damaged.

Slide countershaft to rear of case to clear front bearing. Tilt and remove through opening at top of case (Fig. S-15).

Remove snap ring and countershaft front bearing cover from front of case. Pull bearing.

Remove snap ring from front end of countershaft. Press gears and spacer from shaft, one at a time. Remove key from countershaft after removing each gear.

Reassembly

All bearings, thrust washers, bushings, and splines should be lubricated with a light gear oil before reassembling to prevent scoring. All parts should move freely after being assembled in their proper places.

Make sure bearings are a press fit on shafts and that the outer races of these bearings fit tightly in their bores. The transmission case should be drained carefully and washed out before parts are installed. The bearings should be washed in a pressure bearing washer and examined for defects. Replace if necessary and lubricate. Examine teeth on all gears carefully. Cracked or chipped teeth, or spots where case hardening is worn through, renders gears unfit for further use and where this condition exists, the gears should be replaced.

Inspect splines on mainshaft and on the main drive gear for evidence of wear. If the sliding gears or clutch hub have brinelled into the sides of the splines, replace the shaft.

Inspect reverse idler shaft and bearings, and if found worn, they should be replaced.

Do not remove the clutch housing from trans-

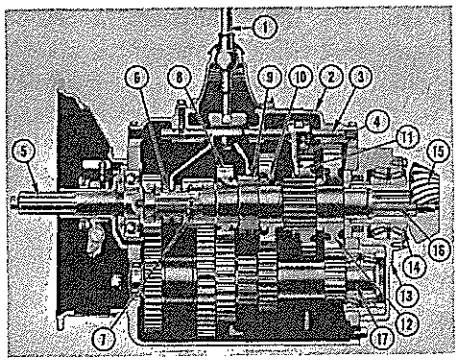


FIGURE S-16. TRANSMISSION AND ADAPTOR (FULLER 5G-720)

1. Shift Lever
2. Housing
3. Shift Bars
4. Shift Yoke
5. Clutch Shaft and Drive Gear
6. 4th & 5th Speed Sliding Clutch Gear
7. 4th Speed Gear
8. 3rd Speed Gear
9. 2nd & 3rd Speed Sliding Clutch Gear
10. 2nd Speed Gear
11. 1st & 2nd Reverse Sliding Clutch Gear
12. 1st Speed Gear
13. Adaptor
14. Bearings
15. Pinion
16. Mainshaft
17. Countershaft

mission unless absolutely necessary. If it is detached, extreme care should be taken during reassembly to maintain the alignment between its machined face and the mainshaft bores in the case.

Replace bushings in mainshaft gears having excessive radial clearance. The following instructions will apply to installation of replacement bushings.

Remove oil bushings. Clear bore of gear carefully and remove all burrs. Lubricate outside diameter of bushings and inside diameter of the gear. Carefully press bushing fully into gear. Face off any projecting ends of the bushing. Drill oil holes in bushing, working through holes in gear. Remove all burrs resulting from drilling operations and break all sharp edges on ends of bushing with bearing scraper.

Clean gasket surfaces of all parts thoroughly. Replace all gaskets and use gasket cement when reinstalling all parts which utilize gaksets.

COUNTERSHAFT

Install gears and spacer in the same order as removed. Install new snap ring.

Now install countershaft front bearing, bearing cover and snap ring in the countershaft front bearing bore of case.

Lower countershaft assembly into case and insert front end of countershaft into the front roller bearing. Start countershaft rear bearing adaptor onto rear end of countershaft. Align notch in flange of adaptor with dowel pin in transmission case and insert adaptor into bore of transmission case.

If bearings were removed from countershaft rear bearing adaptor, replace at this time. Start retainer nut into adaptor to hold bearings in place. Do not put adaptor in vise to tighten retainer nut as distortion to the adaptor bore may result.

The dowel pin in the transmission case will prevent the adaptor from rotating in the case, making it possible to torque the large retainer nut to 300 ft. lbs.

REVERSE GEARING

To install, place the roller bearings and the spacer in bore of the gear with the spacer between the bearings. Lower the reverse gear into the case with the chamfered teeth to the rear.

Install reverse idler shaft and drive it into case, through the bearings and spacer. Replace the reverse shaft lock and tighten the capscrew and lockwasher securing it.

MAINSHAFT

Mount the mainshaft in a vise equipped with copper jaws. Clean and oil mainshaft gear seats. Install second gear with external clutching teeth to the front of the mainshaft.

Install key and second and third speed clutch gear. Slide the clutch gear collar onto the clutch gear.

Press on third speed gear sleeve and install the third speed gear with external clutching teeth to the rear of shaft.

Press on fourth speed flanged sleeve with the flange to the rear of shaft. Install fourth speed gear on sleeve and secure with splined washer. Place washer in groove of shaft under the fourth speed gear. Turn washer until splines on inside diameter of washer are lined up behind splines on shaft. Install key to lock in place.

Place fourth and fifth speed sliding clutch gear on shaft and install pilot bearing.

Place reverse sliding gear on shaft with yoke collar facing front of transmission.

Install first speed sliding gear on rear of mainshaft with the external clutch teeth to the front of the shaft.

Lower the mainshaft assembly into the case, rear end of shaft first.

Engage the gear teeth of the mainshaft with the teeth of those on the countershaft. Install the bearing retaining plate at the rear end of the countershaft. Install capscrews, tighten and replace lockwire.

CLUTCH SHAFT AND DRIVE GEAR

Press drive gear shaft into bearing. Clean shaft and threads, make sure there is no oil or dirt on the threads. Soak a swab with "LOCTITE" and draw it across the threads in at least four places 90° apart. It is not necessary to completely cover the threads.

Install bearing nut, use special spanner type wrench and tighten to 150 lbs. torque. **(NOTE: This is a left hand thread.)** Allow to stand in normal temperature 8 to 10 hours before exposing to oil.

Check the oil coupling tube in the bore of the drive gear for damage. (Fig. S-17).

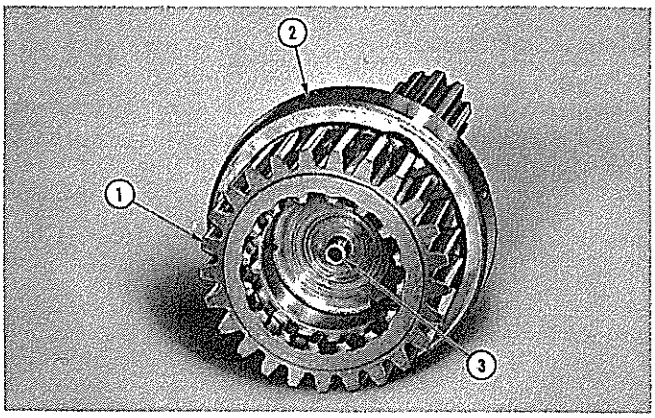


FIGURE S-17. OIL COUPLING TUBE
1. Drive Gear 2. Bearing 3. Oil Coupling Tube

Install the drive gear assembly in bore of the case with bearing bore of drive gear over the pilot bearing of the mainshaft. Install the drive gear bearing cover, taking care not to damage the oil seal, and pull up tight with attaching capscrews. Replace clutch release mechanism.

SHIFTER BAR HOUSING

Install shifting bars, yokes, and blocks in the same order as removed, at the same time replacing in their proper position, the interlock pin and balls which prevent movement of the remaining shifting bars after one has been shifted. Install screws into yokes and bars and tighten securely. Replace lockwires.

Turn shifter housing over and install steel balls and over them replace the yoke bar tension springs. Install cover over the yoke bar tension springs.

NOTE: After each bar and corresponding yoke or block has been assembled, it may be necessary to move it to the neutral position before the next bar can be installed. After all parts are replaced, make sure the assembly is shifted into neutral position. Install cover making sure that the shifting yokes enter the yoke slots of the sliding gears. Replace capscrews and tighten evenly.

GEAR SHIFT LEVER

Mount the housing in a vise with large opening upward making sure that the gear shift lever pivot pin is in place and securely tightened.

Install the shift lever so that the slot in the side of the pivot ball engages the pivot pin in the housing. Install tension washer and spring in the order named. Remove the partially completed assembly from the vise and install dust cover and ball. Tighten securely the screw by which the dust cover is attached.

Shift transmission into neutral position and place the assembly on the transmission making sure the lower end of the lever enters the lever notch milled into the yokes. Replace capscrews and tighten securely.

ADAPTOR

Install bushing and oil seals over the transmission mainshaft. Lip of inside oil seal must be pointing in; lip of outside oil seal must be pointing out.

Replace adaptor gasket and adaptor on transmission and tighten capscrews and nuts. Torque the ⅝ capscrews to 190 ft. lbs.

Some ring gear and pinion sets may require the use of shims to obtain correct mounting distance setting of the pinion. This is done by the following procedure.

Place inner bearing cone, bearing cup, and spacer into adaptor bore. Replace bearing retainer on adaptor and secure with capscrews and lockwashers. Torque capscrews to 15 ft. lbs. and position spacer and outer bearing cone into bearing cup.

Before installing the pinion, place an accurate straight edge on the outer bearing cone face as near to center of bearing as possible. Measure from the bottom of the straight edge to the machined surface of the adaptor. A reading of 2.032 should be obtained. This should be repeated at different positions around bearing to make sure faulty reading is not taken due to the outer bearing cone cocking in the cup. See Figure S-18.

If a measurement of less than 2.032 is obtained, subtract this from 2.032 to determine the correct quantity of shims required.

As an example, if the measurement taken was 2.025, shim requirement would be determined by

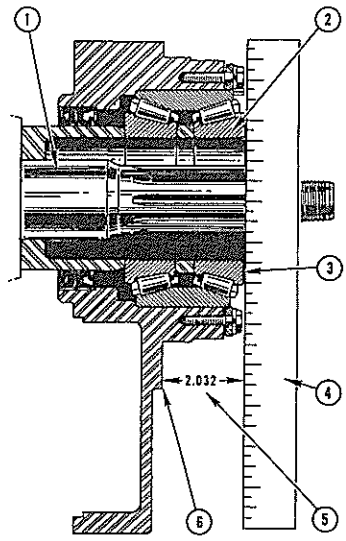


FIGURE S-18. ADAPTOR MD MEASUREMENT

1. Mainshaft
2. Outer Bearing Race
3. Shims
4. Straight Edge
5. 2.032 Measurement
6. Machined Surface

the following:

Required Distance	2.032
Measurement	2.025
Required Shims	.007±.002

The shims are .004 thick, in this case two shims (.008) would be within tolerance.

A mounting distance will be etched on the end of the pinion preceded by the letters MD and the symbol (—); as example, (MD —0.016).

The proper number of shims required are included when installing ring gear and pinion sets in machines at the factory. If a ring gear and pinion set which has shims is removed for any reason, the same shims, or the same number of shims must be used if the set is reinstalled.

Ring gear and pinion sets furnished on parts orders will have the proper number of shims included. However, when installing a pinion in a transmission adaptor, double check the MD marking to make certain the correct number of shims are installed.

Now, by adding the required shims as determined by measurement above and the required shims as determined by the MD markings on the end of the pinion, the total being the number of shims needed to adjust the spiral bevel pinion.

Place shims and bearing onto pinion hub and insert pinion over mainshaft into adaptor.

Replace spacer and retainer nut over end of mainshaft. Tighten nut to 300 ft. lbs. torque, using special wrench. Replace locking setscrew. Centerpunch the outer edge of setscrew lightly to prevent its working out of retainer nut.

NOTE: The double row, tapered roller bearings used in this machine have the required amount of lateral (end play) built in during the assembly process by the bearing manufacturer. These bearings are made up in matched sets. Each set includes two bearing cones, a cup, and a ground spacer located between the two cones.

The bearings must be kept in matched sets and parts of one set are NOT interchangeable with any other set. Keep the parts of each set together and install in the same bore from which they were removed.

Each set is identified by a code number which is etched on the faces of cones, cup and also on the spacer. All parts having the same code number are of the same bearing set.

Some bearings will have identifying letters in addition to the set number. Bearings which have letters in addition to the code must be installed with the "A" cone in the "A" side of the cup and the "C" cone in the "C" side of the cup.

Those bearings without letters have been manufactured so that the cones can be used in either side of the cup without affecting the accuracy of the end play setting.

The bearing cones may be heated in oil to facilitate installation.

CLUTCH BRAKE (Fig. S-19)

Remove the six mounting capscrews and lift the clutch brake assembly, fiber spacer and gaskets (1), and filler block (2) from side of transmission case.

Remove cotters (6, 14) and pull clevis pins (4, 16) from each end of the brake band (19). Remove snap rings (17, 23), one from each end of the gear shaft (21) and the single thrust washer (18). Remove gear (22) from splined end of the shaft and drive the shaft from the bushings (24) in brake housing (7) using a hard wood dowel or other suitable material to prevent damaging the shaft. Lift out brake drum (20) and brake band (19). Press bushings from housing only if they are damaged or show signs of wear.

Turn clutch brake assembly over and remove the four capscrews securing cylinder head (3) to housing. Remove cylinder head and gasket (8). Push in piston (9) against spring pressure to relieve tension from piston yoke roll pin (13) and re-

move pin. Remove yoke (15) and push piston out through top of housing. Lift piston spring (12) from housing. Remove "O" ring (25) from groove in piston.

Remove jam nut (11) and adjusting nut (26) from lower part of housing. Lift off guide plate (10) and remove anchor rod (5). Remove "O" ring (27) from anchor rod.

Clean and inspect all parts before reassembly. Replace "O" rings, gaskets, and parts showing damage or excessive signs of wear. Clean all gasket surfaces.

Reassembly

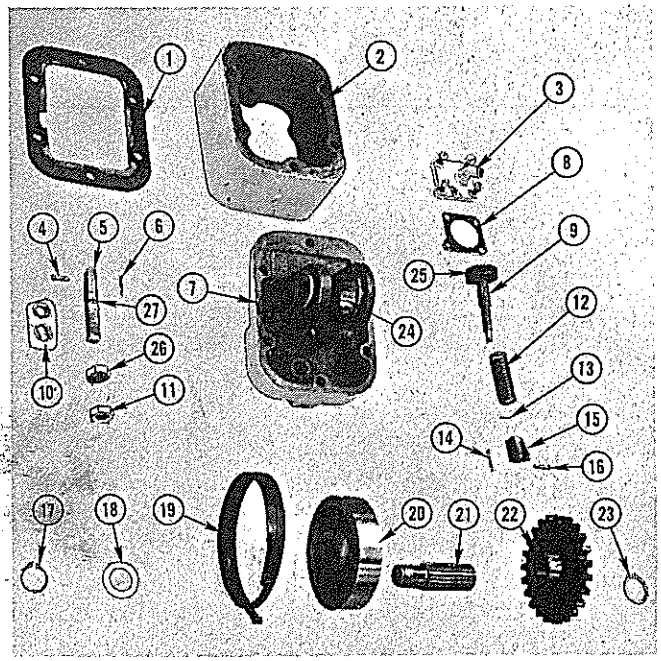


FIGURE S-19. CLUTCH BRAKE

1. Gasket and Spacer	10. Guide Plate	19. Brake Band
2. Filler Block	11. Jam Nut	20. Brake Drum
3. Cylinder Head	12. Spring	21. Shaft
4. Clevis Pin	13. Roll Pin	22. Gear
5. Anchor Rod	14. Cotter Pin	23. Snap Ring
6. Cotter Pin	15. Piston Yoke	24. Bushing
7. Housing	16. Clevis Pin	25. "O" Ring
8. Gasket	17. Snap Ring	26. Adj. Nut
9. Piston	18. Thrust Washer	27. "O" Ring

Place new "O" ring (27) on anchor rod (5) and insert into housing (7) clevis end first. Use care when installling anchor rod to avoid damaging "O" ring. Place guide plate (10) over anchor rod and replace adjusting nut (26) and jam nut (11).

Install new "O" ring (25) in groove of piston (9) and replace piston and spring (12) in housing, taking care not to damage "O" ring. Press down on end of piston (9) against spring (12) pressure until hole in end of piston shaft is aligned with hole in clevis (15) and insert roll pin (13).

Press bushings (24) into support flange if removed. Place brake band (19) between flanges with the offset end positioned in the piston yoke clevis (15).

Replace clevis pin (16) and secure with cotter (14). Position brake drum (20) inside band—refer to markings on drum for proper installation. Replace shaft (21) and install gear (22) onto splined end of shaft. Secure with snap ring (23). Place washer (18) over opposite end of shaft and secure with snap ring (17). Position free end of brake band into anchor rod (5) and align the holes. Insert clevis pin (4) through holes and secure with cotter (6).

Using a new gasket, replace cylinder head (3) and secure with capscrews and lockwashers. Cement new gasket in place on filler block (2) and place clutch brake assembly on block. Insert a capscrew in each side to retain parts in place.

Place the fiber spacer, with a gasket on each side of it (1), onto transmission side of filler block. Hold complete assembly against transmission case and secure with capscrews and lockwashers. The fiber spacer will provide correct thickness to obtain the proper amount of clutch brake gear backlash. Check to be sure that backlash is present.

To adjust clutch brake, loosen the jam nut (11) and tighten the adjusting nut (26) to 40 inch pounds of torque. When this has been done, **back off the adjusting nut four full turns** and lock into position with the jam nut. Refer to Fig. S-20.

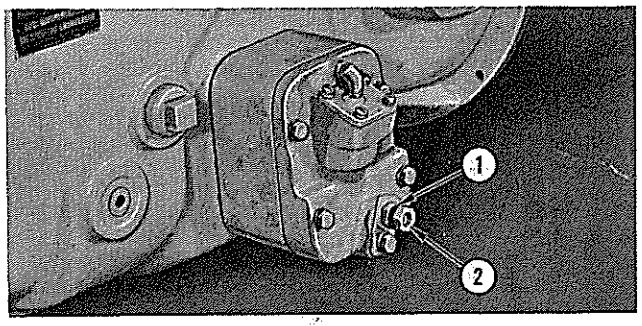


FIGURE S-20. CLUTCH BRAKE ADJUSTMENT

1. Adjusting Nut 2. Locknut

TRANSMISSION OIL PUMP (Fig. S-21)

Remove capscrews and lockwashers securing oil pump to transmission case and remove pump and gasket (19).

Remove the six capscrews and lockwashers securing reversing assembly outer head (3) to pump housing (18). Pull head (3) and gasket (4) from

side of pump housing being careful not to damage the soft metal gasket.

Turn pump housing and tap gently until reversing head (5) and idler gear (6) fall from housing. Do not permit parts to fall onto a hard surface as they are finely machined parts and may be damaged.

Insert end of screwdriver into housing between gear spacer (9) and pump drive gear (17) and pry against gear to start pump rotor (7) and shaft far enough from bore to permit complete removal from housing. Drive gear (17) may now be removed from housing. Remove spacer (9) and key (8) from rotor shaft.

Expansion plug and bushings should be removed from bores in housing if examination shows excessive signs of wear or damage.

Remove by-pass valve assembly by releasing retainer ring (12) from valve hole in housing and sliding out spring (13) and poppet valve (11).

To reassemble oil pump, reverse the disassembly procedure. All parts must be cleaned thoroughly with solvent and blown dry with compressed air. Replace parts showing excessive wear or damage.

After installation of oil pump to transmission, check drive gear backlash. A minimum backlash of 0.006" must be present. If necessary, add sufficient shims between the transmission case and pump body until required amount of backlash has been obtained

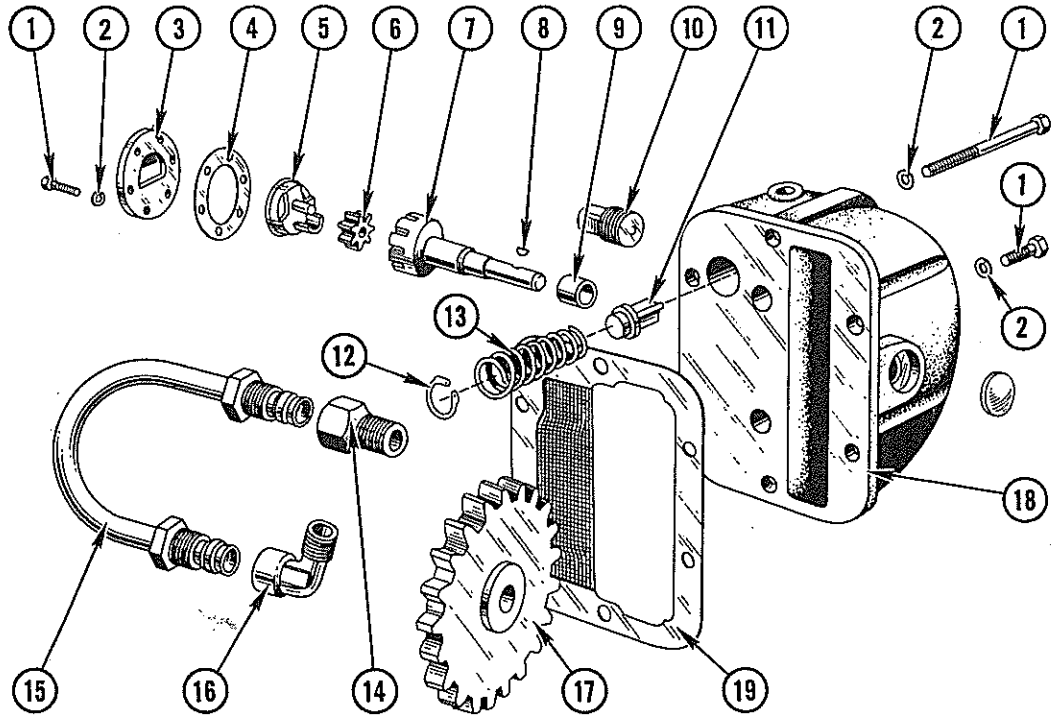


FIGURE S-21. OIL PUMP

1. Capscrew
2. Lockwasher
3. Head
4. Gasket
5. Reversing Head
6. Idler
7. Rotor
8. Key
9. Spacer
10. Pipe Plug
11. Poppet Valve
12. Retainer Ring
13. Spring
14. Connector
15. Tube Assembly
16. Street Ell
17. Drive Gear
18. Housing
19. Screen and Gasket

Installation

Attach hoist to transmission and raise until transmission shaft is in line with hub of clutch disc.

Move transmission forward, engaging splines on transmission shaft with splines in the clutch disc hub.

Replace capscrews securing transmission bell housing to generator end bell.

Replace engine, generator, clutch and transmission in Tournapull case and complete reassembly of machine.

Refer to Section "G" of this manual for procedure on adjusting backlash.

Fill transmission with correct amount and type of lubricant. See Section "K" of this manual.

TRANSMISSION

SPICER 6453

The transmission is a selective gear type, providing five forward and one reverse speeds. The gear sets constituting the three top speeds are of the helix type and operate constantly in mesh. The different speeds are engaged by sliding clutch gears which require a relatively short shift. First, second, and reverse speed gears are of the straight spur type requiring a slightly longer shift for complete engagement.

The engaging ends of all shifting members are bullet form chamfered to prevent chipping and to facilitate shifting. All gears and shafts are made of heat treated, high grade alloy steel.

Changing Speeds

For gear shift lever positions refer to diagram shown in Fig. S-2.

Removal

Remove hood, radiator and cockpit. Drain lubricant from final drive compartment and remove the fuel tank and battery box.

Remove engine, generator, clutch, and transmission as a unit (see Section "C"). Place on stand for further disassembly.

Support transmission with chain hoist. Remove capscrews securing transmission bell housing to generator end bell. Pull transmission straight away from generator. Care must be taken to see that the transmission drive shaft clears the clutch disc. Position transmission on stand or bench for further disassembly.

Drain lubricant from transmission case. Clean exterior of case thoroughly. It is important that no dirt or foreign matter be allowed to enter the case. Dirt is particularly harmful to bearings, sleeves, and bushings.

Disassembly

ADAPTOR

Remove setscrew locking pinion retaining nut in place on transmission mainshaft (Fig. S-22). Using the special wrench provided in the tool kit, back the retainer nut from the mainshaft. Remove "O" ring from inside pinion.

Pull pinion from adaptor. As pinion is withdrawn, the outer bearing cone and spacer will remain on pinion hub. Remove spacer and bearing cone from pinion hub.

Remove the four capscrews and ferrules, and the four nuts securing the adaptor to the transmission case. Remove adaptor and gasket.

Remove capscrews securing bearing retainer to adaptor, and remove retainer. Press inner bearing cone and bearing cup from bore of adaptor.

Remove bushing and double oil seal from transmission mainshaft.

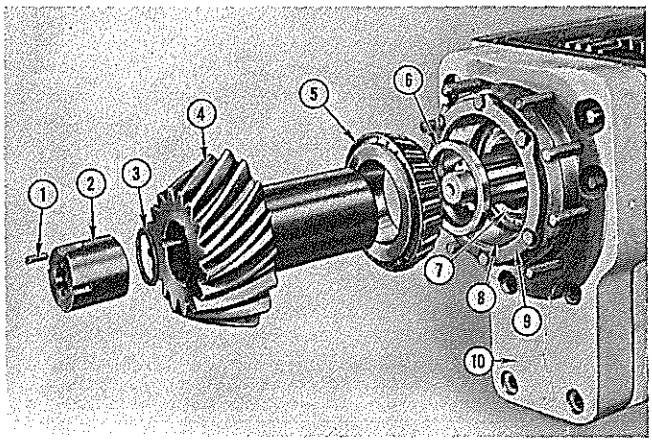


FIGURE S-22. PINION REMOVAL

1. Setscrew
2. Nut
3. "O" Ring
4. Pinion
5. Outer Bearing Cone
6. Spacer
7. Inner Bearing Cone
8. Bearing Cup
9. Retainer
10. Adaptor

SHIFT LEVER (FIGURE S-23)

Shift the transmission into neutral position. Remove locknut plunger spring retainer, spring and lockout plunger from hole on right hand side of shift lever housing.

Remove capscrews holding shift lever assembly to shifting bar housing and lift off shift lever assembly.

Remove lockout plunger from low and reverse relay shift finger.

Place shift lever assembly in a vise with the ball up. Remove the small pin that holds the spring collar down. Release the snap ring securing the rocker shaft in the housing. Remove the rocker shaft from housing and shift lever. Withdraw gear shift lever and felt ring from housing.

Place the shift lever in vise and remove knob from upper end of the lever. Slide collar, spring, and compression cup up and off end of shift lever.

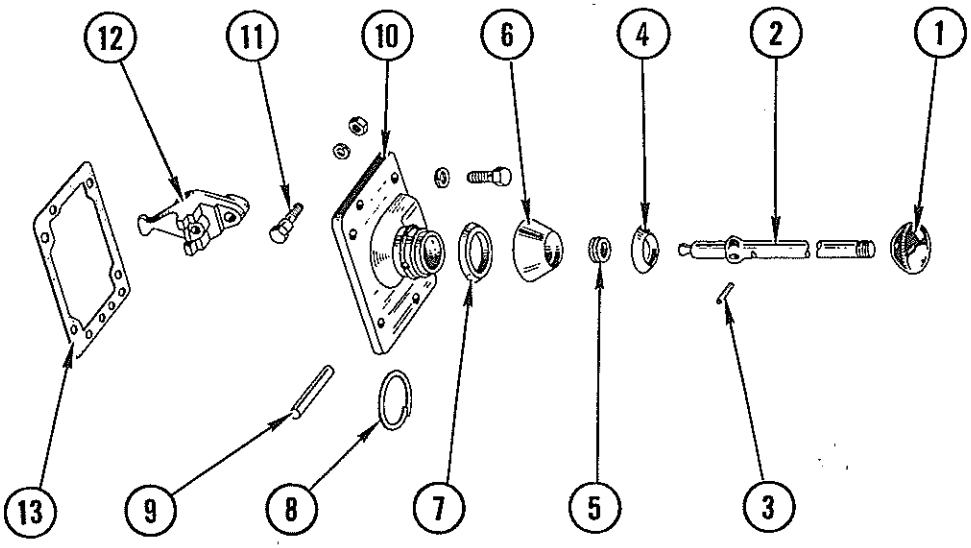


FIGURE S-23. SHIFT LEVER, EXPLODED VIEW

1. Knob
2. Shift Lever
3. Pin
4. Collar
5. Spring
6. Cup
7. Washer
8. Snap Ring
9. Rocker Shaft
10. Housing
11. Stud
12. Finger
13. Gasket

Place shift lever housing in vise with open end up. Remove nut, lockwasher, stud, and low and reverse relay shift finger.

SHIFTING BAR HOUSING (FIGURE S-24)

With transmission in neutral position, remove capscrews that secure shifting bar assembly to the transmission case. Remove the housing by lifting straight up. Turn upside down and jar on floor to remove poppet springs and balls.

Place assembly in vise with fourth and fifth speed shift yoke uppermost and cut the lockwires. Remove lockscrews from shifting yokes and bars.

Remove welch plugs from front end of housing and from interlock cross hole.

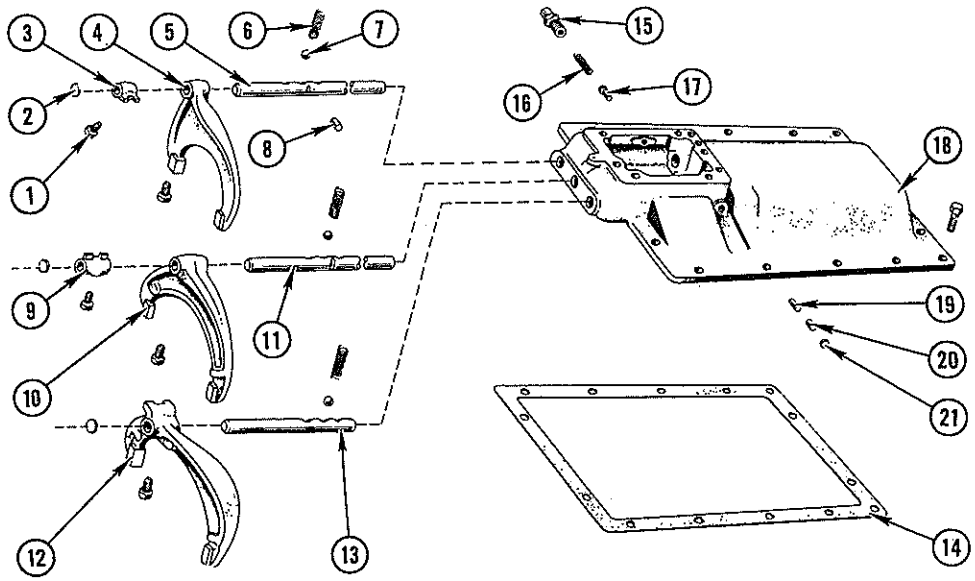


FIGURE S-24. SHIFT BAR HOUSING, EXPLODED VIEW

1. Setscrew
2. Welch Plug
3. 1st & Reverse Speed Shift Block
4. 1st & Reverse Speed Shift Yoke
5. 1st & Reverse Speed Shift Bar
6. Spring
7. Ball
8. Interlock Pin
9. 2nd & 3rd Speed Shift Block
10. 2nd & 3rd Speed Shift Yoke
11. 2nd & 3rd Speed Shift Bar
12. 4th & 5th Speed Shift Yoke
13. 4th & 5th Speed Shift Bar
14. Gasket
15. Retainer
16. Spring
17. 1st & Reverse Speed Shift Finger Plunger
18. Housing
19. Interlock Pin
20. Interlock Pin
21. Welch Plug

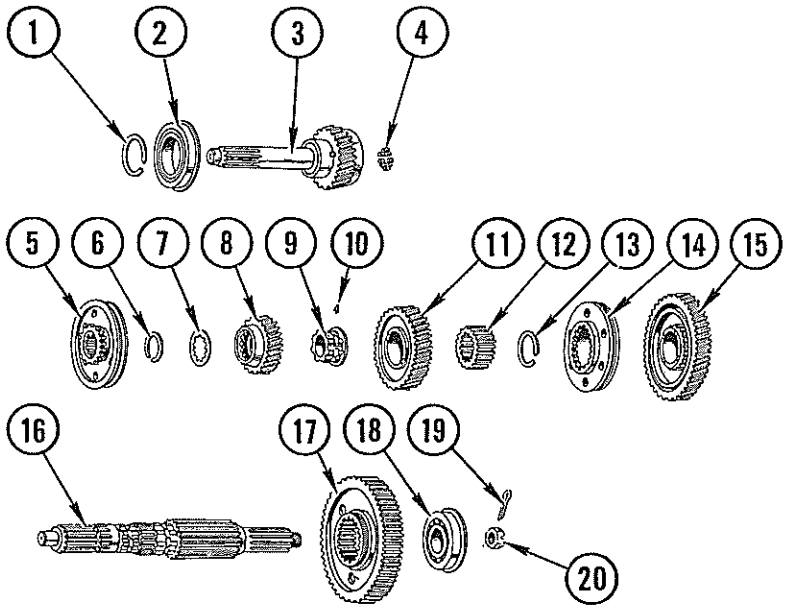


FIGURE S-25. CLUTCH SHAFT & MAINSHAFT, EXPLODED VIEW

1. Snap Ring
2. Bearing
3. Clutch Shaft and Drive Gear
4. Roller Bearings (14)
5. 4th & 5th Speed Sliding Clutch Gear
6. Snap Ring
7. Splined Washer
8. Overdrive Gear
9. Overdrive Gear Sleeve
10. Overdrive Gear Sleeve Pin
11. 3rd Speed Gear
12. 2nd & 3rd Speed Clutch Gear
13. Snap Ring
14. 2nd and 3rd Speed Clutch Collar
15. 2nd Speed Gear
16. Mainshaft
17. 1st and Reverse Speed Gear
18. Bearing
19. Cotter Pin
20. Nut

Starting with fourth and fifth speed shifter bar, remove all shifter bars in order through the front end of the housing. Remove small interlock pin from hole in second and third speed shifting bar.

Shifting yokes and blocks will fall free as bars are withdrawn.

Remove interlocks from cross hole in housing.

CLUTCH SHAFT AND DRIVE GEAR (FIGURE S-25)

Remove capscrews and keys from clutch release yoke and release shaft. Remove clutch release shaft from yoke and housing. See Fig. S-27.

Remove capscrews from drive gear bearing retainer and remove retainer. Main drive gear and bearing can then be removed as a unit. Remove pocket bearing rollers (14) from main drive gear.

Mount the main drive gear assembly in a vise with copper jaws and remove snap ring securing the bearing to shaft. Press bearings from shaft.

MAINSHAFT (FIGURE S-25)

Remove mainshaft and gear assembly from case by lifting front end of mainshaft and sliding forward to clear rear bearing bore of case. Lift mainshaft up out of transmission case.

Remove low and reverse sliding gear from rear of mainshaft.

Remove fourth and fifth speed gear clutch collar from end of shaft.

Remove snap ring, thrust washer, fourth speed gear and gear sleeve from mainshaft. Remove third speed gear.

Remove snap ring, second and third speed clutch gear and second speed gear from mainshaft. Remove small pin located in bore of second and third speed clutch gear.

COUNTERSHAFT (FIGURE S-26)

Remove capscrews from countershaft rear bearing cap, remove cap. Remove cotter pin and nut from countershaft.

Pull reverse idler shaft from case and lift reverse idler gear and bearings from inside case.

Slide countershaft assembly toward rear of transmission case so rear bearing is part way out of bore. Remove bearing with puller.

Slide countershaft toward rear of transmission case so front end of countershaft clears the front countershaft bearing. Lift up on the front end of shaft and remove from transmission case through opening at top.

Remove countershaft front roller bearing from bearing bore in case.

It is unnecessary to remove clutch bell housing from case unless damaged or leaking.

Remove snap ring from drive gear end of countershaft. Press off drive gear and remove key.

Remove snap ring and press off fourth speed gear and remove key.

Press off third speed gear and remove key.

Remove second and third speed gear spacer. Press off second speed gear and remove key.

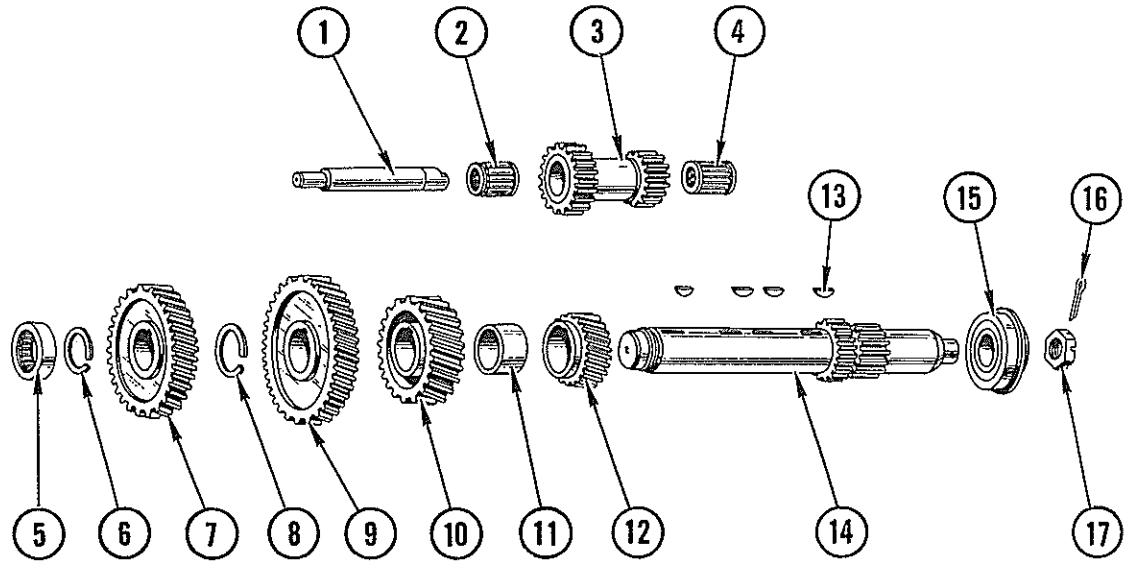


FIGURE 5-26. COUNTERSHAFT AND REVERSE IDLER GEARING

1. Reverse Idler Shaft
2. Bearing
3. Reverse Idler Gear
4. Bearing
5. Bearing
6. Snap Ring
7. Drive Gear
8. Snap Ring
9. Overdrive Gear
10. 3rd Speed Gear
11. Spacer
12. 2nd Speed Gear
13. Key
14. Countershaft
15. Countershaft Rear Bearing
16. Cotter Pin
17. Nut

Reassembly

Refer to page F-14 for cleaning and inspection procedures.

COUNTERSHAFT

Assemble the gears, spacers, snap rings and keys in the same order as removed. Install countershaft front bearing in bore of case. Lower the countershaft assembly into case and insert into the front roller bearing. Install countershaft rear bearing with snap ring on the outer diameter of the bearing toward rear of case. Install rear bearing nut and cotter pin.

REVERSE GEARING

To install, place the two roller bearings in the reverse idler gear. Place the idler gear in the case with the larger gear end (25 teeth) toward the front of the transmission.

Start the reverse idler shaft into the case and drive it through the bearings. Make sure that the flat milled surface on the end of the shaft is lined up so that the countershaft rear bearing cap protrusion locks the idler shaft securely.

Install capscrews in countershaft rear bearing cap and tighten.

MAINSHAFT

Mount mainshaft in vise equipped with copper jaws. Lubricate the shaft and place second speed gear over front end of mainshaft with clutching gear teeth toward front end of shaft.

Slide second and third speed clutch gear in position on splines next to second speed gear. Install snap ring in place next to clutch gear.

Place second and third speed clutch collar with longest hub of collar toward rear of the mainshaft, and position on second and third speed clutch gear.

Install third speed gear on the mainshaft with clutching teeth toward rear of mainshaft or toward second and third speed clutch gear assembly.

Install small pin, place with head on inside of fourth speed flanged sleeve. Press sleeve into mainshaft with flanged end of sleeve toward rear of mainshaft and the pin lined up in spline of the shaft. Do not press on flange of sleeve.

Place the fourth speed gear on mainshaft with the clutching teeth toward front end of shaft. Slide fourth speed thrust washer forward on splined shaft until positioned against shoulder of the fourth speed gear clutching teeth and secure with snap ring.

Place the fourth and fifth speed clutch collar assembly on mainshaft, making sure the external splines on collar match the internal splines on the fourth and fifth speed gear.

Place low and reverse sliding gear on splines on rear of mainshaft with the shift fork collar toward the front end of the mainshaft.

Install the mainshaft gear assembly in case by lowering the rear end of the shaft into rear bearing bore of the case. Then lower the front end. Position shaft by engaging the teeth of the helical gears on

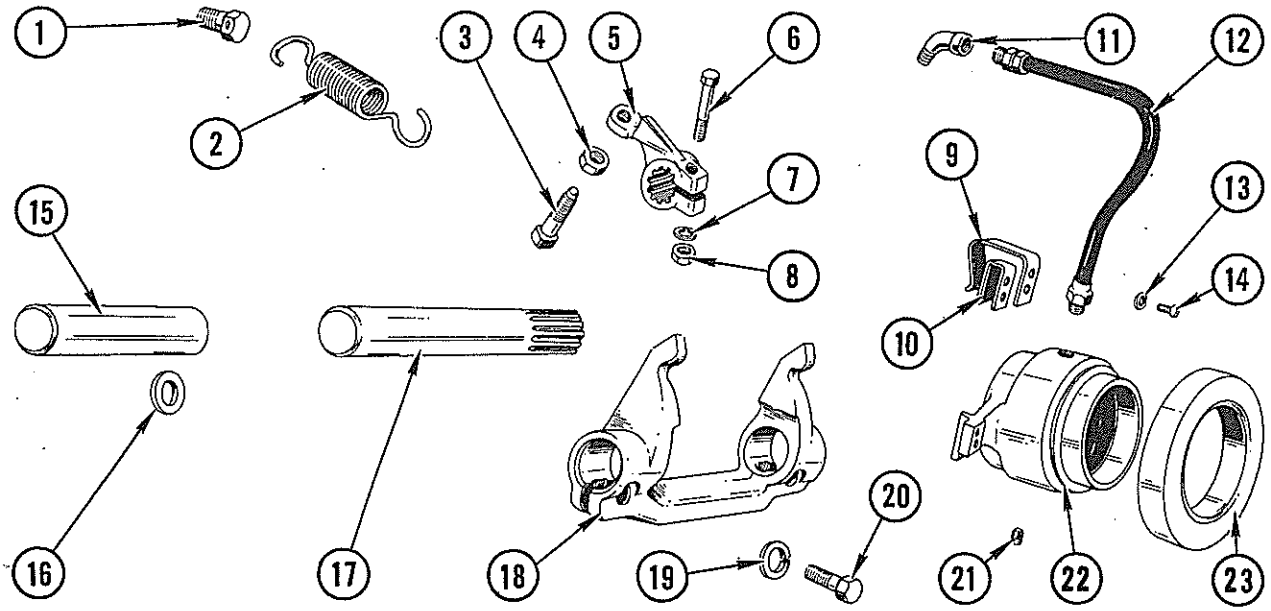


FIGURE 5-27. CLUTCH RELEASE MECHANISM

1. Capscrew
2. Spring
3. Adjusting Screw
4. Locknut
5. Lever
6. Screw
7. Lockwasher
8. Nut
9. Spring
10. Pad
11. Elbow
12. Hose
13. Lockwasher
14. Screw
15. Short Shaft
16. Washer Key
17. Long Shaft
18. Clutch Release Yoke
19. Lockwasher
20. Capscrew
21. Pipe Plug
22. Carrier
23. Bearing

the mainshaft with the teeth of those on the countershaft.

CLUTCH SHAFT AND DRIVE GEAR

Press drive gear shaft into bearing with the snap ring on the outer diameter of the bearing toward the front of the drive gear and the shield next to the gear teeth. Install snap ring.

Coat gear bearing bore of drive gear with grease. Place bearing rollers (14) on the inside of the main drive gear bearing bore.

Install main drive gear assembly through the bearing bore in front of the case. Position main drive gear so that the pocket bearings in the inner bore of the drive gear slide onto the bearing surface of the mainshaft.

Place bearing cap and gasket in position, so that the oil drain hole is in proper location with the oil drain hole of the case. Install capscrews and tighten.

SHIFTING BAR HOUSING

Place housing in a vise upside down and assemble parts from front end of housing in same order as removed.

Start low and reverse shift rod through right hand hole in front of housing. Place low and reverse shift block in position and slide the shift rod through the shift block and second and third supports of the housing. Place low and reverse shift fork on the shift rod, long hub of fork toward front of housing. Set shift rod in neutral position, align shift fork and shift block on rod and install setscrews. Lock with wire.

Install interlock in hole in side of shifter housing against low and reverse shift rod.

Place some grease on small interlock pin. Install pin in hole in second and third speed shift rod. Make sure pin does not drop out when installing shift rod.

Place second and third speed shift rod block with the flat side of block toward low and reverse shift block. Slide second and third speed shift rod into center hole of shifter housing, through shift rod block and second support web of housing.

Place second and third speed shift fork on the shift rod with long end of the hub toward front. Slide the shift rod through the shift fork and the third support web in shifter housing to neutral position. Align shift rod block and fork, install setscrews and lock with wire.

Install interlock in hole in side of shifter housing against second and third speed shift rod.

Place fourth and fifth speed shift fork in position and slide fourth and fifth shift rod through fork and second support web. Align shift fork and install setscrew, lock with wire.

Install welch plugs in shift rod and interlock holes in housing.

Install the three poppet balls in their proper

location over the shift rods. Place one poppet spring on top of each ball. Install gasket on top of the shifter housing.

Check interlocks by shifting into low or reverse, then try to shift fourth and fifth shift rod. Interlock should lock out fourth and fifth.

SHIFT LEVER HOUSING

Place shift lever housing in vise upside down.

Place low and reverse shift finger in housing and install the shift finger stud. Secure with nut and lockwasher. Check to be sure finger is free to move.

Place shift lever in vise right side up. Place compression cup, spring and collar down over shift lever in this order. Screw knob on top of lever.

Place shift lever housing in vise. Place felt ring on shift lever housing. Install shift lever in housing, and line up hole in lever with cross hole in housing. Install rocker shaft through hole. Make sure the slot in the end of the rocker shaft is lined up with the groove in the shift lever housing. Install snap ring in groove of housing.

Compress the compression cup spring on lever and install pin which holds the spring collar in place.

Place some grease on low and reverse lockout plunger and install in low and reverse shift finger.

Install the shift lever assembly on shifter housing. Make sure low and reverse shift finger is in proper location in shift block and shifter housing.

With the shifter housing and the transmission gears in neutral, position shifter housing on main case. Check to be sure that all shift forks are positioned properly with the transmission gear clutches. Secure housing to main case with capscrews and lockwashers.

Install low and reverse lockout plunger in hole on right hand side of shifter housing. Install lockout plunger spring and spring retainer.

Shift transmission into each speed to make sure poppets are working properly.

TRANSMISSION

ALLISON CLT-3340

The Allison Transmission combines the advantages of a torque converter with planetary range gearing for automatic adjustment of the output torque to meet load demand. Four speeds forward and two speeds reverse are obtained by positioning the selector valve in the cockpit.

Although the shifts are manually controlled, lockup occurs automatically in 3rd and 4th speeds forward. This automatic lockup eliminates converter slippage at hauling speeds. With the engine RPM above 1720 and the transmission in 3rd speed forward, or with the engine RPM above 1630 and the transmission in 4th speed forward, torque multiplication is not needed. The unit is automatically put in direct drive. When the engine RPM drops below 1540 and the transmission is in 3rd speed forward, or when the engine RPM drops below 1550 and the transmission is in 4th speed forward, the lockup automatically disengages, bringing the torque converter into use.

Refer to transmission manufacturer's manual for disassembly and reassembly procedures.

Changing Speeds

The Allison Transmission may be up shifted or down shifted with engine at high idle regardless of the load. However, a down shift should not be made if the MACHINE SPEED exceeds MAXIMUM SPEED that can be attained in the next lower range. Down shifting under this condition will overspeed the engine and cause serious damage.

The transmission control lever has seven positions; 4 positions forward, neutral, and 2 positions reverse. The positions are clearly marked on the shifting quadrant. (Fig. S-28.)

To select a gear range, move the control lever to the desired position marked on the quadrant.

For smoother operation of the machine, progressive shifting is recommended. Do not skip positions when up shifting or down shifting.

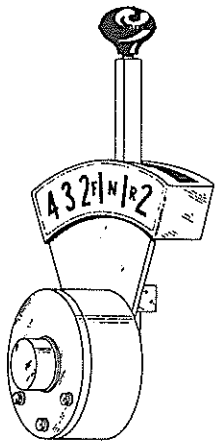


FIGURE S-28. SHIFTING QUADRANT

Removal

Removal of the Allison Transmission can best be accomplished by removing the complete power train as a unit. The following information covers complete power train removal. However, engine and generator may be removed separately if desired.

HOOD

Drain coolant from radiator and engine block.

Disconnect air line at connection on air horns.

Disconnect battery ground strap.

Remove capscrews securing hood to radiator grille and cockpit and lift hood from machine.

GRILLE AND RADIATOR

Disconnect headlight wires at connectors located at the left headlight.

Remove capscrews and lockwashers securing radiator grille to the Tournapull case. Remove nuts and washers from each rubber mount fastening the grille to the radiator. Remove radiator grille from machine.

Attach hoist to radiator and take up slack. Remove nuts from studs located at each side of the radiator bottom tank and remove radiator from machine.

Inspect rubber radiator mounting pads. If replacement is required, remove four capscrews, lockwashers and nuts securing pads to mounting brackets and replace with new parts.

COCKPIT

Disconnect cable leads at terminals located on lid of rectifier tank.

Disconnect air lines at air supply tank. Remove air tank mounting bolts and remove air tank.

Disconnect air cleaner discharge hose at air cleaner.

Disconnect throttle linkage from underside of foot accelerator pedal.

Disconnect transmission control cable from connection at shift quadrant.

Disconnect air lines at foot brake application valve.

Disconnect engine emergency shut-down control from lever on engine air box.

Disconnect heat indicator bulb and oil pressure hose from engine.

Disconnect transmission oil pressure line and heat indicator at connection on transmission.

Disconnect transmission oil cooler lines at connection on engine oil cooler.

Disconnect cranking motor cable at connection on cranking motor solenoid.

Disconnect cable at terminals on transformer and at switch box and remove cable from cable clamps located under cockpit.

Disconnect battery cable and 6 volt tap wire from cable clamps located under cockpit.

Attach hoist to cockpit and take up slack. Remove the four mounting bolts securing the cockpit to the case. Raise cockpit slightly and check to make certain that all wires, cables, hoses and controls have been disconnected. Hoist cockpit from machine.

POWER TRAIN (ENGINE, GENERATOR AND TRANSMISSION)

Attach hoist to lifting eyes on engine and take up slack.

Remove front and rear engine mounting bolts. (NOTE: REMOVE SHIMS AND SPACERS FROM MOUNTING PADS AND KEEP THEM TOGETHER IN SETS FOR USE WHEN RE-INSTALLING THE SAME ENGINE.)

Remove capscrews and lockwashers securing transmission to pinion adaptor.

Hoist engine slightly and move toward front of machine to remove splined output shaft of transmission from splined pinion bore. Raise power train assembly to clear Tournapull case and move to clean work area for disassembly.

DISCONNECTING TRANSMISSION FROM POWER TRAIN

The following describes the procedure for removing the transmission from the generator.

Position drive train assembly on stand or block securely in upright position.

Cover all fittings to prevent dirt from entering and degrease the entire assembly.

Remove the two covers on the generator end bell and remove nuts and locks securing flex plate to transmission torque converter. Rotate the flex plate to facilitate removal of all the nuts through these openings.

Attach hoist to transmission and take up slack. Remove capscrews and lockwashers securing transmission to generator housing. Pry transmission from generator and move it straight out until torque converter clears generator housing.

Disassembly and Reassembly

Place transmission on stand or bench and proceed with disassembly. (Refer to Transmission Manufacturers Maintenance Manual for disassembly, repair and reassembly of the Allison Transmission.)

Assembly

If the transmission or any parts were replaced that could affect the engine crankshaft end play, make the following check before mounting the transmission onto the generator.

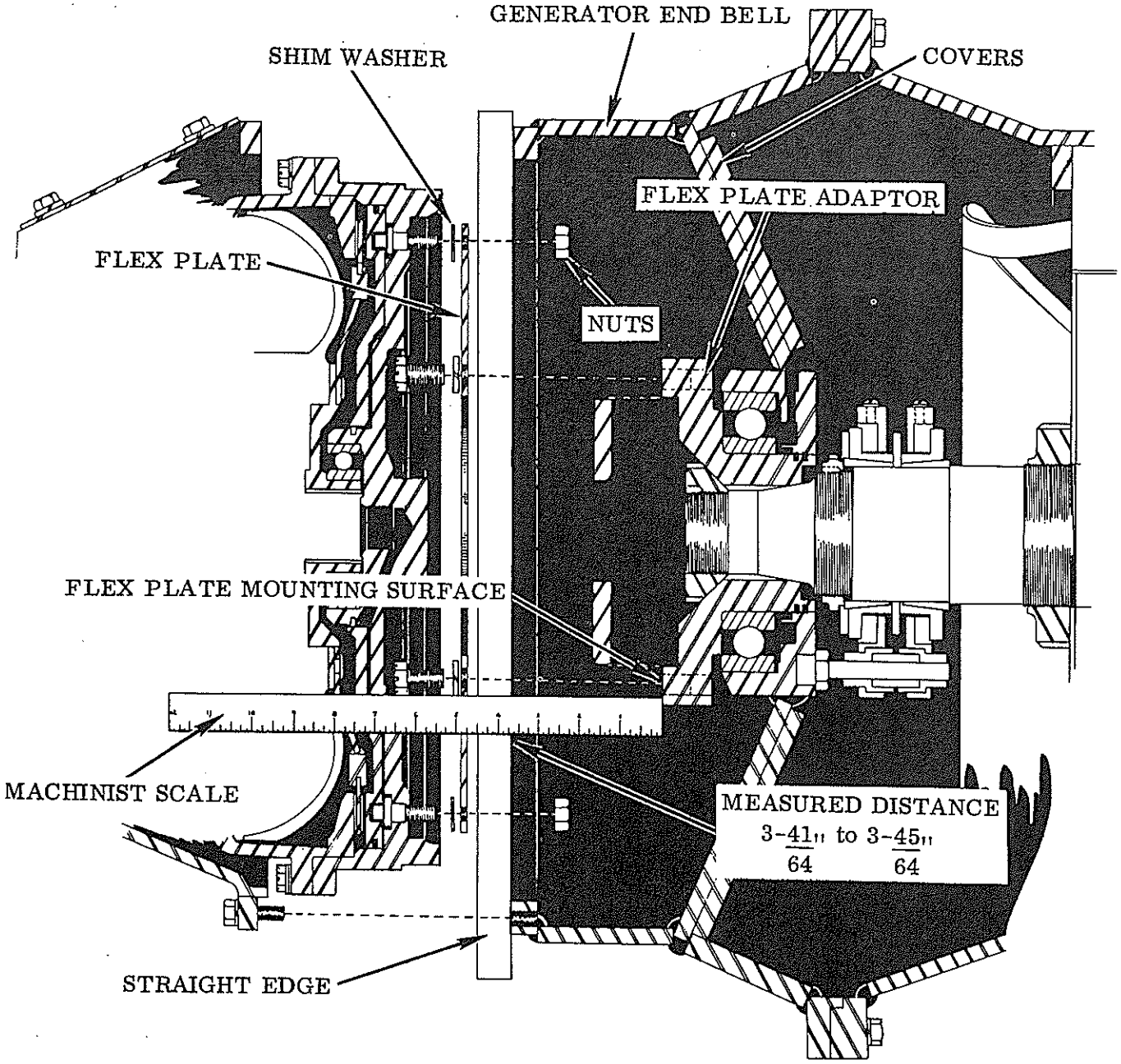
Remove capscrews securing flex plate to flex plate adaptor and remove flex plate.

Place a straight edge across the generator housing and measure from the straight edge to the flex plate mounting surface of the adaptor. This distance should be 3-41/64 inches to 3-45/64 inches. If this measured distance happens to be above 3-45/64 inches, add one shim washer (.082 inch thick) between flex plate and torque converter at each stud.

Replace flex plate onto adaptor and secure with capscrews. Torque capscrews 96 to 115 ft. lbs.

Move transmission into position. Guide hub of torque converter into bore of flywheel hub disc and secure with capscrews and lockwashers.

Check engine crankshaft end play. There must be a minimum end play of .003 inch.



Installation

(Engine, Generator and Transmission)

POWER TRAIN INSTALLATION WITH ORIGINAL PARTS

Attach hoist to power train and move into position in Tournapull case. Install gasket on transmission mounting flange.

Align splined output shaft with bore of pinion hub. Move power train back toward rear case to join transmission to adaptor. Install capscrews and lockwashers and tighten to standard torque.

Replace the same shims and engine mounting spacers beneath the front engine support in their original position. Install front and rear engine mounting bolts and tighten.

POWER TRAIN INSTALLATION WITH REPLACEMENT PARTS

If replacement engine, generator or transmission are being installed, attach hoist to power train and move into position in Tournapull case. Install gasket on transmission mounting flange.

Carefully maneuver power train back into case

and align splines of transmission output shaft with splines in bore of pinion gear hub. Move power train back until transmission mounting flange and companion flange adaptor are joined. Install capscrews and lockwashers and tighten securely.

Install rear engine mounting capscrews but do not tighten.

Leave hoist attached and loosen capscrews securing transmission and generator. Check with feeler gauge at top and bottom of mounting flange between transmission and generator. Adjust by raising or lowering front end of engine to obtain 0.010" space at top and bottom.

Measure space beneath front engine mounting brackets with feeler gauge to determine approximate number of shims required. Insert shims and tighten mounting bolts to proper torque.

Again, using feeler gauge, check space between transmission and generator end bell at both top and bottom. Add or take away shims at front engine mount to obtain not more than 0.002" (plus or minus) variation between top and bottom.

Check space between transmission adaptor on each side with feeler gauge. This reading must not be more than 0.010" (plus or minus) variation between each side.

Install remaining capscrews and lockwashers securing transmission to adaptor and tighten to standard torque.

TRANSMISSION ADAPTOR

Removal

Remove Power Train as previously instructed.

Remove drain plug from final drive case and drain lubricant.

Remove fuel tank and battery box.

Remove large center cover from rear of case.

From inside of case, in front of the differential, remove ½" locknuts securing transmission adaptor to front of final drive case.

Remove transmission adaptor from case. Degrease the entire adaptor assembly.

Disassembly

Place adaptor assembly on work bench and remove pipe plug and large nut from pinion shaft.

Press pinion gear from adoptor housing and lift out bearing cone, oil seal and carrier.

Press bearing cone and spacer from pinion gear hub if required.

Remove six capscrews and lockwashers securing bearing retainer to adaptor housing and remove bearing retainer. If bearing assembly is to be replaced, remove bearing cup from adaptor housing. Inspect and replace all parts showing signs of wear or damage.

Reassembly and Adjustment

Before reassembly, make sure all parts are free of dirt. Clean bearings and bearing surfaces thoroughly.

Install bearing cup in bore of adaptor housing.

Replace bearing retainer and secure with capscrews and lockwashers. Torque capscrews to 15 ft. lbs.

Before installing pinion, place adaptor housing on bench with bearing retainer uppermost. Place bearing cone in bearing cup.

Lay straight edge on bearing cone face, across center of bearing.

Measure from the machined mounting surface of the adaptor to the straight edge. A reading of 2.148 should be obtained. Do this in several different places around bearing to make sure a faulty reading is not taken due to the bearing cocking in the cup.

If a measurement of less than 2.148 is obtained, subtract this from 2.148 to determine the correct quantity of shims required.

EXAMPLE: If measurement taken was 2.141, shim requirement would be determined as follows:

Required distance	2.148
Measurement	2.141
Required shims	.007±.002

The shims are .004 thick. In this case, two shims (.008) would be within tolerance.

A mounting distance will be etched on the end of the pinion preceded by the letters MD and the symbol (—). Example: MD —0.016.

Add the required shims determined by measurement and the shims required for the MD markings on the end of the pinion.

EXAMPLE: Two (.004) shims were required by actual measurement and the MD markings on end

of pinion reads −0.016. Therefore, the required number of shims for the MD marking would be .004 inch shims.

Add the two shims (determined by measurement) and the four shims (determined by the MD markings) together. A total of six shims would be required.

Place the determined amount of shims over pinion gear hub, up tight against gear shoulder.

Heat bearing cones and spacer in oil to facilitate installation.

Place outer bearing cone over pinion gear hub and position up tight against shims.

NOTE: The double row, tapered roller bearings used in this machine have the required amount of lateral (end play) built in during the assembly process by the bearing manufacturer These bearings are made up in matched sets. Each set includes two bearing cones, a cup and a ground spacer located between the two cones.

The bearings must be kept in matched sets and parts of one set are NOT INTERCHANGEABLE with any other set. Keep the parts of each set together and install in the same bore from which they were removed.

Each set is identified by a code number which is etched on the face of each cone, cup and spacer. All parts having the same code number are of the same bearing set.

Some bearings will have identifying letters in addition to the set number. Bearings which have letters in addition to the code must be installed with the "A" cone in the "A" side of the cup and the "C" cone in the "C" side of the cup.

Bearings without letters have been manufactured so that the cones can be used in either side of the cup without affecting the accuracy of the end play setting.

Position bearing spacer over pinion gear hub and tight against bearing.

Install pinion gear assembly in bore of adaptor housing.

Replace inner bearing cone, oil seal and seal carrier.

Install large splined nut. Tighten nut 400 to 500 ft. lbs. torque. Secure nut with pipe plug.

Installation

Make sure the machined surfaces of the final drive case and transmission adaptor are clean and apply Permatex to the machined surface of the adaptor.

Position transmission adaptor to final drive case. Reach inside of differential compartment, replace the eight ½" locknuts that secure the adaptor to the final drive case. Tighten locknuts to standard torque.

FINAL DRIVES

INDEX

FINAL DRIVES

PINION

Removal

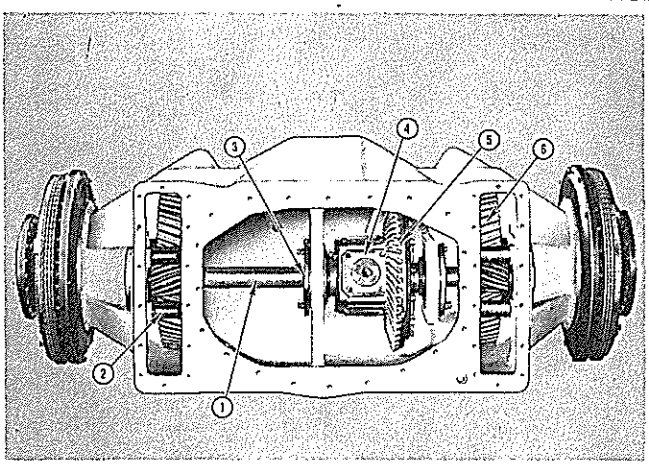


FIGURE G-1. FINAL DRIVES

1. Pinion
2. Staybolt Spacer
3. Adjusting Cage
4. Differential
5. Ring Gear
6. Final Drive Gear

Block up machine and remove the wheel, tire and brake from side to be worked on.

Remove drain plug and drain the lubricating oil from main case. Remove the fuel tank and battery box. Also remove the final drive cover plates and gaskets from rear of case.

Cut lockwires from case staybolts. Remove staybolts, copper washers, and staybolt spacers from case.

Remove capscrews fastening pinion bearing retainer cap and shims to the case. Remove retainer cap and shims. Do not damage shims during removal or in handling after removal since they may be re-used during installation.

Remove final drive axle (see page G-3) and roll the final drive gear forward in the case until there is sufficient clearance to allow removal of final drive pinion and inner bearing cone.

Place end of pry bar between inner face of pinion gear and inside case wall. Pry final drive pinion out of case. The inner and outer bearing cones will come with the pinion. Outer bearing cup will fall free after it has cleared the bore in the main case wall (Fig. G-3).

Pull bearing cones from pinion. Remove inner bearing cup from bore in inside case wall.

NOTE: If special tools are available, pinion may be removed without removing final drive axle.

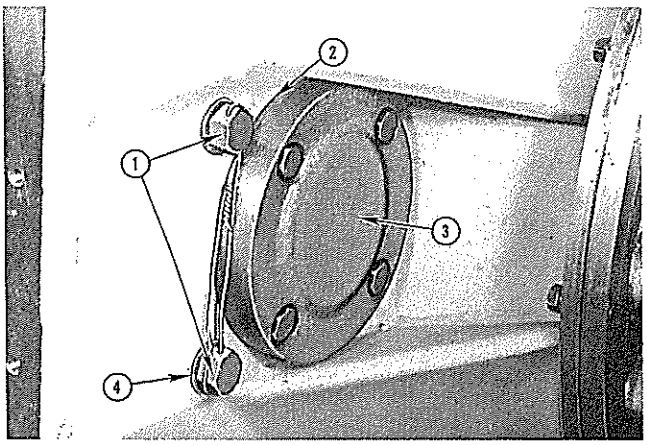


FIGURE G-2. PINION BEARING RETAINER CAP

1. Staybolts
2. Shims
3. Bearing Cap
4. Copper Washer

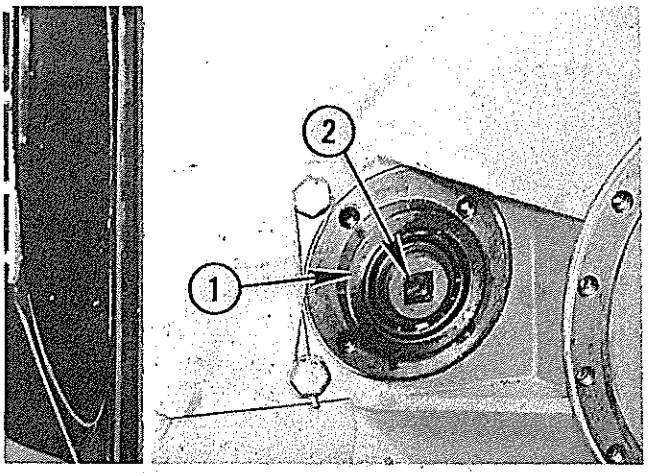


FIGURE G-3. REMOVING PINION

1. Bearing Cup
2. Pinion Shaft

Reassembly

Position inner bearing cup in bore in the case wall.

Press bearing cones onto pinion shaft. Replace pinion and bearing cones into case. Position outer bearing cup in bore in outer case wall over the bearing cone.

Replace staybolt spacers, washers, and staybolts. Tighten staybolts to 190 ft. lbs. torque to align case.

Mount a dial indicator on the inner final drive case wall and put the indicator button against the outside case wall as close to the outer pinion bearing bore as possible (Fig. G-5).

Set the dial indicator at "0". Loosen the staybolts several turns to allow normal case spread (a few thousandsths of an inch).

Assemble only enough shims behind the pinion bearing retainer cap to increase the normal case spread 0.003" to 0.010". (This must be done with staybolts loose.)

Tighten bearing retainer capscrews and read total spread on dial indicator (normal spread plus the 0.003" to 0.010" obtained by adding shims).

Subtract 0.003" to 0.005" from the dial indicator

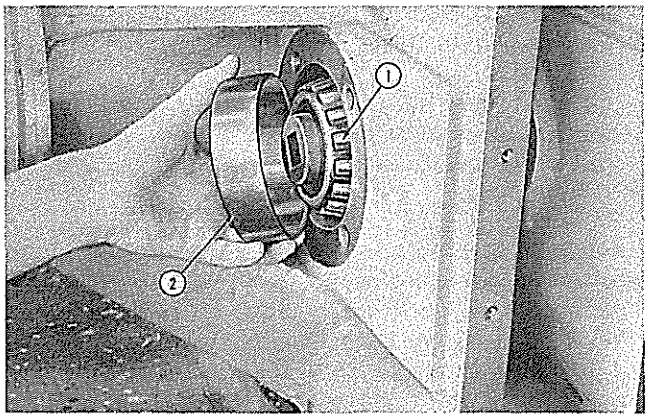


FIGURE G-4. REPLACING BEARING CUP
1. Cone 2. Cup

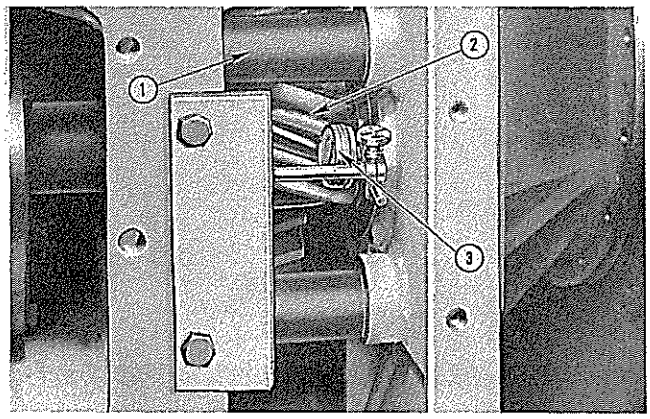


FIGURE G-5. MEASURING CASE SPREAD
1. Spacers 2. Pinion 3. Dial Indicator

reading. This is the amount of shims to be positioned behind the pinion bearing retainer cap.

Replace final drive axle and tighten locknut. See page G-5.

Tighten staybolts to 190 ft. lbs. torque and remove dial indicator. Install lockwires.

Position shims and retainer cap, secure with capscrews.

Replace cover plates and gaskets, fuel tank and battery box.

Refill final drive compartment with correct amount and type of lubricant (see Section "K").

Complete reassembly of machine.

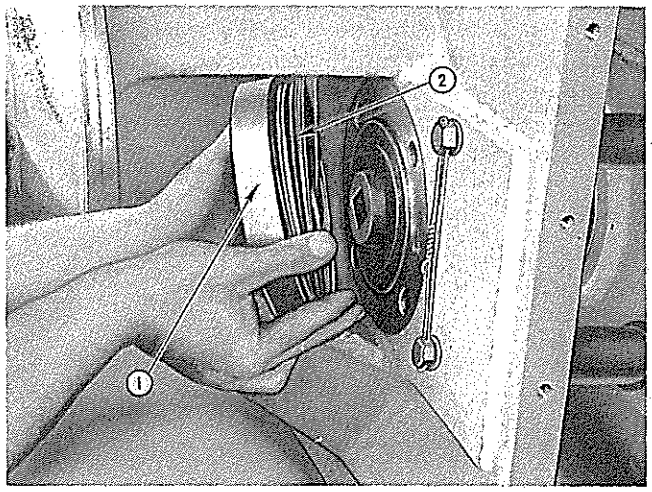


FIGURE G-6. REPLACING CAP AND SHIMS
1. Cap 2. Shims

AXLE

Removal

Block up machine and remove wheel and tire from side to be worked on.

Remove drain plug and drain lubricating oil from main case. Remove the fuel tank and battery box. Also remove the final drive cover plates and gaskets from rear of case.

Cut lockwires from case staybolts. Remove staybolts, copper washers and staybolt spacers from the case.

Remove capscrews fastening pinion bearing retainer cap and shims to the case. Remove retainer cap and shims. Do not damage shims during removal or in handling after removal since they may be re-used during installation.

Remove capscrews and lockwashers securing final drive axle bearing retainer cap to the inside wall of the rear case. Remove cap and gasket.

Pull cotter pin from splined axle nut. Place special wrench over axle nut and brace wrench against case to prevent its turning.

Insert a 1" square drive wrench into the hole in the end of the final drive pinion. By taking advantage of the ratio between the pinion and the final drive gear, the axle locknut may be removed by turning the pinion in a clockwise direction until the nut has been loosened and freed of the axle (Fig. G-7).

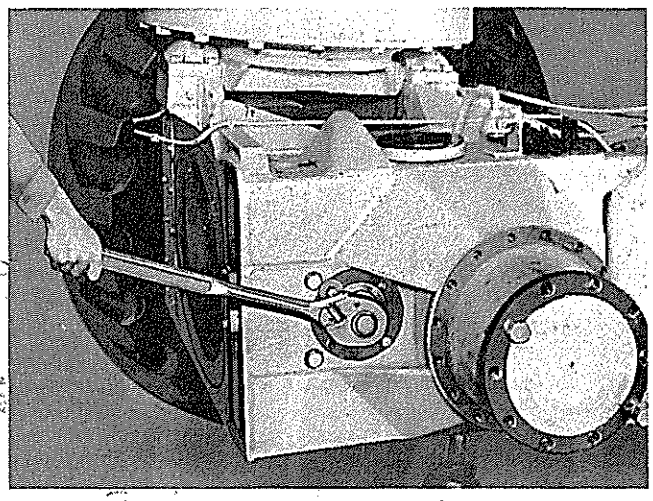


FIGURE G-7. REMOVING AXLE LOCKNUT

Place a wood block beneath the final drive gear to prevent a sudden drop of the gear as the axle is removed. Place a bar between the axle flange and the axle housing and another bar through the

final drive compartment, between the final drive gear and the case wall (Fig. G-8). (Axle may have to be tapped with a sledge to loosen it. Place a wood block between the gear and the inside case wall. With a sledge hit the axle flange slightly above center.)

Pry the axle flange away from the case and at the same time, with the other bar, pry final drive gear toward inside wall of case. Rotate axle to allow an even pull completely around the gear and axle. Continue this prying action until final gear and collar are free of the axle.

Remove final drive pinion, see page G-2.

Remove inner bearing cone and spacer from the axle as it clears the bore in the inner case wall (from inside differential compartment). Continue removing axle and remove outer bearing cone and spacer from axle (from inside final drive compartment).

NOTE: Do not allow bearing cones to fall to the bottom of the case as they be damaged.

Pull axle completely from case. Roll final drive gear from case.

Remove capscrews and copper washers securing inner bearing retainer to inner case wall. Remove retainer and bearing cup.

Using a small pry bar, remove oil seal and axle outer bearing from axle housing (Fig. G-9). Back out lockbolt securing outer bearing race in axle housing bore and remove bearing race.

NOTE: Special tools are available to pull the final drive axle.

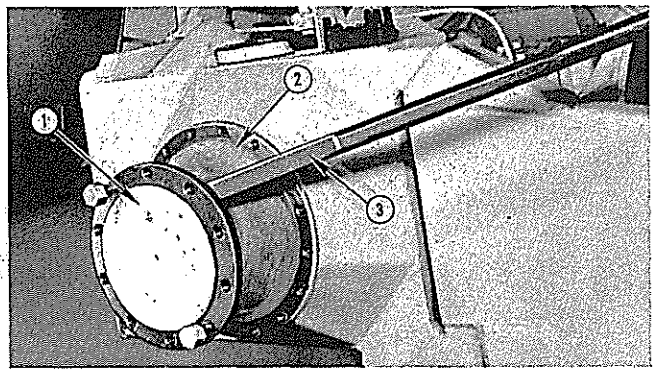


FIGURE G-8. PRYING AXLE
1. Axle Flange 2. Housing 3. Bar

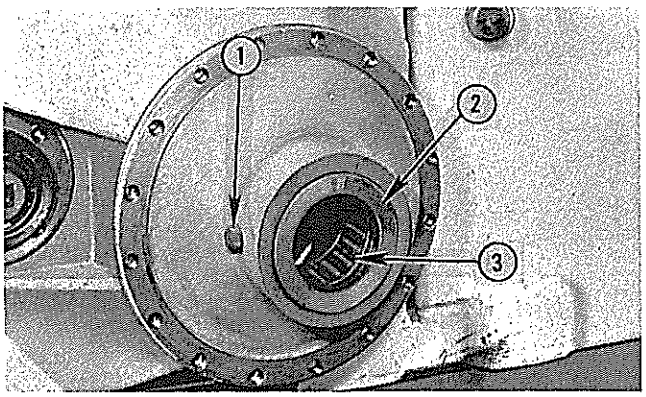


FIGURE G-9. AXLE HOUSING
1. Lockbolt 2. Oil Seal 3. Bearing

Installation

Clean all parts thoroughly and inspect for wear or damage and replace if necessary.

The double row tapered bearing used in the inner case wall is a matched set. See page F-8 for more complete information on this type bearing.

Press outer bearing race into axle housing. Align hole in race with lockbolt. Tighten lockbolt, locking race into position.

Replace roller bearing and oil seal into axle housing. Lip of seal should be pointing toward center line of machine.

Insert inner bearing cup into bore in case wall. (See page F-8 for information on double row tapered roller bearings.) Position inner bearing retainer over cup and secure to case wall with capscrews and washers. Fit tapered collar into tapered bore in drive gear, and roll gear and collar into case. Side of gear with collar must be toward center line of machine.

Replace final drive pinion, see page G-2. Do not replace bearing retainer cap.

Maneuver gear until axle can be started through it. Place outer tapered roll bearing cone into cup in case wall. Position drive gear and collar until axle can be guided through them and into place. Check to be sure the collar is seated squarely against the outer tapered bearing cone, and squarely into the tapered bore in the drive gear.

Replace bearing spacer and inner bearing cone. Place axle locknut over axle and tighten. (Place special wrench over axle locknut and brace wrench against case. Insert the 1" square drive wrench into the hole in the end of the pinion shaft. By taking advantage of the ratio between the pinion and the final drive gear, the axle locknut may be tightened by turning the pinion in a counterclockwise direction. 550 ft. lbs. of torque must be applied to the pinion in order to tighten the axle locknut to the required amount (approx. 3900 ft. lbs.). Hold pinion outer bearing cup in case while turning pinion to tighten axle locknut. Use two capscrews and flat washers as shown in Fig. G-7.

Replace cotter through axle shaft and locknut. Position gasket and bearing retainer cap. Secure with capscrews and copper washers.

Replace final drive pinion bearing retainer cap and shims. Re-adjust pinion and ring gear as outlined on page G-7.

Replace cover plates and gaskets, fuel tank and battery box. Refill final drive compartment with the correct amount and type of lubricant (see Section "K").

Complete reassembly of machine.

DIFFERENTIAL

The differential provides a means of slowing the inner wheel and speeding the outer wheel when turning, and accomplishes a proportioning of power between the wheel with poor traction and the wheel with better traction.

The differential pinion is a compensating linkage with the differential housing, used to connect the axle shafts to the drive shaft. If the pinions were removed from the differential, the vehicle could not move. The nature of a standard differential is to permit power to flow to the wheel with the least resistance. This inherent nature results from the freedom of the pinions to rotate within the differential housing, giving the compensation needed on turns. The only way we can prevent all the engine power from going to the wheel with the least resistance, and still keep the differential simple in design and construction, is to restrict the rotation of the pinions when one wheel starts to slip.

The LeTourneau-Westinghouse differential capitalizes on the simple design of the standard differential by placing large friction bushings at the top of each differential pinion. There is no intricate gearing, collars or springs to require maintenance. When one wheel starts to slip, the pinions rotate within the differential housing. The rotation forces the pinions out against the bushing which restricts the speed of pinion rotation. As the speed of their rotation is restricted, a portion of engine power is automatically diverted to the opposite wheel. The greater the speed of the slipping wheel, the greater the restriction, and the greater the portion of engine power that is diverted to the opposite wheel.

The reason one wheel can pull approximately four times as much as the other is that the pinion is small and rotates rapidly when differentiating. At the same time the lubricated bronze bushings are very large, which increases the lineal feet per minute at the bushing surfaces which resists the differentiating action enough to make one wheel pull approximately four times as much as the other.

When the Tournapull is traveling in a straight line, the differential pinion gears act merely as linkage, and do not rotate with respect to the differential pinion bushings. When the Tournapull is turning, the differential pinion gears are meshed to both differential gears, and therefore act as compensators as well as linkage.

Removal and Disassembly

Block up machine and remove both wheels and tires.

Remove drain plug and drain lubricating oil from main case. Remove fuel tank and battery box. Also remove final drive cover plates and gaskets.

Remove both final drive pinions. See Page G-2.

Block up under the differential to prevent its falling or turning.

Loosen locknuts from locking capscrews on differential adjusting cages (Fig. G-10). Remove the capscrews from the right adjusting cage. With use of a small bar, unscrew and remove adjusting cages (Fig. G-11). Bearings cups will be removed with adjusting cages.

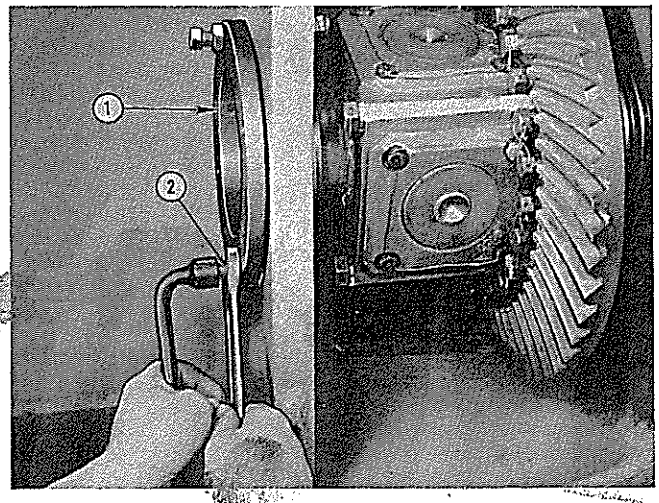


FIGURE G-10. REMOVING LOCKING CAPSCREW
1. Adjusting Cage 2. Capscrew

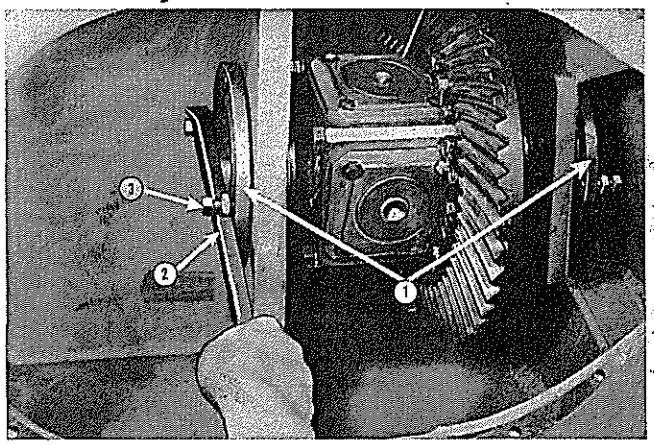


FIGURE G-11. REMOVING ADJUSTING CAGE
1. Adjusting Cage 2. Bar 3. Capscrew

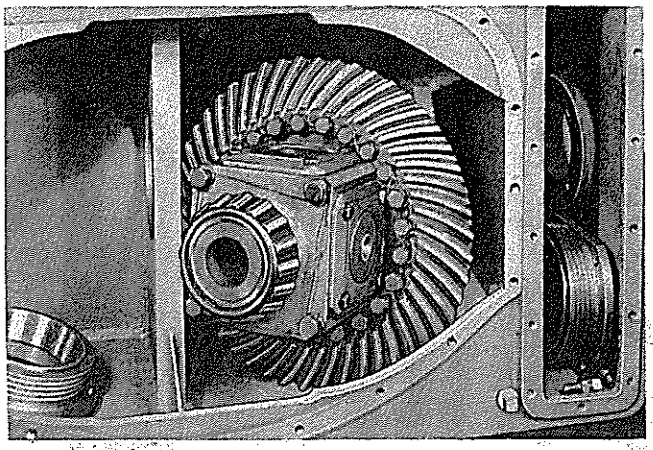


FIGURE G-12. REMOVING DIFFERENTIAL

Move differential and ring gear as far to the right as possible, until left bearing cone clears bore in case wall. Pull left end of differential to the rear (See Fig. G-12). Lift ring gear and differential from case and place on bench for disassembly.

Pull bearing cones from differential cage (if necessary). Mark bearing cones so they may be re-installed in their respective cups.

Cut lockwires and remove capscrews securing ring gear to differential cage. Separate cage and ring gear.

Cut and remove lockwires from the capscrews securing the pinion bushings to the cage. Lift the pinions, bushings, and shims from the differential cage.

NOTE: Mark pinions, bushings, shims and cage assembly so that they may be replaced in the position from which they were removed.

Cut and remove the lockwires from the four capscrews fastening the two halves of the differential cage together. Remove capscrews and separate two sections of cage (Fig. G-14).

Remove idler gears and bushings from cage assembly.

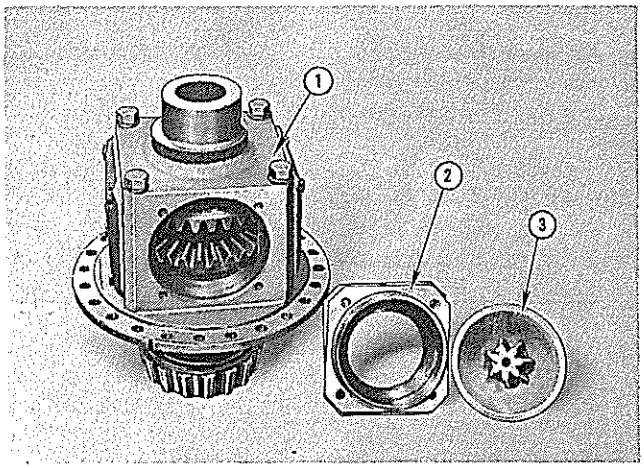


FIGURE G-14. BUSHING AND GEAR REMOVED
1. Differential 2. Bushing 3. Pinion

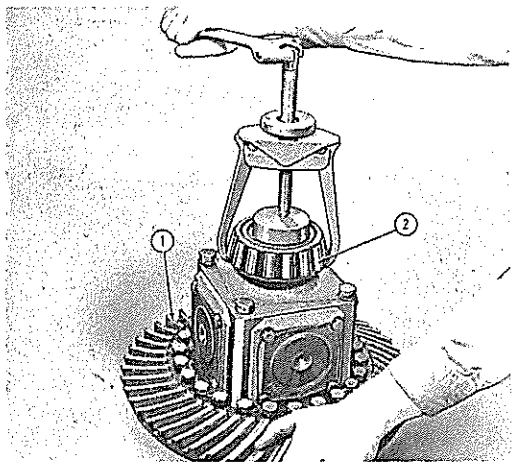


FIGURE G-13. PULLING BEARING CONE
1. Ring Gear 2. Bearing Cone

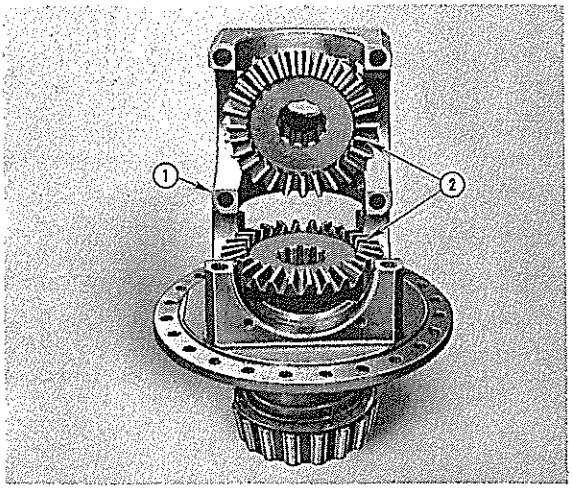


FIGURE G-15. DIFFERENTIAL HOUSING
1. Housing 2. Idler Gears

Reassembly

Thoroughly clean all parts of the differential assembly. Check each part for wear or damage. Replace parts that show evidence of excessive wear or damage.

Press idler gear bushings into each section of differential cage. Install idler gears.

Put the two sections of differential cage together (mate the punch marked surfaces) and install capscrews. Install all four pinion bushings in cage and torque capscrews securely, two halves of differential cage together, at 125 ft. lbs. Remove the pinion bushings.

Replace pinion gear and bushings two at a time (opposite each other). Lubricate the bushings thoroughly and match the marks made during disassembly.

Check the free play of the two pinions by fastening a dial indicator rod to the differential cage

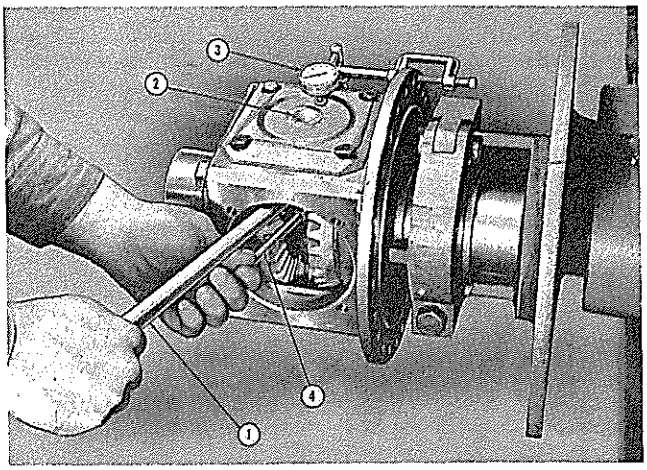


FIGURE G-16. CHECKING FREE PLAY
1. Bar 3. Dial Indicator
2. Pinion 4. Bar Support

with the indicator positioned over the pinion gear. With the gear down in the bushing, set the indicator to "O" and rest the button on the gear (Figure G-16). Raise the pinion gear against the indicator to determine the amount of free play. The free play should be between 0.010" and 0.020". Shims may be added between the bushing and the cage to obtain the correct reading.

Remove the two pinion gears and install the remaining two. Make the same check for "free play" as outlined above. Each of the four readings should read the same or within .002" end play of each other. When checking do not revolve side gears. Replace pinion gears, bushings and shims then torque pinion bushing capscrews to 30 ft. lbs.

Position ring gear over differential, secure with capscrews and lockwires. Torque capscrews to 190 ft. lbs.

Installation

Replace bearing cones on differential cage (if removed). Position differential and ring gear into case, ring gear to the right. Replace adjusting cages and bearing cups. The adjusting cage with the two flat sides goes on the right end of the differential. Position "X" on pinion between the "X's" on the ring gear.

After differential has been installed and mated with the spiral bevel pinion, the backlash must be checked. Fasten dial indicator to main case with indicator stem against ring gear. Move ring gear back and forth to determine the amount of backlash present. Refer to Figure G-17.

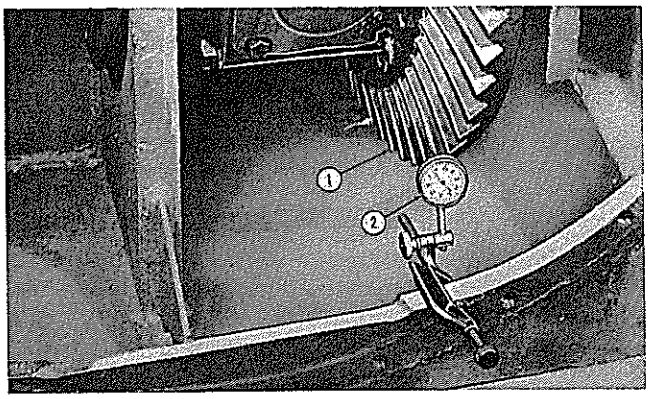


FIGURE G-17. CHECKING BACKLASH
1. Ring Gear 2. Dial Indicator

The backlash must be maintained within —.000" to +.003" of the backlash stamped on the gear.

To obtain this adjustment, loosen the lockbolts in the adjusting cages and turn the cages either in or out depending upon the direction the ring gear has to be moved to secure the correct backlash. Use the special wrench provided. The closer the ring gear is moved to the pinion, the less the backlash. Check for backlash at four points equidistant around the circumference of the gear.

Coat the ring gear and pinion teeth with a thin coating of red lead and check the tooth pattern. Turn the ring gear one complete turn in each direction under no load condition. The tooth patterns of the ring gear should approximate the ones shown in Figure G-18.

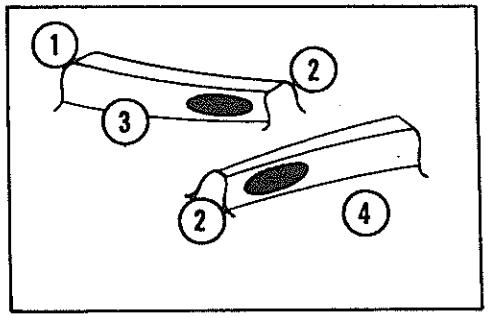


FIGURE G-18. RING GEAR TOOTH BEARING PATTERN, UNLOADED
1. Heel 2. Toe 3. Forward 4. Reverse

As the load increases, the tooth pattern should extend toward the heel of the teeth, in proportion to the load, until the tooth patterns approximate those in Figure G-19.

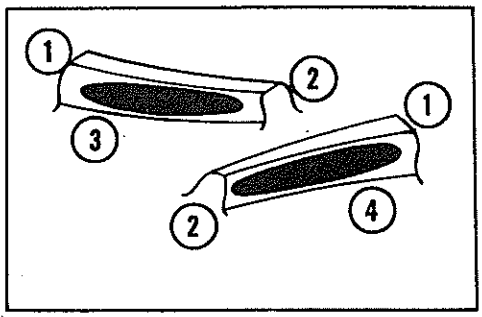


FIGURE G-19. RING GEAR TOOTH BEARING PATTERN, LOADED
1. Heel 2. Toe 3. Forward 4. Reverse

NOTE: The patterns shown are what could be considered ideal patterns, which are almost impossible to obtain, and the patterns can deviate within reasonable limits. The full load pattern can be considered acceptable even though the pattern should run up the toe or back to the heel as long as it extends along the tooth approximately its full length and does not indicate heavy tooth bearing on the

heel or toe. The patterns ARE NOT acceptable if they run off the toe or heel of the teeth as this will usually result in chipping of the teeth. The patterns can also run higher toward the top than those shown and even run slightly off the top as long as most of the tooth bearing is below the top. The pattern, however, CANNOT run to the bottom of the teeth as this would cause scrubbing of the teeth and premature failure of the ring gear and pinion.

After adjustment has been obtained, tighten locking capscrews and locknuts on differential adjusting cages.

Replace final drive axles, gears and pinions. Also, any other assemblies that have been removed.

Fill compartment with correct level and type of lubricant. (Refer to Section "K" of the maintenance manual.

TROUBLE SHOOTING

TROUBLE: Noisy gears.
- CAUSE: Chipped, broken, pitted or galled teeth.
  - REMEDY: Replace gears.

TROUBLE: End play in axle.
- CAUSE: Bearing failure.
  - REMEDY: Replace bearing(s).
- CAUSE: Loose axle nut.
  - REMEDY: Tighten nut. Replace if threads are damaged.
- CAUSE: Loose retainer cap.
  - REMEDY: Tighten retainer cap capscrews.

TROUBLE: Axle oil seal leakage.
- CAUSE: Lubricants may not be those which are recommended. Oils lighter than the recommended may seep out under seals. Incorrect type of oil may break down and become thin from heat of operation.
  - REMEDY: Remove lubricant and replace with recommended type.
- CAUSE: Oil seal incorrectly installed with lips cupped outward from lube chamber.
  - REMEDY: Remove oil seals and install with lips cupped inward.
- CAUSE: Gear case filled with oil above level plug.
  - REMEDY: Lower oil level to level plug.
- CAUSE: Oil seals becoming burned and hardened as a result of overheating.
  - REMEDY: Correct cause of overheating and install new oil seals.

TROUBLE: End play in pinion.
- CAUSE: Loose bearing cap or bearing out of adjustment.
  - REMEDY: Tighten cap—adjust bearing.

TROUBLE: Differential slips on pulls.
- CAUSE: Excessive wear in pinion and bushings.
  - REMEDY: Remove shims or replace worn parts.

TROUBLE: Noisy operation on turns—rough operation.
- CAUSE: Broken gear teeth—galled bearings.
  - REMEDY: Replace broken or worn parts.

TROUBLE: Shock load on ring gear when starting.
- CAUSE: Excessive backlash between ring and pinion.
  - REMEDY: Readjust backlash.

BRAKES, WHEELS AND TIRES

INDEX

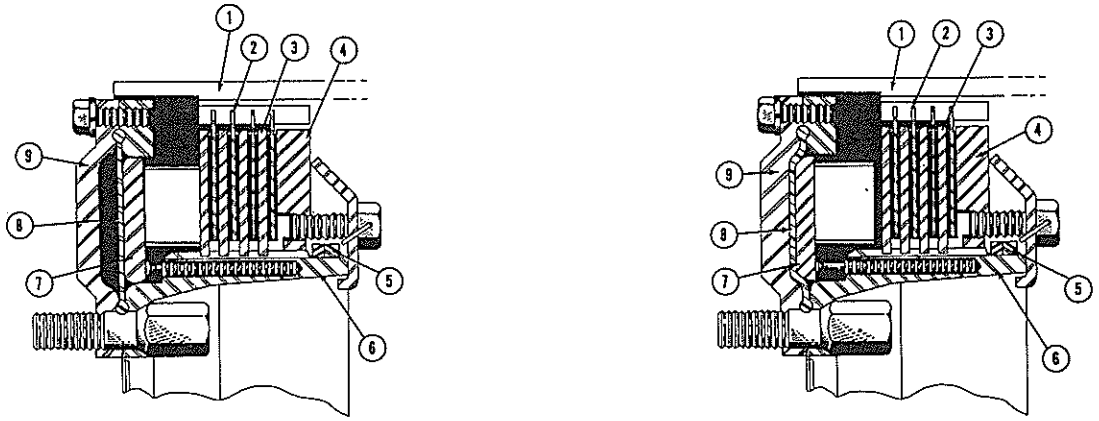
BRAKES, WHEELS AND TIRES

BRAKES

Each wheel is equipped with an air actuated and spring released multiple disc brake. The principle parts of the brake are: brake drum which is bolted to the wheel; brake hub which is bolted to the main case structure; discs of two types, steel discs which are splined to the brake hub and fabricated discs which are splined to the brake drum; and the pressure plate and diaphragm.

When a brake is actuated by foot pressure on the metering type air valve on the floor of the cockpit, or by a hand brake valve, compressed air from the supply tank is admitted to the brake. The air exerts pressure through the diaphragm against the pressure plate. The pressure plate presses against the discs forcing them together. Since part of the discs are splined to the revolving brake drum and part to the stationary brake hub, the wheel is braked when the discs are forced together.

When air to the brake is cut off (brake pedal, or valve released), the return springs force the pressure plate back to its original or released position. These springs are compressed when the brake is engaged. See Fig. H-1.



APPLIED RELEASED

FIGURE H-1. WHEEL BRAKE OPERATION

1. Brake Drum
2. Revolving Discs
3. Stationary Discs
4. Backing Plate
5. Snap Ring
6. Brake Hub
7. Pressure Plate
8. Diaphragm
9. Diaphragm Backing Plate

Removal

Block up Tournapull or trail unit so that the wheel and tire to be removed will roll free.

Place a sling around the wheel and tire. Remove the capscrews securing the wheel to the hub, or to the axle.

Remove tire and wheel from machine.

Bleed air system and disconnect the air line to the brake to be removed.

Disassembly

The following instructions apply to disassembling the brake assembly after it has been removed from the machine.

The brake can be disassembled while still on the machine as described. However, the same capscrews which secure the brake assembly to the main case fasten the brake hub to the plate, with the exception of the four short capscrews. These four, the middle capscrews in the groups of three, do not extend through to the brake plate on the main case. If tapered capscrews are all removed, the drum will be separated from the plate and the plate from the main case all in one operation.

To remove the brake as a unit remove all the capscrews except the four short ones. It is then necessary to remove only these four to separate the hub from the plate (see Fig. H-2).

Be sure no air pressure is applied to the brake.

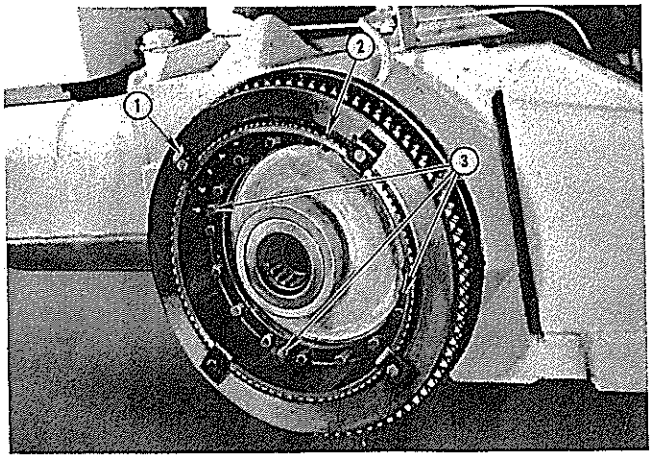


FIGURE H-2. WHEEL BRAKE, MOUNTED

1. Snap Ring Guard
2. Snap Ring
3. Leave These Capscrews To Remove Brake As Unit

Cut the lockwires and remove the capscrews securing the four snap ring guards around the circumference of the brake (Fig. H-2).

Pry out snap ring, using bar or other suitable tool.

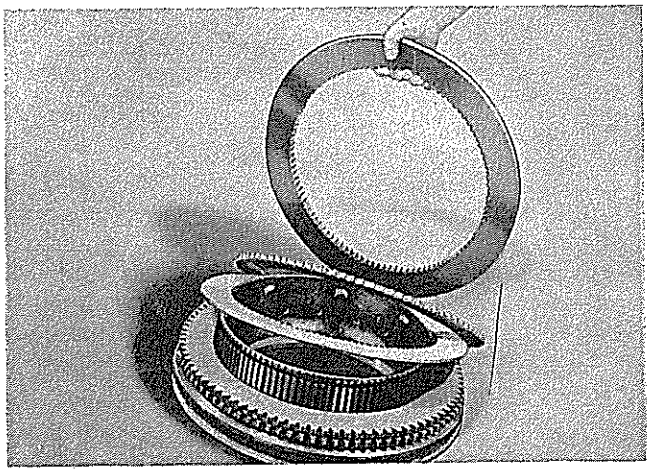


FIGURE H-3. REMOVING BACKING PLATE AND DISCS

Remove the backing plate, lined and unlined discs from the hub (Fig. H-3).

Remove the four capscrews securing the hub to the diaphragm backing plate. Note the position of the brake release springs and guides as the hub and plate are separated (Fig. H-4).

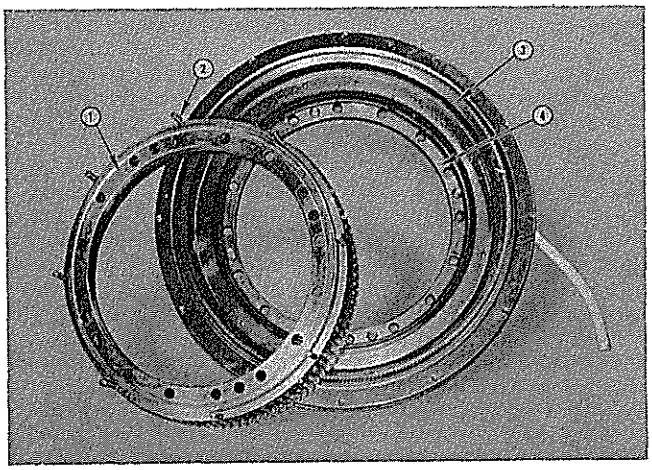


FIGURE H-4. BRAKE HUB, REMOVED

1. Brake Hub
2. Springs and Guides
3. Pressure Plate
4. Backing Plate

Remove springs and guide pins from hub.

Remove pressure plate (Fig. H-5).

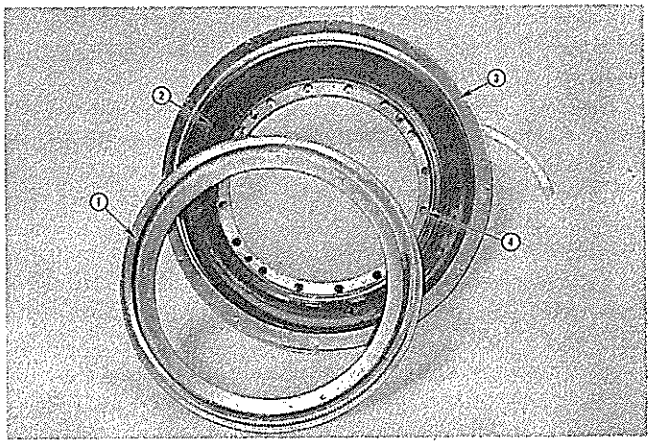


FIGURE H-5. PRESSURE PLATE, REMOVED

1. Pressure Plate
2. Diaphragm
3. Retainer Ring
4. Backing Plate

Mark position of dust guard in relation to the backing plate.

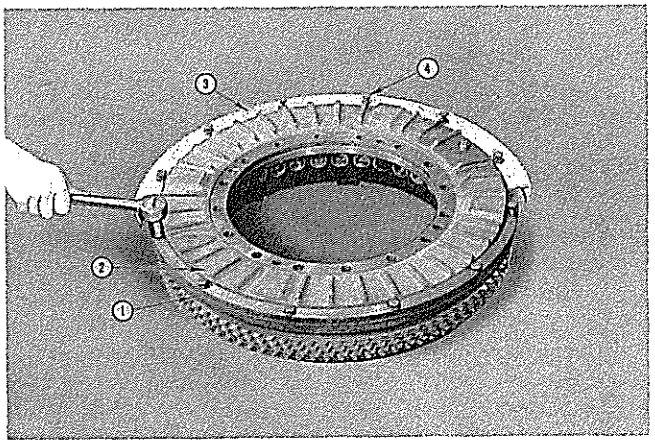


FIGURE H-6. REMOVING BACKING PLATE

1. Retainer Ring
2. Backing Plate
3. Dust Seal
4. Capscrew

Remove the capscrews and lockwashers securing the diaphragm retainer ring, dust guard and backing plate together (Fig. H-6).

Separate the three units. Remove diaphragm from backing plate.

Reassembly

Clean all parts thoroughly. Inspect carefully for damage or wear.

Check diaphragm carefully. A leaking diaphragm causes slippage and excessive wear, and must be replaced with a new unit.

Keep the brake hub splines clean. Any obstruction in the splines is apt to cause uneven movement and sluggish brake action.

Correct any defect in the air lines which may retard the flow of air to the brake such as compressed, broken or clogged lines.

In extremely cold weather, any moisture present in the air lines may freeze and impede the flow of air. Add alcohol to the air system to absorb the moisture and help eliminate this condition (1 pint each day to the air supply tank).

NOTE: Whenever a brake is disassembled and is found to have small type release spring guides, discard them and replace with heavier ones. The heavier ones can be made from #12d common nails, including the head. Cut the nail to 2⅜" (+0") (−⅛") overall length, and remove burrs from cut end.

Lubricate the diaphragm with a thin coating of good grade cup grease.

Place diaphragm on backing plate and replace retainer. Be sure that diaphragm is seated properly so that it will not be pinched.

Replace the capscrews fastening the dust guard and retainer ring to the backing plate. Torque to 30 ft. lbs.

Check condition of brake release springs. Replace if necessary. (See above.)

Install brake release spring and guide pins in holes around the circumference of brake hub. Put pressure plate over hub with flat side against diaphragm. Place brake hub on brake plate and replace the four short capscrews that hold the hub to the plate (middle capscrews in groups of three), torque to 190 ft. lbs.

Replace brake discs, starting with a steel disc next to the pressure plate; alternate steel and lined discs.

Replace backing plate. Install snap ring in groove in hub.

Replace snap ring guards and secure with capscrews. Install lockwires.

Install brake unit on machine and secure with capscrews (torque to 190 ft. lbs.). The brake must be mounted so that the air inlet fitting on the brake backing plate is in such a position that it can be connected to the air line from the metering valve.

Reconnect air line to brake backing plate. Apply air pressure and check for air leaks.

Replace tire and wheel.

NOTE: If replacement steel discs are installed in the brake hub the variation in thickness of discs may result in a tight brake. Should this occur and the counterbore of the backing plate faces the disc, reverse the position of the backing plate so that the counterbore faces the ring guards and snap rings.

TIRES

The tires should be checked at least once each week (before operation) with an accurate pressure gauge.

Tire pressure may be varied due to operating conditions. Consult tire manufacturers representative for recommendations.

Recommended normal air pressure (when tires are cold) for the various size tires is as follows:

18.00 x 25 16 PR . . . . . 30 p.s.i.
23.5 x 25 12 PR . . . . . 40 p.s.i.
65" 18 PR W.B.S.T. . . . 45 p.s.i. max.

While a weekly inflation check with a gauge is recommended, the operator must watch the tires constantly as punctures or slow leaks may develop at any time.

Do not depend on the valve cores being air tight; always keep valve caps securely applied to the valve stems. Caps also protect the valves from damage and deterioration.

Do not bleed air from tires which are hot due to operating. Under such circumstances it is normal for the pressure in the tube to increase due to expansion.

A bent or damaged rim which does not support the bead properly may cause abnormal strain on the tire and result in failure.

Should a tire become cut exposing the cords of the body plys of fabric, it should be removed and repaired. Neglected cuts cause many tire failures. Water, sand, grit, dirt and other foreign materials work their way into a tire through a cut, eventually causing thread or ply separation and tire failure.

A tire may be retreaded if removed in time.

Tires and tubes should be stored indoors if possible. If not practical to store inside, be certain to cover them with tarpaulin to keep out dirt, water and other foreign materials. Storage should be in a dark, cool, dry and free-from-draft location. Avoid contact with petroleum products such as oil, grease, fuel oil, etc.

Before storing used tires, clean thoroughly, inspect for damage, and repair where necessary. When a rubber tired vehicle is placed in storage, it should be blocked up to take its weight from the tires, and the tires deflated. If the vehicle cannot be blocked up, check the air and tires twice a month and keep propely inflated.

Always store or transport tires standing up. Be careful not to damage beads with hooks, ropes or chains. If necessary to raise tire by bead, always pad bead with burlap or canvas. Do not lift rims by the valve holes. Use babbitt or lead hammer, never a sledge.

Changing

TWO PART WHEEL

Remove wheel and tire from the machine.

Deflate the tire by removing the valve core from the valve stem in the tube. Do not attempt to remove the locking or sliding rings until the tire is completely deflated.

Remove the locking ring from the center of the wheel (Fig. H-7).

After the lock ring is removed, loosen beads of the tires. It is advisable to loosen the outer bead first and remove the rim from the tire. Then loosen the inner bead and remove the wheel.

To help in removing tapered beads, the wheels and rims may have tapped holes around the outer edge of the rims.

Remove the corks from these tapped holes. If the threads are rusted, clean and oil thoroughly before inserting capscrews into holes.

After cleaning and oiling, insert special capscrews into holes and tighten until the screws have forced the bead off the rim. Be sure to apply uniform pressure on all the capscrews. Use a tire tool if necessary to help dislodge the tire bead.

To mount the tire, lay it over the inner part of the

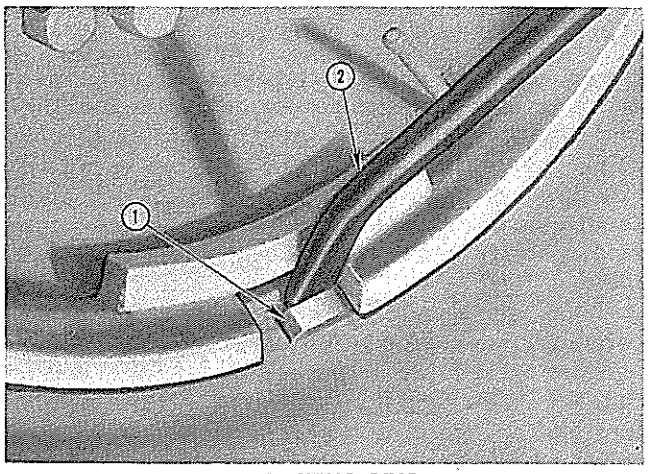


FIGURE H-7. REMOVING LOCKING RING
1. Lock Ring 2. Bar

wheel, then place the outer rim section of the wheel inside the tire. Be sure the sliding ring is in place on the wheel rim first.

After the outer rim section is in place inside the tire, place the locking ring in position and seat it properly. It is very important that the tire and wheel be correctly assembled, and that the locking ring be in its exact position before inflating tire.

Next, stand to one side of the tire and inflate to 75 pounds pressure to seat the tire beads, then completely exhaust the air from the tire. Inflate to the correct operating pressure.

Replace tire and wheel on machine. Torque the wheel mounting capscrews to 550 ft. lbs.

ONE PIECE WHEEL

Proceed as above to remove wheel and tire.

After tire has been completely deflated remove the locking ring from around the wheel rim with a pry bar (Fig. H-8).

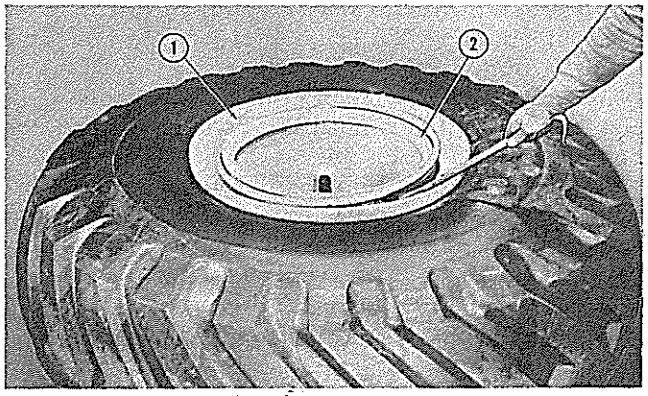


FIGURE H-8. REMOVING LOCKING RING
1. Rim 2. Lock Ring

Attach hoist to tire and lift tire, inner sliding ring and outer sliding ring from wheel.

To separate the tire and rings loosen the rings by driving wedges between the rings and tire beads. Remove sliding rings from the tire (Fig. H-9).

To mount tires, first seat the sliding rings inside the tire beads and place tire over wheel. Place locking ring in its correct position. Lock ring must be correctly positioned.

Next stand to one side and inflate tire to 75 pounds pressure to properly seat the beads, then completely exhaust air from tire. Inflate to the correct operating pressure.

Replace tire and wheel an machine. Torque the wheel mounting capscrews to 550 ft. lbs.

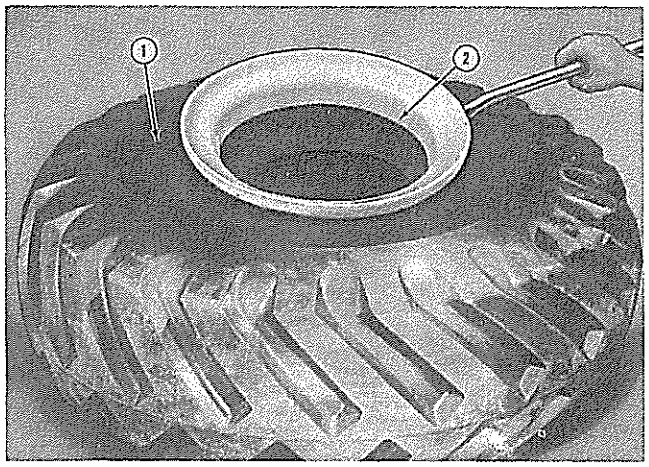


FIGURE H-9. REMOVING RIM
1. Tire 2. Sliding Rim

WIDE BASE WHEEL

Special tools are available to aid in changing the wide base tire. See Fig. H-10.

Securely block all wheels other than the one on which the tire change is being made. Jack up the wheel sufficiently for the tire to clear the ground. As a safety precaution block up under the axle to prevent falling if jack should slip.

Remove the valve core and exhaust all the air pressure before starting to dismount the tire. Always replace valve cap after the rim is disassembled to protect the soft metal threads during tire removal.

Place the flat hooked end of a bar tool into one of the four breaking slots between the bead seat band and the rim flange. With a 5' length of pipe slipped over the straight end of the tool for leverage, twist the tool in a circular direction. A second operator now inserts another bar tool between the bead seat band and the side flange, and with the same twisting action holds the amount of space

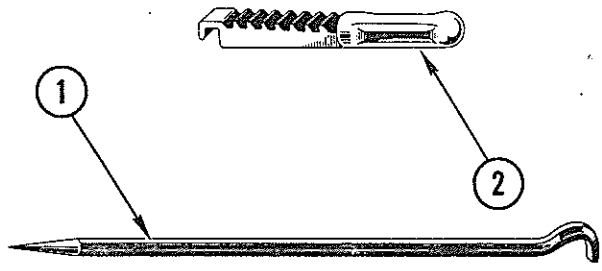


FIGURE H-10. SPECIAL TIRE TOOLS
1. SV-2568 Bar Tool 2. SV-2567 Ratchet Tool

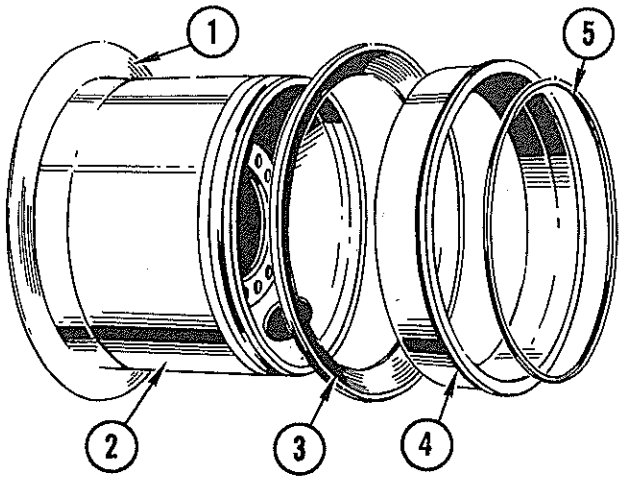


FIGURE H-11. WIDE BASE TIRE

1. Inner Rim Flange
2. Rim Base
3. Rim Flange
4. Bead Seat Ring
5. Lock Ring

gained with first tool. Move the first tool forward around the circumference of the bead seat band until the outer tire bead is loose.

Start the bead seat band in away from the lock ring by placing a bar tool in the gutter section between the ends of lock ring and prying radially with the tool. Using two tools as described above, work completely around the tire.

Pry out lock ring starting at prying notch and working around the tire using two irons to pry and hold.

After lock ring has been removed, pry the bead seat band out over the gutter section and remove it, together with the side flange, from the rim base.

Four similar breaking slots are provided on the inside of the tapered bead rims, and inside bead may be broken loose from the rim base in the same way as the outer bead. Another method is to place a small jack between the side flange and some part of the vehicle. By extending the jack, pressure is exerted to force the tire bead off the rim taper. Work progressively around the tire to loosen the bead at all points on the circumference.

Before working the tire off the rim make certain that the valve is pried out sufficiently to clear the gutter section.

Before replacing tube in tire, inspect the tire carefully, inside and out, for breaks, bruises, nails, etc. Clean out all dirt and foreign matter inside the casing.

Replace tube in casing, starting at the bottom and working around the tire. Adding air as the tube is worked in will help to hold it in place and eliminate the possibility of wrinkles.

Insert flap in casing. Make sure it is properly centered and free from wrinkles. Rotate the tire as the flap is worked in so that the portion being inserted is at the bottom of the tire. In some cases it may be necessary to spread the beads, using spreader or car jack.

Clean wheel of rust and dirt by scraping and by the use of a wire brush. Pay special attention to the cleaning of all foreign matter out of the lock ring gutter. Apply coating of rust preventive to bead seats (zinc chromate and red lead are excellent). The prevention of rust building up inside and under the tire bead means the difference in the use of the simple hand tools or force enough to require power tools.

Place rear flange on rim base and line up the driving lug on flange with slots in rim.

Hoist or roll tire into position, making certain that the valve stem lines up with the valve slot before sliding tire onto wheel. If hoist is not used, lower wheel far enough to permit top of tire to be hooked over top of rim, then raise the wheel and "walk" tire on in the same manner as described for removing the tire.

Hook two of the ratchet tools into the rim gutter approximately four inches from either side of the valve slot. Place the bead seat band in the outside flange, lining up the driving lug on the flange with the slot in the bead seat band. Mount the bead seat band and side flange on the rim base by hooking them over the two ratchet tools and sliding on the rim. Be sure the driving lug on the bead seat is lined up with the valve slot in the rim base.

Engage two of the bar tools in the proper notches of the ratchet tools and force the bead seat band into position by prying. Holding pressure against the band with one bar tool, slide the other ratchet tool and bar tool around the circumference of the rim, stopping approximately every foot to pry the bead seat band in. Follow up with second ratchet tool and bar tool to hold pressure against the band and retain clearance gained.

After going around the rim once in this manner it should be possible to hook one of the bar tools into the gutter for additional prying. Continue to work around the rim, using the two bar tools without the ratchet tools, until the bead seat band has been forced 3/4" to 7/8" inside the gutter edge.

Hold the band in this position and drive the tapered end of a bar tool, or any suitable tapered wedge, between the band and the rim base, directly under the bead in the bead seat band.

Hook one end of the lock ring into the gutter next to the wedge. Retain pressure with one of the bar tools against the bead seat band, and at the same time pry or snap the lock ring into place with the flattened end of another bar tool. When lock ring is in place remove wedging tool from between ends of lock ring.

Pry the bead seat band out over the ledge of the lock ring, making certain that no "binding" occurs when this is done. NEVER START TO INFLATE A TAPERED BEAD TIRE UNLESS THE BEAD SEAT HAS BEEN PRIED OUT OVER THE LOCK RING.

Check to be sure that driving lugs on both

flanges are engaged, then inflate to approximately 75 pounds pressure to insure proper seating of the beads. Completely exhaust air from tire. Inflate to recommended air pressure.

Replace wheel and tire on machine (if removed) and torque wheel mounting capscrews to 550 ft. lbs.

TUBELESS TIRE

Securely block all wheels other than the one on which the tire change is to be made. Jack up the wheel sufficiently for the tire to clear the ground. As a safety precaution block up under the axle to prevent falling if jack should slip.

Attach sling hoist around tire, remove wheel mounting capscrews, and remove wheel and tire from machine.

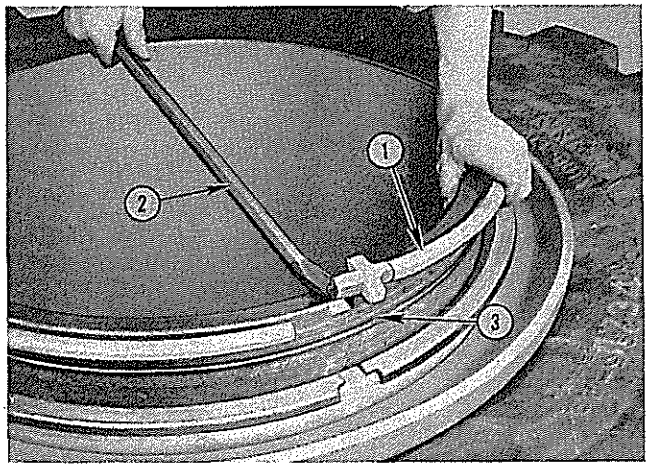


FIGURE H-12. REMOVING LOCK RING
1. Lock Ring 2. Tire Tool 3. "O" Ring

Remove valve core and exhaust air pressure before starting to dismount tire. Always replace valve cap to protect the soft metal threads during tire removal.

The use of a hydraulic bead breaker is a "must". Use according to manufacturer's recommendations.

Break outer bead loose from bead seat.

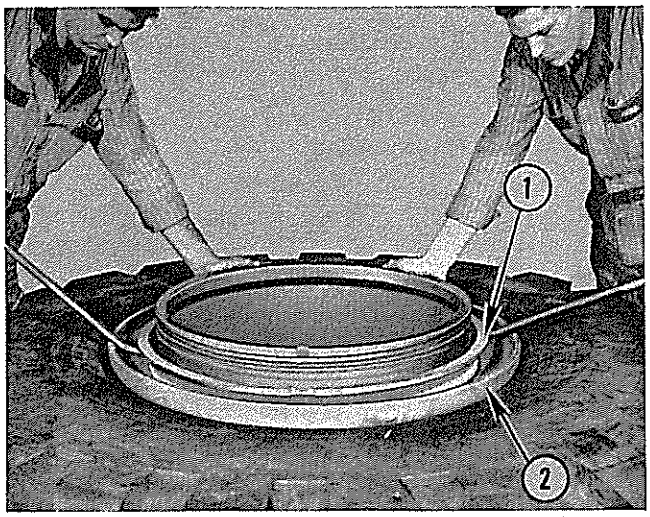


FIGURE H-13. REMOVING BEAD SEAT BAND
1. Bead Seat Band 2. Flange

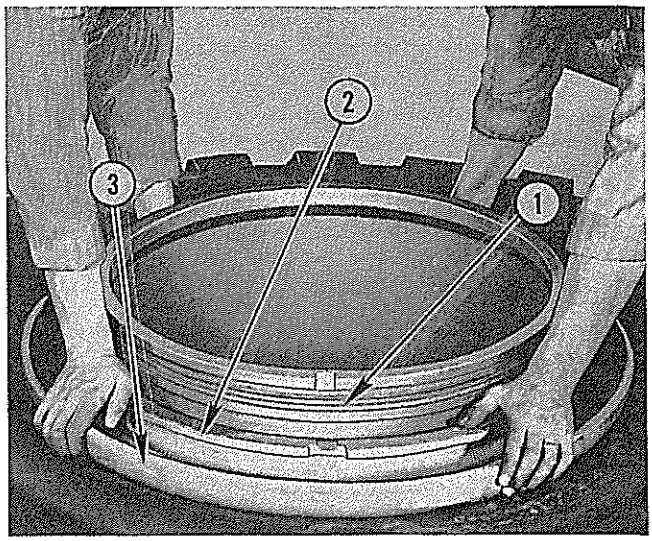


FIGURE H-14. REPLACING BEAD SEAT BAND
1. "O" Ring Groove 2. Bead Seat Band 3. Flange

Insert flat end of tire tool into lock ring breaking notch and pry out lock ring (Fig. H-12).

Remove "O" ring from rim base, being careful not to damage it.

Then remove bead seat band and outer ring (Fig. H-13).

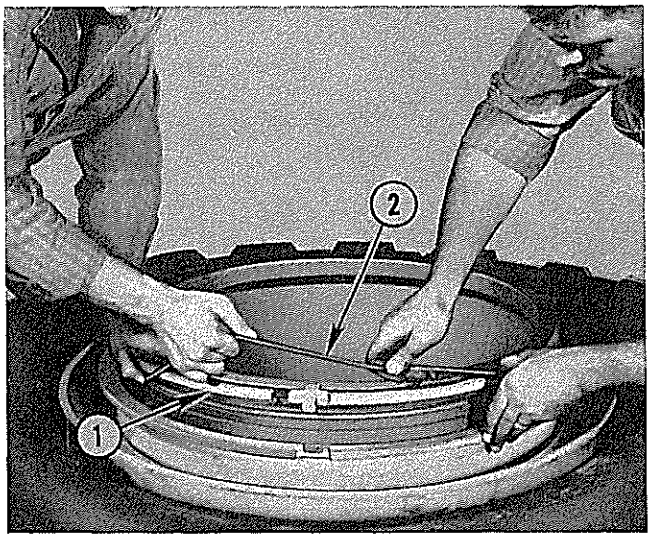


FIGURE H-15. REPLACING "O" RING
1. Lock Ring 2. "O" Ring

Turn tire over and with hydraulic bead breaker loosen bead from wheel. Lift wheel rim out of tire.

To mount the tire, first clean dirt and rust from all wheel parts, being particularly careful to clean "O" ring groove and bead seats. It is advisable to paint used rims with a good anti-rust paint. Insert the proper valve and tighten securely. Fifty to fifty-five inch pounds torque is recommended. With inner ring in place raise at least 4" off the floor with blocks so that weight of tire will help to seat the inner bead.

Coat beads lightly with tire mounting compound or soap flake solution. Raise tire with rope or chain

sling and lower into position.

Put top flange in place. Position bead seat band on rim base being careful to line up lug in base with lug slot in bead seat band (Fig. H-14).

Install lock ring and tap into place with babbitt or lead hammer. Lock ring drive lug must fit into gutter slot. Tap bead seat band down so that "O" ring groove is visible.

Insert "O" ring in groove and lubricate with tire mounting compound, or soap flake solution. See Fig. H-15.

Remove valve core so that the most rapid initial air flow can be obtained. If upper bead and "O" ring do not seal within one minute, raise the tire by the tread. This tends to push upper bead into position.

As soon as sealing is effected, reinstall the valve core and inflate to 75 pounds per square inch to seat bands. Deflate tire to recommended operating air pressure.

Replace wheel and tire on machine. Tighten wheel mounting capscrews to 550 ft. lbs. torque.

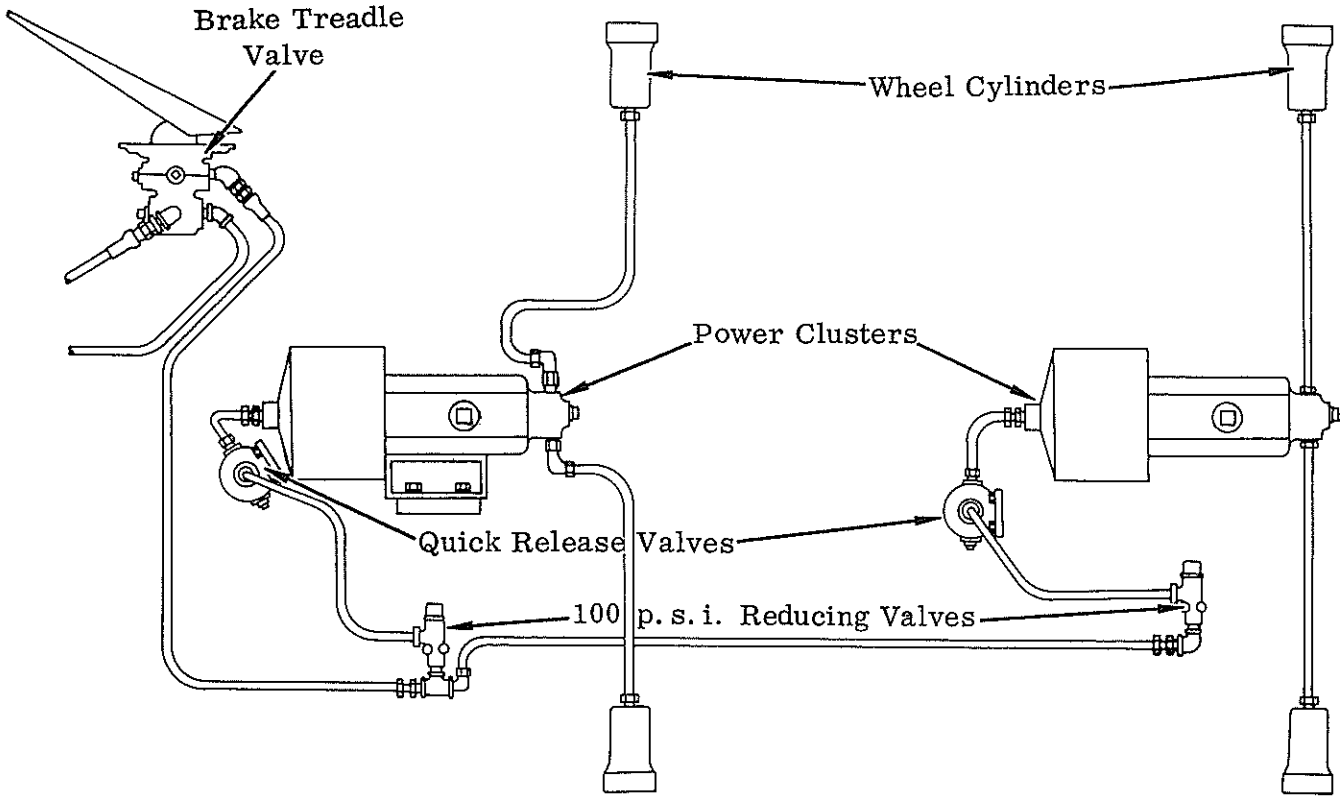
SHOE BRAKES (Air/Hydraulic)

Operation

The brakes are controlled by the foot operated treadle valve in cockpit. This valve meters air through a 100 p.s.i reducing valve to the air cylinder portion of the power clusters. The air cylinders operate hydraulic master cylinders which, in turn, force hydraulic fluid under pressure out to each wheel cylinder. Within the wheel cylinder, the hydraulic fluid forces two plungers to move brake shoes out against brake drum providing the braking action for stopping the machine.

The brake treadle valve is a metering type valve. As brake pedal is depressed, the braking action will gradually increase. Depressing brake pedal fully will apply 100 p.s.i. air pressure to the air cylinder and full hydraulic pressure, approximately 1500 p.s.i., to the wheel cylinders.

When the brake pedal is returned to full released position, the air pressure and hydraulic pressure decrease to zero, allowing return springs to pull the brake shoes away from the brake drums.



BRAKE PIPING DIAGRAM

Removal

Block all wheels except the one having the brake assembly to be removed.

Jack up machine until the tire is clear of the ground. If working on Tournapull brakes, stack blocks of wood under the final drive case. If wheel is on trail unit, place blocks under frame members.

Bleed air from supply tank.

Back brake shoes away from brake drum by turning adjusting bolts of wheel cylinders all the way into cylinder.

TOURNAPULL WHEEL

Place sling around tire, attach hoist and take up slack. Remove wheel mounting capscrews, wheel and tire assembly from machine. Remove brake drum.

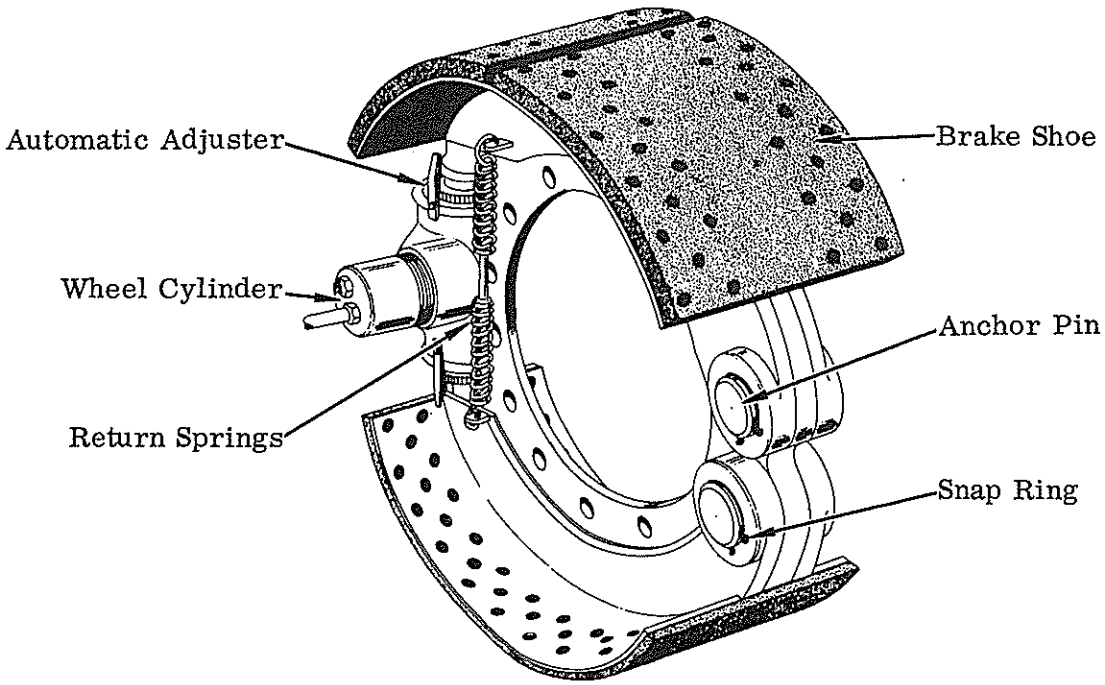
TRAIL WHEEL

Place sling around tire, attach hoist and take up slack.

Remove capscrews, lockwashers, bearing hub cap and gasket from wheel. Remove cotter pin from axle nut and nut securing wheel hub to axle. Remove outer bearing cone and pull wheel and tire assembly straight out. Brake drum, wheel and inner bearing with seal will come off as a unit.

Brake shoes may be removed from brake by removing return springs, snap rings from brake shoe anchor pins and anchor pins.

Parts replacement may be accomplished with the brake assembly mounted on machine. Disconnect hydraulic line from power cluster to wheel cylinder at the wheel cylinder. Thoroughly clean brake assembly before attempting to disassemble to wheel cylinder.



SHOE BRAKE ASSEMBLY

Disassembly

WHEEL CYLINDER

Loosen setscrews (9) and unscrew wheel cylinder housing (2) from spider (20). Remove wedge assembly by pulling it straight out of spider. Remove piston (6) from wheel cylinder housing. Remove rubber cup (5), ball (4) and spring (3) from wheel cylinder housing.

If necessary, wedge assembly may be disassembled by compressing spring (23) and removing "E" washer (7). The flat washer (24), spring and washer (22) may then be removed from wedge shaft (8). The wedge shaft, rollers (21) and retaining cage may be disassembled by removing rollers from cage and then pull wedge from cage.

AUTOMATIC ADJUSTERS

Remove capscrews (18), detents (15), guide

springs (17) and guides (16) from the spider. Pull the adjusting bolts (13) and actuators (14) from the plungers (19). Remove the plungers from the spider. Boot retainers (11) and boot (12) may be removed if necessary.

NOTE: Each time the brakes are relined, the automatic adjusters should be disassembled and all parts inspected for signs of wear or damage.

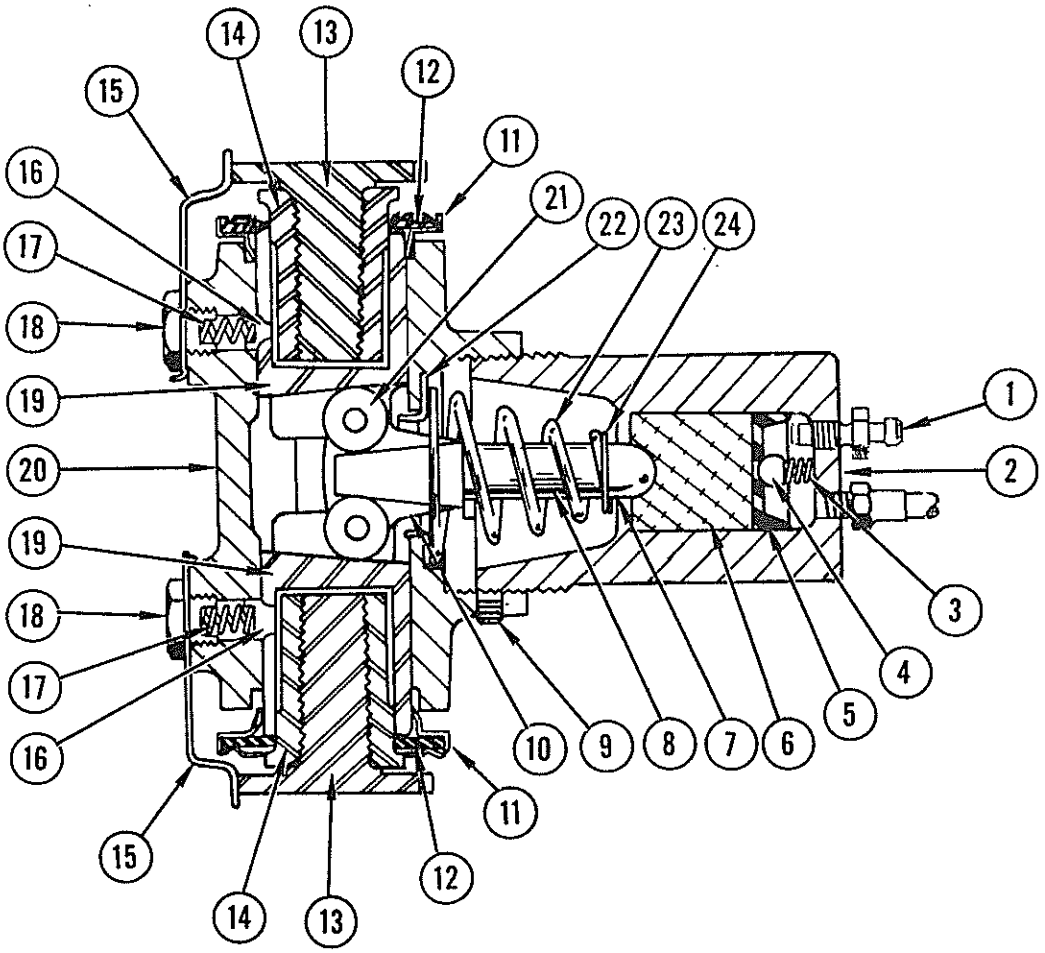


FIGURE H-16. WHEEL CYLINDER

1. Bleeder Valve
2. Wheel Cylinder Housing
3. Spring
4. Ball
5. Rubber Cup
6. Piston
7. "E" Washer
8. Wedge Shaft Assembly
9. Locking Setscrew
10. Cage Assembly
11. Boot Retainer
12. Boot
13. Adjusting Bolt
14. Actuator
15. Adjusting Bolt Detent
16. Plunger Guide
17. Plunger Guide Spring
18. Capscrew
19. Plunger
20. Spider
21. Rollers
22. Washer
23. Spring
24. Flat Washer

Reassembly and Installation

Before reassembly, coat all threads, guide tip and entire plunger with good grade of grease. Also coat wedge and plunger bore with grease.

Place rubber cup (5) on piston (6). Place ball (4) in port of cup and place spring (3) over the ball. Install assembled parts into wheel cylinder housing (2). Use care to prevent damage to sealing lip of cup while inserting it into bore of housing.

If wedge assembly was disassembled, reassemble at this time. Install wedge shaft (8) and rollers (21) into cage (10). Bend lip of cage down to retain rollers. Install washer (22) with lipped side down toward rollers. Install spring (23) and flat washer (24). Compress spring (23) and secure it with "E" washer (7).

AUTOMATIC ADJUSTERS

If boots (12) and boot retainers (11) were removed, replace them at this time. Screw adjusting

bolts (13) all the way into the actuators (14). Then back the adjusting bolts out one-fourth of a turn and install assemblies into the spider. Align the guide slots in plungers with guide holes in spider. Install guides (16) and guide springs (17) into spider. Attach adjusting bolt detents (15) .and install capscrews (18). Tighten capscrews securely.

Place a "C" clamp on both the adjusting bolts (13). Tighten "C" clamp without using force. This will hold both plungers all the way in the spider bores.

Screw the wheel cylinder housing assembly all the way into the spider until tight. DO NOT USE FORCE. If the hydraulic fittings are not properly located, unscrew wheel cylinder until they are. Bleeder valve must be in top port of wheel cylinder. Tighten locking setscrew (9) to secure wheel cylinder in place. Remove "C" clamp.

Replace brake shoes. Position shoes on spider, install anchor pins with snap rings and install return springs.

TOURNAPULL WHEEL

Install the brake drum on brake assembly. Hoist tire and wheel assembly and position to axle flange. Install wheel mounting capscrews and torque to 550 ft. lbs.

TRAIL WHEEL

Check condition of seal and bearings. Replace parts as necessary. Handpack bearings before assembly and fill hub half full of medium weight wheel bearing grease. Lubricate lip of seal with grease.

Hoist wheel, tire and brake drum assembly and slide straight onto axle. Be careful to avoid damaging seal. Install outer bearing cone, replace axle nut. Tighten nut, rotating wheel to be sure bearing rollers are in place, until bearings have slight drag. Then back out off one notch or until bearings are free rolling. Install cotter pin, gasket, hub cap and secure with capscrews and lockwashers.

POWER CLUSTER

Removal

POWER CLUSTER

Open drain cock in air supply tank and drain all air from the air system.

Disconnect air line from air cylinder of power cluster.

Disconnect hydraulic line connecting master cylinder with wheel cylinder.

Remove capscrews securing power cluster bracket to vehicle and remove power cluster with bracket attached.

Disassembly

It is not necessary to remove bracket from power cluster to complete disassembly.

Place assembly in a vise with air cylinder up. Remove eight capscrews with shakeproof lockwashers (2), Figure H-19, securing air cylinder to cylinder head. As the piston return spring is slightly compressed, place one hand on top of air cylinder to aid in removing the capscrews.

Lift air cylinder (1) from cylinder head (8).

Carefully remove end of boot (6) from groove in hub of cylinder head (8). Examine boot for breaks or cracks. Replace if damaged.

Remove indicator pin (12). The indicator pin also serves as one of the four capscrews securing cylinder head to bracket. Remove the remaining capscrews and lockwashers (10 and 11) and remove cylinder head from bracket (9).

Remove snap ring (29) from groove in bore of master cylinder housing (19). A heavy spring tension will be against this snap ring. This can be relieved by placing a bronze drift or similar tool through bronze washer (28) and into piston (25). Press down on tool to compress spring (23) while snap ring is being removed.

Remove bronze washer (28), piston (25) and cup (24) from master cylinder (19).

Remove piston return spring (23).

Remove master cylinder from vise. Turn cylinder upside down and the check valve assembly (20, 21 and 22) will fall out.

Reassembly

Examine all seals and cup for nicks and breaks. Replace if necessary.

Clean all parts thoroughly. Before assembly, lubricate all parts of master cylinder and walls of cylinder body with brake fluid. Lubricate inside walls of air cylinder with a light weight engine oil.

Replace master cylinder body and bracket in vise with open end of master cylinder body up.

Install check valve assembly (20, 21 and 22)

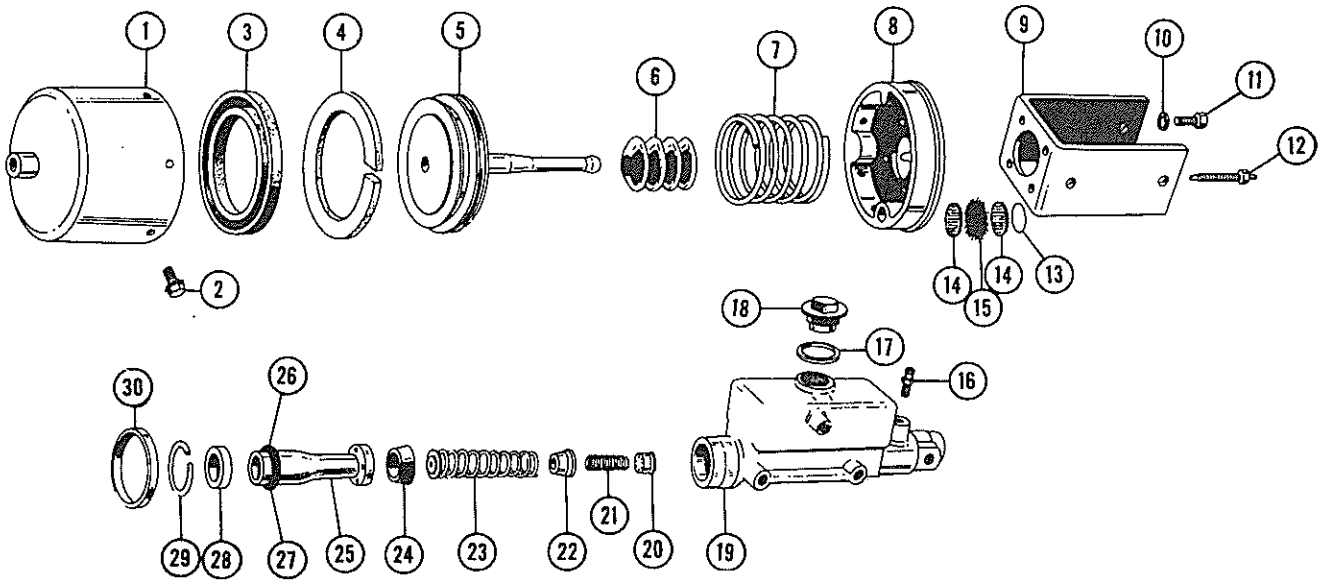


FIGURE H-17. POWER CLUSTER ASSEMBLY

1. Air Cylinder
2. Capscrew and Shakeproof Washer
3. Piston Cup
4. Felt Wiper
5. Piston and Rod Assembly
6. Boot
7. Piston Return Spring
8. Cylinder Head
9. Bracket
10. Lockwasher
11. Capscrew
12. Indicator
13. Retainer
14. Screens
15. Filter
16. Bleeder Valve
17. Gasket
18. Filler Plug
19. Hydraulic Master Cylinder
20. Check Valve
21. Spring
22. Retainer
23. Piston Return Spring
24. Cup
25. Piston
26. Secondary Cup
27. Secondary Cup Ring
28. Bronze Washer
29. Snap Ring
30. Sealing Band

with valve portion down.

Insert piston return spring (23) with retainer end up. Install cup (24) on spring with small hub inside of cup fitting into hole in spring retainer.

Place piston (25) with secondary cup (26) and ring (27) on top of cup (24) and press downward. Use extreme caution to keep sealing lip of cup from being damaged when entering cylinder.

Install bronze washer (28) on top of piston. Insert tool into piston and press downward until top of bronze washer clears snap ring groove enough to allow snap ring (29) to be installed.

If retainer (13), bronze screens (14) and filter (15) were removed from cylinder head, replace them.

Attach cylinder head (8) to bracket (9) with 3 capscrews and lockwashers (10 and 11) and indicator (12). Tighten securely.

Attach large end of boot (6) to groove in hub of cylinder head. Place piston return spring (7) over boot.

Install piston and rod assembly (5) with rod entering plunger (25). Install small end of boot (6) into groove on hub of piston.

Replace felt wiper (4) and cup (3) onto piston. Spring side of cup away from piston.

Install air cylinder (1) over piston assembly and attach to cylinder head with 8 capscrews and shakeproof washers (2). Use caution when installing piston cup into cylinder to prevent damage to sealing lip of cup.

Replace power cluster on vehicle. Connect air and hydraulic fittings. Fill master cylinder with S.A.E. 70–R–3 brake fluid. Follow procedure for bleeding power cluster as outlined below.

Adjusting and Bleeding Procedure

All mechanical adjustments must be made prior to bleeding the brakes.

BRAKE ADJUSTMENT

Jack up the wheel being adjusted if not already jacked up.

With an adjusting spoon or screwdriver, turn the adjusting bolt out, on one shoe at a time, until the shoe moves out against the drum with a heavy drag.

Back off the adjusting bolt until the shoe has a very light drag. Repeat for the other shoe. Repeat for the other wheel.

NOTE: If it is not convenient to jack up the vehicle the following procedure may be used. Turn the adjusting bolt out until the shoe is tight against

the drum. Back adjusting bolt off eight (8) notches.

BLEEDING

The following instructions are for the front brakes. The same procedure is used for the rear brakes.

Fill the front power cluster master cylinder with S.A.E. 70–R–3 hydraulic brake fluid.

Attach a pressure gauge, reading from 0 to 2500 p.s.i., to hydraulic port on master cylinder.

Start engine and run until air pressure gauge on the instrument panel reads 120 p.s.i. or better.

BLEEDING FRONT POWER CLUSTER

1. Depress foot brake pedal.
2. Open bleeder valve (16) on power cluster allowing air to escape.
3. Close bleeder valve.
4. Release foot brake.
5. Repeat procedure until air has been expelled from the power cluster.

BLEEDING FRONT WHEEL CYLINDERS

1. Depress foot brake pedal.
2. Open bleeder valve (1) allowing air to escape.
3. Close bleeder valve.
4. Release foot brake pedal.
5. Repeat procedure until all air has been expelled from wheel cylinders.

NOTE: Extreme care should be taken to prevent brake fluid getting on the brake shoes during bleeding procedures. Any fluid spilled must be removed.

Upon completion of adjustments and bleeding procedures, depress foot brake pedal. Gauge attached to power cluster should read 1500 p.s.i. (± 50) and hold this pressure as long as brake pedal is depressed.

If gauge does not read 1500 p.s.i. (± 50) or does not hold this pressure while the brake pedal is depressed, it would indicate that air is still in hydraulic system or that brakes were not properly adjusted.

Re-bleed system and make adjustments as outlined above.

Check all connections for leaks.

Remove gauge from power cluster and check fluid level. Add fluid if necessary.

If the above procedures are followed and the final pressures correspond to those stated, the brake system should perform satisfactorily.

STEERING ASSEMBLY

INDEX

STEERING ASSEMBLY

Principle parts of the steering assembly are: the kingpin housing, steering motor with gear reduction box, ring gear and kingpin.

The kingpin housing is bolted solidly to the trail unit yoke structure by four bolts. The steering motor and gear box unit is attached to the bottom plate of the kingpin housing. The kingpin housing rotates around the kingpin on large tapered roller bearings. The kingpin is secured to the prime mover by a mounting arrangement which permits the top of the kingpin to move from side to side in short arcs. The ring gear is bolted to the kingpin flange. Teeth on the pinion gear, extending from the bottom of the motor gear box, are in mesh with the teeth on the ring gear.

When the electric motor is operated the pinion gear rotates, moving the ring gear right or left depending upon the direction of rotation of the motor. Ring gear, kingpin and prime mover turn together as a unit since they are all interconnected.

The steering switch on the instrument panel automatically returns to the off position when released, locking the prime mover at whatever angle it makes with the trail unit at that instant. The locking effect comes about through the steering motor brake, which stops the rotation of the motor rotor and gear box pinion as soon as the current to the motor is shut off. The precision fit of the entire chain of gears from the steering motor to steering ring gear prevents any free play or slack in the prime mover with the steering motor brake applied.

The degree of turning in either direction is controlled by limit switches inside the kingpin housing. These switches can be set for turns of any angle up to approximately 90 degrees, right and left, from the straight ahead position.

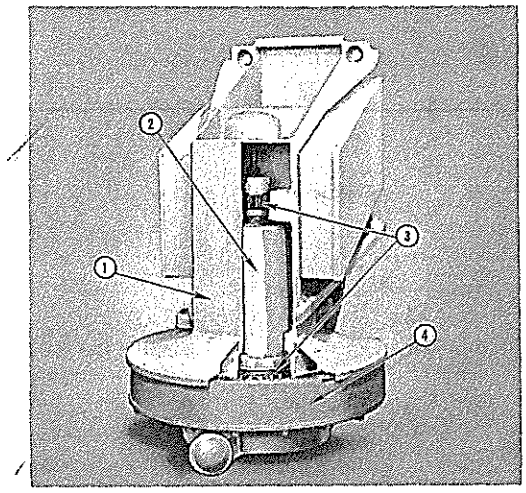


FIGURE I-1. STEERING ASSEMBLY

1. Kingpin Housing
2. Kingpin
3. Roller Bearing
4. Ring Gear

Removal

Disconnect all conductor cables to the main switch boxes mounted on the steering trunnion housing. Remove cable clamp from cables and remove. Disconnect all hoses, tubing and cables that lead back to the trail unit. Bleed the air system before performing this operation.

Position blocks to hold the trunnion assembly firmly in an upright position. Crib up nose of Tournapull and block drive wheels, fore and aft.

Attach sling hoist to the trail unit yoke. Take up slack until the tension is relieved on the connecting bolts. Remove the four connecting bolts securing the trail unit to the Tournapull. Separate the two units.

Attach hoist to steering trunnion assembly. Remove the capscrews and lockwashers securing the front and rear trunnion caps to the trunnion sockets. Lift trunnion assembly from the Tournapull. Lower unit to floor or place on stand for further disassembly.

Remove the shims and bearing inserts from the trunnion sockets and caps. Keep the shims together as they were removed, as they should be replaced when reassembling the steering trunnion.

NOTE: Steering motor and gear box can be removed without removing complete steering assembly. Remove cover and disconnect leads to motor terminal strips. Remove gear box mounting bolts, these are accessible through openings in trunnion assembly. Attach hoist to motor, lift motor and gear box out of housing. Lift straight up to prevent damage to gear box pinion. See Fig. I-6.

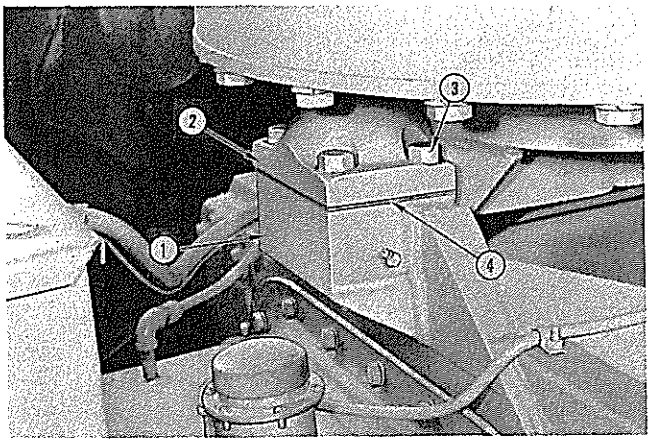


FIGURE I-2. TRUNNION CAP AND SOCKET

1. Socket
2. Cap
3. Capscrews
4. Shims

Disassembly

Remove the limit switch housing cap and disconnect the leads to the limit switches. Then remove the limit switches after backing off the capscrews clamping the switches to the mounting plate in the

top of the kingpin housing. Remove the limit switch cam by loosening the cam shaft jam nut and backing cam shaft out of threaded hole in top of kingpin.

Loosen capscrew and nut locking split nut on the kingpin. Drive a chisel, or similar tool, into the slot in the split nut, and then back nut from threads on kingpin (Fig. I-3).

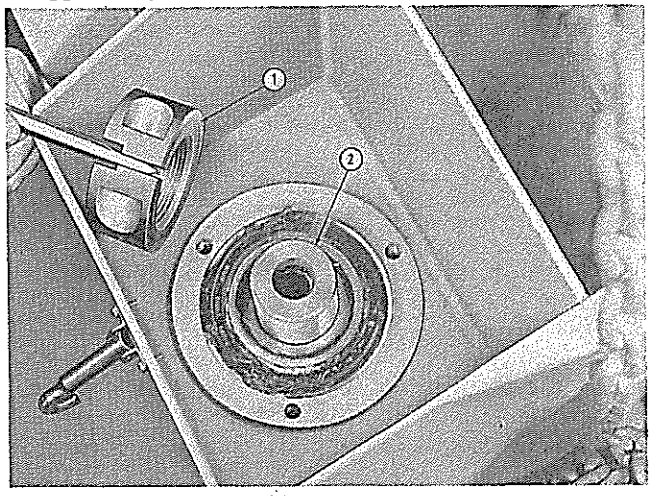


FIGURE I-3. REMOVING SPLIT NUT
1. Nut 2. Kingpin

Hoist off kingpin housing. Upper bearing cone, bearing cup, seal, and lower bearing cup will be removed with the housing. Lower bearing cone will remain in position on the kingpin. Lift straight up to prevent damaging gear box output pinion (Fig. I-4).

Remove upper and lower bearing cups, upper bearing cone and seal from the bores in the kingpin housing.

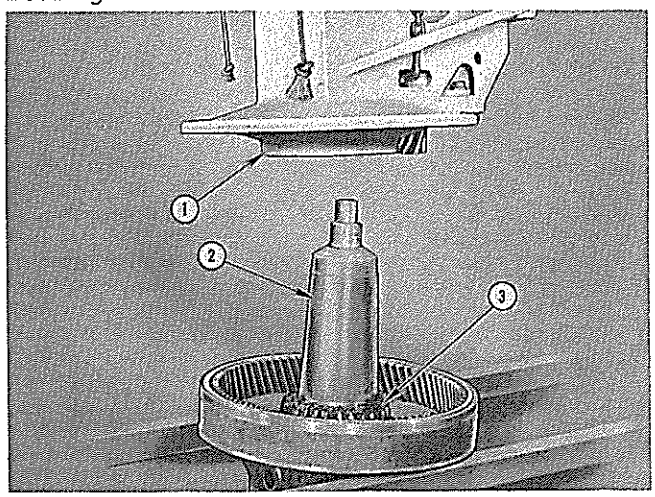


FIGURE I-4. REMOVING KINGPIN HOUSING
1. Housing 2. Kingpin 3. Lower Bearing Cone

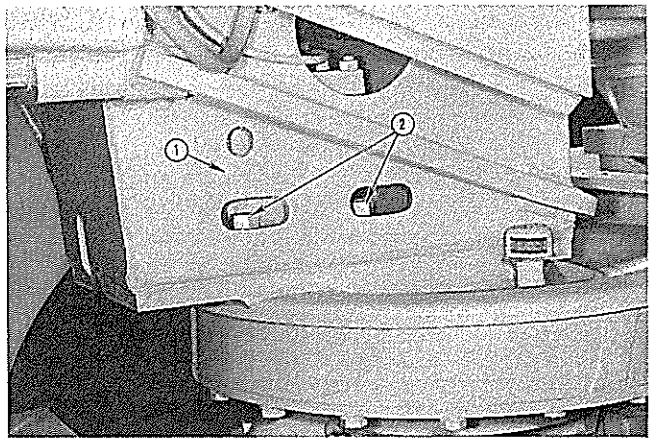


FIGURE I-5. GEAR BOX MOUNTING
1. Housing 2. Gear Box Mounting Capscrews

Remove lower bearing cone from the kingpin. (Fig. I-4).

Remove the gear box mounting bolts. The front and rear mounting bolts are accessible through openings in the side of the kingpin housing. (Fig. I-5).

Hoist the electric motor and gear box out of the housing, lift straight up to prevent damage to gear box pinion. Refer to Section "K" of this manual for A.C. electric motor and gear box removal and disassembly.

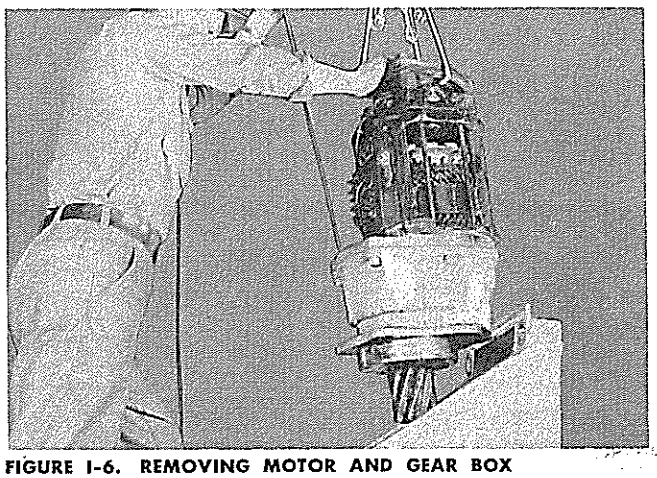


FIGURE I-6. REMOVING MOTOR AND GEAR BOX

To separate the steering gear and kingpin, cut the lockwires and remove the capscrews that secure the steering gear to the kingpin flange.

NOTE: The steering trunnion may be disassembled while still mounted on the Tournapull. Follow the instructions above with the exception of removing the trunnion caps and lifting the unit from the machine.

Reassembly

Clean and inspect all bearings, lubricate thoroughly before reassembly. Check oil seals for dryness, hardness, or excessive wear. Replace if damaged or if the seal's condition is such that it will cause leaks.

Carefully inspect the teeth on the ring gear for chips or excessive wear. If this condition is in evidence, remove the ring gear mounting capscrews and rotate the gear until the teeth which have not been used occupy the old position of teeth which

have been used. This change can be made when the wear on gear teeth is noticeable. The same method can be used to position any chipped or broken teeth so that they will not interfere with the operation of the unit.

Inspect the electric motor for damage to windings, for dirt, and for mechanical trouble.

Place coat of permatex on kingpin flange. Install ring gear on base. Replace capscrews. The seven tapered collars and the seven flat head capscrews are to be placed at rear of the ring gear, one in the center-rear, and three on each side. Replace tapered capscrews. Torque capscrews with tapered collars to 190 ft. lbs. and torque tapered capscrews to 285 ft. lbs.

If neoprene seal between ring gear and kingpin housing must be replaced, scrape off old one and replace.

To install seal ring, clean rim of ring gear with naphtha and apply a coat of "rubber to metal cement" to the ring gear and to the seal ring. Let dry until tacky. Press the seal ring into the ring gear and let dry over night, under pressure.

Grease gear rim before assembling housing into it to lubricate rubber seal ring.

Replace lower bearing cone on kingpin. Lubricate circle gear and bearing. See Section "L". Install bearing cup in lower bore of kingpin housing. Place housing in position over kingpin.

Position upper bearing cup in housing. Replace oil seal and upper bearing cone. Lip of seal should be toward top of kingpin.

Replace split bearing retainer nut. Adjust to approximately 1250 ft. lbs. torque, and replace lockbolt into nut.

Replace steering cam shaft in threaded hole in top of kingpin and tighten jam nut. Install limit switches. (Position of limit switches can be adjusted after machine is in operation condition and degree of turn can be checked.)

Install motor and gear box in housing. Secure with mounting capscrews.

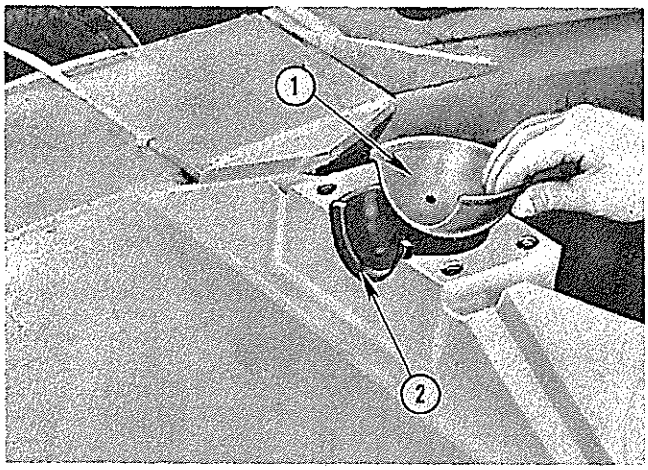


FIGURE I-7. REPLACING INSERT

1. Insert
2. Oil Seal

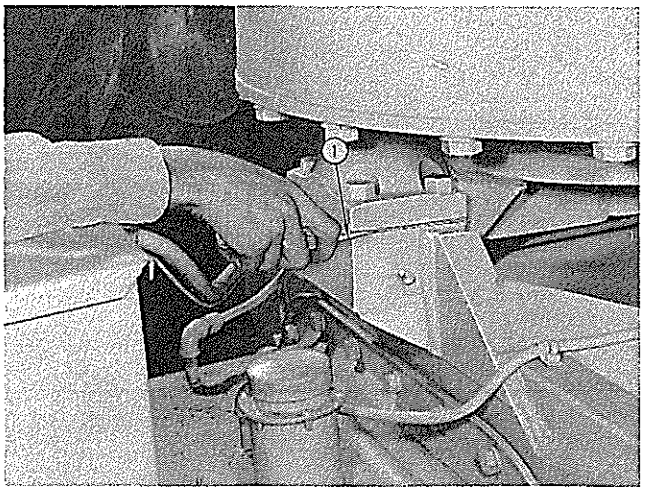


FIGURE I-8. CHECKING GAP

1. Feeler Gauge

Replace insert bushings in trunnion sockets and caps. The bushings must fit without any rocking motion. See Fig. I-7.

Hoist trunnion assembly onto machine. Assemble cap and insert over rear ball as follows: Tighten each capscrew to 200 ft. lbs. torque making sure the space between sockets under each capscrew is equal (within 0.005"). (Fig. I-8).

Check space between top and bottom sockets as near front or rear center as possible with feeler gauge. To this dimension add 0.010" to obtain the thickness of shims to be placed between the sockets.

Remove cap and coat ball and socket with #250 E.P. oil, and position shims. Replace cap and leave capscrews and lockwashers loose.

Repeat the same procedure for the front trunnion joint. Then tighten all capscrews to 300 ft. lbs. torque.

Lubricate steering trunnion assembly as out-

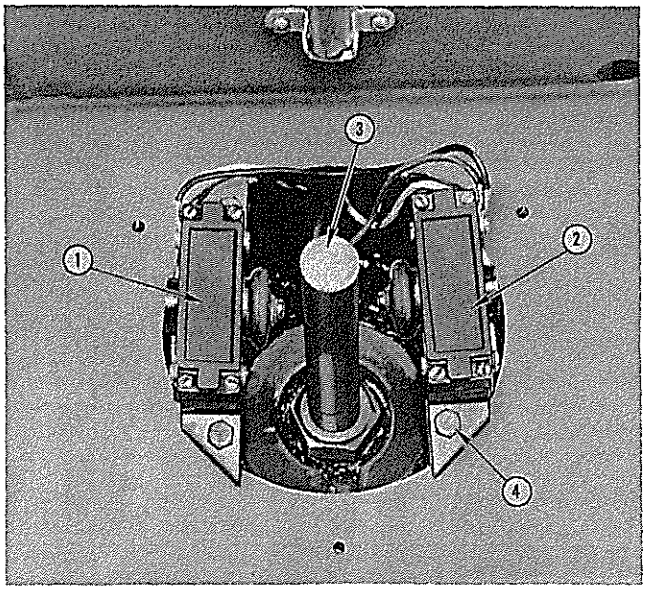


FIGURE I-9. STEERING LIMIT SWITCHES

1. Left Turn Limit Switch
2. Right Turn Limit Switch
3. Cam
4. Clamp Screws

lined in section "K" of this manual.

Complete reassembly of machine. After run in period, trunnion balls are to be from 0.000" to 0.010" loose in their sockets.

Adjustment

Remove limit switch cover and loosen the screws clamping the limit switches to the housing. Operate steering motor until nose of machine is at an approximate angle of 90 degrees, (right or left) with the rear unit. If the nose of the machine was moved to the left, move the left limit switch until the striker plate is against the cam. Switch must make a definite "clicking" sound, but not bottom completely. Tighten clamping screws. Repeat the procedure with nose of Tournapull in the opposite direction. See Fig. I-9.

A.C. ELECTRIC MOTOR, GEAR BOXES, AND MAIN SWITCH

INDEX

A.C. ELECTRIC MOTOR, GEAR BOXES, AND MAIN SWITCH

A.C. ELECTRIC MOTOR

The A.C. electric motors used on the equipment are induction type motors, all of the three phase 120 cycle, high slip type. These motors have been designed especially to handle various operations peculiar to the equipment.

These motors are instantly reversible in operation. Each direction of rotation is controlled by a separate main switch, which are controlled by a single control switch. Direction of rotation may be reversed by reversing two of the three main leads to the motor. This reversal is made in the wiring of the main switches.

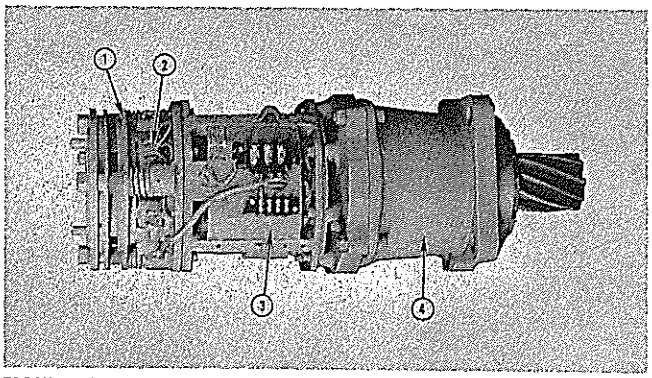


FIGURE J-1. A.C. MOTOR AND GEAR BOX

1. Motor Brake
2. Brake Coils
3. Motor Stator
4. Gear Box

The electric motor is made up of the following major assemblies.

1. Stator — the outside or stationary member which is bolted to the gear reduction box.

2. Rotor — the inner or rotating member, which is attached to the pinion shaft and drives the gears in the gear reduction box.

3. Brake — a spring loaded, disc type, electromagnetic unit which is automatically released when the electric motor is operated.

Each A.C. electric motor is equipped with an electrically operated disc brake. This brake is held in the engaged position by strong coil springs when the motor is inoperative. It is disengaged automatically by the electromagnets which are energized as the electric motor is operated. The instant the flow of current to the motor is shut off, the electromagnets are de-energized and the brake springs reengage the brake.

The electric motor brake is simple in construction, and includes the following assemblies:

1. Adjusting Ring—an externally threaded ring which is used to adjust the motor brake air gap. A clockwise turn decreases the air gap and a counterclockwise turn increases it.

2. Brake Discs (two types) — (1) steel discs or stationary plates held in position by these brake studs, and (2) internally splined friction discs. Spring pressure forces the discs together until released by action of the electromagnets.

3. Coils — six electromagnetic coils pull the brake into the released position when energized by the current which at the same time flows to the motor.

4. Springs — powerful coil springs which force the brake discs together braking the rotor. The brake springs are manufactured with several different compression ratings. The brakes supporting the heavier loads are equipped with springs having higher compression ratings.

The nameplate for the A.C. motor is attached to the motor stator and includes; size, number of teeth on pinion, voltage, cycles, RPM, motor number and part number of the motor.

Removal

Position the component operated by the A. C. motor so there will be no movement when the braking action of the motor is removed.

Remove the capscrews securing the motor cover to the stator. Remove the cover.

Disconnect all wires leading to the motor terminal strip and mark for easy reconnection.

Before separating motor and gear box, remove drain plug and drain lubricant from gear box.

Place sling around rotor. Enough tension must be maintained to prevent mounting capscrews from binding as they are removed. Remove the mounting capscrews (Fig. J-2).

Pull motor straight away from the gear box until motor pinion clears the gear box bore. Take care not to damage the oil seal in the gear box bore, if equipped, or the motor pinion.

Place on bench for further disassembly. Cover opening in gear box to prevent entrance of foreign material.

It will be necessary to remove the steering motor and gear box as a unit (refer to Section "I"). Follow the above instructions for separating the motor and gear box.

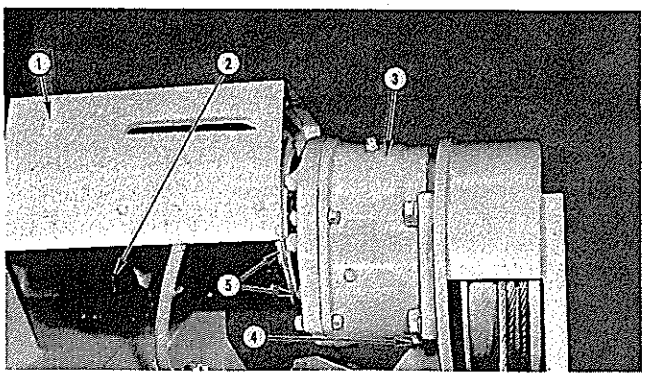


FIGURE J-2. A.C. MOTOR AND COVER

1. Cover
2. Motor
3. Gear Box
4. Drain Plug
5. Motor Mounting Capscrews

Disassembly

Remove the end bell capscrews, disconnect the brake coil leads at the terminal strip, and using sling or chain hoist, lift brake assembly, end bell and rotor as a unit from the stator (Fig. J-3).

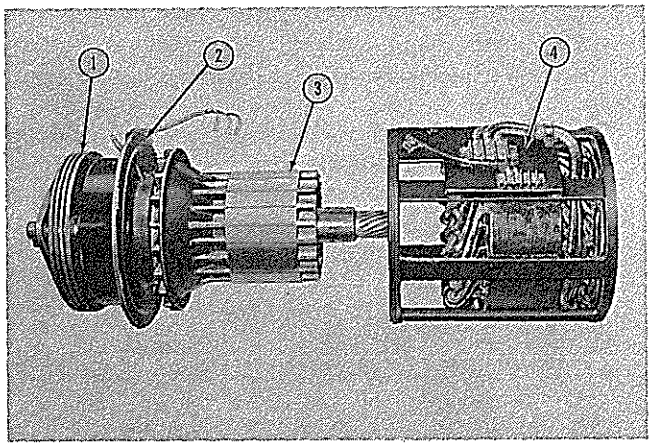


FIGURE J-3. ROTOR AND BRAKE REMOVED

1. Brake
2. End Bell
3. Rotor
4. Stator

Remove cotter from brake hub nut and loosen nut.

Loosen the nut on the lockbolt which locks the adjusting plate in position and remove adjusting plate.

Remove the three stud nuts and lockwashers, then the brake plate, stationary plates, and the brake discs (Fig. J-4).

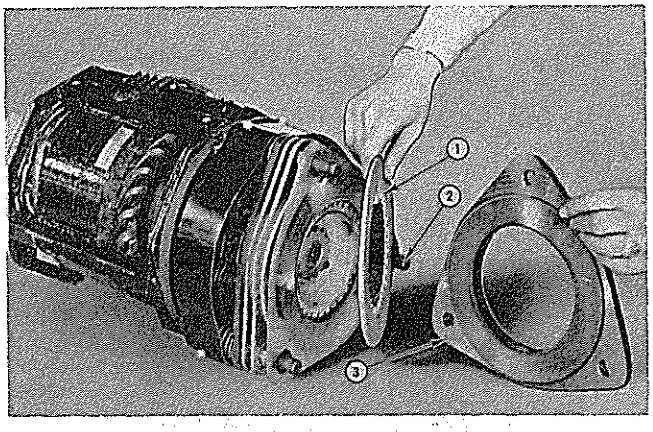


FIGURE J-4. REMOVING BRAKE PLATE AND DISCS

1. Discs
2. Stud
3. Brake Plate

Remove the brake hub locking nut, brake hub, floating plate and coil springs (Fig. J-5 and J-6).

Remove the bearing retainer capscrews and lift off the end bell from rotor.

Remove cover band from around the brake coils.

If coils are damaged, or should for some reason need to be removed, remove hold-down screws clamping the coils to the top end bell and remove the brake coils. See Figure J-7.

Remove the bearing retainer locknut. The bearing retainer nut may be locked in position by a pin inserted in a hole drilled parallel to the rotor shaft, half in the nut and the other half in the rotor shaft.

Using the special wrench provided with the machine, remove the retainer nut. Pull outer and inner seal rings, bearing and retainer from rotor shaft.

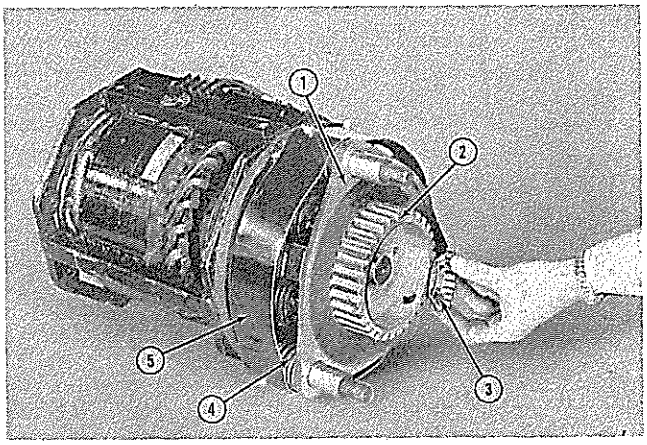


FIGURE J-5. REMOVING BRAKE HUB LOCKNUT

1. Floating Plate
2. Brake Hub
3. Locknut
4. Spring
5. Cover Band

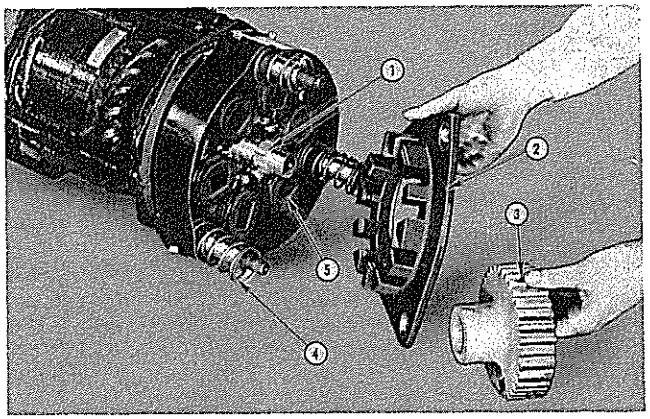


FIGURE J-6. HUB AND FLOATING PLATE, REMOVED

1. Rotor Shaft
2. Floating Plate
3. Hub
4. Spring
5. Brake Coil

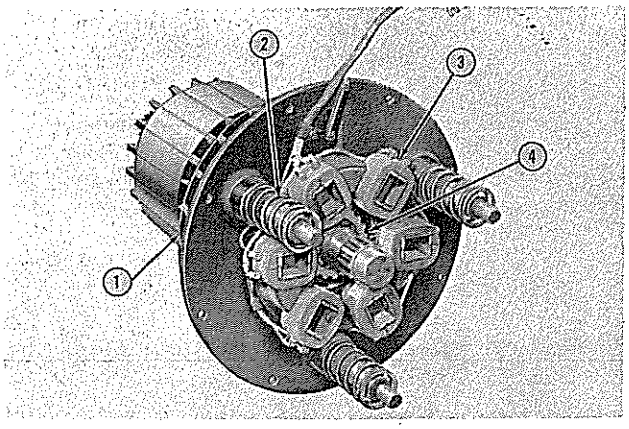


FIGURE J-7. TOP END BELL

1. End Bell
2. Spring
3. Brake Coil
4. Locknut

Reassembly

Replace inner and outer seal rings, oil seal, bearing retainer and bearing.

Place seal and bearing retainer locknut and torque locknut to 300 ft. lbs. for #1 motor, or 350 ft. lbs. for #2 motor.

Install lockpin in hole drilled in the locknut and rotor shaft (if equipped).

Replace end bell and install bearing retainer capscrews.

Replace coil springs on the three studs and place floating plate over rotor shaft, aligning the holes over the studs.

Replace hub and hub locknut, torque nut to 75 ft. lbs. for #1 motor, or 300 ft. lbs. for #2 motor.

Install disc, stationary plate, disc, stationary plate, and brake plate, over the brake hub, then the adjusting plate, in that order.

Replace washers and nuts on studs.

Adjust brake as described in the following paragraphs and tighten lockbolts. Replace brake cover band.

Reassemble motor to gear reduction box and secure with mounting capscrews.

Reconnect electrical wiring to motor terminal strips.

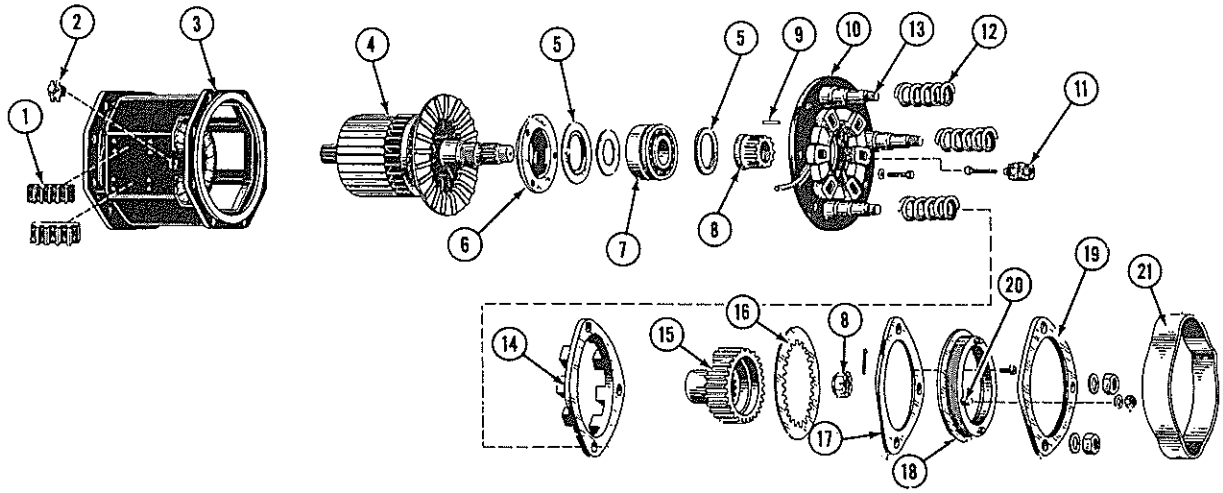


FIGURE J-8. A.C. MOTOR, EXPLODED

1. Terminal Strip
2. Heat Switch
3. Stator
4. Rotor
5. Seal Ring
6. Bearing Retainer
7. Bearing
8. Retainer Nut
9. Lock Pin
10. Top End Bell
11. Brake Coil
12. Spring
13. Stud
14. Floating Plate
15. Brake Hub
16. Disc
17. Stationary Plate
18. Adjusting Plate
19. Brake Plate
20. Lock Bolt
21. Cover Band

Brake Adjustment

Loosen the nut on the tapered bolt locking the adjusting plate in position.

Insert a bar between the adjusting lugs on the adjusting ring and turn either clockwise or counterclockwise until the air space between the floating plate and the end bell is 1/32" for single disc brakes or 1/16" for double disc brakes. Clockwise rotation decreases the space, counterclockwise rotation increases the space.

After the proper adjustment is obtained, tighten the nut on the end of the tapered bolt, locking the ring in position.

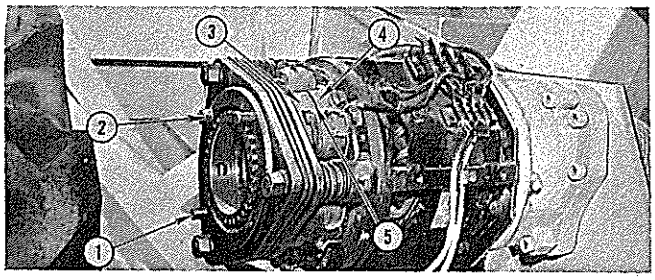


FIGURE J-9. MOTOR BRAKE ADJUSTMENT

1. Adjusting Ring
2. Lock Bolt
3. Floating Plate
4. Top End Bell
5. Air Space

GEAR BOX

Removal

Remove the steering motor and gear box as described in Section "I" of this manual.

If motor and gear box are connected to a cable drum, separate in the following manner.

Unwind the cable from the cable drum. Remove the setscrew from the cable dead end in the cable drum and remove cable.

Remove the setscrew from the cable drum locknut and back nut from gear box output shaft. Pull drum free of shaft.

Drain lubricant from gear box.

Disconnect the leads from the electric motor ter-

minal strip and release electric cable from any clamps on the motor stator or cover. Fasten a rope sling about the motor and gear box to relieve the tension on the mounting capscrews. Remove capscrews and lower unit to floor.

Separate motor and gear box as previously described.

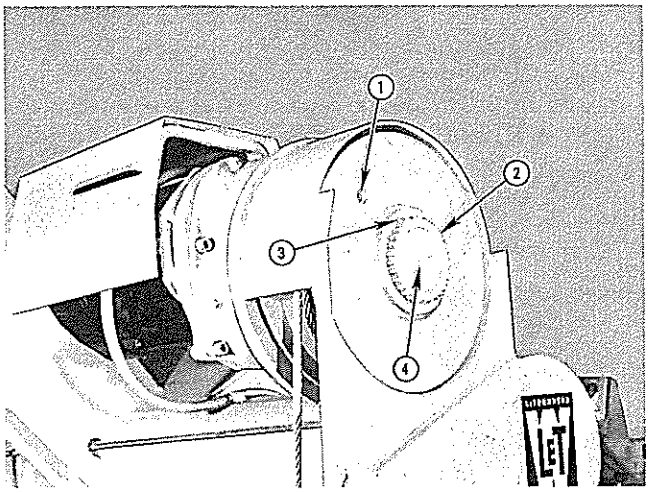


FIGURE J-10. GEAR BOX AND CABLE DRUM

1. Cable Dead End
2. Locknut
3. Setscrew
4. Output Shaft

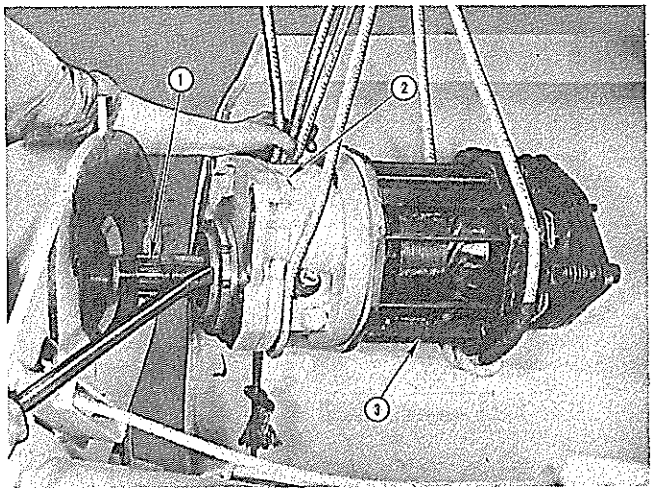


FIGURE J-11. REMOVING MOTOR AND GEAR BOX

1. Output Shaft
2. Gear Box
3. Motor

NO. 1 GEAR BOX

Disassembly

Place the gear box on its side so that the output shaft parallels the work bench.

Remove the socket head capscrews securing the retainer to the gear box (Fig. J-12). Remove the retainer and oil seal.

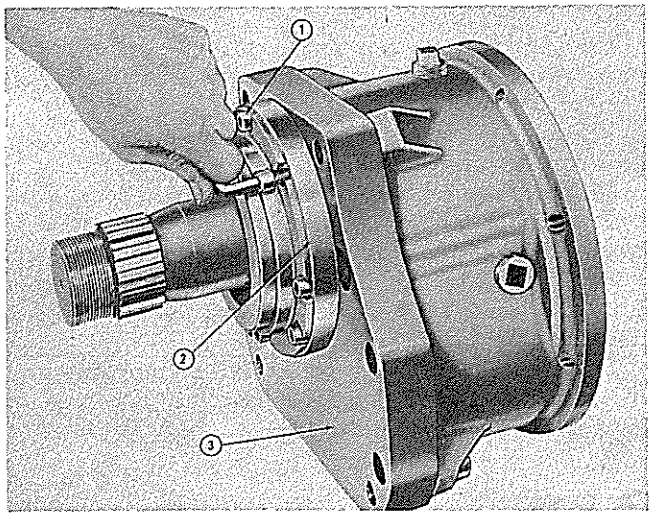


FIGURE J-12. REMOVING CAPSCREWS

1. Capscrews
2. Retainer
3. Gear Box

Take a soft hammer and tap the oil seal out of the retainer (Fig. J-13).

Remove two dowel bolts used to keep face plate and case in alignment.

Remove two socket head capscrews securing face plate to the case (Fig. J-14).

Separate the face plate and case. The gears will remain with the face plate assembly (Fig. J-15).

Remove the first reduction gear and the second

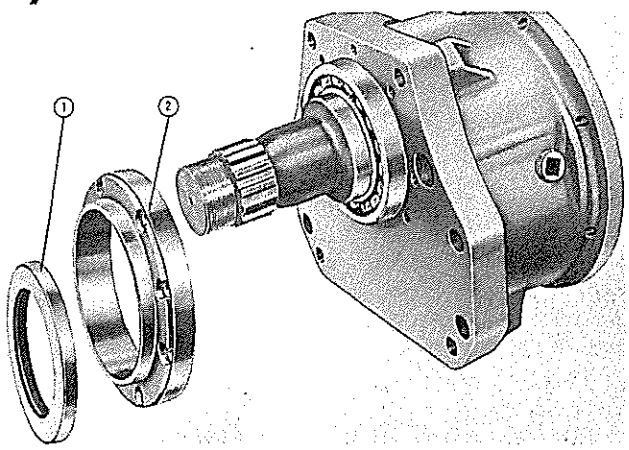


FIGURE J-13. OIL SEAL AND RETAINER, REMOVED

1. Oil Seal
2. Retainer

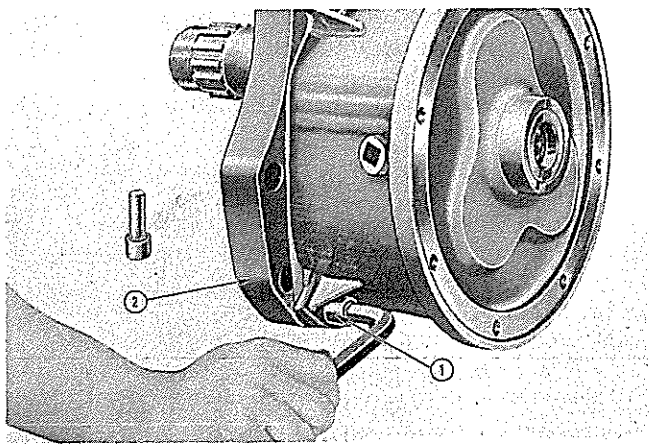


FIGURE J-14. REMOVING CAPSCREWS

1. Capscrew
2. Backing Plate

reduction gear. These gears may be removed by tapping lightly with soft hammer.

Using an expansion type bearing puller, remove the four bearings in the case and the two bearings in the face plate.

Remove locking setscrew from splined locknut (Fig. J-16).

Place a special wrench and extension bar on splined locknut and remove locknut. (This locknut has 1000 ft. lbs. of torque applied.)

Pull the output shaft. Tap out output shaft bearing with soft hammer (Fig. J-17).

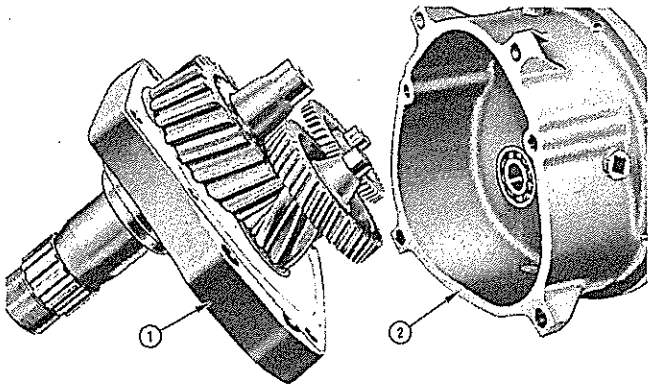


FIGURE J-15. BACKING PLATE, REMOVED
1. Backing Plate 2. Case

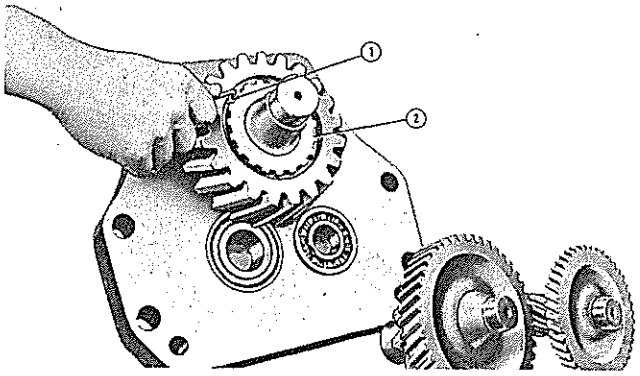


FIGURE J-16. REMOVING SETSCREW
1. Setscrew 2. Locking Nut

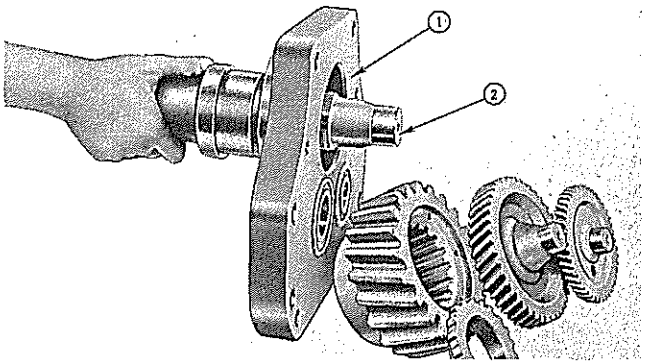


FIGURE J-17. REMOVING OUTPUT SHAFT
1. Backing Plate 2. Output Shaft

Reassembly

Carefully check all gear teeth for damage. Wash and check all bearings and replace those damaged. Clean gear box and all parts before reassembly.

Tap output shaft bearing into face plate with soft hammer. Place output shaft through bearing. Position output gear shaft (with collar of gear toward outside of face plate) and replace locknut.

Tighten locknut to 1000 ft. lbs. torque and install locking setscrew.

Replace bearings in face plate and gear box case. Install second reduction gear then first reduction gear.

Position new gasket on face plate and place gear box case over gears into face plate. Secure with socket head capscrews.

Replace dowel bolts through face plate and into case.

Replace output bearing retainer, secure with capscrews, torque to approximately 75 ft. lbs. Install oil seal.

When replacing oil seal in the retainer, use special care to prevent damage to the oil seal.

When reassembling reduction gears, check carefully to be sure there is clearance between the second reduction gear and the output gear shaft. Also, when replacing the bearing retainer, be sure to tighten the socket head capscrews evenly to keep bearing from binding.

Secure motor to gear box. Install on machine and fill gear box with required amount and type of lubricant (see Section "K").

NO. 2 GEAR BOX

Disassembly

Remove the five capscrews, lockwashers and nuts securing the face plate to the gear box case.

Remove face plate and gasket. Note the bearings in face plate (Fig. J-18). Use puller to remove bearings. Remove rotor shaft, oil seal and bearing at the same time.

Drive out roll pins (if so equipped) and remove the capscrews securing the output shaft bearing retainer to the gear box and remove the retainer and gasket (Fig. J-19). Bearing retainer may be equipped with "O" ring.

Remove the setscrews from first and second reduction gear bearing caps. With special wrench, remove bearing caps (Fig. J-20). Remove locking setscrews from locknuts and remove locknuts (Fig. J-21).

Pull first and second reduction gears from the gear box case. Remove locking setscrew from output shaft locknut and remove locknut. Remove outer bearing cones and bearing cups from the bores in

the case and press bearing cones from shafts.

Drive out the output shaft, using a soft hammer. Outer roller bearing will come out with the shaft. Press bearing and oil seal from shaft and remove locking ring. Remove output gear from case.

NOTE: Steering gear box may have an oil seal ring in addition to the oil seal.

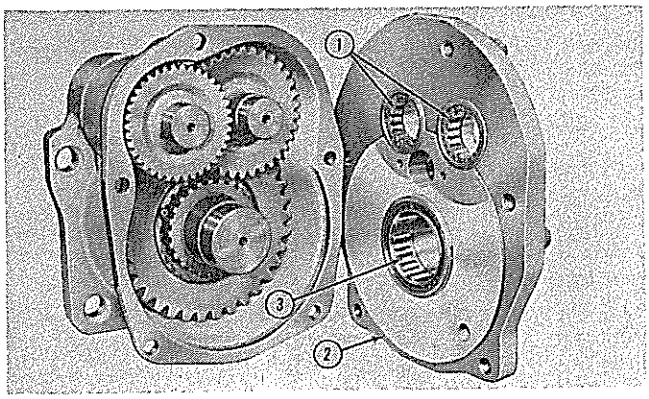


FIGURE J-18. FACE PLATE REMOVED

1. Bearing
2. Face Plate
3. Output Shaft Bearing and Seal

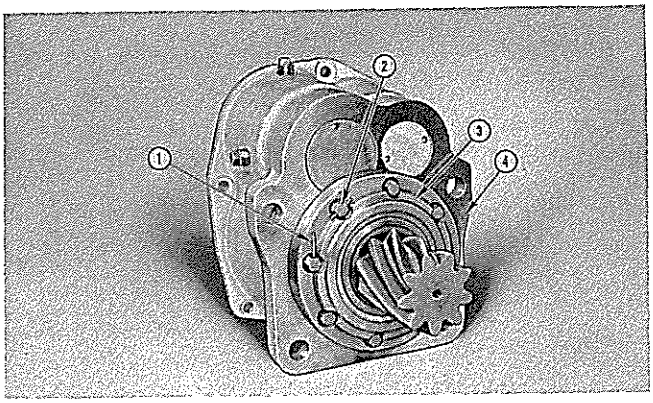


FIGURE J-19. BEARING RETAINER AND CAPSCREWS

1. Roll Pin
2. Capscrew
3. Retainer
4. Case

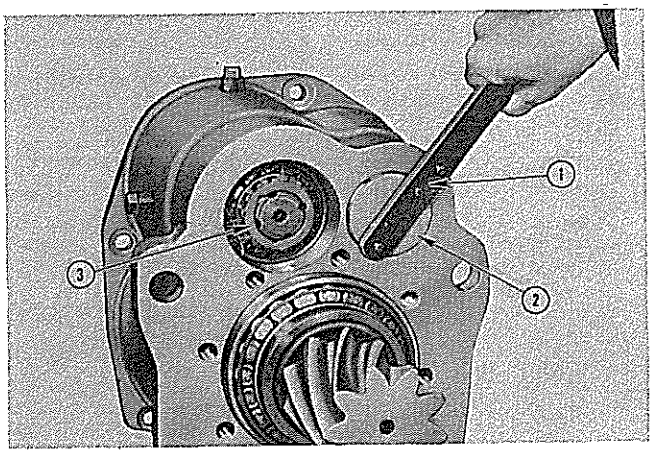


FIGURE J-20. REMOVING BEARING CAP

1. Wrench
2. Bearing Cap
3. Locknut

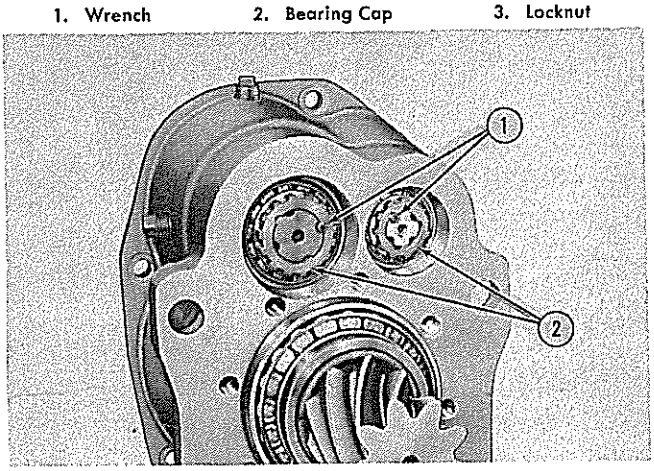


FIGURE J-21. LOCKNUTS AND SETSCREWS

1. Setscrew
2. Locknut

Reassembly

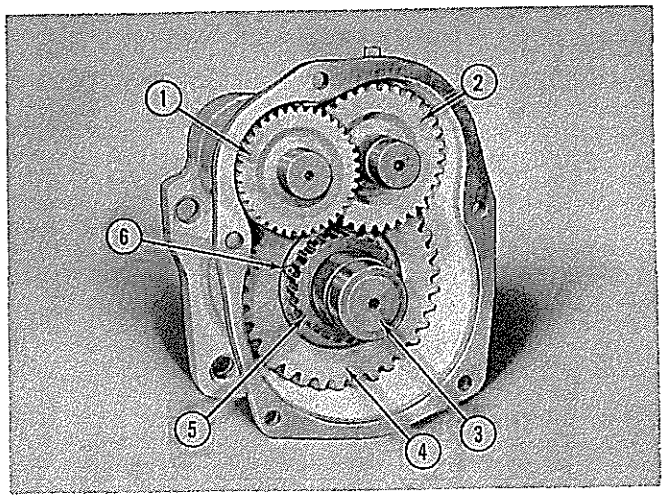


FIGURE J-22. GEAR BOX REDUCTION GEARS

1. First Reduction Gear
2. Second Reduction Gear
3. Output Shaft
4. Output Gear
5. Locknut
6. Setscrew

Carefully check all gear teeth for damage. Wash and check all bearings and replace those damaged. Clean gear box and all parts thoroughly before reassembling.

Check oil seals for dryness, hardness, or excessive wear. Replace if damaged or if condition of seal is such that it will leak.

Install bearing on output shaft. Press oil seal into retainer. Install bearing and oil seal in face plate.

Install shaft in case by pressing bearing into large bore in case. Position output gear over the splines on shaft, thread locknut on shaft and tighten with 2000 ft. lbs. torque. Install locking setscrew in face of gear and between splines on the locknut.

Press bearings into blind bores in the face plate. Press the bearing cones on first and second reduction gear shafts. Press bearing cup into the bores in case. Install second reduction gear, then first reduction gear into case.

Slide spacers on gear hubs, install the bearing cones, thread bearing locknuts onto gear hubs and

tighten locknuts. Tighten first reduction gear locknut with 100 ft. lbs. torque and second reduction gear locknut with 200 ft. lbs. torque.

Position the face plate on the case, inserting the gasket between the face plate and the case and secure with capscrews, lockwashers and nuts.

Install and tighten bearing retainer plugs in bores in case. Replace "O" ring into bearing retainer (if so equipped). Install bearing retainer, seal and gasket. Secure with capscrews and copper washers, torque to approximately 75 ft. lbs.

Secure motor to gear box. Install on machine and fill gear box with the required amount and type of lubricant (see Section "K").

NO. 3 GEAR BOX

Disassembly

Remove capscrews and lockwashers securing the face plate to the case and remove the face plate and gasket. The bearings (Fig. J-23) in the face plate must be removed with an expansion type puller. Remove rotor shaft oil seal and bearing at the same time.

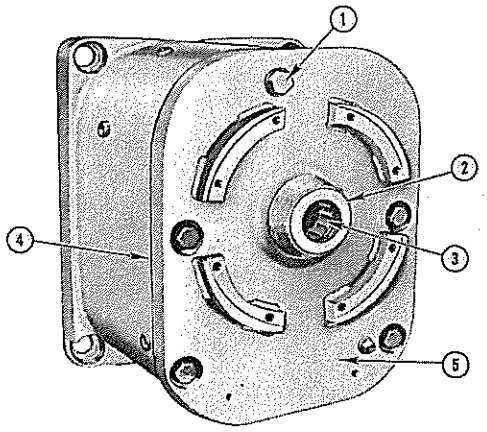


FIGURE J-23. GEAR BOX FACEPLATE

1. Capscrew
2. Oil Seal
3. Bearing
4. Gasket
5. Faceplate

Drive out roll pins (if so equipped) and remove capscrews securing the output shaft bearing retainer to the case. Remove retainer, gasket and oil seal (Fig. J-24). (Bearing retainer may be equipped with an "O" ring.)

Remove setscrews from first and second reduction gear bearing caps. With special wrench remove bearing caps (Fig. J-25). Remove locking setscrews from reduction gear shafts and remove locknuts. Remove the first and second reduction gears from the case.

Remove setscrew from output shaft locknut and remove locknut. Now drive out the shaft, using a soft hammer. Drive out the output shaft bearing from the inside of the case.

Remove the output gear from the case. Remove oil seal from output shaft.

Tap the first and second reduction gear bearings out of their respective bores in the case.

NOTE: Steering gear box is equipped with an oil seal ring in addition to the oil seal.

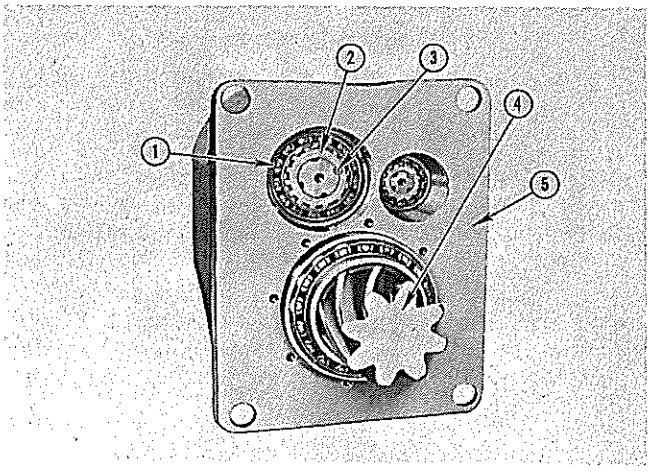


FIGURE J-25. RETAINER REMOVED

1. Bearing
2. Locknut
3. Setscrew
4. Pinion
5. Case

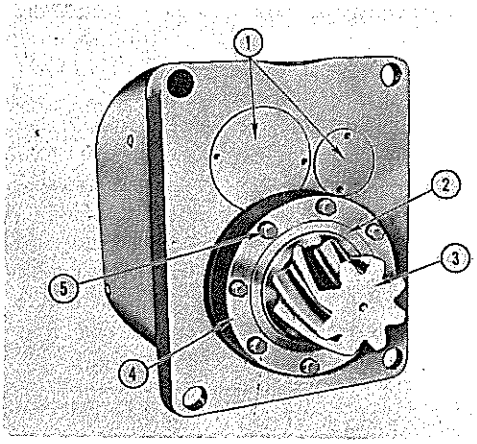


FIGURE J-24. BEARING RETAINER PLUGS

1. Plug
2. Oil Seal
3. Pinion
4. Retainer
5. Capscrew

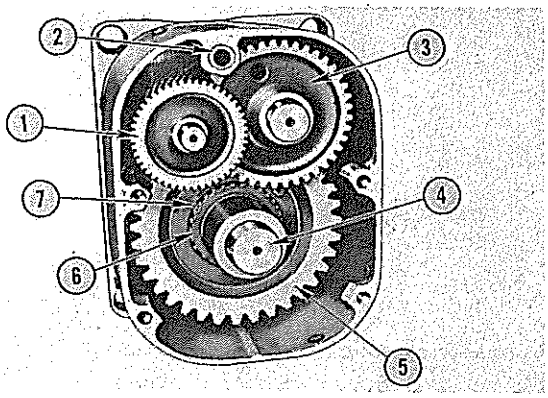


FIGURE J-26. REMOVING GEARS

1. 1st Reduction Gear
2. Dowel
3. 2nd Reduction Gear
4. Output Shaft
5. Output Gear
6. Locknut
7. Setscrew

Reassembly

Carefully check all gear teeth for damage. Wash and check all bearings and replace those damaged. Clean gear box and all parts before reassembly.

Check oil seal for dryness, hardness, or excessive wear. Replace if damaged or if condition of seal is such that it will leak.

Replace oil seal on output shaft.

Install bearings in gear box case and face plate.

Set output gear into case and install output shaft through bearing and into gear. Drive shaft into splines in gear.

Replace locknut and torque to 2000 ft. lbs. Install setscrew.

Install first and second reduction gears into case.

Replace locknuts on first and second reduction gear shafts and torque to 100 and 200 ft. lbs. respectively.

Replace gasket and face plate. Install capscrews to secure face plate to case. Replace bearing retainer plugs over first and second reduction gear locknuts.

Replace oil seal, gasket and retainer over output shaft. Replace hex head capscrews to secure retainer to case, torque to approximately 75 ft. lbs.

Secure motor to gear box. Install on machine and fill gear box with required amount and type of lubricant (see Section "K").

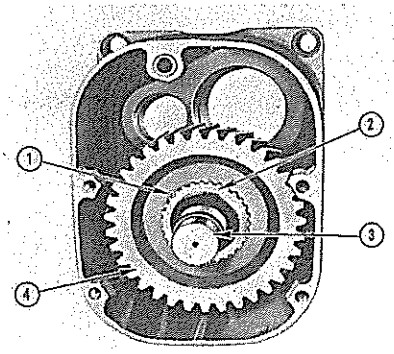


FIGURE J-27. OUTPUT GEAR

1. Setscrew
2. Locknut
3. Output Shaft
4. Output Gear

CONTROL, LIMIT AND HEAT CONTROL SWITCHES

The main switches which operate the A.C. electric motors are remote controlled by finger-tip switches on the instrument panel.

Each finger-tip control has two individual switches mounted to its frame. The switches are operated by the lever arm which protrudes through the instrument panel.

A finger-tip control switch in the released position does not have current flowing through it. When a switch is closed, the control circuit energizing the holding coil of the corresponding main switch is closed. The main switch then closes and the A.C. motor will operate.

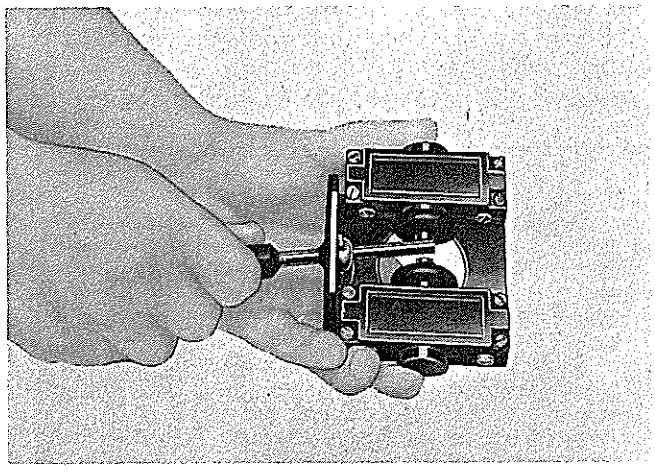


FIGURE J-28. FINGERTIP CONTROL SWITCH

The control circuit also includes limit switches and heat control switches. Both are safety devices which prevent damage to the machine from improper operation.

The limit switches are operated by the action of a stop plate against an actuator arm. The action of the actuator will cut off the flow of current to the motor, thus preventing any damage to the equipment.

To adjust a limit switch, first remove the cover and loosen the jam nut on the adjusting screw. Back out adjusting screw until spring pulls actuator against switch, and the switch makes a "clicking" sound. Turn adjusting screw in until switch again makes the "clicking" sound. Tighten jam nut.

Install switch on machine. Loosen the two capscrews and nuts clamping the actuator arm to the actuator shaft. Move the component, governed by the limit switch to the limit of travel desired. Place actuator arm against the stop block on moving component and open the limit switch by hand (pulling against the spring). Holding the switch open, tighten the two capscrews and nuts clamping

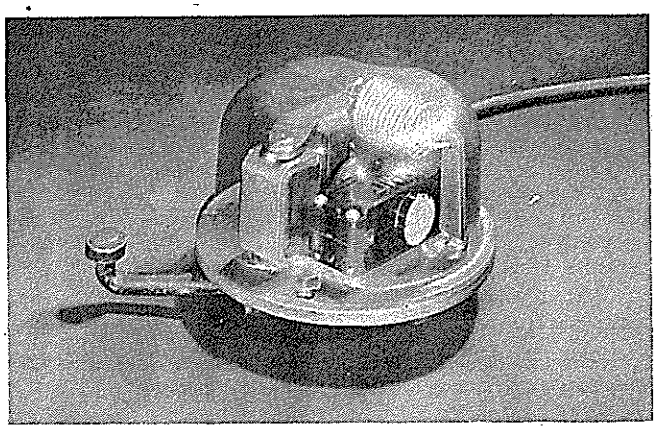


FIGURE J-29. LIMIT SWITCH

the actuating arm to the actuator, being sure the actuating arm is against the stop block.

When correct adjustment has been obtained, replace gasket and cover.

The heat control switch is operated by temperature changes. This safety switch has an element constructed of two metals having different rates of expansion and contraction. When subjected to an increased temperature, the metals expand and "bow up" away from the contact points, opening the motor control circuit and stopping the A.C. motor. When the metals cool they contract, returning to their normal position, closing the control circuit.

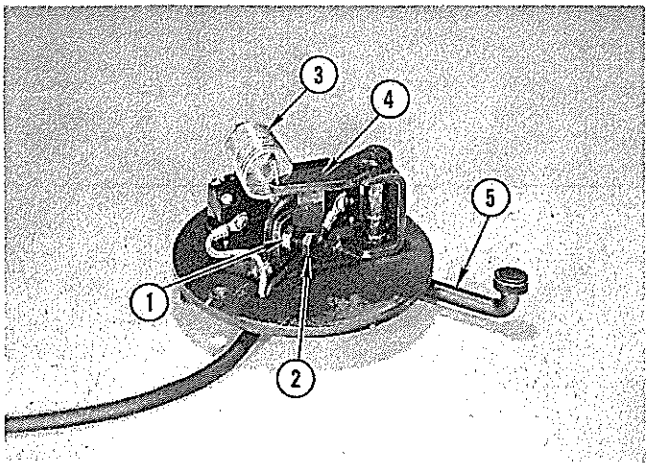


FIGURE J-30. LIMIT SWITCH ADJUSTMENT

1. Jam Nut
2. Adjusting Screw
3. Spring
4. Actuator
5. Arm Structure

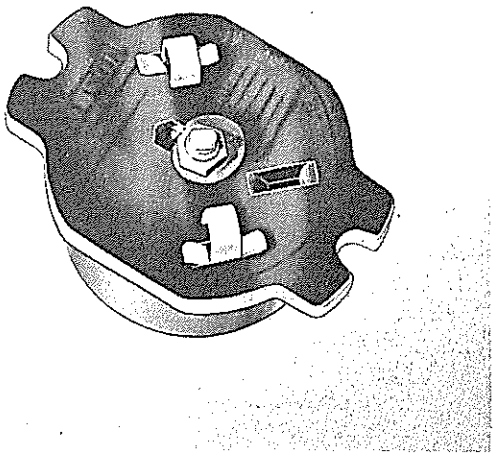


FIGURE J-31. HEAT CONTROL SWITCH

MAIN SWITCH

Main switches, inserted in the circuit between the generator and the motor, control the flow of current to the motor. When the contacts within the switch are closed, the A.C. electric motors will operate.

Heavy current flows through these switches when the A.C. motor is in operation, and large contact points of special material are used to carry the heavy load.

Main switches are operated by electromagnets which are called holding coils. These coils are energized by a separate circuit known as the control circuit, see Section "L".

Disassembly

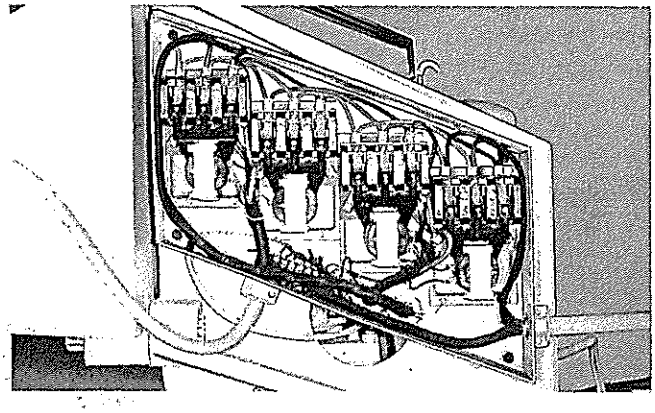


FIGURE J-32. MAIN SWITCH BOX

Remove switch box cover and disconnect leads from switch and holding coil.

Remove screw and washer securing the moving contact point to arm structure and lift out point, holder, spring and shims (if present). Remove spring from holder (Fig. J-33).

NOTE: For point replacement only the moving points can be removed by lifting up on the moving contact, rotate 90 degrees and remove. Stationary points can be removed by removing the screw securing it to the base and lifting out point.

Remove screws securing coil and magnet structure to contactor base structure and lift magnet and coil out of mounting bracket. Remove cap-

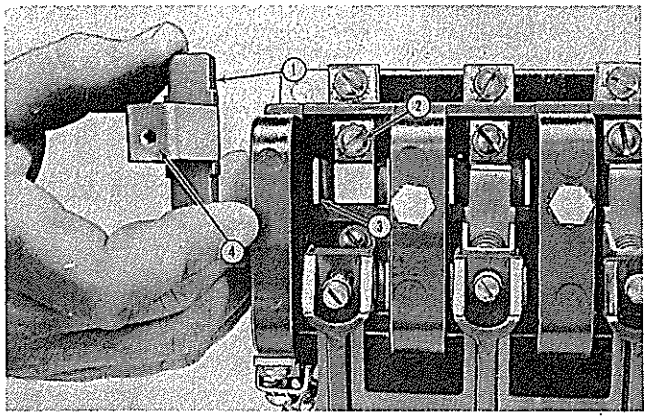


FIGURE J-33. MOVING POINT, REMOVED

1. Moving Point
2. Machine Screw
3. Arc Snuffer
4. Point Holder

screws, nut and lockwasher securing coil to magnet structure and separate the two units (Fig. J-34). Press down on the magnet and arm structure and remove the key (Fig. J-35). Lift out arm structure and remove the arm support spring (Fig. J-36).

Remove the two capscrews securing the base to contactor base plate structure and lift off the base.

Remove stationary point structure, arc snuffers, and terminal strips from top and bottom of contactor base.

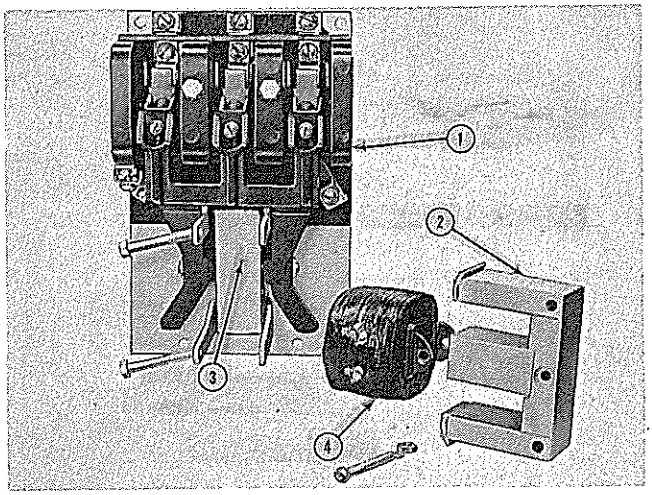


FIGURE J-34. REMOVING MAGNET

1. Base
2. Magnet
3. Bar Magnet and Arm
4. Coil

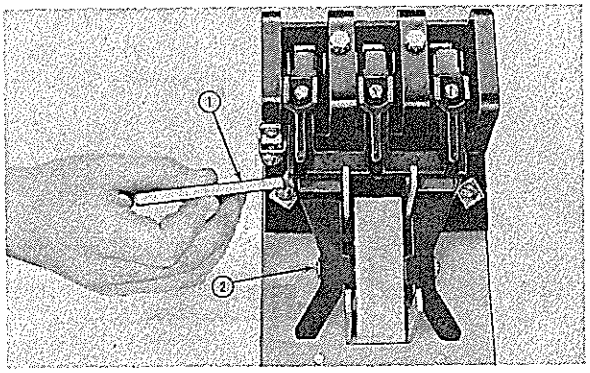


FIGURE J-35. REMOVING KEY

1. Key
2. Bar Magnet and Arm

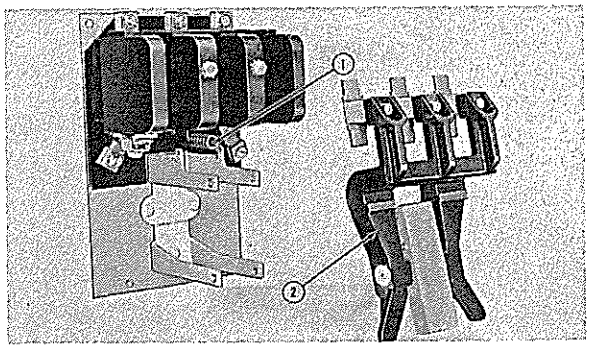


FIGURE J-36. MAGNET AND ARM, REMOVED

1. Spring
2. Bar Magnet and Arm

Reassembly

Replace terminal strips, arc snuffers and stationary contactor points in contactor base.

Position contactor base on base plate and secure with capscrews.

Place arm support spring on stud on contactor base and replace arm structure over spring.

Replace key holding arm structure to contactor base.

Reassemble coil to magnet structure and replace in bracket on arm structure. Replace moving contact points, holders and springs. Complete reassembly and installation of unit.

Adjustment

To avoid excessive wear and arcing of the main switch points, all three points must make contact at the same time with a maximum of 0.015" variation between any two points. This also means that the top and bottom portions of each individual moving contact point must contact the mating stationary point at the same time, within the 0.015" limit.

When installing a new magnet and arm assembly, moving or stationary contact points, or replacing a complete main switch assembly, shimming between the arm and moving contact holders may be necessary to keep within the specified limits.

Incorrect angle will cause the top or bottom of the contact points to engage first. If such is the case, replacement of the holder will be necessary.

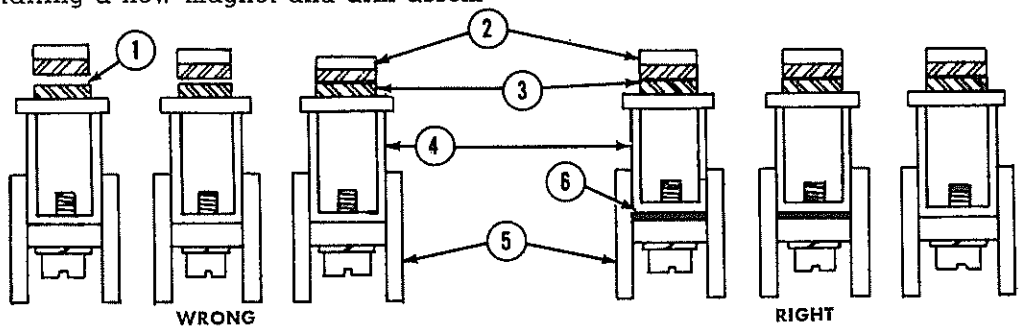


FIGURE J-37. SHIMMING BETWEEN ARM AND MOVING CONTACT HOLDER

1. Gap
2. Stationary Points
3. Moving Points
4. Point Holder
5. Magnet and Arm
6. Shims

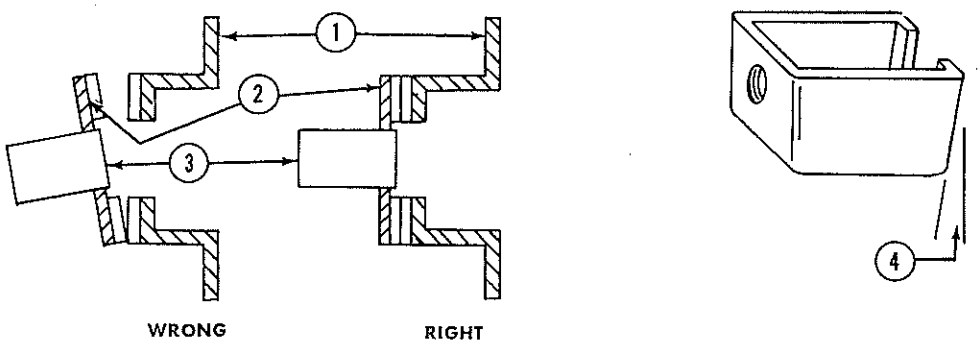


FIGURE J-38. MOVING CONTACT HOLDER ANGLE

1. Stationary Points
2. Moving Points
3. Holder
4. Point Holder Angle

MAINTENANCE AND LUBRICATION

INDEX

MAINTENANCE AND LUBRICATION

Proper maintenance, lubrication, and lubricants are essential for successful operation with a minimum of unproductive down time.

Use care in lubricating the machine. Use only the recommended lubricants obtained from a reputable supplier.

Clean all grease fittings and filler plugs before lubricating. Any foreign material in the fittings or plugs may be forced into the machine and cause faster wearing of the moving parts.

Do not over lubricate. Too much lubricant may rupture the oil seals.

The lubrication intervals specified by shifts of operation are based on an average work period of approximately 10 hours per shift. The intervals may vary somewhat, depending upon climate and working conditions.

Extreme Pressure (E.P.) gear oils specified must meet U.S. Army Specification MIL-L-2105. Engine oils must meet U.S. Army Specification MIL-L-2104A.

MAINTENANCE

A.C. Electric Motors

Every 100 shifts remove motor cover and blow the dust and dirt from around the windings, rotor and brake assembly with an air hose.

Inspect all electrical connections every 10 shifts, making sure they are tight and free from grease and dirt.

Check brake clearance every 10 shifts. Excessive clearance at the brake magnets will cause improper brake release, over-heating the motor, and warping of the plates thus causing them to wear out prematurely. Insufficient brake clearance will also prevent proper brake release.

Adjust the brake as follows: Loosen the nut on the tapered bolt locking the adjusting plate in position. Tap bolt down to release tension.

Insert a bar between the adjusting lugs on the adjusting ring and turn either clockwise or counterclockwise until the air space between the floating plate and the end bell is 1/32" for single disc brakes or 1/16" for double disc brakes. Clockwise rotation decreases the space, counterclockwise rotation increases the space.

After the proper adjustment is obtained, tighten the nut on the end of the tapered bolt, locking the ring in position.

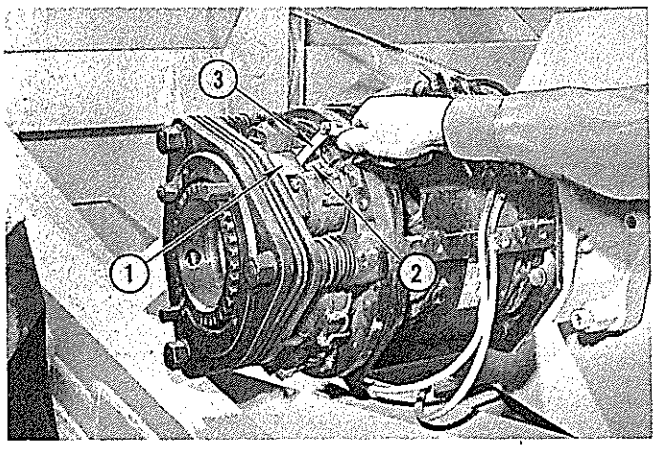


FIGURE K-1. CHECKING BRAKE CLEARANCE

1. Floating Plate
2. End Bell
3. Feeler Gauge

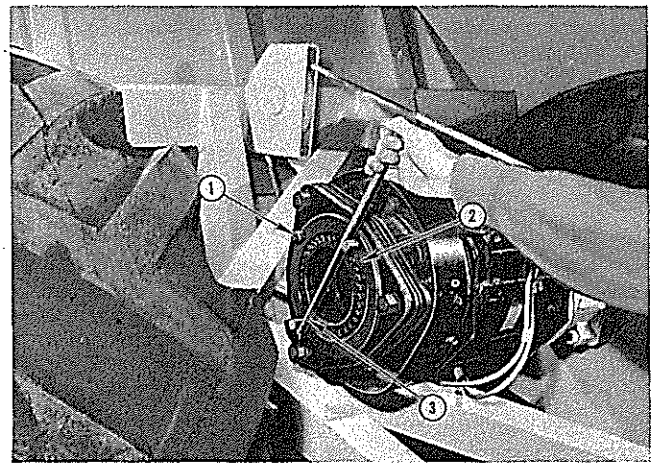


FIGURE K-2. ADJUSTING MOTOR BRAKE

1. Locknut
2. Adjusting Ring
3. Bar

A.C. Generator

Inspect the generator at 50 shift intervals for any large accumulation of oil and dirt on the stator. Any excessive amount of waste material will prevent proper cooling of the generator. Make sure that drains in the bottom of the engine compartment are open and the waste materials are draining away. The drains sometimes plug up with mud and allow the dirt and water to build up to the level of the generator stator.

Inspect the stator windings. Remove accumulation of grease and dirt with a low pressure siphon hose and a cleaning fluid, such as carbon tetrachloride. After the windings have been washed down with the cleaning fluid, blow off the surplus fluid with air.

Make sure the leads connected to the transformer and generator terminals are tight. Remove any accumulation of grease or dirt found on the terminal strips with cleaning fluid.

The generator brushes should be inspected for wear whenever the generator is disassembled. The brushes are 3/8" thick when new and should be discarded when one half of the brush has worn away.

Air Brakes

Correct any defect in the air lines which may retard the flow of air to the brake, such as compressed, broken or clogged lines.

In extremely cold weather, moisture in the air lines may freeze and impede the flow of air. Add alcohol to the air system to absorb the moisture and help to eliminate this condition (1 pint each day to the air tank).

Air Cleaners

Daily inspection is necessary to determine the amount of maintenance to be given the air cleaners.

The wire screen condensing element will need very little attention if the correct oil level is maintained, using the proper oil. However, the bottom of the screen element should be inspected whenever the air cleaner is serviced. Any accumulation of dirt or straw should be removed. The heavy duty oil bath air cleaner is provided with a removable section in the lower portion of the element. When service of the element is required this removable piece can be taken out, washed in a cleaning fluid, dried and replaced. A push up, slight turn to the left, and a downward pull will remove the pre-filter element.

The inlet tube requires periodic attention, since an accumulation of dirt will restrict the air flow to the engine. Cleaning is best accomplished by pushing a rag on a stick through the inlet tube.

The entire air cleaner should be removed from its mounting and the wire screen condensing element washed thoroughly in cleaning solvent or steam clean at least once each season—more often if dust conditions are severe.

Loose connections between the air cleaner and the engine will allow dust to enter the cylinders. Vibration may loosen these connections. Check them frequently and keep air tight.

Air Compressor

Water lines connect the two openings in the compressor water jacket to the water circulating system of the engine. The lower opening is connected to the pressure side of the engine cooling system and the upper opening to the suction side. Both connections should be checked for leaks and tightened periodically. During cold weather, compressor jacket should be drained whenever the engine is drained. Anti-freeze will protect the compressor to the same extent as the engine.

Keep the air inlet fittings tight. Check the blanking cover and gasket covering the air inlet opening or the intake manifold not in use for leaks and improper installation.

With compressor running, check for noisy operation and oil or water leaks.

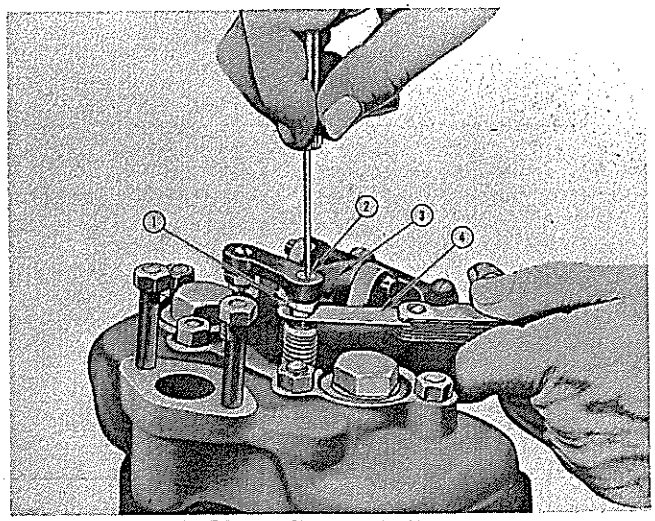


FIGURE K-3. ADJUSTING UNLOADING VALVES

1. Locknut
2. Adjusting Screw
3. Unloader Valve
4. Feeler Gauge

Check the unloading valve clearance. Clearance must be 0.010" minimum to 0.015" maximum. To adjust the clearance loosen the locknuts and turn the adjusting screws until the proper clearance is obtained (Fig. K-3). Then tighten the locknuts. Clearance can be checked only when the compressor is loaded. Check the unloading lever for binding at the same time.

Keep the oil lines clean and tight. One line connects the compressor end cover with the lubricating oil distribution cavity on the engine. The oil in this line is under pressure. Oil which has circulated through the compressor lubricating system drains back into the engine crankcase through a line from the compressor base.

The compressor drive belt should be checked regularly for wear and kept under firm tension. A slipping compressor belt wears both the belt and the pulleys and will prevent the compressor from delivering its rated amount of air. A properly adjusted belt can be pushed down ½" with normal thumb pressure.

Refer to "Fan Belt", page K-6 for belt adjusting procedure.

Failure of the compressor to maintain normal air pressure usually denotes loss of efficiency due to wear, provided loss is not excessive in the remainder of the system. Another sign of wear is excessive oil passing. If either of these conditions develop and inspection shows the remainder of the system to be in good condition, the compressor must be repaired or replaced.

Excessive leakage past the discharge valves can be detected by fully charging the system with air and then (with engine stopped) carefully listening

at the compressor for the sound of escaping air.

For the Type "U" compressor, fully charge the system (compressor unloaded), coat the unloading box cover with soap suds to check for leakage past the unloading diaphragms. Leakage of a one inch soap bubble in three seconds is not permissible. If excessive leakage is found, the compressor should be repaired or replaced.

For "Tu-Flo" type compressors, remove cover from air strainer opening. Fully charge the system (compressor unloaded), and observe for leakage by squirting oil around valve stems. If excessive leakage occurs, the unloader piston seal should be replaced.

Batteries

Precautions should be taken to prevent machine downtime caused by dead batteries. Batteries of one-half charge or less cannot be depended upon to supply adequate current for starting and the various other electrical demands placed upon it. Therefore, it is not only imperative that the battery charging circuit be operating properly, but also that periodic checks be made on the batteries for proper water level, condition of cables and clamps, and cleanliness.

Any withdrawal of current must be balanced by current input from the battery charging circuit. If the output should exceed the rate of current input, this will result in the batteries becoming discharged.

Periodic servicing of the batteries will, in most cases, prevent premature failure. The most important of these servicings is the addition of water to the cells to prevent the electrolyte level from falling below the tops of the battery plates. Plates and separators exposed to air will dry out and become ruined.

Over-filling should also be avoided as this will cause a loss of electrolyte. This not only results in a loss of battery capacity, but overflowing of the electrolyte on cables and clamps will cause corrosion.

When adding water, use only distilled water or water from local sources approved by the battery manufacturers. Water having a high mineral content will greatly shorten the life of the battery.

Add water just prior to operation of the machine to insure a good mixture between water and electrolyte. The water will stay on top in cold weather and freeze at about 32° F. unless it is thoroughly mixed.

Keep the top of the batteries clean by washing them off with ammonia or soda solution. Be sure caps are fastened securely to prevent the solution from entering the cells. When through cleaning, rinse the tops of batteries with clean water.

Check battery cables to be sure a good contact is being made between the clamps and terminals. Remove any corrosion which may be present and apply a coating of petroleum jelly to the clamps to retard corrosion.

The following specific gravity readings indicate the different charge values:

1.280	Full Charge
1.225	Half Charge
1.150	Discharged

In tropical climates, the full charge should read between 1.220 and 1.215. The battery charging circuit should maintain the batteries above 1.155. See page L-11 for instructions on making temperature corrections when making specific gravity tests.

Batteries which are being charged or have been recently charged, will have gas at each of the cells which is highly explosive. A spark or flame at this gas will result in an explosion. When charging of the batteries has been completed, remove the caps and blow air across the cells to dissipate these gases. Do not blow hard enough to splash the electrolyte.

Use a hydrometer to check the specific gravity of the batteries at each cell. Hold the tube in a vertical position with the float suspended in the electrolyte. The reading should be taken at eye level (See Fig. K-4).

A common cause of battery failure is overcharging. This is usually caused by improper adjust-

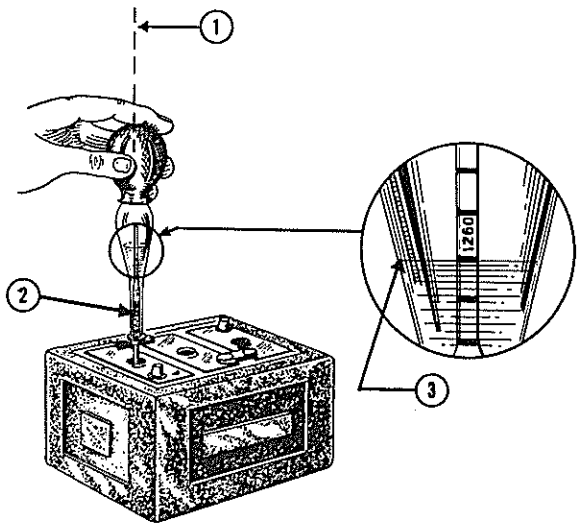


FIGURE K-4. CHECKING SPECIFIC GRAVITY

1. Hold Tube Vertical
2. Float Must Be Free
3. Take Reading at Eye Level

ments, defects or faulty operation of the battery charging circuit.

One of the evidences of over-charging is the swelling of the positive sides of the cell covers.

This is caused by the following: During the normal charging action, water in the electrolyte is converted to hydrogen and oxygen. This oxygen enters the positive plate to reconvert the lead sulphate into active material. When full charge has been reached, there remains no lead sulphate to convert. Should charging continue after this point, the oxygen will gradually convert the lead in the positive plate into lead peroxide. This lead requires more room for expansion than the original lead and therefore as it swells it will cause the positive sides of the cell covers to be raised.

Another indication of over-charging is the necessity of frequent addition of water.

Cable

Proper care and treatment is very important and will pay big dividends in the way of longer cable life.

The windings of the first layer of a multiple layer drum is important. It is important to recognize the fact that a properly wound first layer, upon which subsequent layers may be wound with uniformity, will result in less abuse to the rope.

The relation of rope lay must be considered in relation to the winding on the drum. Using a right lay rope and underwinding on a smooth face drum, rope must be started from the right flange. When overwinding a right lay rope, start from the left flange, as seen from the back of the drum. The reverse is true of left lay rope.

A reversal of the procedure outlined above will cause spaces between the initial wraps of rope in the first layer. Succeeding layers of rope will be crowded down into these spaces, nicking the wires and causing unnecessary crushing and abrasion.

The perfectly wound first layer obtained under proper winding conditions, results in uniformity in subsequent layers and longer rope life.

Whenever possible, the drum anchorage should be positioned as to favor right lay rope, since left lay rope is not always immediately available from stock.

This method also applies to either regular or long lay rope. Listed below are some suggestions that will help prolong the cable life.

Check cable frequently for worn or frayed spots.

Lubricate at intervals determined by operating conditions. Use a mixture of crater compound and petrolatum.

Use the recommended sizes of cable as the design of the sheave wheels vary somewhat for cables having different diameters.

When installing new cable, make sure the cable reeves evenly onto the cable drum. Do not permit the cable to criss-cross or stack up on the drum.

Always make sure the sheave wheels and/or rollers are turning free of debris and that none are broken, because if either of these are not functioning properly, the cable will wear extremely fast.

Replace sheave wheels having badly worn cable grooves, especially those having a rope lay impression worn into them.

Do not cause cable to become kinked by allowing an excessive amount of slack.

Unless operating in dusty conditions, lubricating the cable will normally add to its life. Apply cable dressing as needed. If the dressing is applied to cable in dusty condition, dust and grit will adhere to the lubricant and become abrasive. This will greatly accelerate the cable wear.

Engine Oil Cooler

Engine oil coolers should be cleaned periodically to insure continued efficient cooling of the oil. The cooler element should be removed for inspection and cleaned of sludge and hardened oil deposits in the oil cooler core; and rust or lime deposits in the water coolant area surrounding the core.

Steam cleaning, under pressure, or immersion into a solvent may be employed for cleaning those units which contain a normal accumulation of sludge and hardened oil; or, the cooler may be removed from the engine unit and immersed into a vinegar bath consisting of 1 part vinegar to each 15 parts water. The length of time required for the vinegar to soften the lime and rust deposits will vary depending upon the established frequency of cleaning.

After cleaning, oil coolers must be flushed thoroughly to remove all cleaning solvent or vinegar, and softened deposits. After flushing, all traces of moisture must be removed from the oil passage ways of the cooler by heating, before installation onto the engine.

It is recommended not to attempt cleaning any oil cooler wherein the history of the usage shows an engine failure which has released metal particles from worn or broken parts into the lubricating oil. In all probability, all metal particles could be flushed out after the unit is thoroughly cleaned, however, a few particles could become lodged in the cooler, and later loosen and circulate through the system with the lubricating oil.

Therefore, the chance is too great to take, considering the cost of the cooler against the cost of another tear-down of the engine. In this instance, recoring of a tube type oil cooler, or replacement of the core element in a plate type oil cooler is strongly recommended.

Fan Belt

The compressor and fan drive belt may be adjusted by either adjusting the compressor, as described previously, or by adjusting the fan, as follows.

Loosen the large nut at the rear of the fan shaft and the locknut on the adjusting screw. Turn the adjusting screw clockwise to tighten or counterclockwise to loosen the belt. Lock both nuts tight after belt has been adjusted.

The belt should have enough slack so it can be pushed in approximately ½" from a straight line between the rims of the two pulleys, midway between the pulleys.

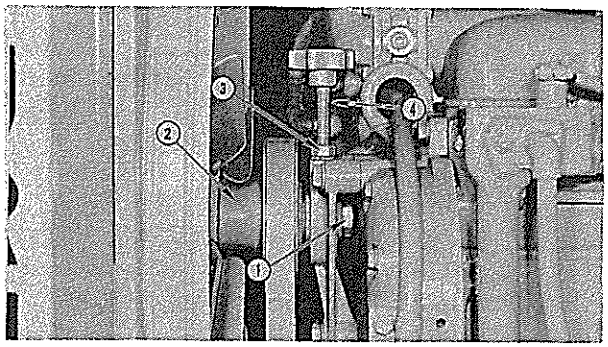


FIGURE K-5. ADJUSTING FAN BELT
1. Slotted Nut 2. Fan Hub 3. Locknut 4. Adjusting Screw

Radiator

Drain and flush radiator every three to six months, depending upon the condition of the coolant and the type and amount of service required of the engine. Flush the radiator and the engine block separately. Flushing water should enter the radiator at the bottom connection, the reverse of the regular flow of water. Thermostats must be removed before flushing engine.

A badly clogged radiator may have to be cleaned with the aid of a commercial cleaner. Follow the manufacturer's recommendation when using cleaning solvent. With caution, a solution of washing soda may be used to remove the grease and oil. The solutions should be lukewarm before used, and allowed to stay in the radiator or water jackets for three to four hours. The effectiveness of the solution will be increased if the engine is warm. Drain and thoroughly rinse the engine and radiator so that no trace of the cleaning solution remains.

A leaking water pump should be repaired immediately and defective parts replaced. Be sure all hose connections are tight and that the hoses themselves are in good condition. Even a slight leak will be sufficient to pass large quantities of air, causing a greatly accelerated corrosion attack.

Main Switches

Check the condition of the contactor points for wear or pitting every 50 shifts. Pitted or burned contactor points tend to reduce or restrict flow of current to the electric motors. To avoid rapid burning or pitting of points, the engine speed should be kept as near high idle as possible while operating any of the electric motors. Check tightness of screws that hold the power leads to switches, also main power leads coming in on the multiple cable.

Check the hinge bolts and other hardware on the contactor group. These must not be loose or binding. Keep excessive dust blown off. If grease or oil has worked into the assembly, wash with a solvent such as carbon tetrachloride. Keep the control panel cover securely fastened and in place at all times.

Check the collector cups and blow out any accumulation of dust, dirt or other foreign material every 100 shifts. More often if necessary in dusty conditions.

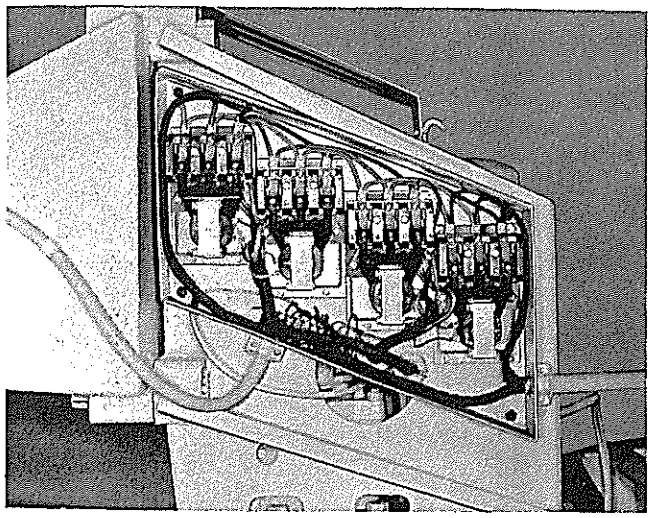
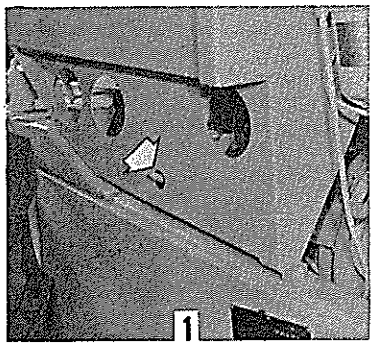
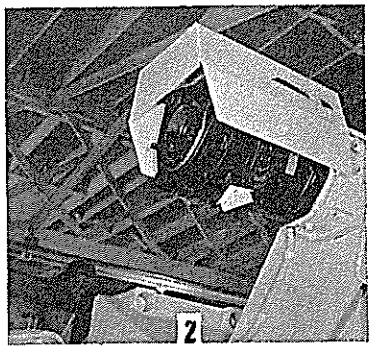


FIGURE K-6. MAIN SWITCH PANEL

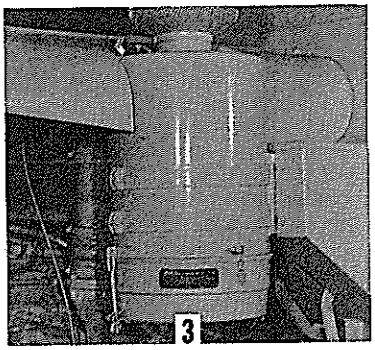
LUBRICATION

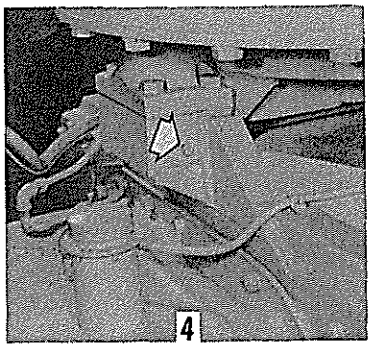


1. A.C. GENERATOR REAR BEARINGS — Lubricate every shift with Mobilplex E.P. No. 2. Do not over lubricate. Make certain tube between fitting and bearing is filled with grease, otherwise the bearing will not receive lubricant during the first few lubrication intervals. *

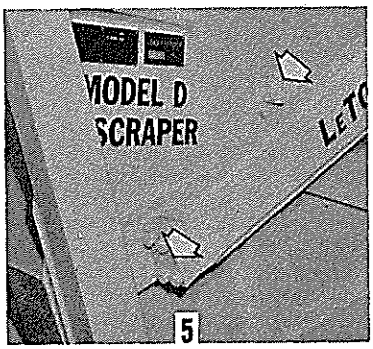


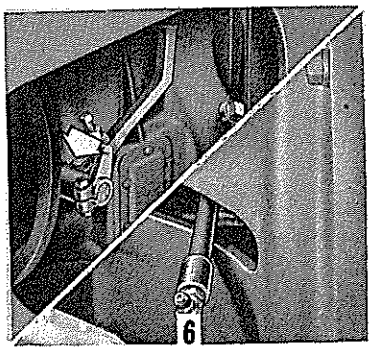
2. A.C. ELECTRIC MOTOR BEARING (Brake end of motor only) — Lubricate every shift with Mobilplex E.P. No. 2. One shot with a hand gun should be sufficient. Make certain tube between fittings and bearing is filled with grease, otherwise bearing will not receive lubricant during the first few lubrication intervals. Do not over lubricate. *





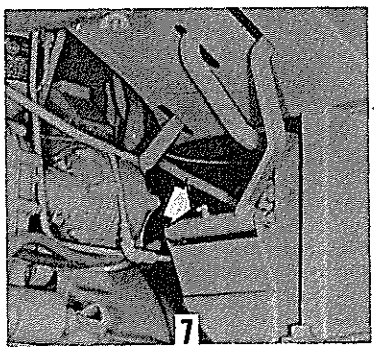
3. AIR CLEANER — Check oil level every shift. Change oil every 5 shifts or more often if operating conditions warrant. Use same lubricant as used in the engine crankcase. Fill to level mark on the disc. Capacity is approximately 5 quarts. Every 50 shifts clean filter body and element with cleaning fluid and blow dry with compressed air.

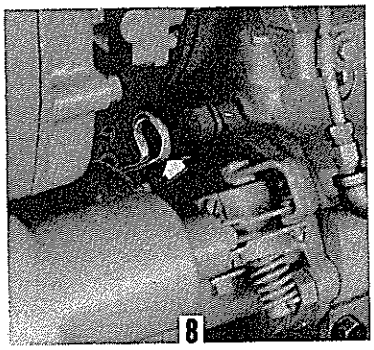




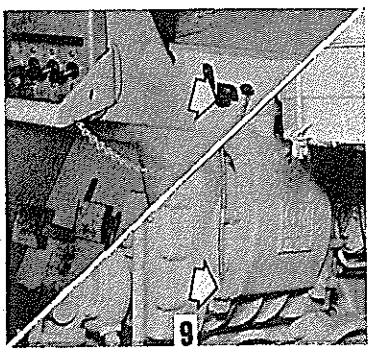
4. BALL AND SOCKETS (Steering Trunnion) Lubricate once each shift. Use #250 E.P. gear oil. Lubricate through fitting until a small amount of old oil has been forced from around the ball and socket caps.

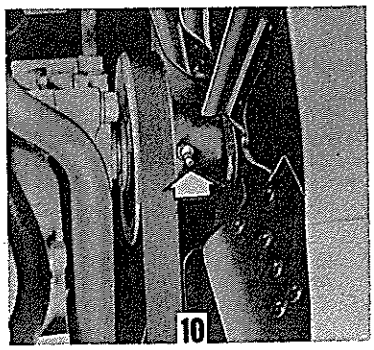
5. BALL AND SOCKETS (Trail Units) — Lubricate once every shift. Use chassis grease (heavy) for temperature above 32° F., and chassis grease (medium) for temperatures below 32° F.





6. CLUTCH RELEASE SHAFT AND BEARING — Lubricate once every 10 shifts. Use chassis grease (heavy) for temperatures above 32° F., and chassis grease (medium) for temperatures below 32° F. Lubricate through grease fittings on each side of transmission. Two or three strokes with a hand gun should be sufficient.

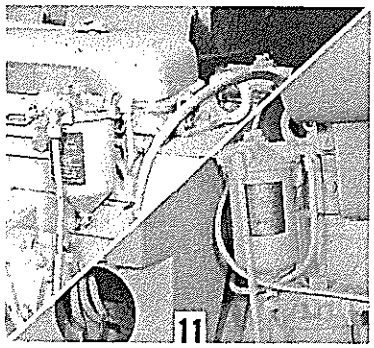


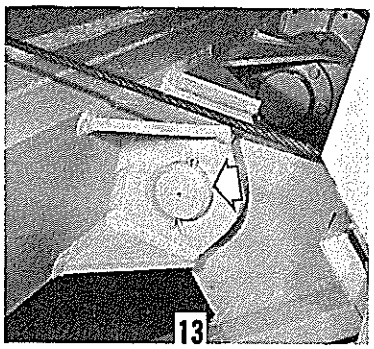


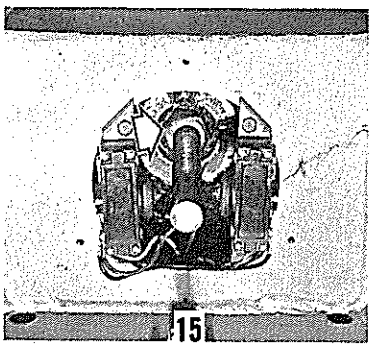
7. CLUTCH PEDAL SHAFT — If machine is equipped with lubrication fitting on clutch pedal linkage, lubricate once every 10 shifts. Use chassis grease (heavy) for temperatures above 32° F., and chassis grease (medium) for temperatures below 32° F.

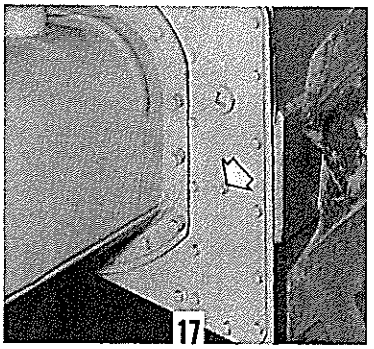
8. CRANKCASE — Check level every shift. Change oil every 10 shifts. Use SAE # 30 Heavy Duty engine

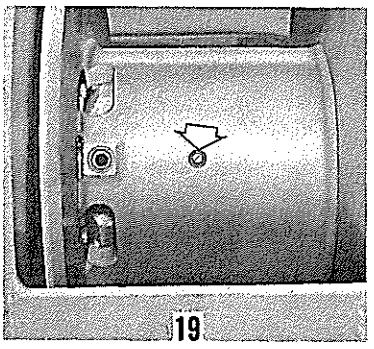
* (Recommended lubricant — MOBILPLEX E.P. NO. 2)











oil for temperatures above 32° F., and SAE #20 Heavy Duty engine oil for temperatures below 32° F. Capacity 4 gallons.

9. ENGINE EMERGENCY SHUT-DOWN CONTROL —

Lubricate cable every 10 shifts with light engine oil.

10. FAN BEARINGS —

Lubricate every 100 shifts. Use a high grade short fiber grease. Remove plug on fan hub, install grease fitting and fill with hand gun, remove fitting and replace plug. Do not over lubricate. Hub may be equipped with fitting.

11. FUEL FILTERS —

AC — Drain sediment from filter bodies every shift. Replace elements and clean bodies every 50 shifts.

LUBER-FINER (Optional) — Drain filter shell every shift. Replace element and clean shell every 50 shifts.

12. GEAR BOXES —

Check the level of the lubricant every 10 shifts. Change lubricant every 100 shifts. Use SAE #90 E.P. gear oil for temperatures above 32° F., and SAE #80 E.P. gear oil for temperatures below 32° F. Fill to level plug.

13. HINGE PINS (Crane and Arch) —

Lubricate every shift. Use chassis grease (heavy) for temperatures above 32° F., and chassis grease (medium) for temperatures below 32° F.

14. HOOK (Crane) —

Lubricate every 10 shifts with wheel bearing grease (medium). Fill until a small amount of old grease is forced out.

15. KINGPIN UPPER BEARING —

Check level of grease at upper bearing every 50 shifts. Repack if level is below upper bearing, use wheel bearing grease (medium).

16. LUBE OIL FILTERS —

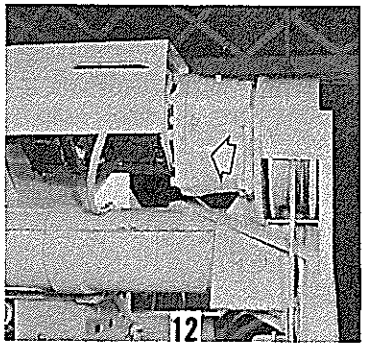
AC — Clean shell with fuel oil and replace element every 10 shifts.

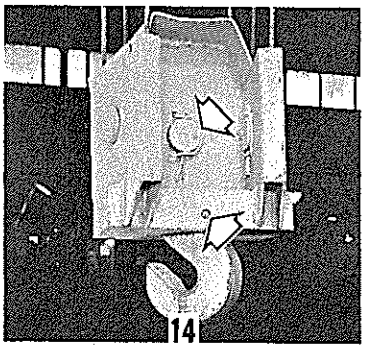
CUNO — Drain sediment from filter body once each shift. Replace element every 10 shifts.

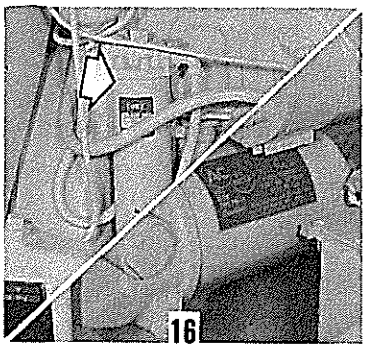
LUBER-FINER (Optional) — Drain the sediment every shift. Replace element every 10 shifts.

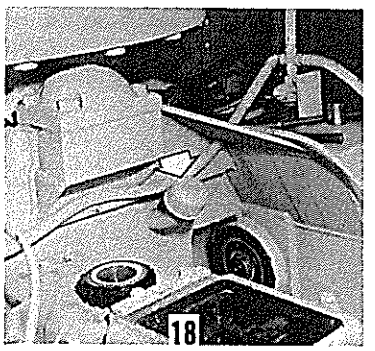
17. MAIN CASE (Includes Final Drives) —

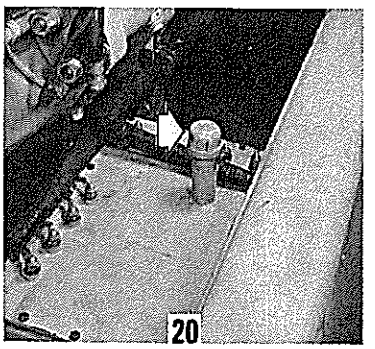
Check level of lubricant every 10 shifts. Change oil every 100 shifts. Use SAE #90 E.P. gear oil for temperatures above 32° F.,

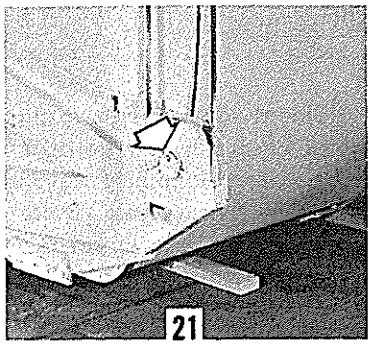


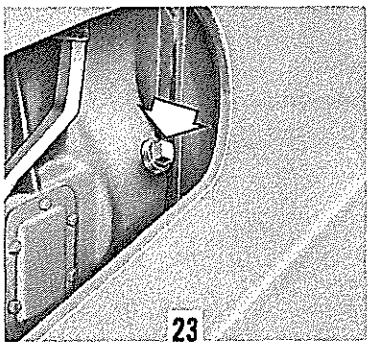


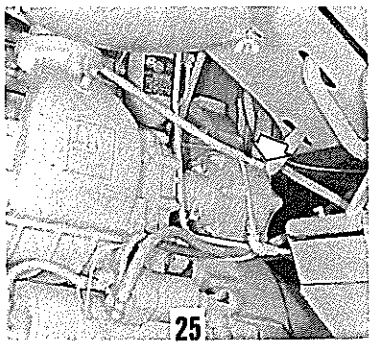


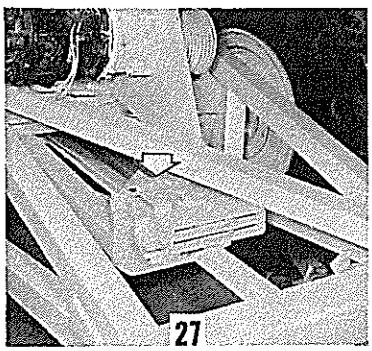












and SAE #80 E.P. gear oil for temperatures below 32° F. Fill to level plug. Capacity is approximately 32 gallons.

18. MAIN CASE BREATHER —
Wash in cleaning fluid and dip in clean crankcase oil every 10 shifts.

19. QUICK RELEASE CABLE DRUM (Arch)
Remove plug in drum (under cable) and lubricate cable drum every 10 shifts with chassis grease (heavy) for temperatures above 32° F., and chassis grease (medium) for temperatures below 32° F. Do not over lubricate

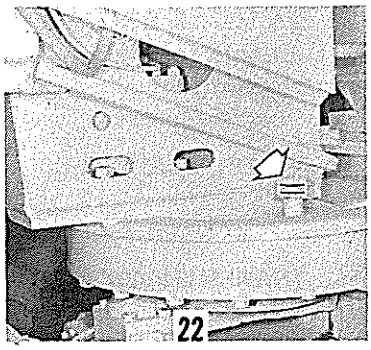
20. RECTIFIER TANK —
Check level of oil in rectifier tank every 10 shifts. Replace when water and/or dirt are present in quantity. Use a good grade transformer oil. Keep the level as near the top of the tank as practical (approximately 1" above plates). Use good grade transformer oil. Check the selenium coating on the plates for flaking or purple discoloration. If large areas of these conditions exist the rectifier should be tested as outlined in "Section "L" of this manual. Clean vent hole in tank filler cap.

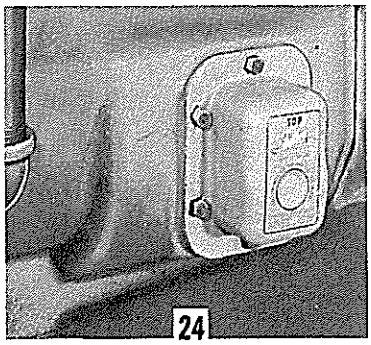
21. SHEAVE BEARINGS AND FAIRLEAD ROLLERS —
Lubricate every shift. Use chassis grease (heavy) for temperatures above 32° F., and chassis grease (medium) for temperatures below 32° F.

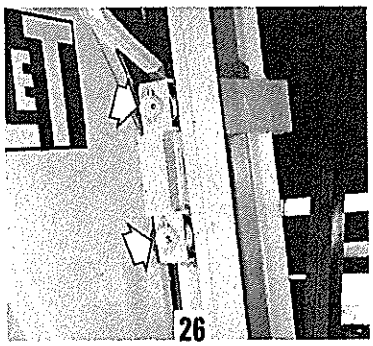
22. STEERING GEAR AND PINION —
Check the lubricant level every 10 shifts. Change grease only when the trunnion is disassembled. Use wheel bearing grease. Fill to 1" above bottom of pinion gear.

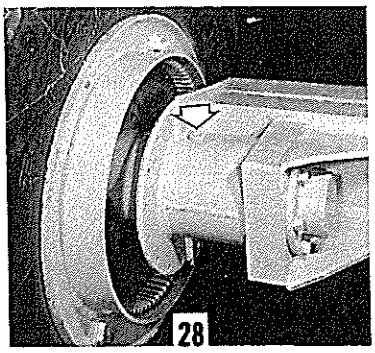
23. TRANSMISSION (Fuller) —
Check level every 10 shifts. Change oil every 50 shifts. Use SAE #90 gear oil (straight mineral oil) for temperatures above 10° F., SAE #80 gear oil (straight mineral oil) for temperatures between −10° F. to +10° F., SAE 20 non-detergent type engine oil for temperatures below −10° F. Capacity—3 gallons.

24. TRANSMISSION OIL FILTER (Fuller) —
Change oil filter element every 50 shifts.









25. THROTTLE LINKAGE —
Lubricate every 10 shifts. Use engine oil. Two or three drops at each connection.

26. TRACK ROLLERS —
Lubricate every shift. Use chassis grease (heavy) for temperatures above 32° F., and chassis grease (medium) for temperatures below 32° F.

27. TAILGATE ROLLERS —

Lubricate every shift. Use chassis grease (heavy) for temperatures above 32° F., and chassis grease (medium) for temperatures below 32° F.

28. WHEEL BEARINGS —

Lubricate every 10 shifts. Use wheel bearing grease (medium).

29. TRANSMISSION (Allison CLT 3340) —

Apply machine brakes and, with engine operating at 100 RPM and oil at normal operating temperature (160° to 180° F.), place transmission in fourth gear. Raise scraper bowl to "carry" position to level machine and check oil level. Oil should be between Add and Full mark on dipstick. Check oil level every 10 shifts.

Change oil, filter element and clean pump screen after first 5 shifts of machine operation. Thereafter, change oil and filter element every 50 shifts. Use Type C-1 transmission fluid. Before starting engine, pour 3 to 5 gallons hydraulic transmission fluid into transmission. Start engine and run at idle speed with transmission in neutral for 2 minutes to charge system.

Check level as described above and add oil if necessary.

NOTE: The lubricating intervals specified by shifts of operation are based on an average work period of approximately 10 hours per shift.

ELECTRICAL THEORY AND TESTING

INDEX

ELECTRICAL THEORY AND TESTING

The electrical system on LeTourneau-Westinghouse equipment consists of five basic circuits. These circuits are: Basic Excitation, Three Phase Power, Battery Charging, Booster, and Control.

In order for the mechanic to do a more thorough job of testing the system it is necessary that he understands the operation of the circuits and the component parts.

Following is a brief description of the circuits, generator, transformers, and rectifiers.

THEORY

Basic Excitation Circuit

The purpose of the basic excitation circuit is to provide the direct current necessary to initially excite the alternating current generator.

Before any usable amount of alternating current can be generated and delivered to the electrical system, an exciting current must be flowing through the generator field, and the field itself must be rotating.

The engine, to which the generator rotor is directly connected, drives the rotating field (rotor). The basic excitation circuit provides the current flow through the field windings.

Closing the key switch and the D.C. main switch on the instrument panel allows direct current from the batteries to flow through the switches and through the booster rectifier to the generator field windings (through the generator brushes and slip rings). The current flows through the field windings to a grounded terminal, then on to the batteries completing the circuit.

A capacitor is connected across the D.C. main switch to reduce arcing of the switch points when the switch is operated.

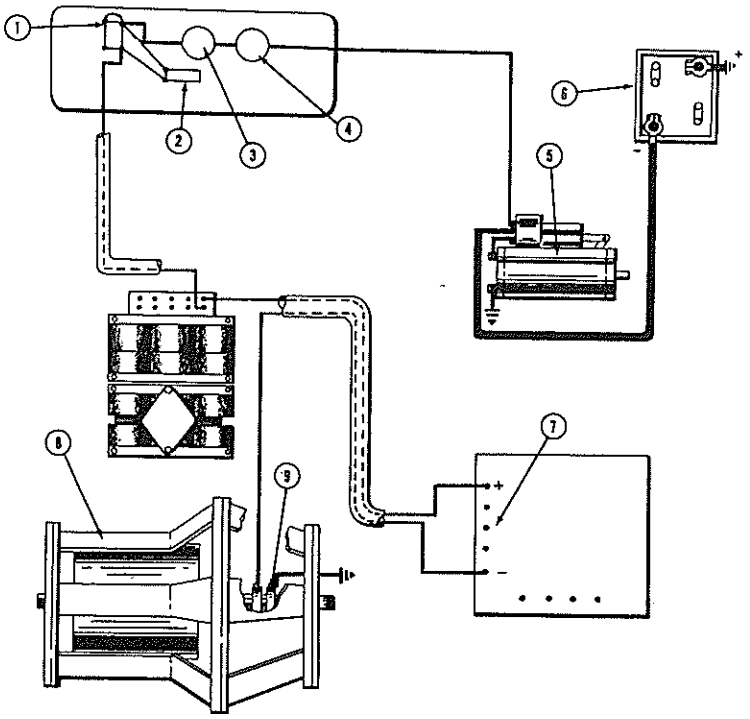


FIGURE L-1. BASIC EXCITATION CIRCUIT

1. D.C. Main Switch
2. Capacitor
3. Key Switch
4. Ammeter
5. Cranking Motor
6. Battery
7. Booster Rectifier
8. A.C. Generator
9. Slip Rings (Field)

Three Phase Power Circuit

The purpose of the three phase power circuit is to provide the current necessary to operate the alternating current induction motors.

When rotating at 1800 RPM, and properly excited by the excitation circuit, the generator will deliver 3 phase, 300 volt, 120 cycle, alternating current to an electric motor, when the power circuit to that motor is completed.

When the main switch between the generator and the motor is closed, current flows through the generator stator windings through the constant voltage transformer and the main switch to the motor stator windings and to the brake coils on the motor brake, releasing the electromagnetic motor brake, and rotating the motor rotor simultaneously.

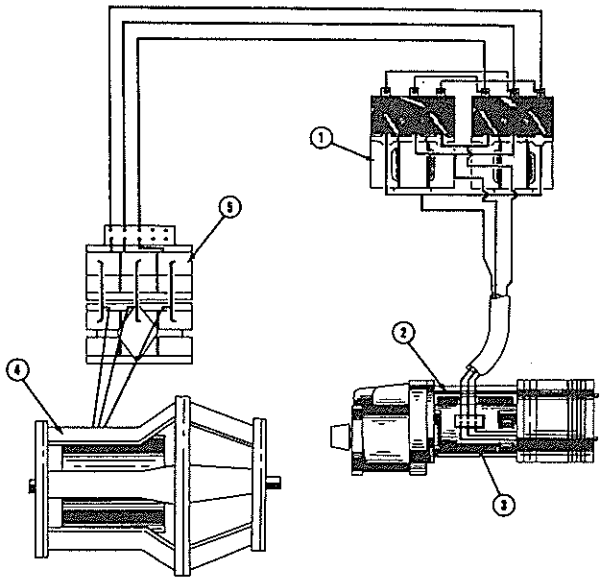


FIGURE L-2. THREE PHASE POWER CIRCUIT

1. Main Switches
2. A.C. Motor
3. Brake Leads
4. A.C. Generator
5. Voltage Control Transformer

Battery Charging Circuit

The purpose of the battery charging circuit is to provide current necessary to keep the storage batteries in a charged condition and provide no load excitation to the generator.

As the generator output increases, the main transformer secondary windings are energized, sending an A.C. output into the main or battery charging rectifier.

This output is changed into direct current in the main rectifier and is available for battery charging or generator excitation upon demand.

The output of the main transformer secondary windings varies with the position of the flux bridge and also in proportion to the amount of current flowing into the main transformer primary windings.

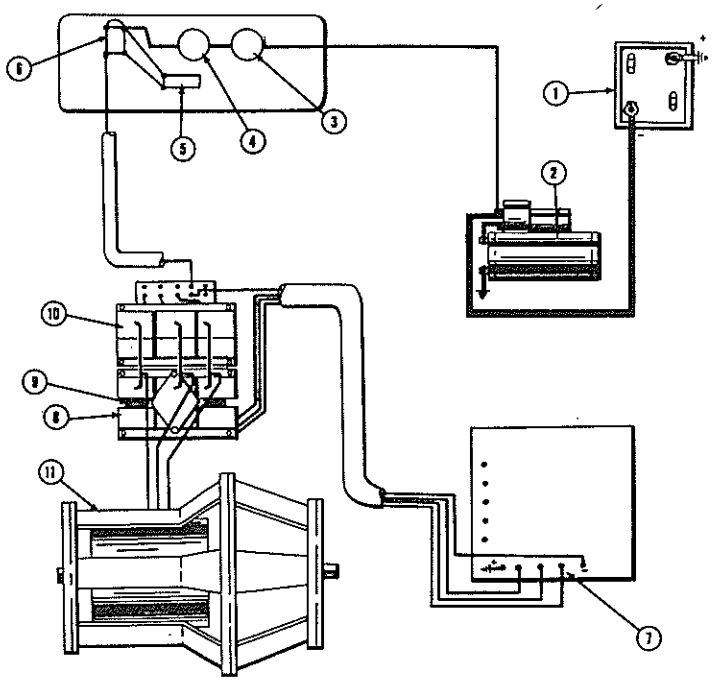


FIGURE L-3. BATTERY CHARGING CIRCUIT

1. Battery
2. Cranking Motor
3. Ammeter
4. Key Switch
5. Capacitor
6. D.C. Main Switch
7. Main Rectifier
8. Main Transformer
9. Flux Bridge
10. Constant Voltage Transformer
11. A.C. Generator

Booster Circuit

The purpose of the booster circuit is to provide a means of maintaining the generator output when a load is placed on the electrical system.

When the main switch between one of the motors and the generator is closed, current flows from the generator to the motor through the primary windings of the constant voltage transformer.

If the load on the motor increases or if additional motors are operated, the current flow from the generator through the heavy primary windings of the constant voltage transformer increases to handle the additional load.

The output of the secondary windings of the constant voltage transformer is proportional to the amount of current flowing through the primary windings. When current flows through the primary windings, induced current at a reduced voltage flows from the secondary windings and from there to the booster rectifier.

Here the alternating current is converted into direct current and fed into the excitation circuit being supplied by the main transformer (see Battery Charging Circuit), increasing the generator output to take care of the increased load without a drop in terminal voltage at the generator output terminals.

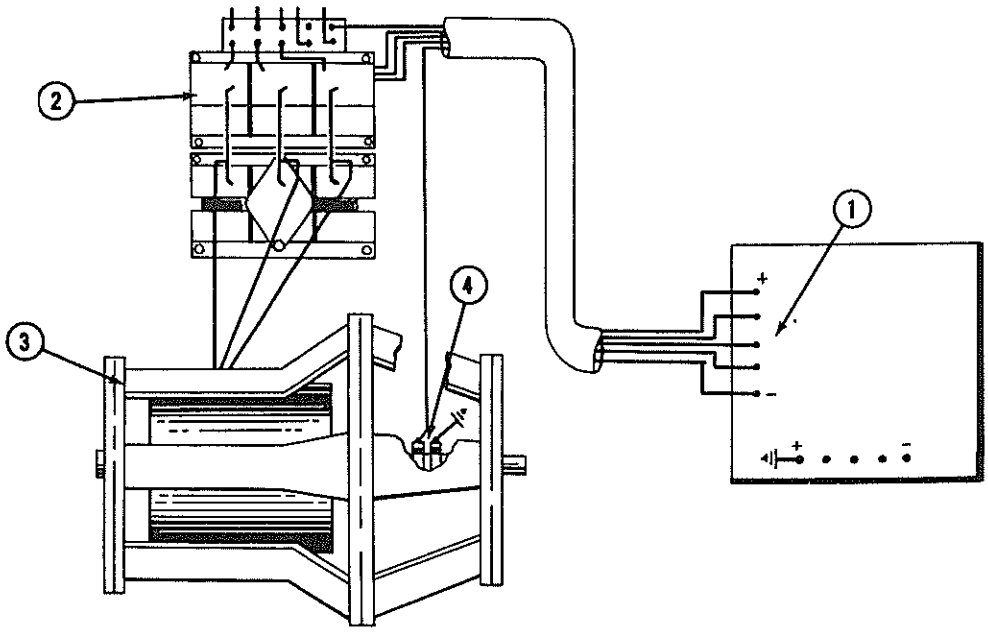


FIGURE L-4. BOOSTER CIRCUIT

1. Booster Rectifier
2. Constant Voltage Transformer
3. A.C. Generator
4. Slip Rings

Control Circuit

The control circuit provides current necessary to operate the main switches in the 3 phase power circuit.

The control circuit for each motor includes the control switch on the instrument panel, main switch coils, heat control switch, and limit switch (if used).

When the control switch on the instrument panel is closed, current from one phase of the three phase system flows from the constant voltage transformer through the switch. From the control switch the current flows through the main holding coil, through the limit switches and heat control switch back to one of the remaining two phases (activating the switch). As the main switch is activated three phase current flows to the motor and brake causing the motor to operate (see Three Phase Power Circuit).

When the component operated by the motor has reached its safe limit of travel the limit switch opens the control circuit, the main switch opens, stopping the flow of current to the motor, and the motor stops. The motor can be reversed until the limit of travel has been reached in the opposite direction.

If the temperature of the motor at any time exceeds safe operating limits, the heat control switch automatically opens the control circuit to the motor. This is true of all motors except the steering motor. On the steering motor the heat switch is connected with a warning light on the instrument panel. This light remains on at all times unless the temperature of the steering motor exceeds the safe operating range, opening the circuit and causing the light to go off.

When the motor has cooled to safe operating temperatures the switch closes the circuit and the motor will operate.

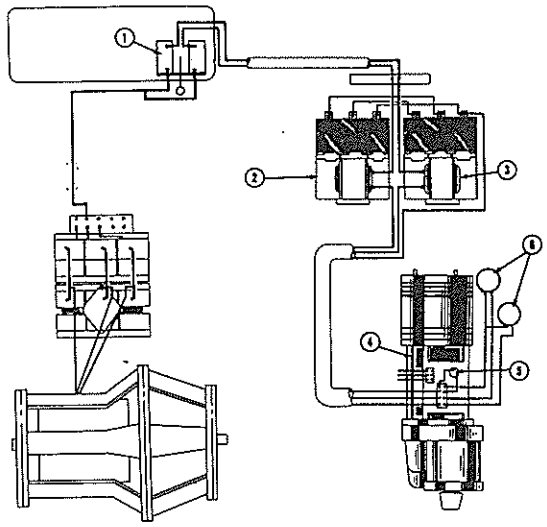


FIGURE L-5. CONTROL CIRCUIT

1. Control Switch
2. Main Switches
3. Holding Coil
4. A.C. Motor
5. Heat Switch
6. Limit Switches

A.C. Generator

The A.C. generator operates on the principle of a coil cutting magnetic lines of force causing a current to flow in the coil windings. The coil in this case is stationary (stator), while the magnetic field (rotor) rotates.

The generator is mounted in line with and driven by the engine. This unit is designed and constructed to produce current without the fluctuation and power loss of the ordinary generator, and to handle the loads required by the various operations peculiar to the equipment.

The generator is a three-phase, 8 pole, 300 volt, 120 cycle, rotating field type, rated on the basis of rotor speed of 1800 RPM.

The three major assemblies that make up the A.C. generator are:

1. Stator — the outside or stationary member which bolts to the engine flywheel housing at the front and to the end bell and torque converter housing at the rear.

2. Rotor — the rotating member which is attached to the engine flywheel by a drive disc and to the secondary flywheel by a splined hub.

3. Brush Holder — two aluminum brush holders which hold the segments of the generator brushes. Each holder is composed of two half rings, held together by capscrews.

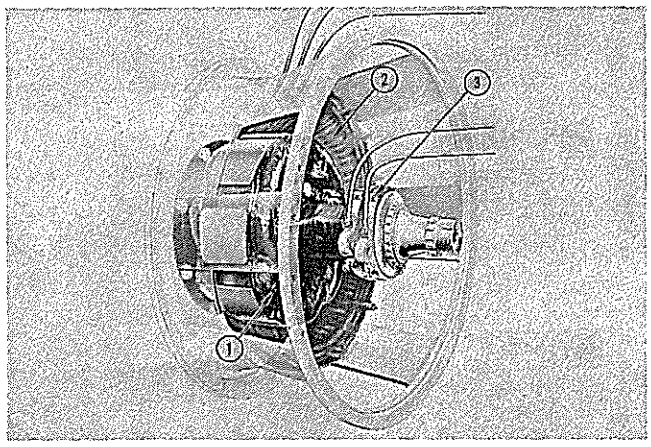


FIGURE L-6. A.C. GENERATOR

1. Rotor
2. Stator
3. Brushes

The exciting current flows through the generator field wire to the inside slip ring, through the rotor windings and out the rear slip ring to the ground. With the rotor energized and rotated by the engine, the lines of force set up by the magnetic field in the rotor are cut by the stator windings, thereby generating alternating current. The current leaves the stator by the 3 A.C. leads from the generator to the constant voltage transformer.

Transformers

A transformer is basically a device for receiving electric current at one voltage and sending it out at a different voltage. The output voltage may either go higher or lower than the input, depending upon the windings. The input coil is connected directly to the main line and is called the primary coil. The output coil is connected to the secondary line and is called the secondary coil.

The two unit transformer group provides excitation current for the A.C. generator field, current for charging the batteries, and a voltage boost for the excitation circuit. Rectifiers convert the alternating current from the transformers secondary windings into the direct current required for generator excitation and battery charging.

The Constant Voltage Transformer is connected

in the excitation circuit to help maintain constant voltage at the generator output terminals regardless of the varying loads experienced during the operating cycle.

The Main Transformer provides current necessary for no load excitation of the generator, and keeps the batteries charged. The flux bridge is used as a means of controlling the output of the main transformer. The flux bridge is nothing more than an obstruction to allow only a specified amount of current to reach the secondary windings. By moving the flux bridge in or out, with shims, the output of the transformer secondary windings can be controlled.

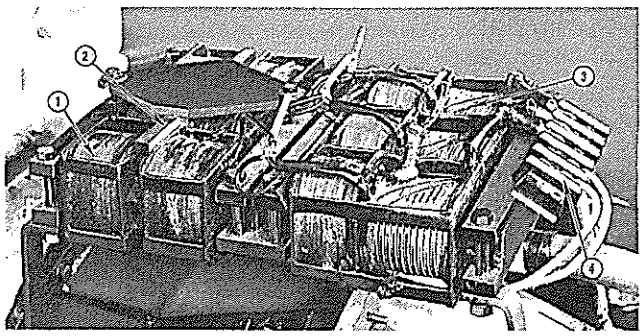


FIGURE L-7. TRANSFORMERS

1. Main Transformer
2. Flux Bridge
3. Constant Voltage Transformer
4. Terminal Strip

Rectifiers

Selenium coated plate type rectifiers, mounted in the oil cooled rectifier tank, receive alternating current from the transformers' secondary windings and deliver direct current to the generator field, battery charging system, and for the operation of lights and accessories.

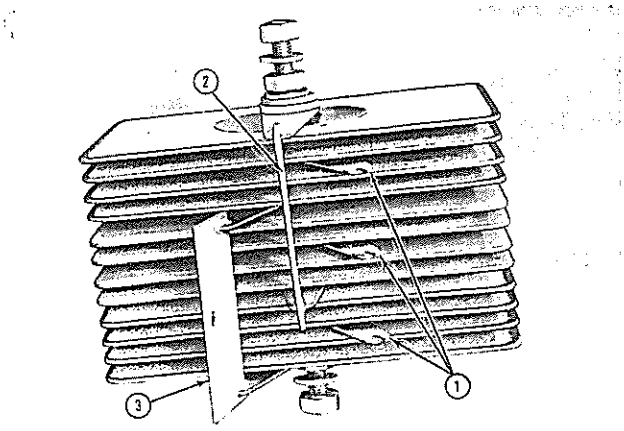


FIGURE L-8. RECTIFIER

1. A.C. Terminals
2. D.C. Positive
3. D.C. Negative

The rectifiers consist of full wave selenium coated aluminum plates, with suitable connectors and insulators.

Selenium will allow current flow in one direction only when it is plated on aluminum. This flow is always from the selenium side to the aluminum side of a plate. If a single phase is connected to the selenium side of one plate and the aluminum side of another, connecting the aluminum side of the first plate to the selenium side of the second will produce a pulsating direct current in an exterior circuit when the phase itself is alternating. For a three phase system (as used in LeTourneau-Westinghouse equipment), the minimum number of plates would be 6 or multiples of this, dependent upon the use to which the rectifier is subjected.

The direct current from the battery charging rectifier must flow through the batteries, out the battery ground to grounded terminal of the rectifier to complete battery charging circuit. Therefore, the battery charging rectifier is the only one that is grounded.

TESTING

Test Meter

This test meter has been designed specifically for LeTourneau-Westinghouse electrical equipment testing. Encased in a steel box with a leather carrying handle, it is small enough to be carried from job to job.

Although the test meter is a very accurate instrument, it is not a delicate piece of laboratory equipment. However, the user of this meter should exercise reasonable caution in its use. It should not be dropped or roughly handled.

The meter may be used for both Alternating Current (A.C.), and Direct Current (D.C.) volts, also for D.C. Amperes. The following scales are available on the meter and are sufficient to cover all tests on LeTourneau-Westinghouse equipment.

0 to 500 Volts A.C.	0 to 100 Volts D.C.
0 to 100 Volts A.C.	0 to 100 Amps D.C.
0 to 200 Volts D.C.	

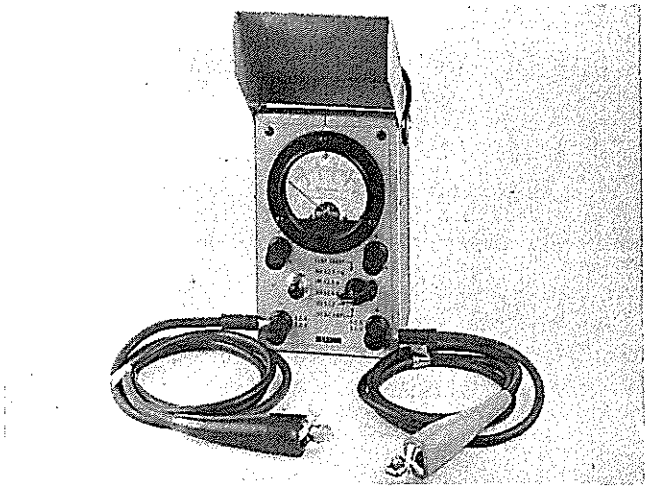


FIGURE L-9. TEST METER

In addition to the above the meter includes built in batteries and a test lamp. This test lamp is used for ground tests and for checking continuity of wires.

Directly below the meter are two binding posts labeled (+) and (−). These binding posts are to be used only for D.C. amperage tests. Use the test leads supplied with the meter.

The binding posts at the bottom of the meter, also marked (+) and (−), are used for all voltage tests and for ground and continuity tests with the test lamp. Use the test leads supplied with the meter.

The selector switch is a six position switch and can be set to the scale desired. Positions are marked clearly and identified.

The meter should be checked for accuracy 2 or 3 times each year. This accuracy test can be a comparative test using another new test meter or the meters in any good electric shop as standard.

Should the meter require repair send it to the factory from which it was purchased. Flashlight batteries for the test lamps are standard #1 batteries and can be purchased from most retail stores. The test lamp itself is a 2 volt pintle type lamp, No. GE 49, which can be purchased in any radio shop or electrical supply house.

Batteries can be replaced by removing the four screws securing the meter panel to the case.

CAUTION: Never place the test leads across a live circuit with the selector switch set in the test lamp position. The current in the live circuit will probably be more than the lamp capacity, causing it to burn out.

Keep meter face and case free from grease and dirt. Do not drop or abuse meter. With good care it should give long and satisfactory service.

D.C. Amperage Tests

For direct current amperage tests it is necessary to disconnect the wire under test and connect the test meter in series with this wire since amperage tests are series or "in-the-line" tests.

Attach the two test leads to the top pair of binding posts marked D.C. Amps. Turn the selector switch to the position marked 100 Amps D.C.

Disconnect the wire under test and fasten this wire to one of the leads on the test meter.

Touch the second meter lead to the connector and remove it with rapid motion. Watch the needle carefully. Make certain that the needle is not swinging off the scale to the right. Under this condition a short circuit is indicated and if the meter is left in the circuit for any appreciable length of time, it will sustain damage resulting from the heavy current flow.

After checking for short circuits, as described above, fasten the meter lead to the connector.

While making direct current checks, should the meter swing to the left rather than the right, polarity of the meter is reversed and the test leads must be reversed. The left swing is then changed to right.

After the meter has been connected, testing is a matter of comparing the reading on the correct printed scale on the meter with the known value obtained under normal operation.

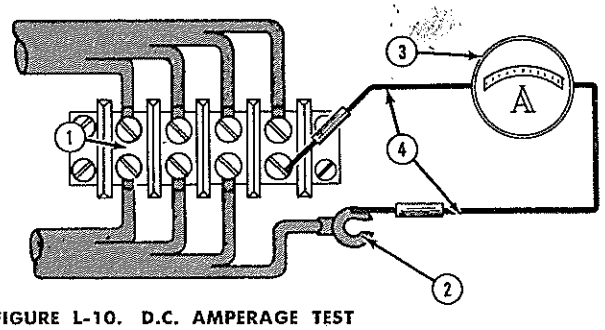


FIGURE L-10. D.C. AMPERAGE TEST

1. Terminal Strip
2. Wire
3. Ammeter
4. Test Leads

Voltage Tests

Before making any voltage test determine if the test is going to be in alternating or direct current voltages. Select the meter scale to be used accordingly. If this precaution is not taken, the meter may be seriously damaged.

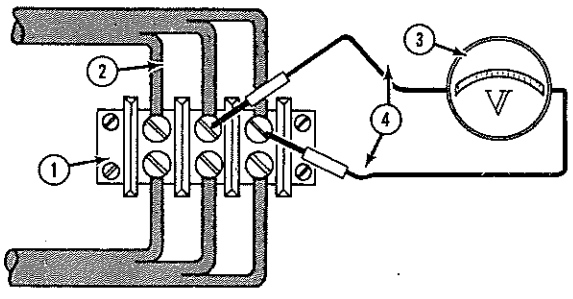


FIGURE L-11. A.C. VOLTAGE TEST

1. Terminal Strip
2. Wire
3. Voltmeter
4. Test Leads

Proceed with the test, reading the scale calibration corresponding to the test being taken.

A voltage test, whether it be alternating or direct current, is always an "across-the-line" test and no wires need be disconnected.

Attach the two test leads to the two bottom binding posts on the test meter. Turn the selector switch to the position on the scale desired.

Using the clip ends of the test leads, connect the meter across (in parallel with) the circuit or equipment under test.

After the meter has been connected as described above, testing again is a matter of comparing the reading on the correct printed scale on the meter with the known value obtained under normal operation.

In testing D.C. volts it may be necessary to reverse the clip positions to obtain the correct direction of swing of the meter needle. This condition will not arise during A.C. voltage tests.

A variation in the voltage readings between phases of the motor being tested indicates an open circuit either in the motor or in the conductor cable between the motor and the main switch.

Figure L-12 gives readings on the A.C. voltmeter taken with the point of the test between the generator and the open in the circuit. Tests are made

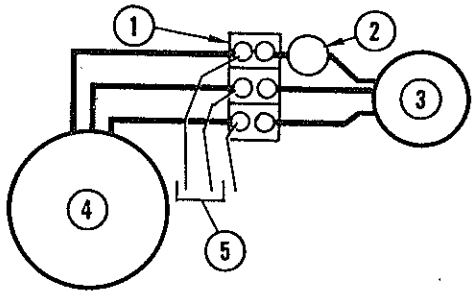


FIGURE L-12. HIGH VOLTAGE READING

1. Terminal Strip
2. Open
3. Motor
4. Generator
5. High Reading

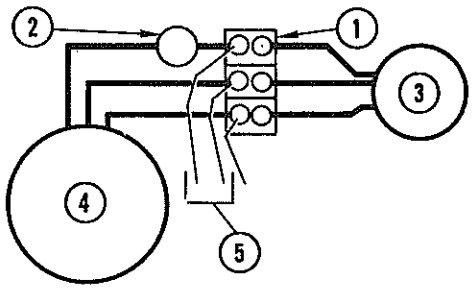


FIGURE L-13. LOW VOLTAGE READING

1. Terminal Strip
2. Open
3. Motor
4. Generator
5. Low Reading

in two of the three leads at one time. One lead will be present in two of the three tests which will have high voltage readings, and the open can be isolated in this lead. (Main switch must be closed.)

Figure L-13 gives readings on the A.C. voltmeter when the open in the circuit is between the point of test and the generator. Note also that the same lead is present in both low readings. The open can be isolated in this lead.

Continuity Test

An open or ground in the stator can be located by a continuity test after the leads to the brake coils have been disconnected.

An open in the leads to the motor can be located by a continuity test.

A continuity test is a test to determine whether or not an individual wire has a break which will prevent it from conducting current, and to localize the break.

Attach the two test leads to the two bottom binding posts on the test meter. Position the selector switch in the lamp short position.

If the lead from the test lamp will not reach from one end of the wire to be tested to the other, it is only necessary to disconnect one end of the wire under test, apply one test lead to each end of the wire. If the lamp glows, the wire is not broken. If the lamp fails to glow, the wire has a break somewhere along its length causing an open circuit. Either locate the break and repair it or replace the wire.

If the test leads will not reach from one end of the wire to the other, one of the two following methods can be used:

1. Add extensions to the leads of the test meter, or;

2. Disconnect the wire to be tested from each piece of electrical equipment at the opposite ends. Ground one end of this wire to a good ground and then touch other end with one of the test leads. Hold the outer test lead to a good ground. The test lamp will glow if the wire in question is in good condition. Should the test lamp fail to glow, there is a break in the wire.

Often the break can be localized as the test meter is applied to the wire in question, the wire is flexed at points which are apt to be flexed during the operation of the machine. Should the light glow as the wire is flexed a break at the point of flex is indicated. Although in some cases breaks in the multi-wire conductors can be repaired, it is advisable, whenever possible, to replace the entire cable with a new unit.

Ground Test

The LeTourneau-Westinghouse 3 phase electrical system is an ungrounded system. Therefore whenever occasion arises for testing the system always make a ground test in conjunction with any test. A ground test should be made as a preventive maintenance measure at least three times a year.

Place one lead of the test light on a connector in the circuit to be tested and place the other lead on a good ground on the frame of the machine. A lighted lamp during the test indicates a ground. When testing generator, motor or transformer for ground, all wires must be disconnected from the terminal strips of the unit being tested, completely isolating the unit. Place one test lead on an A.C. terminal and the other lead on a good ground. Repeat the test for each of the A.C. terminals.

REMEMBER, the system, since it is an ungrounded system, must have two grounds to completely ground and short a circuit. An indication or arcing and burning at one point due to ground can mean

that the circuit is grounded at one other point also. Locate and correct this before operating the machine.

If the second ground is not located, failure may result at this point during future operations.

Test Procedures

Before making any test read the instructions carefully on making amperage and voltage tests. Select the proper scale on the test meter for the test, being sure that the scale selected is sufficient to accommodate the highest reading to be encountered. Make certain any leads removed to make a test are reconnected before proceeding to the next test.

When making ground tests, the unit being tested must be completely isolated. Disconnect all leads from the terminal strips. Make the required tests and replace the leads.

The readings given are achieved with batteries and component parts of the electrical system in good operating condition. The engine is running at high idle (approximately 1800 RPM).

Voltage readings taken may vary slightly due to the temperature at which the generator is operating. A higher temperature will result in a lower voltage reading. However, the temperature will not cause a variation between any two phases during the same test.

When making a test with the test lamp, touch the ends of the two test leads together to make certain the batteries and the lamp are in good condition. Lamp should glow.

The tests following were made under normal no load conditions. The readings are approximate, definite readings cannot be given because of the difference in normal operating characteristics of each machine.

Batteries

The batteries must be operated at or near full charge and keep the electrolyte at the proper level. A battery half-charged or less cannot be depended upon for starting and wears out rapidly. A low battery indicates that the charging system is out of adjustment or very often an old or defective battery.

The following is a chart indicating charge at different specific gravity readings:

CHARGE	SPECIFIC GRAVITY
Full	1.280
Half	1.225
Discharge	1.150

In tropical climates, full charge should read between 1.200 and 1.215. The battery charging circuit should maintain the battery above 1.155.

The specific gravity of the electrolyte varies with the temperature. As the temperature increases, the electrolyte expands or becomes thinner so that the specific gravity is reduced. As temperature drops the electrolyte contracts or becomes thicker so that the specific gravity increases. Unless these variations in specific gravity which are produced by temperature are taken into account, the readings may not give a true indication of the state of charge of the battery.

Correction can be made for temperature by adding four gravity points to the reading for every 10 degrees that the electrolyte is above 80° F. For every 10 degrees that the electrolyte is below 80° F., four gravity points must be subtracted from the gravity reading.

The voltage reading across each cell of the fully charged battery should be two volts.

Refer to Batteries in Section "K" of this manual for proper electrolyte level and maintenance of batteries.

A.C. Generator

(AMPERAGE TO THE GENERATOR FIELD)

Attach the two test meter leads to the top binding posts. Set the selector switch to the 100 D.C. Amp scale. Read the bottom scale on the meter.

Remove the negative (field lead) from the booster rectifier terminal strip on the rectifier tank lid. Connect the test meter leads in series with the field lead and the terminal from which the lead was removed.

Turn on the key switch and the D.C. main switch. Start the engine and after warm up operate at high idle. The meter should read approximately 10 Amps D.C.

Do not operate any electric motors during this test.

(VOLTAGE TO THE GENERATOR FIELD)

Attach the two test meter leads to the bottom binding posts. Set the selector switch to the D.C. Volt scale. Read the second scale from the bottom on the meter.

Attach one of the test meter leads to the negative terminal of the booster rectifier terminal strip on the rectifier tank lid. Fasten the other test lead to a good ground. No wires are to be disconnected during this test.

Turn on the key switch and the D.C. main switch. Start the engine and after warm up operate at high idle. The meter should read approximately 30 Volts D.C.

Do not operate any electric motors during this test.

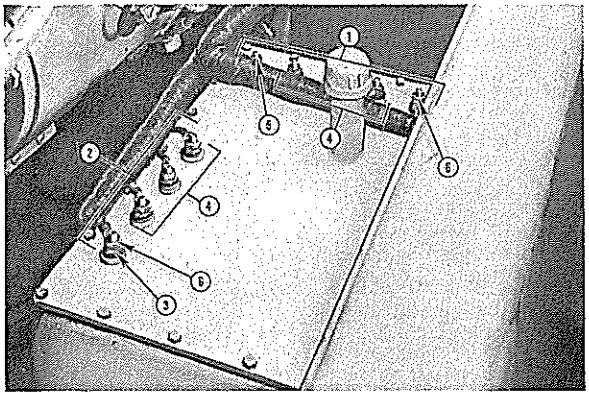


FIGURE L-14. RECTIFIER TANK LID

1. Constant Voltage Rectifier Terminals
2. Main Rectifier Terminals
3. D.C. Negative
4. A.C. Terminals
5. From Generator Field
6. To Main Switch

(OUTPUT VOLTAGE — NO LOAD)

Attach the two test leads to the bottom binding posts. Set the selector switch to the 500 A.C. Volt scale. Read the top scale on the meter.

Turn on the key switch and the D.C. main switch. Start the engine and after warm up operate at high idle.

Make a voltage test across the three A.C. terminals on the constant voltage transformer input terminal strip, (three tests, A to B, A to C, and B to C). Meter should read approximately 300 Volts A.C. No wires are to be disconnected during this test. Readings should not vary over 5% between any two tests.

Do not operate any electric motor during this test.

(VOLTAGE BOOST TO THE GENERATOR FIELD)

Attach the two test meter leads to the bottom binding posts. Set the selector switch to the 100 D.C. volt scale. Read the second scale from the bottom on the meter.

Attach one of the test leads to the negative terminal of the booster rectifier terminal strip on the rectifier tank lid. Fasten the other lead to a good ground.

Remove the leads to an electric motor brake at the motor terminal strip.

Turn on the key switch and the D.C. main switch. Start the engine and after warm up operate at high idle.

Operate the finger-tip switch on the instrument panel controlling the motor with the brake leads removed.

Meter should read approximately 45 to 60 Volts D.C. Since this test is made with a locked motor rotor, make tests as rapidly as possible to keep motor from overheating.

Transformers

(CONSTANT VOLTAGE)

Attach the two test meter leads to the bottom binding posts. Set the selector switch to the 100 A.C. Volt scale. Read the second scale from the bottom on the meter.

Connect the test leads to two of the three A.C. terminals of the booster rectifier terminal strip on the rectifier tank lid.

Turn on the key switch and the D.C. main switch. Start engine and after warm up operate at high idle.

Read the "no load" output of the transformer secondary directly from the test meter. The meter should read approximately 5 to 7 Volts A.C.

Remove leads to an electric motor brake at the motor terminal strip. Operate the finger-tip switch on the instrument panel controlling the motor with the brake leads removed.

Read the "load" output of the transformer secondary directly from the test meter. Meter should read approximately 60 Volts A.C.

Repeat the above test for each of the combinations of A.C. terminals on the booster rectifier terminals, (A to B, A to C, and B to C). Voltage readings should not vary more than 5% between any two tests.

(MAIN TRANSFORMER)

Attach the test meter leads to the bottom binding posts. Set the selector switch to the 100 A.C. Volt scale. Read the second scale from the bottom of the meter.

Turn on the key switch and the D. C. main switch. Do not start engine.

Make a test from the negative terminal of the main rectifier to a good ground. Meter should read approximately 24 Volts D.C. If no voltage is indicated on the meter, make a continuity check on the

leads to the battery and check condition of the batteries.

To test the main transformer secondary output operate the engine at high idle and make a three phase voltage test at the three A.C. terminals of the main rectifier on the rectifier tank.

Set the selector switch at the 100 Volt A.C. scale. Read the second scale from the top. Meter should read approximately 26 to 30 Volts A.C.

Rectifiers

It must be assumed that the transformer output will be the same as the corresponding input at the rectifier. However, due to possible aging of the rectifier or other defects, this does not insure that the rectifier is functioning properly.

(MAIN RECTIFIER OUTPUT)

Attach the two test meter leads to the bottom binding posts. Set the selector switch to the 100 D.C. Volt position. Read the second scale from the bottom of the meter.

Attach one test lead to the positive terminal of the main rectifier terminals on the rectifier tank lid. Fasten the other lead to a good ground. Do not disconnect any wires during this test.

Turn on the key switch and the D.C. main switch. Do not start engine.

The test meter should read approximately 24 Volts D.C. This is the battery voltage.

Start the engine and after warm up operate at high idle.

Ammeter on instrument panel should show normal charge rate. Voltage reading on test meter should be approximately 25 to 28 Volts D.C.

A defective rectifier will not show a charge rate on ammeter or any voltage increase. However, a rectifier may not show a charge rate because of age or a loose A.C. connection. These conditions must be taken into consideration.

(BOOSTER RECTIFIER OUTPUT)

Attach the two test meter leads to the bottom binding posts. Set the selector switch to the 100 D.C. Volt position. Read the second scale from the bottom of the meter.

Attach one test lead to the negative terminal of the booster rectifier terminal on the rectifier tank lid. Fasten the other test lead to a good ground. No wires are to be disconnected during this test.

Turn on the key switch and the D.C. main switch. Do not start engine.

Meter should read approximately 19 to 20 Volts D.C. This is the battery voltage less the voltage drop of the booster rectifier.

Start engine and after warm up operate at high idle. Meter should read approximately 30 Volts D.C. This reading is the generator field voltage.

Subtract the main rectifier output voltage from the field voltage. The difference is the no load output of the booster rectifier.

(CONTINUITY)

If it is suspected that there is a defective rectifier, remove it from the rectifier tank and proceed as follows:

Attach the two test meter leads to the bottom binding posts. Set the selector switch to the lamp short position.

Attach one test lead to the mounting bolt of the rectifier under test.

With the other lead, touch all other portions of the rectifier at random. A light during this test will indicate that a plate or plates are shorted out to the mounting bolt, and that the rectifier is defective.

Reverse the test leads and repeat the above test. This must be done, since occasionally the plates will short out in one direction only.

Attach either of the test lamp leads to any one of the A.C. terminals. Touch the other lead alternately to the D.C. positive terminal and the D.C. negative terminal.

The test lamp should glow only when touching either the D.C. positive or the D.C. negative terminal. If the light glows when D.C. terminals are touched, the rectifier is defective since the current is free to flow in both directions through the plates. If the light does not glow at all during this test, this also indicates a defective rectifier since it must pass current in one direction only to perform its function in the circuit.

Repeat the test for the remaining A.C. terminals.

Reverse the test leads and repeat the above test. This is necessary because it is not possible to determine in advance in which direction the rectifier plates may be defective.

The brilliancy of the test meter lamp will vary with the number of plates in the rectifier being checked. Caution should be exercised when checking that the glowing lamp does not go undetected, especially when making tests in brightly lighted areas.

(VOLTAGE DROP)

Attach test meter leads to bottom binding posts. Set the selector switch to the 100 D.C. Volt position. Read the second scale from the bottom of the meter.

Attach one test meter lead to the positive terminal of the booster rectifier and the other to a good ground. No wires are to be disconnected during this test.

Turn on the key switch and the D.C. main switch. Do not start engine. Record the voltage reading.

Attach one test meter lead to the negative terminal of the booster rectifier, and the other to a good ground. No wires are to be disconnected.

Turn on the key switch and the A.C. main switch. Do not start engine. Make a voltage reading. Subtract the 2nd reading from the first reading, the remainder is the voltage drop across the booster rectifier.

Average voltage drop across the booster rectifier is 3 to 4 Volts D.C.

Repeat the above procedure for the main rectifier. Average voltage drop across the main rectifier is 2 to 3 Volts D.C.

Control Circuit

(A.C. INPUT VOLTAGE TO SWITCH PANEL)

Attach the two test meter leads to the bottom binding posts. Set the selector switch to the 500 A.C. Volts scale. Read the top scale on the meter.

Turn on the key switch and the D.C. main switch. Start the engine and after warm up operate at high idle.

Test the A.C. voltage across the three A.C. input leads at the point of connection with the first main switch on the switch panel. The A.C. input leads are part of the multiple wire conductor which connects the instrument panel, generator and main switch panel. Make three tests (A to C, B to C, and A to B). No wires are to be disconnected for this test.

Meter should read approximately 300 Volts A.C. There should be no more than 5% variation between any two of the phases tested.

(MAIN SWITCH)

If motor does not operate when the main switch is engaged, make the following tests:

Make a voltage test from input to output side of main switch as the finger-tip control switch on the instrument panel is engaged and disengaged rapidly. Make three tests, one for each of the three leads. This test is made to determine whether or not the contactor switches are functioning. A voltage reading on all or any of the tests when the finger-tip switch is closed indicates that the contactor points are not operating properly if the motor does not run.

(OPEN HOLDING COIL)

If the main switch does not pull in when the finger-tip switch on the instrument panel is engaged there may be two sources of trouble, either an open holding coil or an open control circuit.

First make a voltage test, with the selector switch at the 500 A.C. Volt scale, across the two leads of the main switch holding coil as the finger-tip switch is engaged. A voltage reading on this test indicates an open holding coil. Replace the coil. If, however, no voltage is recorded, proceed to the test for an open control circuit.

(ISOLATING OPENS IN CONTROL CIRCUIT)

Since each circuit has its own "C" phase return, but all are energized by the same phase (A or B) the following assumptions may be made:

Should no control circuit work but normal voltage exsists at the main switches, the open exists between the transformer and the control switches. If one control circuit does not function then the open exists in that circuit only.

The phase which has been used to energize the control circuits may be determined in this manner; set the test meter selector switch to the 500 A.C. Volts scale. Remove the "C" phase return lead from a switch that functions. Attach one test meter lead to this return line. Touch the other tester lead to one of the remaining two phases as the control switch for that unit is operated. If meter registers a voltage reading, touch the other phase. The meter will register no reading when the input phase to control circuits has been located.

Set the test meter selector switch to the Lamp Short position. After the input phase has been determined, disconnect the leads at the holding coils that come from the instrument panel in the defective circuit. Attach one lamp lead to the energized phase, connect the other lead to the wire disconnected from the holding coil. Operate the finger-tip control switch. A light indicates that this circuit is complete through the control switch to the holding coil.

Attach one test lead to the coil terminal from which the lead has been removed. Attach the other to the return phase. A light indicates that the control circuit is complete from the holding coil, through the limit switches, if used, through the heat switch and back to the return phase. No light indicates an open in that part of the control circuit from the holding coil, through the heat switch, limit switch, to the return phase.

(OPEN HOLDING COIL TEST)

Place test lamp leads across holding coil terminal after disconnecting one of the leads to the holding coil.

If the coil is in good condition the test lamp will glow. A faulty coil will give no glow. Replace coil if defective.

(LIMIT SWITCH)

Check the limit switch for mechanical operation. If the limit switch is not defective, mechanically, proceed with the following:

Use the test meter in the Lamp Short position. Do not operate the engine during this test. Keep the key switch and the D.C. main switch in the off position.

Make a test directly across the two connections of the limit switch controlling the movement which is not operating. For example: If the hoist motor on the bowl will go down but not up, make a test across the limit switch. If the light does not glow the limit switch is faulty and should be replaced.

NOTE: Actuating arm should touch the switch button until moving part has reached its limit of travel. Travel.

(HEAT CONTROL SWITCH)

The following test is made to determine the condition of the heat control switch.

Before making this test make certain that the heat switch is not open due to an overheated motor. If the switch is not too hot to touch for one second with a finger, the heat control switch should be closed.

Put the two test lamp leads directly across the two terminals of the heat switch. If the test lamp glows the heat control switch is operating properly. If the lamp does not glow, the heat switch has failed and should be replaced.

(CONDUCTOR CABLES)

Make a visual inspection of all connections at both the main switch panel and the motor terminal strip.

If they are in good order, look for a pinched cable or a spot where the cable might be flexing. If a break is found, it can be repaired in some cases, however, it is advisable to replace the entire cable. See "Continuity Testing" for the correct procedure when a break is suspected in a conductor.

(INSTRUMENT PANEL)

Remove the machine screws securing the instrument panel to the cockpit and pull the panel down, exposing the rear of the panel. It is advisable to disconnect battery ground before removing panel.

If the open circuit has been isolated (by the preceding tests) forward of the main switch the first thing to establish is whether or not the finger-tip control switch is functioning properly, as this is the most likely point of trouble.

Disconnect the top holding coil lead at the main switch that is controlled by the inoperative switch. Make certain that this lead does not touch any other leads or terminals in the main switch panel.

Test across the terminals of the finger-tip switch controlling the movement that is inoperative.

Make tests on switches across terminals to which leads are connected. If the test lamp glows when switch is depressed, the switch is operating properly. If the lamp does not glow the switch is defective and should be replaced.

(CONTINUITY OF COCKPIT CONTROL CIRCUIT)

Make a continuity test on the conductor between the finger-tip control switch and the top of the holding coil.

Make a continuity test on the conductor between the common lead terminal for the finger-tip switches and the center A.C. lead on the constant voltage transformer output terminal strip.

A.C. Electric Motor

(MOTOR)

Attach the two test meter leads to the bottom binding posts. Set the selector switch to the 500 A.C. Volt position. Read the top scale on the meter.

Check the motor brake for proper clearance, binding, warping, and other mechanical troubles and make certain that there are no loose wires or visible defects.

Turn on key switch and the D.C. main switch. Start engine and after warm up operate at high idle.

Disconnect the three A.C. input leads from the motor terminal strip. Attach one test meter lead to one of the A.C. leads, and the other lead to another A.C. lead. Close the finger-tip control switch controlling the motor under test. Make three tests (A to C, A to B, and B to C).

Meter should read approximately 300 Volts A.C. Readings should vary no more than 5% between any two tests.

Reconnect the A.C. leads to the motor terminal strip. Repeat the above test with the leads connected.

Readings should be the same as above. If normal reading is not obtained, disconnect brake leads. Make voltage readings (as above). If uneven readings persist, trouble is in the stator. If readings are even, trouble is in the brake coils or wires.

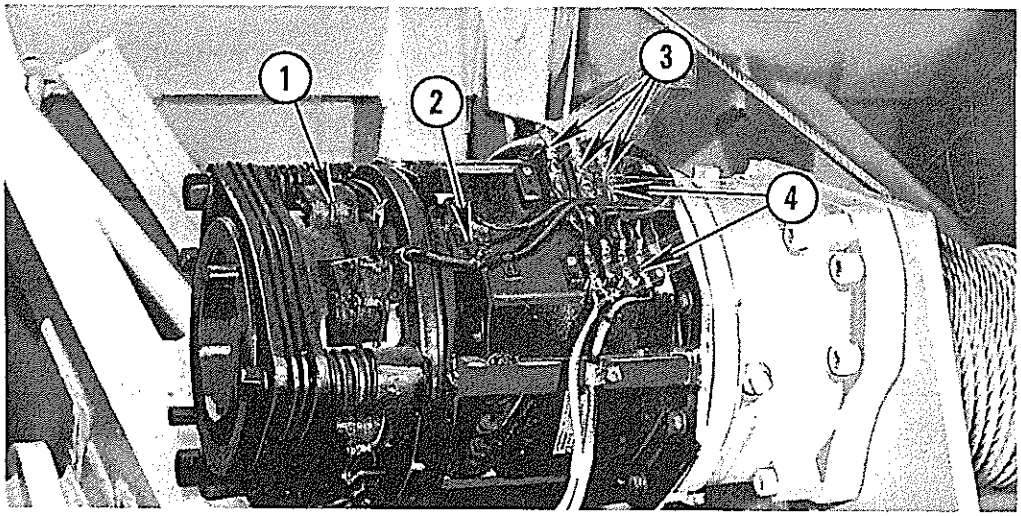


FIGURE L-15. MOTOR TERMINAL STRIPS

1. Brake Coils 2. Heat Switch 3. Main A.C. Leads 4. Terminal Strips

(GROUND TEST)

Turn the test meter selector switch to the Lamp Short position.

Disconnect the leads at the motor terminal strip (A.C. input, and the leads to the motor brake).

Attach one test lamp lead to an A.C. terminal, and touch the other lead to a good ground, the lamp should not glow. If the lamp does glow, it indicates a ground. Make three tests (A to ground, B to ground, and C to ground).

Repeat the above test for the motor brake by attaching one test lamp lead to a brake lead and the other to a good ground on the motor frame. Make three tests. If the test lamp glows, a ground is indicated. Proceed to the next test. If no ground is indicated proceed to "Open Brake Coil" test.

(BRAKE COIL)

Disconnect both leads to the brake coil under test.

NOTE: Because of the manner in which the coils are interconnected, it would be difficult to localize the trouble should these leads be left connected.

Use a test lamp. Touch one test lamp lead to a good ground and touch each of the terminals on the coil with the other lead. If the test lamp glows, a grounded brake coil is indicated. Replace the coil.

(OPEN BRAKE COIL)

Disconnect one lead to the coil under test. Use a test lamp.

Touch one coil terminal with a test lamp lead and the other coil terminal with the remaining test lead. If the coil is in good condition the test lamp will glow. If the lamp fails to glow the coil is open and should be replaced.

TROUBLE SHOOTING

All preceding tests have been made under normal no load conditions. The readings are approximate. Definite readings can not be given because of the difference in normal operating characteristics of each machine.

Since each electrical system will have its normal operating characteristics, the ammeter readings are listed as deviations from the observed normal range of the machine.

It must be assumed that the batteries have been checked and are in good condition.

I. The following circuits can be checked with the key switch and D.C. main switch off.
   - A. Head Lights
   - B. Rear Lights
   - C. Cockpit accessories (windshield wiper, heater, defroster, etc.)

II. Turn on the key switch and press the cranking motor switch. If the engine starts and runs properly, the following circuits have been checked.
   - A. Starting System
   - B. Batteries and excitation circuit to the jumpered side of the D.C. main switch.
   - C. Oil pressure switch
     1. If oil pressure switch does not close, the steering motor warning light will not operate.

III. Turn on the key switch and the D.C. main switch. DO NOT START ENGINE.
   - A. No movement of the ammeter needle indicates:
     1. Open in the excitation circuit between the D.C. main switch and the ground

at the generator. Friction between brush and slip ring may eventually wear away brush, increasing distance between brush rings, and reducing spring pressure against brushes. This condition may increase resistance in the excitation circuit reducing excitation current. If brush springs are exposed to high heat, springs loose their tension with the same result.

B. Less than normal discharge indicates:
   1. Worn brushes or weakened brush springs. See "1" above.
   2. Poor ground at the brushes or poor contact.
      If brush rings are kept from sliding freely on their studs or if studs become misaligned and brush rings bind, the resulting poor contact may reduce or cut off the excitation current completely. This condition may result in no A.C. voltage at all, or in A.C. voltage which rapidly varies from normal to zero reading depending upon whether or not the brush is making contact with the slip ring at the time that the reading is taken.
      (NOTE: This condition will be apparent only when engine is operating, since brushes will not wobble when the rotor is stationary.)
   3. Increased resistance in booster rectifier.
   4. Poor connections.

C. More than normal discharge indicates:
   1. Short in rotor (loss of one or more field poles). This may be confirmed by:
      a. Excite the rotor directly (excluding other portions of the excitation circuit), using 24 V.D.C. excitation current. Place a jumper wire directly from the batteries to the generator field. A current draw of more than approximately 20 amperes indicates a possible shorted rotor.
      b. Take three readings (phase to phase) of the no load, high idle output of the generator.
         (1) Low but even readings indicate a possible shorted rotor.
         (2) Uneven A.C. readings always indicate troubles in the A.C. system. Possibilities are:
            (a) Three phase wires
            (b) Generator stator
            (c) Transformer windings
            (d) Motor stator or brakes
            (e) Main switches

      c. To check pole windings on generator rotor, insert a long steel shim between generator rotor and stator (with excitation current flowing in the field windings—key switch and D.C. main switch on — but without engine operating). In a rotor in normal condition each rotor pole will exert a definite pull on the gauge. No pull above a pole indicates that no current is flowing in the windings of the pole under test and that there must be an open in the excitation circuit between the pole windings and the source of the excitation current.
      If only one of two poles fail to exert a pull there may be a combined open and ground in the rotor. If all the poles fail to exert a pull there may be an open in either the rotor or in the excitation circuit outside the rotor.
      NOTE: Rear generator bearing failure may cause brushes to skip (make and break contact with the slip rings) giving erratic A.C. voltage. Misalignment of generator rotor or stator may result in scrubbing between the two units and a reduction in A.C. voltage. This condition normally does not affect the readings on a rotor test unless rotor windings have been damaged and shorts or opens are evident. If the scrubbing is very severe the stator and/or rotor may become damaged. As a precautionary measure check the air gap with a feeler gauge all around the rotor to make certain there is clearance (0.020" to 0.040") between the rotor and stator. Usually if the stator is at fault, it will have smoked or burned out because of the high current involved. However, unbalanced readings may occur when part of the coils in one phase are shorted out in the stator windings, and this condition may or may not have a visible effect on the stator windings. With all other units in a normal condition, it can be assumed that the cause of a variation in voltage readings lies in the generator stator windings if the variation occurs in a "no load" test. Should one or more windings short out of the field circuit both excitation current and the A.C. output voltage will be effected. Amperage to field will increase, yet due to loss of field

windings, A.C. voltage will be reduced, (this can be applied to motor and transformer windings as well.)

D. Complete discharge indicates:
   1. A short in the excitation circuit between the D.C. main switch and the generator slip rings.

IV. Turn on key switch and D.C. main switch, operate engine at high idle.
   A. No charge rate indicates:
      1. No power to the primary coils of the constant voltage transformer.
         a. Check with test meter in input strips on transformer or;
         b. Check by running an electric motor.
      2. No input or output at secondary coils of constant voltage transformer or main transformer.
         a. Check with test meter at output strip on transformers.
      3. No output from the respective rectifiers (see rectifier tests).
   B. Less than normal charge rate indicates:
      1. Aging rectifiers
      2. Broken leads to rectifiers
      3. Flux bridge not shimmed out far enough.
   C. More than normal charge rate indicates:
      1. Flux bridge lost
      2. Flux bridge shimmed out too far.

V. Turn on key switch and the D.C. main switch, operate engine at high idle, depress fingertip control switch with motor or motors under load.
   A. Loss of power, improperly releasing the motor brakes, overheating indicates:
      1. Defective booster rectifier.
      2. Aging booster rectifier.
      3. Broken A.C. leads to booster rectifier.
      4. No output from the secondary coils of the constant voltage transformer. Even though the motor may operate under a low voltage condition, operating temperature will rise, in some cases high enough to cause the heat control switch to cut out the motor. If this occurs make a voltage check at the motor terminals while the motor is in operation.

         If power leads to brakes become broken or disconnected brakes may be only partially releasing, resulting in a drag on the motor. Burned out brake coils may have the same effect.

         Open coils in the stator are indicated by unequal voltage during A.C. voltage tests with the motor under load.

         The rotor may be dragging on the stator because of the following:
         a. Stator and end bell hold down bolts loose or tightened unevenly, boss filled with dirt, foreign material between the stator and rotor. The rotor may be filled with dirt causing improper ventilation between coils, improper ventilation in the rotor because of the openings in the rotor stack being plugged up. Overloading of the assembly operated, failure of the gear box, or binding assemblies may cause additional drag on the motor.

WIRING DIAGRAMS

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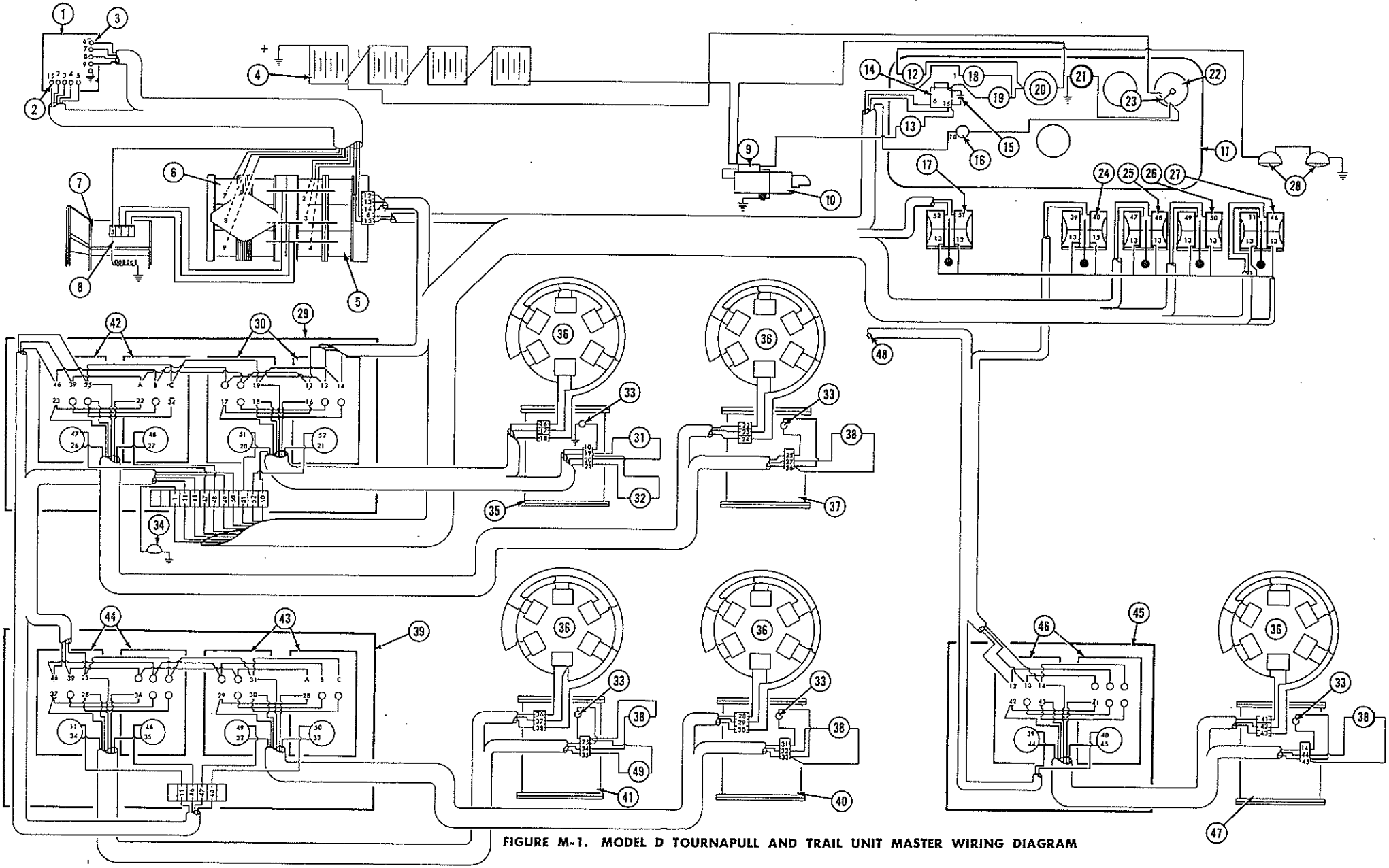

FIGURE M-1. MODEL D TOURNAPULL AND TRAIL UNIT MASTER WIRING DIAGRAM

1. Rectifier Tank Lid
2. Constant Voltage Rectifier Terminals
3. Main Rectifier Terminals
4. Batteries (24 V.D.C.)
5. Constant Voltage Transformer
6. Main Transformer
7. A.C. Generator
8. To A.C. Generator Field
9. Cranking Motor Solenoid
10. Cranking Motor
11. Instrument Panel
12. Head Light Switch
13. Cranking Motor Switch
14. D.C. Main Switch
15. Capacitor (50 mfd.)
16. Steering Motor Warning Light
17. Steering Switch
18. Rear Light Switch
19. Key Switch
20. Ammeter
21. Panel Light
22. Oil Pressure Gauge
23. Oil Pressure Switch
24. Dozer Control Switch
25. Hoist or Hook Control Switch
26. Apron or Boom Control Switch
27. Tailgate or Jib Control Switch
28. Head Lights
29. Right Switch Box
30. Steering Main Switches
31. Right Steering Limit Switch
32. Left Steering Limit Switch
33. Heat Control Switch
34. Rear Light
35. Steering Motor
36. Electric Motor Brake
37. Hoist or Hook Motor
38. Up Limit Switch
39. Left Limit Switch
40. Apron or Boom Motor
41. Tailgate or Jib Motor
42. Hoist or Hook Main Switches
43. Apron or Boom Main Switches
44. Tailgate or Jib Main Switches
45. Dozer Switch Box
46. Dozer Main Switches
47. Dozer Motor
48. To Transformer Terminal Strip
49. Down Limit Switch

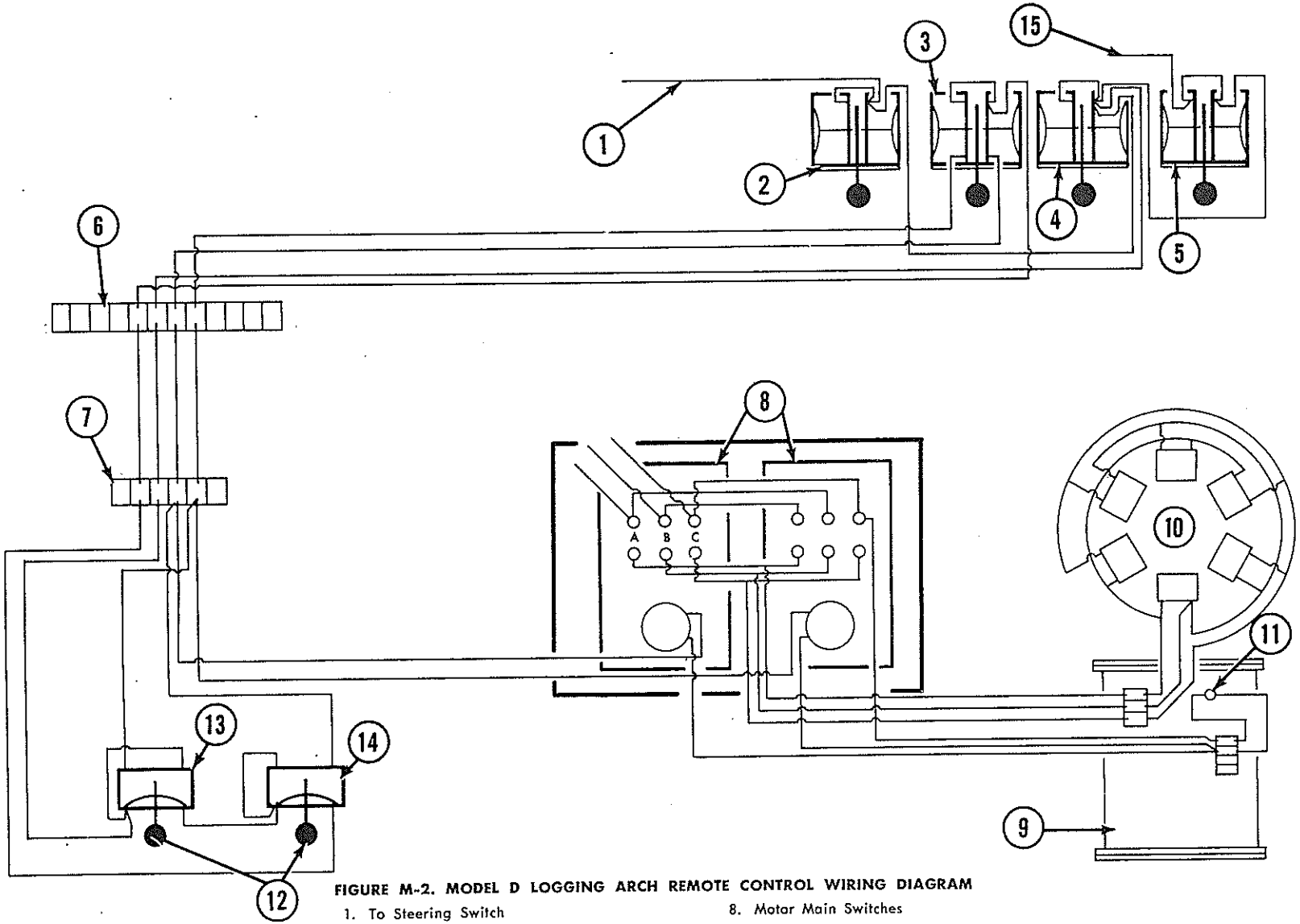

FIGURE M-2. MODEL D LOGGING ARCH REMOTE CONTROL WIRING DIAGRAM

1. To Steering Switch
2. Dozer Control Switch
3. Hoist Control Switch
4. Apron Control Switch
5. Tailgate Control Switch
6. Terminal Strip in Right Main Switch Box
7. Terminal Strip in Left Main Switch Box
8. Motor Main Switches
9. A.C. Motor
10. A.C. Motor Brake
11. Heat Switch
12. Remote Control Switches
13. Winch "In" Switch
14. Winch "Out" Switch
15. Control Phase From Generator

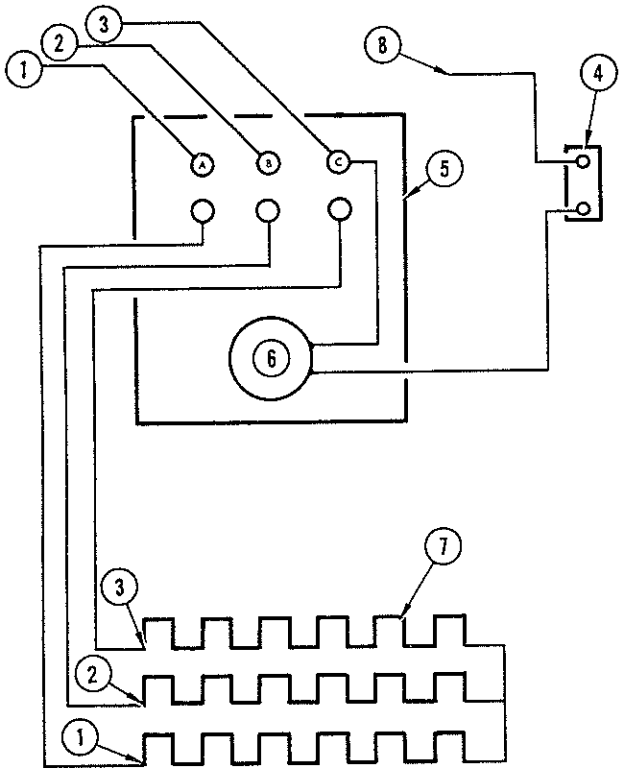

FIGURE M-3. SINGLE POSITION ELECTROTARDER WIRING

1. Phase "A"
2. Phase "B"
3. Phase "C"
4. Electrotarder Control Switch
5. Main Switch
6. Holding Coil
7. Electrotarder Grids
8. 300 V.A.C. Control Circuit

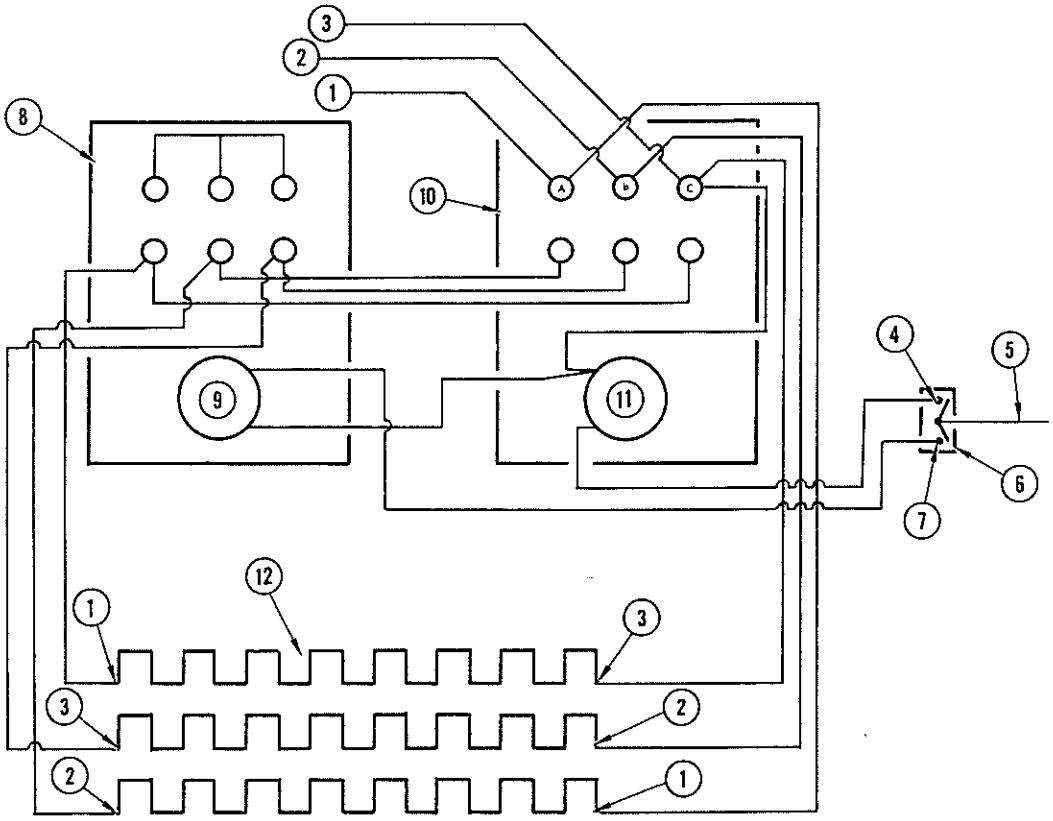

FIGURE M-4. TWO POSITION ELECTROTARDER WIRING

1. Phase "A"
2. Phase "B"
3. Phase "C"
4. High Position
5. 300 V.A.C. Control Circuit
6. Low Position
7. Electrotarder Control Switch
8. High Position Switch
9. High Position Holding Coil
10. Low Position Switch
11. Low Position Holding Coil
12. Electrotarder Grids

MODEL D SCRAPER

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MODEL D SCRAPER

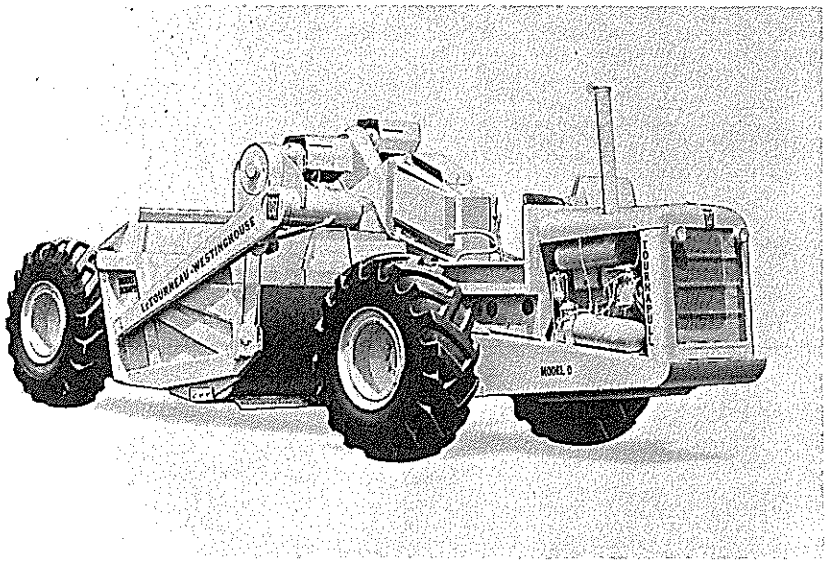

FIGURE N-1. MODEL D TOURNAPULL WITH SCRAPER

SEPARATING TOURNAPULL AND SCRAPER

Lower the apron and bowl until the cables are slack. Crib up nose of the Tournapull using good, solid cribbing. Construct cribbing carefully.

Raise scraper bowl slightly to allow the nose of Tournapull to settle on the cribbing. Block Tournapull wheels, front and rear, to prevent movement when the units are separated.

Remove main switch box cover and disconnect the cables leading to the scraper.

Bleed the air system and disconnect air lines to scraper brakes.

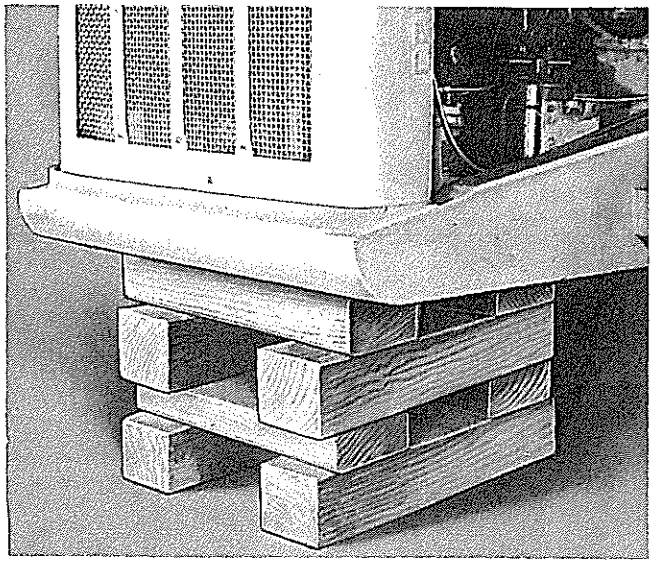

FIGURE N-2. CRIBBING UNDER TOURNAPULL

Place chain hoist around the yoke structure. Position wooden blocks along yoke to protect any tubing which may be damaged by the chain. Apply only enough tension to relieve any strain on the yoke connecting bolts.

Position blocks under each side of the steering trunnion to prevent its tipping when the trail unit is removed.

Remove connecting bolts and lower yoke to the ground.

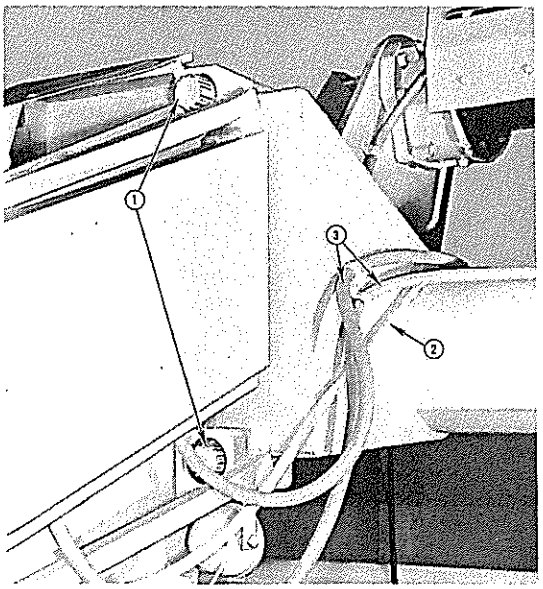

FIGURE N-3. YOKE CONNECTING BOLTS
1. Connecting Bolts 2. Air Line 3. Conductor Cables

MOTOR AND GEAR BOX REMOVAL

CABLE DRUM

Unwind cable from cable drum. Loosen setscrew in cable dead end and pull cable free.

Remove setscrew from cable drum lockbolt. Using wrench and extension handle, back off splined locknut from cable drum shaft. Remove cable drum.

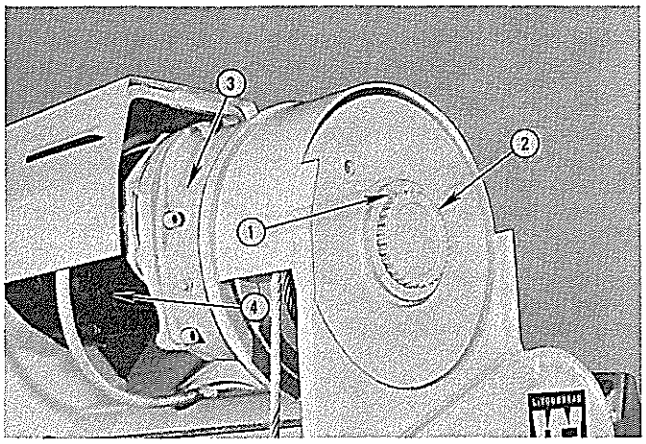

FIGURE N-4. CABLE DRUM

1. Setscrew
2. Locknut
3. Gear Box
4. Motor

MOTOR

Remove drain plug and drain lubricant from the gear box.

Remove capscrews securing motor cover to stator. Disconnect electric cables from terminal strips on motor and free from cable clamps. Remove cover.

Support motor with rope sling. Place only enough tension on sling to relieve tension on motor mounting capscrews.

Remove capscrews securing motor to gear box. Pry motor away from gear box until motor pinion has cleared bore in gear box. Pull motor straight away from gear box to prevent damaging oil seal in gear box bore.

GEAR BOX

Proceed as above to the point of removing the capscrews securing the motor to the gear box. Substitute the following:

Remove the capscrews securing the gear box to the mounting flange. Pry gear box and motor away from flange until the output shaft has cleared the flange.

Place on bench for further disassembly. Refer to Section "J".

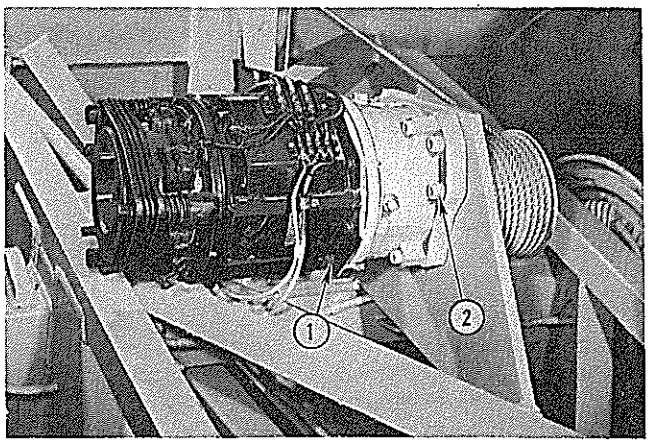

FIGURE N-5. MOTOR AND GEAR BOX MOUNTING

1. Motor Mounting Capscrews 2. Gear Box Mounting Capscrews

YOKE REMOVAL

Disconnect the conductor cable to tailgate motor and limit switches; and air lines to scraper wheel brakes.

Free apron hoist and body hoist cables from the cable dead ends. Pull body hoist cable from the sheaves on body.

Fasten hoist to yoke arms, near the pivot point, to prevent yoke from dropping when caps are removed.

Take up slack in hoist chains. Remove the capscrews and lockwashers securing the yoke arm caps to the yoke arms. Remove caps and shims. Keep shims together for replacement. Separate yoke and body.

APRON REMOVAL

Attach hoist to apron arms. Remove capscrews and lockwashers securing apron arm caps to apron arms. Remove caps and shims. Keep shims together for replacement. Separate apron and bowl.

Lower apron to ground.

Assembling Trunnion Caps

When reassembling yoke or apron ball and socket joints, first clean them thoroughly.

Raise arms with hoist until sockets on arms fit against balls on bowl.

Place cap over exposed side of ball on one side. Place enough shims between cap and socket to make ball a snug fit. Secure with capscrews and lockwashers. Torque capscrews to 350 ft. lbs.

Repeat procedure for opposite side.

Lubricate thoroughly. See Section "K" for the type of lubricant and intervals.

TAILGATE REMOVAL

Back off cable tightener and pull tailgate reverse cable from dead end. Pull cable free of sheaves.

Move tailgate forward until there is enough slack to permit removing wedge from tailgate forward cable clamp. Pull cable from sheaves.

Remove the four capscrews, lockwashers, and nuts fastening the top double sheave housing to the tailgate beam.

Attach hoist to tailgate beam structure. Remove cotter from upper tailgate roller pin. Drive out pin and remove roller.

Lower tailgate beam and remove hoist.

Attach hoist to front of tailgate. Move unit forward until it clears bowl then lift out.

It may be necessary to move tailgate beam structure to the right to permit clearance at rear and sides of bowl.

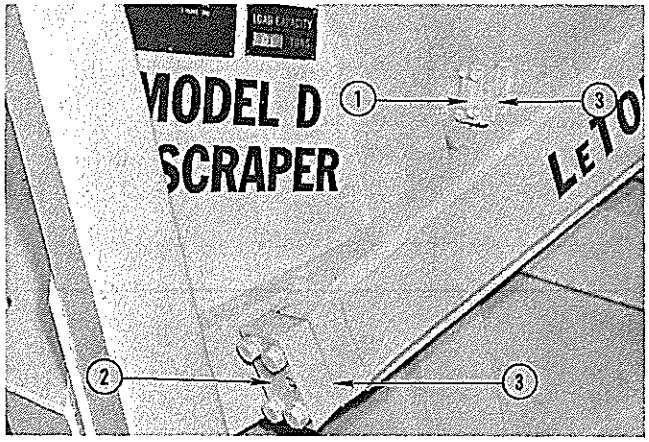

FIGURE N-6. BALL AND SOCKET JOINTS
1. Apron Arm Cap 2. Yoke Arm Cap 3. Shims

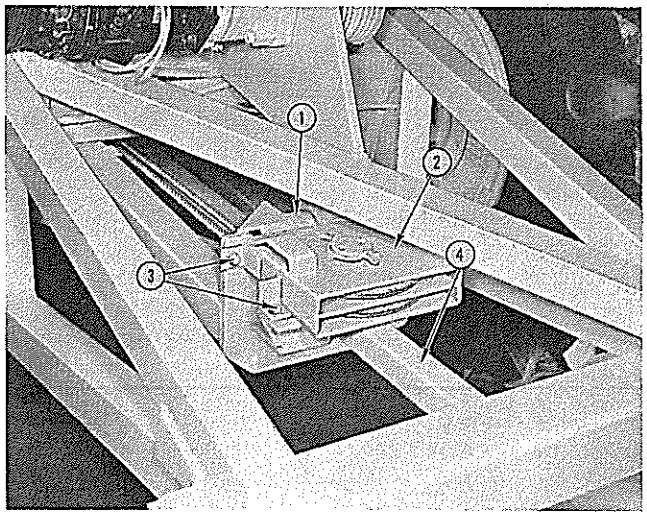

FIGURE N-7. TAILGATE ROLLER AND SHEAVES
1. Roller
2. Sheave Housing
3. Capscrews
4. Tailgate Beam

WHEEL AND AXLE

Removal

Block up machine and remove wheel and tire as described in Section "H" of this manual. Also refer to Section "H" if removal or disassembly of the wheel brake is necessary.

Remove locking setscrew from axle housing cap.

Place special wrench over teeth on axle housing cap and remove axle cap.

Remove locking setscrew from axle nut. Position special wrench over axle nut and brace it against the scraper body to prevent its turning. Then by positioning two capscrews, 180° apart, in the axle flange and using a bar to turn the axle and loosen the nut; remove nut.

Using a bar between the axle flange and the housing pry the axle out.

As the threaded end of the axle clears outer bearing cone, the cone will fall free. Do not permit it to drop to the floor.

Remove axle from housing. Pull inner bearing cone from axle. Remove bearing cup from bore in axle housing.

Loosen outer bearing race lockbolt in axle housing and pull oil seal, roller bearing and the bearing race from housing.

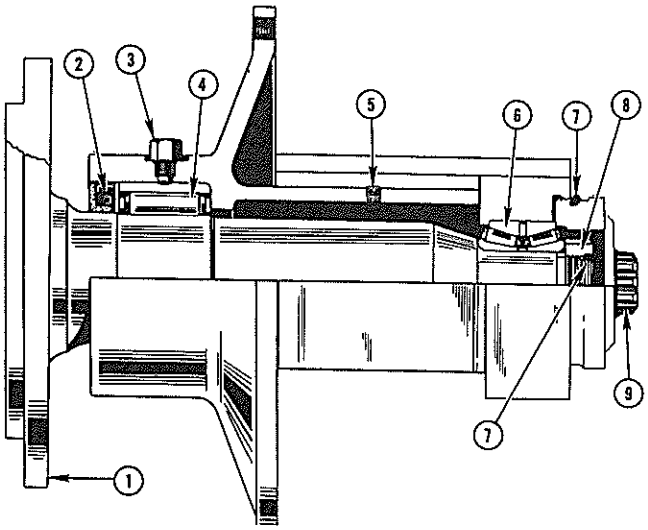

FIGURE N-8. SCRAPER AXLE
1. Axle
2. Oil Seal
3. Lockbolt
4. Bearing
5. Plug
6. Double Row Bearing
7. Setscrew
8. Locknut
9. Axle Housing Cap

Installation

Clean and inspect all parts thoroughly. Replace all damaged or defective parts. Pack bearings with wheel bearing grease (medium) before reassembly.

Press outer roller bearing race into housing. Align hole in race with lockbolt in housing. Tighten lockbolt. Replace outer bearing.

Replace oil seal into axle housing, lip of seal should be pointing toward centerline of the machine.

Press double row tapered bearing cup into the axle bore. Install inner bearing cone onto axle shaft. Install axle into housing.

Replace spacer and outer bearing cone onto axle. Install locknut and torque to 1000 ft. lbs. Replace locking setscrew.

Replace axle housing cap and locking setscrew.

Remove pipe plug from axle housing and fill housing approximately 1/3 full of wheel bearing grease (medium).

Replace wheel and tire. Torque wheel mounting capscrews to 550 ft. lbs.

BLADES

The scraper is equipped with a three piece blade. Each piece is self sharpening and reversible.

The scraper blades should be changed before they wear back into the blade base. Otherwise the blade base or scraper bottom may become permanently damaged.

To change blades, hoist the scraper body and apron to a height that will allow sufficient clearance to work. Next block the apron and bowl as a safety measure, and remove the blade bolts.

When installing the new blades into position — hard faced side up — use a round drift punch, if possible, to help in lining up the bolt holes. Use new bolts whenever a blade is changed.

To reverse the blades, remove the old blade bolts and discard. Use new bolts.

Next, turn the blades over — hard faced side up — and install the left blade tip on the right side, and right blade tip on the left side. This will assure uniform wear.

Then reverse the center section so the hard faced side is up.

Periodically check the scraper runner rail shoes for wear. If worn down almost to the runner rail, the old shoes should be removed and new ones welded or bolted on. The shoes prevent wear on the scraper rails and scraper sides while the blade is in the ground.

MODEL D REAR DUMP

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MODEL D REAR DUMP

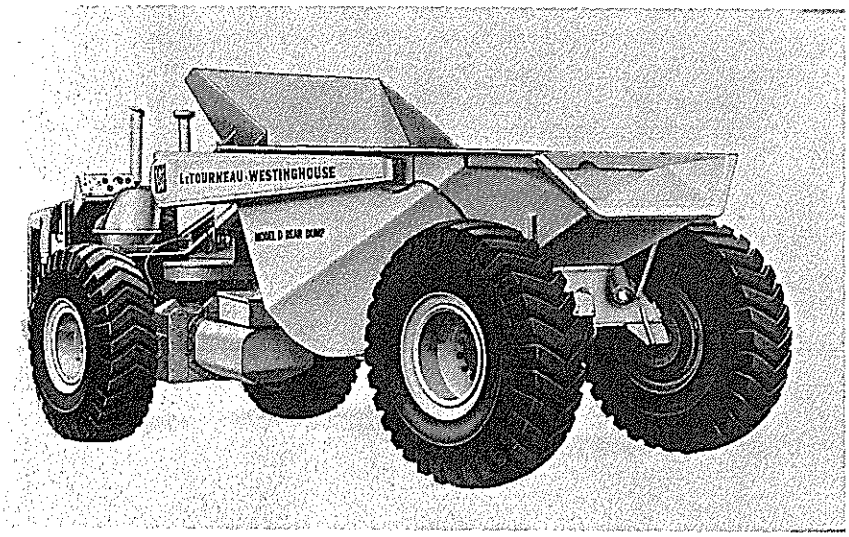

FIGURE O-1. MODEL D TOURNAPULL WITH REAR DUMP

SEPARATING TOURNAPULL AND REAR DUMP

Crib up under nose of the Tournapull, using good solid cribbing. Construct cribbing carefully.

Raise body slightly until nose of Tournapull is resting on the cribbing and the tension is relieved on the return cable. Block Tournapull wheels, front and rear, to prevent movement when units are separated.

Remove cotter and pin from cable anchor on the front of body and remove cable. If cable is to be replaced, back out setscrew from cable dead end on cable drum and pull cable free.

While body is still in the slightly raised position, place blocks between yoke and body stops. Depress bowl control switch on the instrument panel. This will pay out hoisting cables and lower the body on the blocks. After body has come to rest on the blocks continue to operate motor until there is slack in the two hoisting cables.

Move to rear of the machine and remove the two cable tension springs from the underside of body. Back out the two lockbolts from hoisting cable wedge socket. Drive wedges from dead end socket and pull cables free.

Fasten loose end of the return cable onto drum and by operating the bowl hoist control switch, rewind the two hoisting cables onto the cable drum.

Disconnect the conductor cables to A.C. electric motor, rear light, and limit switches at the main switch box. Pull cable from box.

Bleed air from the air system and disconnect air line at fitting on left side of machine near the main switch box.

Place a chain hoist about the yoke structure and apply only enough tension to relieve any strain on the yoke mounting bolts. Remove bolts and lower yoke until both body and yoke structure are resting on ground.

Attach hoist to yoke arm and take up the slack. Remove the capscrews securing the yoke arm caps to the yoke arms. Remove caps and shims. Keep shims together for replacement. Lift yoke arm away from body.

Assembling Yoke Arm

Thoroughly clean ball, socket and cap.

Raise arms with hoist until sockets on arms fit against balls on bowl.

Place cap over exposed side of ball on one side. Place enough shims between cap and socket to make ball a snug fit. Secure with capscrews and lockwashers. Torque capscrews to 350 ft. lbs.

Repeat procedure for opposite side.

Lubricate thoroughly. See Section "K" for type of lubricant and intervals.

WHEEL AND AXLE

Removal

Block up machine and remove wheel and tire as described in Section "H" of this manual. Also refer to Section "H" if removal or disassembly of the wheel brake is necessary.

Remove locking setscrew from axle housing cap.

Place special wrench over teeth on axle housing cap and remove axle cap.

Remove locking setscrew from axle nut. Position special wrench over axle nut and brace it against the rear dump body to prevent its turning. Then by positioning two capscrews, 180° apart, in the axle flange and using a bar as shown in Fig. O-2 to turn

the axle and loosen the nut, remove nut.

Using a bar between the axle flange and the housing pry the axle out.

As the threaded end of the axle clears outer bearing cone, the cone will fall free. Do not permit it to drop to the floor.

Remove axle from housing. Pull inner bearing cone from axle. Remove bearing cup from bore in axle housing.

NOTE: Axle may be equipped with double row ball bearing in place of double row tapered roller bearing on threaded end of axle. This ball bearing will remain in housing as axle is removed.

Loosen outer bearing race lockbolt in axle housing and pull oil seal, roller bearing and bearing race from housing.

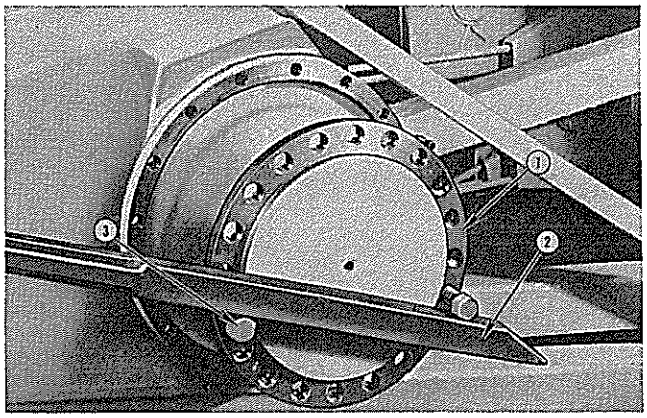

FIGURE O-2. REMOVING LOCKNUT

1. Axle
2. Bar
3. Capscrew

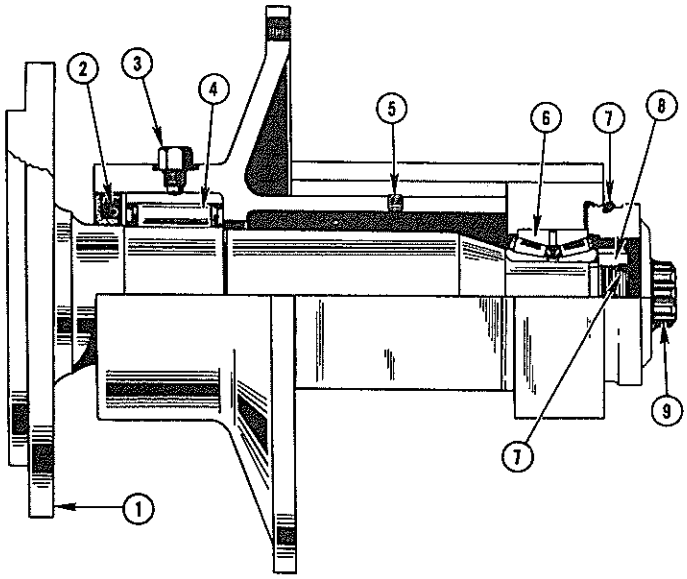

FIGURE O-3. REAR DUMP AXLE

1. Axle
2. Oil Seal
3. Lockbolt
4. Roller Bearing
5. Plug
6. Double Row Bearing
7. Setscrew
8. Locknut
9. Bearing Retainer Cap

Installation

Clean and inspect all parts thoroughly. Replace all damaged or defective parts. Pack bearings with wheel bearing grease (medium) before reassembly.

Press outer roller bearing race into housing. Align hole in race with lockbolt in housing. Tighten lockbolt. Replace outer roller bearing.

Replace oil seal into axle housing, lip of seal should be pointing toward center line of machine.

Press double row tapered bearing cup into axle bore. Install inner bearing cone onto axle shaft. Install axle into housing.

Replace spacer and outer bearing cone onto the axle. Install locknut and torque to 1000 ft. lbs. Replace locking setscrew.

NOTE: If machine was equipped with double row ball bearing, position it over axle shaft and press onto axle and into housing before installing locknut.

Replace axle housing cap and locking setscrew.

Remove pipe plug from axle housing and fill housing approximately 1/3 full of wheel bearing grease (medium).

Replace wheel and tire. Torque wheel mounting capscrews to 550 ft. lbs.

MOTOR AND GEAR BOX REMOVAL

CABLE DRUM

Unwind cables from cable drum. Loosen setscrews in cable dead ends and pull cables free.

Remove setscrew from cable drum locknut. Using wrench and extension handle, back off splined locknut from cable drum shaft. Remove cable drum.

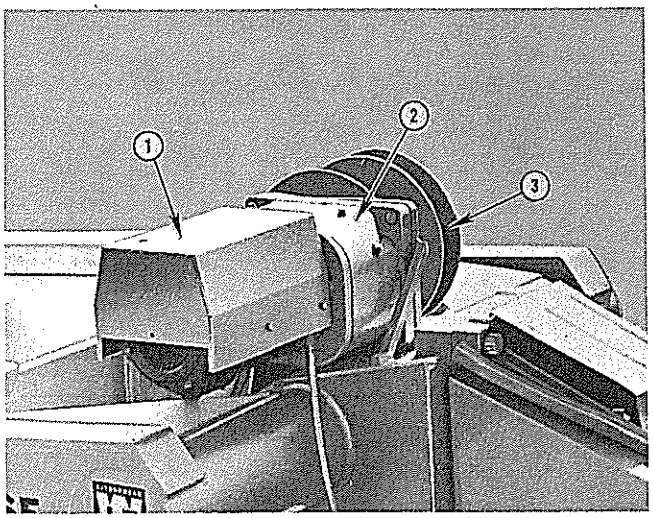

FIGURE O-4. MOTOR AND GEAR BOX

1. Motor
2. Gear Box
3. Cable Drum

MOTOR

Remove drain plug and drain lubricant from the gear box.

Remove capscrews securing motor cover to stator. Disconnect electric cables from terminal strips on motor and free from cable clamps. Remove cover.

Support motor with rope sling. Place only enough tension on sling to relieve tension on motor mounting capscrews.

Remove capscrews securing motor to gear box. Pry motor away from gear box until motor pinion has cleared bore in gear box. Pull motor straight away from gear box to prevent damaging oil seal in gear box bore.

GEAR BOX

Remove drain plug and drain lubricant from gear box.

Remove capscrews securing motor cover to stator. Disconnect electric cables from the terminal strips on motor and free from cable clamps. Remove cover.

Support motor and gear box with a rope sling. Place only enough tension on sling to relieve tension on gear box mounting capscrews.

Remove the capscrews securing the gear box to the gear box mounting flange. Pry motor and gear box away from flange until gear box output shaft has cleared bore in mounting flange.

Separate motor and gear box as described above.

EMERGENCY BRAKING SYSTEM

Operation

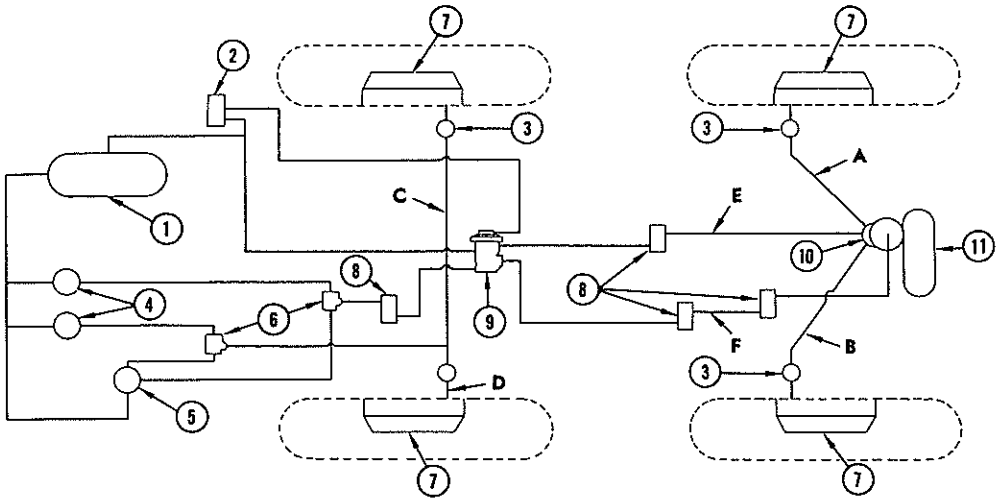

FIGURE O-5. EMERGENCY BRAKING SCHEMATIC

A. Rear Dump Brake Line
B. Rear Dump Brake Line
C. Tournapull Brake Line
D. Tournapull Brake Line
E. Emergency Air Line
F. Service Air Line
1. Main Air Tank
2. Governor
3. Quick Release Valve
4. Hand Brake Valves
5. Foot Brake Valve
6. Double Check Valve
7. Wheel Brake
8. Air Strainer
9. Tractor Protection Valve
10. Emergency Relay Valve
11. Emergency Air Tank

An emergency braking system is available as optional equipment on the Model D Rear Dump. This braking system protects both the operator and the machine in the event of broken air lines.

It is assumed, in the following situations, that the foot treadle valve remains open delivering air to the brakes as in a steady brake application and that leakage through any broken line will sufficiently load the compressor so it cannot build up pressure in the main reservoir.

If either of the lines to the rear dump brakes opens (A and B), the main and emergency air tank pressure will drop to 90 p.s.i. The tractor protection valve will close, closing the emergency and service lines to the trailer. The main air tank minimum pressure will be 90 p.s.i., the emergency air tank

will empty. When the main air tank pressure builds up to 140 p.s.i. the emergency and service lines are opened and the cycle repeats. A minimum of 90 p.s.i. air pressure is available in the main air tank for operation of Tournapull wheel brakes.

If either of the lines to the Tournapull brakes opens (C and D), the main and emergency air tank pressure will drop to 90 p.s.i. at which time the tractor protection valve will close, closing the service and emergency lines to the rear dump. The rear brakes will be applied automatically with 90 p.s.i. air pressure from the emergency tank. The main air tank will continue to empty. There will be no minimum air pressure present in the main air tank to operate the Tournapull brakes.

If the emergency line (E) opens, the rear dump brakes are automatically applied with 120 p.s.i. air pressure from the emergency air tank. The main air tank pressure will drop to 90 p.s.i. and the tractor protection valve will close, closing the service and emergency lines to the rear dump. When the main air tank pressure builds up to 140 p.s.i., the tractor protection valve opens, the rear dump brakes exhaust to the metered pressure applied by the brake valve and the cycle repeats. 90 p.s.i. minimum air pressure is available in the main air tank for the operation of Tournapull brakes.

If the service line (F) opens, the rear dump brakes exhaust and the main air tank pressure drops to 90 p.s.i. The tractor protection valve closes, closing the service and emergency lines to the rear dump. Rear dump brakes are automatically applied with 120 p.s.i air pressure from the emergency tank. When main air tank pressure builds up to 140 p.s.i., tractor protection valve opens, rear dump brakes exhaust and the cycle repeats. A minimum of 90 p.s.i. air pressure is available in the main air tank for operation of the Tournapull brakes.

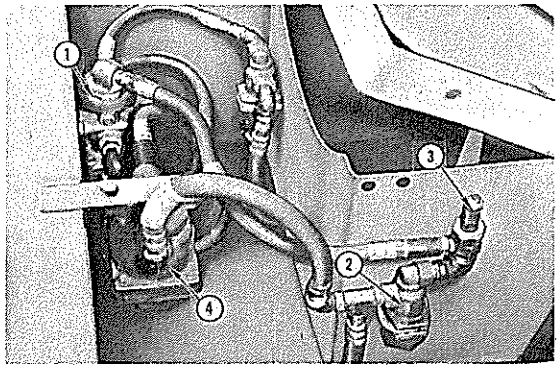

FIGURE O-6. PIPING IN COCKPIT

1. Tractor Protection Valve
2. Air Cleaner
3. Air Strainer
4. Governor

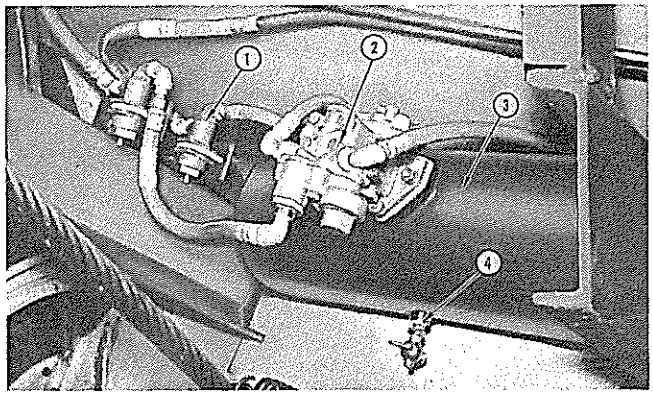

FIGURE O-7. PIPING ON REAR DUMP

1. Air Cleaner
2. Emergency Relay Valve
3. Emergency Tank
4. Drain

Tractor Protection Valve

REMOVAL AND DISASSEMBLY

Bleed the air system. Disconnect the air lines to the valve. Remove mounting bolts and remove valve from bracket.

Remove all dirt or grease from the exterior of the valve by using cleaning solvent and a brush. Inspect body of valve for cracks or breaks. If damaged in any way, the body must be replaced.

Remove the four capscrews and lockwashers securing the cover to the body. Remove the cover and grommet. Lift the service disc valve spring, disc valve, disc valve seat, grommet, emergency valve spring, and emergency and exhaust valve from the body. Remove grommet from emergency and exhaust valve stem.

Remove cap nut securing cap to body and remove cap. Lift diaphragm and exhaust valve plunger assembly and exhaust valve plunger spring from body. Remove exhaust plunger grommet. Remove cotter and slotted nut securing followers and diaphragm to the exhaust valve plunger. Remove followers, grommet and diaphragm.

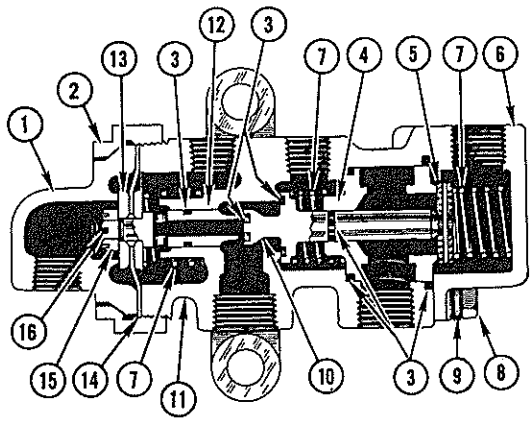

FIGURE O-8. TRACTOR PROTECTION VALVE

1. Cap
2. Cap Nut
3. Grommet
4. Discharge Valve Seat
5. Valve
6. Cover
7. Spring
8. Capscrew
9. Lockwasher
10. Emergency and Exhaust Valve
11. Body
12. Exhaust Valve Plunger
13. Follower
14. Diaphragm
15. Nut
16. Cotter

Mark springs when disassembling in order to get the right spring in the right location when reassembling.

REASSEMBLY

Clean all metal parts in cleaning solvent. Inspect all valves and seats for damage or wear. If either the seat or valve is damaged or worn, the seat or valve or both must be replaced. Check fit of exhaust valve plunger in body. It should be a neat sliding fit.

Check fit of emergency and exhaust valve in disc valve seat guide. It should be a neat sliding fit.

Carefully install the new greased grommets in the groove on emergency and exhaust valve, and diaphragm and exhaust valve plunger assembly.

Place follower, diaphragm, grommet and upper follower on exhaust valve plunger and secure in place with hex nut. Insert cotter pin securing hex nut in place.

Place lubricated disc valve seat grommet in body. Place emergency valve spring and emergency and exhaust valve in guide portion of disc valve seat.

Place emergency and exhaust valve and disc valve seat in body. Hold in place and install the cover grommet, service disc valve and disc valve spring. Position and hold the cover on body while installing lockwashers and capscrews. Place exhaust valve plunger spring and exhaust valve plunger assembly in body. Position and hold cap over diaphragm and exhaust valve plunger assembly and install cap nut securing cap to body.

Emergency Relay Valve

REMOVAL AND DISASSEMBLY

Open drain cocks and bleed the air system. Disconnect the air lines from the relay valve. Remove mounting bolts and remove valve from air tank.

Remove four capscrews and lockwashers attaching relay valve to emergency valve. Remove gasket and separate relay valve from emergency valve.

RELAY VALVE:

Remove all dirt and grease from exterior of valve, using cleaning solvent and a brush.

Inspect the exterior of valve for broken or damaged parts. All broken or damaged parts must be replaced.

Remove capscrews securing cover to body. Remove cover, diaphragm, diaphragm ring, and bleeder passage grommet from body.

Using fingers, pull the diaphragm guide and dampener out. Fig. O-9.

Unscrew the supply valve cap nut and remove the supply valve spring and supply valve.

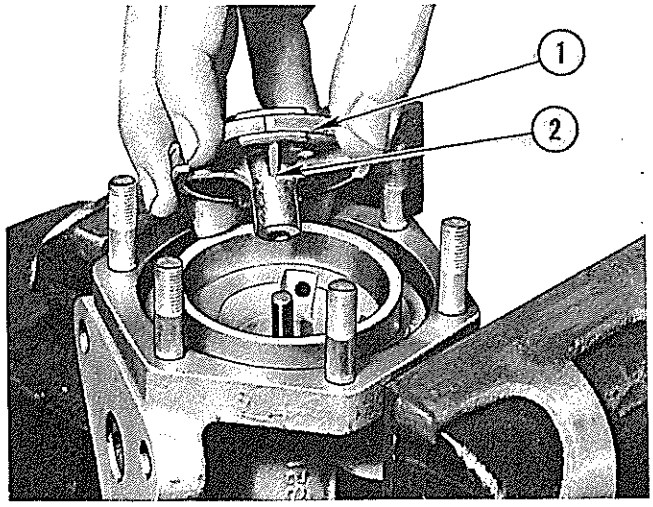

FIGURE O-9. REMOVING DIAPHRAGM GUIDE

1. Dampener
2. Diaphragm Guide

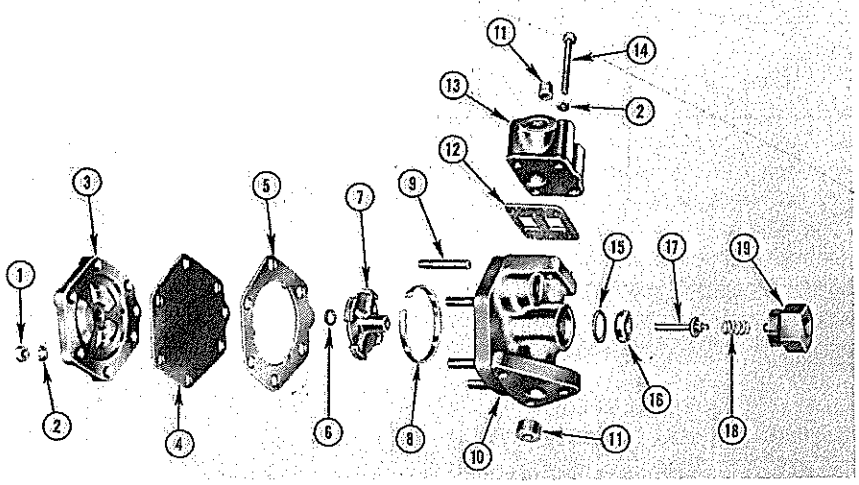

FIGURE O-10. RELAY VALVE, EXPLODED

1. Nut
2. Lockwasher
3. Cover
4. Diaphragm
5. Diaphragm Ring
6. Lower Grommet
7. Diaphragm Guide
8. Guide Ring
9. Stud
10. Body
11. Pipe Plug
12. Gasket
13. Adaptor
14. Capscrew
15. Grommet
16. Supply Valve Seat
17. Supply Valve
18. Supply Valve Spring
19. Supply Valve Cap Nut

NOTE: Do not remove supply valve seat bushing unless replacement is absolutely necessary. Remove the bushing by pressing out through the bottom of the body.

EMERGENCY VALVE:

Remove pressure regulating cap and lift out pressure regulating spring and shims from the cavity in the cap nut. Do not misplace any shims as the same number must be replaced in the valve during assembly. Lift out diaphragm seal ring. Lift out pressure regulating diaphragm assembly.

The pressure regulating valve seat bushing should not be removed unless it has to be replaced. If this bushing has to be removed, it will have to be drilled out.

Remove supply cap nut and strainer from emergency valve cover.

Remove check valve cap nut. Lift out check valve guide, and check valve from cavity of the emergency valve body.

Remove the emergency valve cover from body by removing the four capscrews. Remove emergency valve spring from valve body.

Remove emergency valve cap nut. Using screw driver to keep the upper emergency valve stem from turning, remove the emergency diaphragm retaining nut. Remove diaphragm follower, diaphragm, and lower emergency valve. Remove upper emergency valve.

Do not remove emergency valve seat bushing unless replacement is absolutely necessary. When necessary, remove the bushing by pressing out with a tap through the emergency valve cap nut hole.

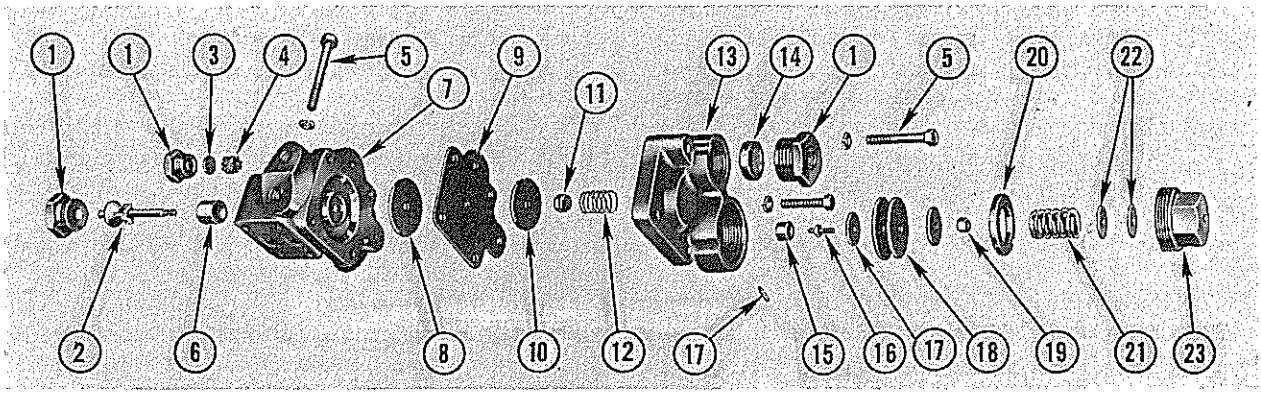

FIGURE O-11. EMERGENCY VALVE, EXPLODED

1. Cap Nut
2. Upper Emergency Valve
3. Disc Valve
4. Check Valve Guide
5. Stud
6. Valve Seat
7. Emergency Valve Body
8. Lower Emergency Valve
9. Diaphragm
10. Diaphragm Follower
11. Locknut
12. Emergency Valve Spring
13. Cover Body
14. Air Strainer
15. Valve Seat
16. Valve
17. Follower
18. Diaphragms
19. Locknut
20. Diaphragm Ring
21. Pressure Regulating Spring
22. Shims
23. Cap

Repair and Replacements of Parts

RELAY VALVE

Wash all metal parts in cleaning solvent. Be sure bleeder passage is open and clean.

Replace all used diaphragms, grommets, and gaskets with new parts.

Inspect fit of diaphragm guide in relay valve body. It must be a free sliding fit.

Inspect condition of guide ring. When lying on a flat surface, the ends of the guide ring should not be in line with the ends of a piston ring. The guide ring must be twisted so one end is about 3/8" higher than the other.

Inspect the condition of supply valve and seat. If valve or seat is worn excessively, it must be replaced. Inspect diaphragm seat on top of body. Seat must be smooth and free from dents or scratches.

Inspect diaphragm ring. Both sides should be smooth and the inside diameter must be smooth and free from nicks, scratches, burrs and sharp edges.

Inspect the cover. The outer ring (that the diaphragm touches) must be smooth and free from nicks, scratches, and sharp edges. Make sure that bleeder passage is open and clean.

If diaphragm exhaust seat on top of the body is only slightly scratched or dented, repair by lapping the body on a flat plate covered with crocus cloth. Do not lap any more than enough to give a smooth surface. Then place body in lathe and polish lightly with crocus cloth to round out edge left by lapping operation.

The original shape of the diaphragm exhaust seat should be maintained as closely as possible and not more than 0.005" should be removed from seat.

If the supply valve and seat are too badly worn, repair by carefully grinding the valve to its seat using grinding tool BWE 202813, Yankee slip collet BWE 233383, and Bendix-Westinghouse grade No. 1000 grinding compound and Bendix-Westinghouse grade No. 305BB grinding compound for finish lap-

ping. Do not use ordinary valve grinding compound. The top of the grinding tool should be moved in a circle while grinding the valve.

Excessively worn valves or valve seat bushings must be replaced. A worn supply valve bushing is pressed out through the bottom of the body and a new bushing pressed in place. When replacing bushings, make sure that the bore into which bushing is pressed is smooth. Be sure that body is supported so that exhaust seat is not damaged. Use new bushing and grommet and use cup grease on bushing and grommet. (The new bushing should be 0.010" larger in diameter than the bushings which was removed. 0.010", 0.020" and 0.030" oversize bushings are available.) Use care in pressing into place so as not to shear grommet.

After pressing bushing in place, use reaming and facing tool BWE 223851 with pilot bushing BWE 223852. Then press a new supply valve into its seat with a force of 400 to 500 pounds. (This force should be exerted against the flat parts of the valve and not against the valve stem.)

To test for leakage, install supply valve, spring, supply valve cap nut, adaptor and gasket. Connect air line with 100 pounds air pressure to the reservoir port. Apply soap suds around the top of the supply valve stem. The maximum leakage is one-inch soap bubble in five seconds. If the leakage is excessive, again grind the valve to its seat. Sometimes leakage is reduced by tapping the top of the supply valve stem several times with a light rawhide hammer while the air pressure remains applied.

After leakage has been reduced to less than the maximum permitted, place diaphragm guide in body. Use a straight edge to check the height of the guide in relation to the diaphragm seat on the body. The top of the guide should not be above the top of the diaphragm seat, otherwise at low application air pressures, there may be leakage between the diaphragm and its seat. The top of the guide should not be more than 0.015" below the top of the diaphragm seat, otherwise the relay valve may not deliver the correct air pressure. If the top of the guide is too high, carefully grind off the top of the supply valve stem to the proper length. If the guide is too low, the supply valve or diaphragm guide or both must be replaced.

EMERGENCY VALVE

Wash all metal parts thoroughly in cleaning solvent. Be sure passages leading to pressure regulating valve cavity are open and clean.

Replace used diaphragm, check valve, and lower emergency valve.

Inspect the condition of upper emergency valve and seat. If valve or seat is worn or damaged, it must be replaced.

Inspect condition of lower emergency valve and seat on body. If valve or seat is worn or damaged, the valve or body must be replaced.

Inspect radii on body and cover where the diaphragm is clamped. They must be smooth and free from nicks, scratches, and sharp edges.

Inspect check valve seat. It must be flat and smooth.

Inspect the pressure regulating ball valve and seat for wear. Replace if necessary.

Inspect retainer for rust and corrosion. Replace if necessary.

If the upper emergency valve and seat are not too badly worn and leakage is excessive, repair by carefully grinding valve to its seat using grinding tool BWE 202813, driver tool BWE 230197 and Bendix-Westinghouse grade No. 1000 grinding compound and Bendix-Westinghouse grade No. 305BB for finish lapping.

Excessively worn valves or valve seat bushings must be replaced. Care must be used in pressing a new oversize bushing into place, using shellac for a seal between bushing and the emergency body. After being pressed into place, the bushing must be reamed using reamer BWE 223850. Then press a new valve into its seat with approximately 1000 pounds force, taking care that the force is exerted against the flat part on the top of the emergency valve and not against the flat part of the top of the emergency valve or not against the top of the stem. After pressing into its seat, the new valve must be ground to its seat.

If the pressure regulating valve bushing is replaced, the new bushing must be pressed into place. (The new bushing should be 0.005" larger in diameter than the bushing which was removed: 0.005", 0.010" and 0.015" oversize bushings are available.) The valve is fitted to its seat by tapping it with a light hammer.

Reassembly

RELAY VALVE

Position supply valve and spring and install supply valve cap nut. Tighten supply valve cap nut securely.

Position guide ring in groove of diaphragm guide and holding it in place with the fingers, push diaphragm guide into place.

Install bleeder passage grommet in body. Install diaphragm rings. Install relay diaphragm. Install cover on body.

Use care to see that bleeder passage openings in body, diaphragm ring, diaphragm, and cover line up.

Install lockwashers and tighten nuts securely.

EMERGENCY VALVE:

Holding check valve cap nut so that threads are up, place check valve guide in groove in cap nut and place check valve in guide. Then, holding emergency body upside down, screw check valve cap into body. Tighten securely.

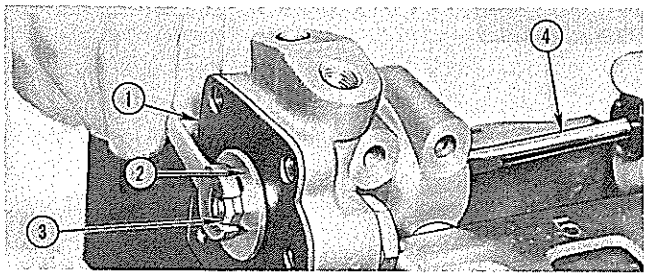

FIGURE O-12. INSTALLING EMERGENCY DIAPHRAGM

1. Diaphragm
2. Diaphragm Follower
3. Nut
4. Screw Driver

Position upper emergency valve in valve body. Install lower emergency valve, diaphragm, and diaphragm follower on the emergency valve stem. Curved side of lower emergency valve and diaphragm follower must be against diaphragm. Install emergency diaphragm retainer nut. Hold valve stem from turning with a screwdriver and tighten nut screw securely. (Fig. O-12).

Position strainer in the emergency valve cover and install supply cap nut. Tighten securely.

Position the pressure regulating diaphragm assembly in emergency valve body being sure edges of diaphragms are beneath the end of the pin. Position diaphragm ring so that curved side is toward diaphragm and notch in the ring engages the pin. Position same number of shims and same spring that were removed during disassembly in the pressure regulating cap, and screw cap into position. Tighten cap securely.

Position emergency valve spring under the emergency diaphragm retaining nut. Carefully line up holes in emergency diaphragm with holes in emergency body and install emergency cover. Securely tighten the four cap nuts and lockwashers that hold the cover to body.

Before installing emergency valve cap nut, make sure that emergency valve can move up and down freely without binding. Install emergency valve cap nut, and tighten securely.

Using a new gasket, position relay valve and emergency valve and install and tighten four capscrews and lockwashers attaching relay valve to emergency valve.

Testing and Adjusting

If facilities are available, the relay emergency valve should be tested on a suitable test rack. If such facilities are not available, the valve should be tested on the machine for serviceability.

Additional tests should be made as follows:

Relay emergency valve must promptly deliver the same air pressure to the brake chambers as the brake valve is delivering to the relay emergency valve. Two accurate air pressure test gages must be used in this test. One air gage is connected to show the pressure being delivered to the relay emergency valve by the brake valve and the other is connected to show the pressure being delivered to the brake chambers by the relay emergency valve.

When the brake valve is moved to its applied position, the relay emergency valve must quickly deliver the same pressure (within 3 pounds) to the brake chambers. Failure of the valve to do this quickly indicates that the top of the diaphragm guide is too far below the relay diaphragm seat. This condition is corrected by replacing either the supply valve or diaphragm guide or both.

Excessive leakage with the brakes lightly applied usually indicates that the diaphragm guide is too high in relation to the relay diaphragm seat. This is corrected by carefully grinding the top of the supply valve stem to the proper length.

No leakage at any other point on the relay emergency valve with brakes applied is permissible.

Service

AIR CLEANER:

Drain filter body every 10 shifts. Replace element every 50 shifts. To change element, unscrew cap from body. Remove cap and gasket carefully so spring will not pop out. Remove spring, spider and element from body. See Fig. O-13.

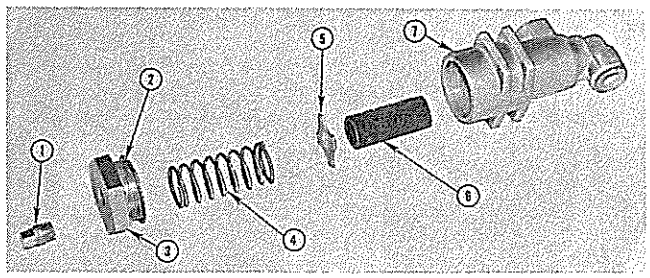

FIGURE O-13. AIR CLEANER, EXPLODED

1. Plug
2. Gasket
3. Cap
4. Spring
5. Spider
6. Element
7. Body

AIR STRAINER:

Drain strainer body every shift. Replace element every 50 shifts. To change element, remove capscrews and lockwashers securing cover to body. Remove cover and gasket. Remove strainer support and element from body. See Fig. O-14.

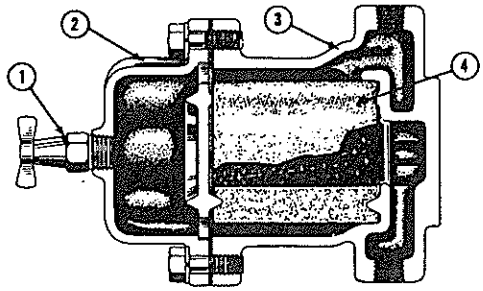

FIGURE O-14. AIR STRAINER

1. Drain
2. Cover
3. Body
4. Element

MODEL D CRANE

INDEX

MODEL D CRANE

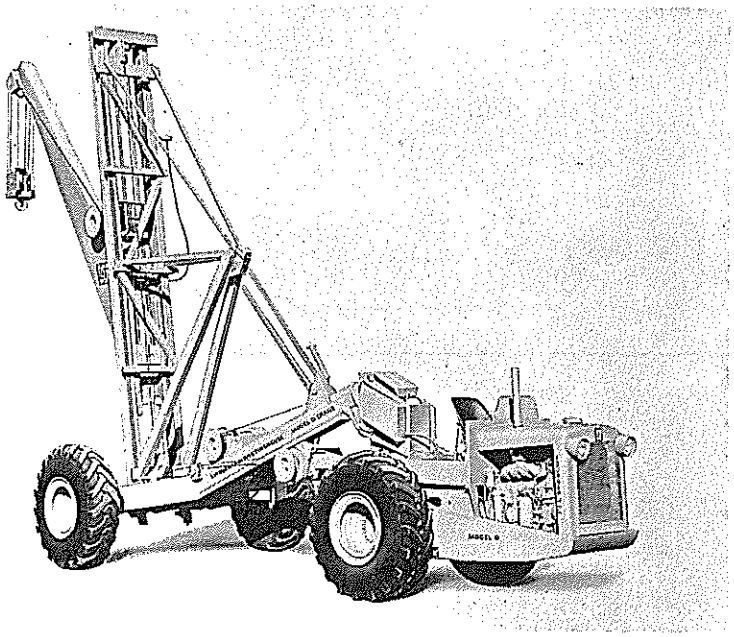

FIGURE P-1. MODEL D TOURNAPULL WITH MODEL D CRANE

SEPARATING TOURNAPULL AND CRANE

Block up front of Tournapull using good, solid cribbing. Considerable care should be exercised in constructing this cribbing to eliminate the danger of the rig moving forward and off the blocks. Block the Tournapull wheels, front and rear, to further lessen the danger.

Raise the jib in the boom track to the limit of its travel. Tilt boom track forward until it comes to rest on the stop block on the crane tongue.

Disconnect the electric cables to the A.C. electric motors and limit switches from the main switch boxes. Bleed the air system and disconnect the air lines to the crane wheel brakes at the connection on the steering trunnion.

Fasten chain hoist to crane tongue and apply only enough lift to relieve the tension on the mounting bolts. Remove the mounting bolts securing the crane to the Tournapull. Separate the two units. Place stand beneath crane tongue, or lower unit to floor. If stand is placed beneath tongue, be sure to block crane wheels, front and rear, to prevent its moving off the stand.

ELECTRIC MOTORS AND GEAR BOXES

Removal

TRAVELING HOOK

Lower hook to the ground and release the cable from cable dead end along side the sheave on the end of the jib structure.

Press "hook up" control switch on the instrument panel until the cable has rewound on the drum.

Remove setscrew from cable drum locknut and remove locknut. Pull cable drum from gear box output shaft.

Release electric cable from cable clamp on the motor cover. Remove capscrews securing the cover to the stator. Remove cover. Disconnect leads from electric motor terminal strip.

Fasten a rope sling around the motor and gear box. Apply only enough tension to relieve any strain on the mounting capscrews. Remove mounting capscrews and pull unit away from crane. Place on bench or stand for further disassembly.

BOOM

Tilt the boom track toward front of machine until it has come to rest on the stop block on the crane tongue.

Lash boom track to the tongue as a safety precaution. Lower the jib and boom structures to a

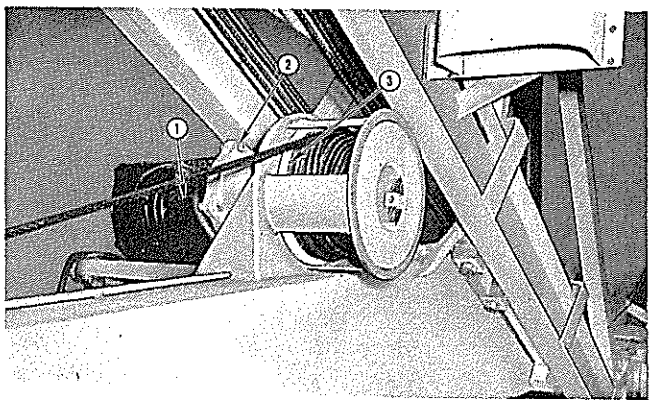

FIGURE P-2. HOOK MOTOR AND GEARBOX
1. Motor 2. Gear Box 3. Cable Drum

point just short of activating the down limit switch and lash into place. By doing this, the jib motor can still be operated. Press the "jib down" control switch until the cable has completely unwound from drum. Loosen setscrew from cable dead end and remove cable.

Remove locking setscrew from cable drum locknut. Back off locknut and pull drum free of the gear box output shaft.

Remove electric cable from cable clamp on the motor cover. Remove capscrews securing motor cover to stator. Remove cover. Disconnect the electric motor leads at the motor terminal strip.

Fasten a rope sling around the motor and gear box. Apply only enough tension to relieve any strain on the mounting capscrews. Remove mounting capscrews and pull unit away from crane. Place on bench or stand for further service or disassembly.

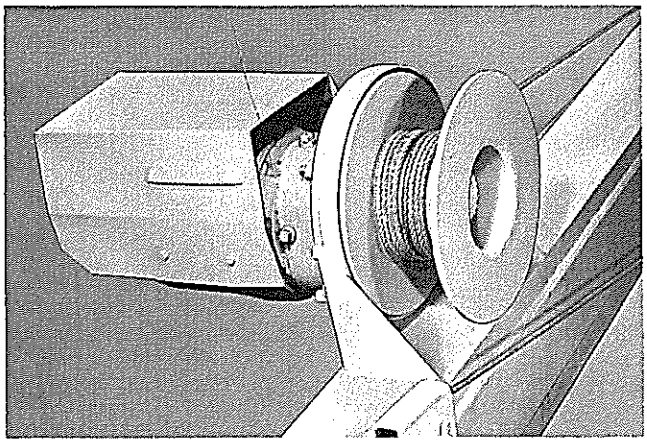

FIGURE P-3. BOOM MOTOR AND GEAR BOX

JIB

While carriage track is in the position described for boom motor and gear box removal, press the "jib down" control switch on the instrument panel until all the cable has unwound from the cable drum. Loosen the setscrew in the cable dead end and pull cable free.

Proceed to remove motor and gear box as described above.

Refer to Section "J" of this manual for further disassembly of the A.C. electric motors and gear boxes.

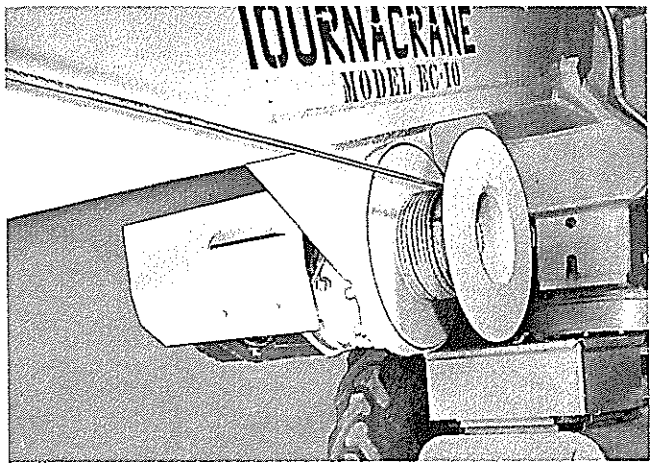

FIGURE P-4. JIB MOTOR AND GEAR BOX

TRAVELING HOOK

Removal

Lower the hook to the ground and free cable from dead end on jib structure. Rewind cable onto drum.

To disassemble sheaves, pull cotter pin and drive out sheave pin. Lift sheave wheel from the structure and remove bearing.

The hook is a non-removable swivel type and does not require disassembly.

BOOM AND JIB STRUCTURES

Removal

With the boom track in an upright position, lower the jib to a point just short of activating the limit switch. Disconnect the leads from the traveling hook electric motor terminal strip and free the cable from clamps alongside the boom structure. Lash the boom and jib structure to the track and release the jib cable from the dead end at top of track. Rewind the cable on drum.

Fasten a chain hoist about the boom track and jib structure and then release the boom tilt cable from dead end alongside of crane tongue sheaves. Rewind the cable onto the drum taking care to keep track structure in an upright position. Disconnect the leads at the two limit switches located on the cross members of the track structure.

Take up enough slack on the hoist to relieve any strain on the track hinge pins. Remove the cotters from each hinge pin and drive out pins. Exercise caution when these pins are removed as the boom track and jib structure may tilt abruptly.

Lower the jib and boom to the ground and separate the two units.

WHEEL AND AXLE

Removal

Block up machine and remove wheel and tire as described in Section "H" of this manual. Also refer to Section "H" if removal or disassembly of the wheel brake is necessary.

Remove capscrews and lockwashers securing the hub cap to the axle housing. Remove hub cap.

Pull cotter from axle and back off locknut. Pull axle from housing. Pull inner bearing cone and

axle bushing from axle. Felt seal is cemented to axle bushing and will be removed from axle with bushing.

Loosen the outer bearing race lockbolt in the axle housing and pull the oil seal, seal spacer, bearing outer bearing race and retainer from housing. Remove spacer tube and tapered collar from housing.

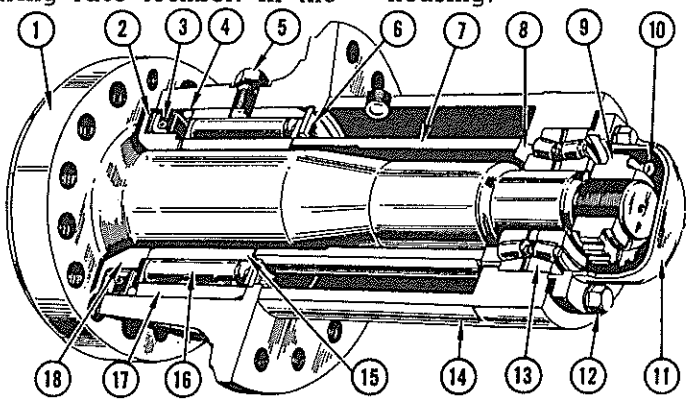

FIGURE P-5. CRANE AXLE

1. Axle
2. Felt Seal
3. Oil Seal
4. Spacer
5. Lock Bolt
6. Retainer
7. Spacer
8. Collar
9. Locknut
10. Cotter
11. Hub Cap
12. Capscrew
13. Bearing
14. Hub
15. Inner Race
16. Roller
17. Outer Race
18. Bushing

INSTALLATION

Clean and inspect all parts thoroughly. Replace all damaged or defective parts. Pack all bearings with wheel bearing grease (medium) before reassembly.

Cement felt seal to axle bushing using 3M felt seal adhesive or its equivalent. Press axle bushing and inner bearing race into place on axle until bushing is seated against axle flange and bearing race is seated against the bushing. Slide spacer onto axle shaft until it bottoms against bearing inner race.

Insert retainer into housing and press until it bottoms against housing shoulder.

Press outer bearing race into housing. Align hole in race with lockbolt in housing. Tighten the lockbolt. Replace bearing, seal spacer, and oil seal into axle housing. Lip of seal should be toward centerline of machine.

Replace axle into axle housing part way. Slide tapered collar into axle bore over axle. Slide the inner bearing cone over axle and into housing. Now position bearing cup into housing until it bottoms against shoulder in bore. Force axle the remaining distance into housing, while holding the bearing cup in position.

Replace spacer and outer bearing cone.

Replace locknut and torque to 1000 ft. lbs. and install cotter. Secure hub cap with capscrews and lockwashers.

Remove pipe plug from axle housing and fill housing approximately 1/3 full of wheel bearing grease (medium).

Replace wheel brake (if removed), wheel and tire. Torque wheel mounting capscrews to 550 ft. lbs.

MODEL D LOGGING ARCH

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MODEL D LOGGING ARCH

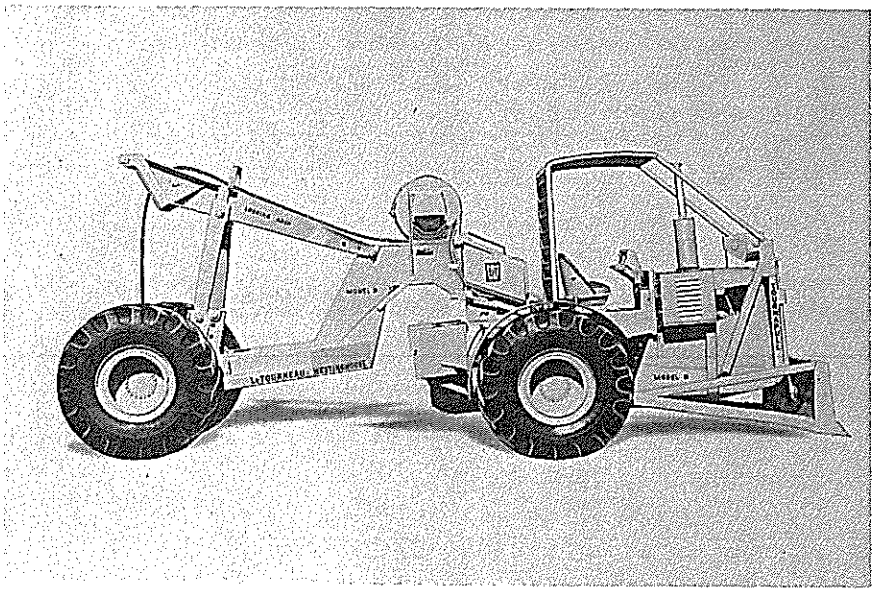

FIGURE Q-1. MODEL D TOURNAPULL WITH LOGGING ARCH

SEPARATING TOURNAPULL AND ARCH

Block up front of Tournapull using good solid cribbing. Considerable care should be exercised in constructing this cribbing to eliminate danger of rig moving forward and off the blocks. Block Tournapull wheels, front and rear. Also place blocks under the fuel tank and ballast box to prevent the machine tipping over backward.

Remove main switch box and disconnect the cable leading to the winch motor, and cable leading to remote control switches.

Bleed the air system and disconnect air lines to the arch wheel brakes and to the quick release cable drum.

Place a chain hoist around the arch yoke structure. Position blocks along the yoke to protect any tubing or cables which may be damaged by the chain. Apply enough tension on hoist to relieve tension on the yoke connecting bolts.

Position blocks on each side of steering trunnion to prevent its tipping when the trail unit is disconnected.

Using the special wrench provided, remove the four connecting bolts and separate the Tournapull and arch. Separate the two units and lower arch yoke to ground.

REMOTE CONTROLS

The arch winch motor can either be operated by the control switch on the instrument panel or by the remote control switches located on the arch yoke.

To winch-in, pull down on the left hand (winch-in) switch. To stop the motor, push up on the switch.

To winch-out, pull down on the right hand (winch-out) switch. To stop the motor, push up on the switch.

Be sure both control switches are pushed all the way in before starting diesel engine. Serious accidents can result if the winch motor starts unexpectedly.

When using remote controls, set the hand throttle to operate the engine at governed RPM. Also apply wheel brakes by using hand brake valves.

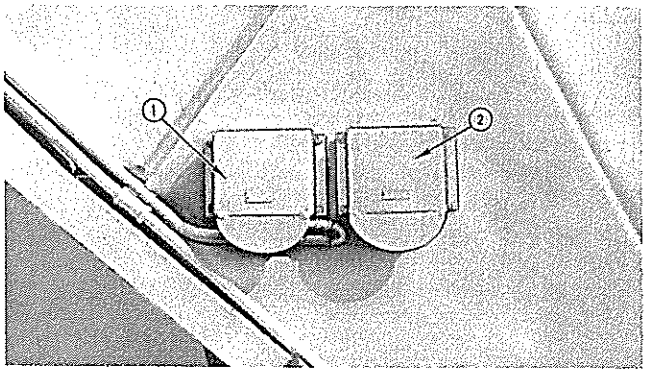

FIGURE Q-2. REMOTE CONTROLS
1. Winch In 2. Winch Out

QUICK RELEASE CABLE DRUM

Removal and Disassembly

Unwind cable from cable drum and remove setscrew securing cable in dead end. Pull cable from drum.

Remove capscrews and lockwashers securing air line guard to cable drum. Remove guard.

Bleed the air system and disconnect the air line

at the quick release drum inlet fitting.

Cut lockwires and remove capscrews securing diaphragm retainer plate to the cable drum. Separate plate and cable drum. Remove thrust plate, pressure plate, and discs from hub.

Remove locking setscrew from cable drum locknut. Remove locknut from gear box output shaft. Pull hub and drum from output shaft.

Cut lockwires and remove capscrews securing backing plate to diaphragm retainer plate. Separate backing plate, diaphragm, and diaphragm retainer plate.

To disassemble air inlet assembly, remove the bearing retainer. Insert driver tool into the air inlet tube from the inside of diaphragm backing plate and drive out tube. Pull bearings and seal.

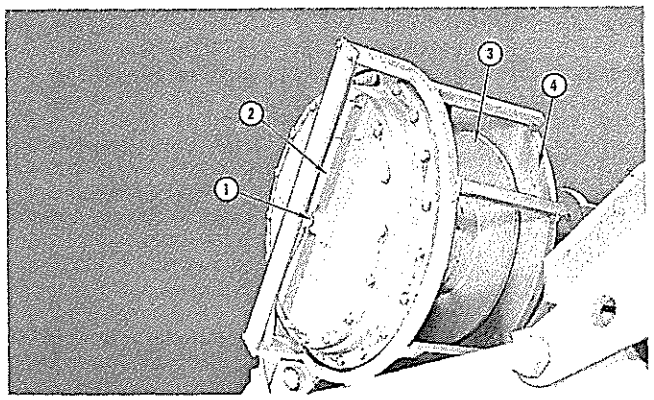

FIGURE Q-3. QUICK RELEASE CABLE DRUM

1. Air Inlet Fitting
2. Backing Plate
3. Drum
4. Gear Box Mount

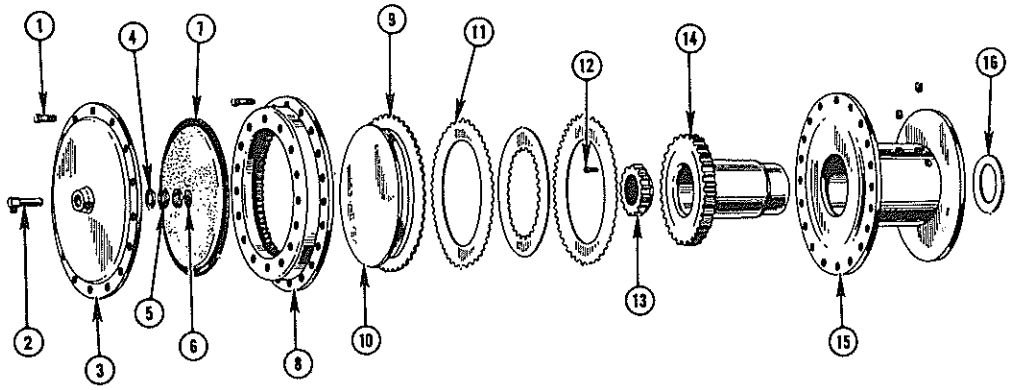

FIGURE Q-4. CABLE DRUM, EXPLODED

1. Capscrew
2. Inlet Fitting
3. Backing Plate
4. Seal
5. Bearing
6. Retainer
7. Diaphragm
8. Diaphragm Retainer Plate
9. Pressure Plate
10. Thrust Plate
11. Disc
12. Setscrew
13. Locknut
14. Hub
15. Cable Drum
16. Washer

Reassembly

To reassemble inlet group, install new oil seal and bearings. Insert new air inlet tube and peen tube over. Replace retainer.

Lubricate diaphragm with a good grade of cup grease and replace on backing plate. Replace the backing plate and diaphragm on retainer plate — secure with capscrews and lockwires.

Replace washers, cable drum, and hub onto the gear box output shaft. Replace locknut and torque to 1000 ft. lbs. Install locking setscrew.

Position discs on hub, starting with an externally splined one, then alternating with internally splined ones.

Replace pressure plate and thrust plate.

Position diaphragm assembly over discs and hub. Secure to cable drum with capscrews and lockwashers.

Reconnect air line. Replace air line guard.

See Section "K" of this manual for lubrication instructions.

MOTOR AND GEAR BOX REMOVAL

Winch

MOTOR

Remove drain plug and drain lubricant from gear box.

Remove capscrews securing motor cover to stator. Lift off cover. Disconnect electric cable from motor terminal strip.

Fasten rope sling around motor. Apply only enough tension to relieve strain on motor mounting capscrews. Remove the capscrews and lockwashers securing the motor to gear box.

Pull motor straight away until motor pinion clears gear box bore. Be careful so as not to damage oil seal in gear box bore.

GEAR BOX

Remove cable drum. Drain lubricant from gear box.

Remove capscrews securing motor cover to stator. Lift off cover. Disconnect electric cable from

motor terminal strip.

Fasten rope sling around motor and gear box. Apply only enough tension to relieve strain on the gear box mounting capscrews.

Remove capscrews and lockwashers securing the gear box to the mounting flange.

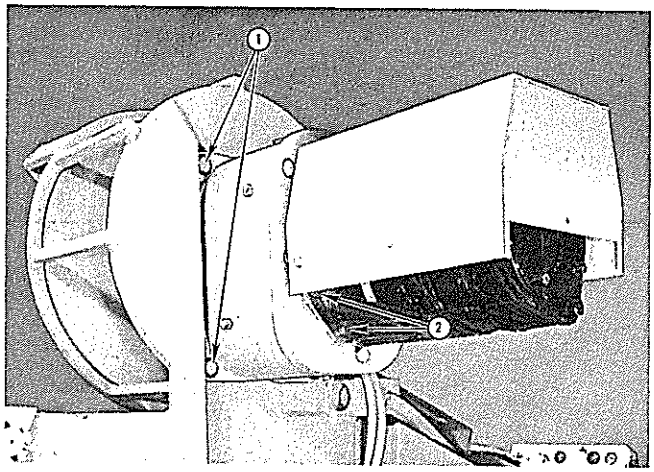

FIGURE Q-5. WINCH MOTOR AND GEAR BOX

1. Gear Box Mounting Capscrews
2. Motor Mounting Capscrews

Pull motor and gear box straight away from the flange. Place unit on bench for further disassembly. Place unit on bench for further disassembly. Refer to Section "J" of this manual for motor and gear box disassembly.

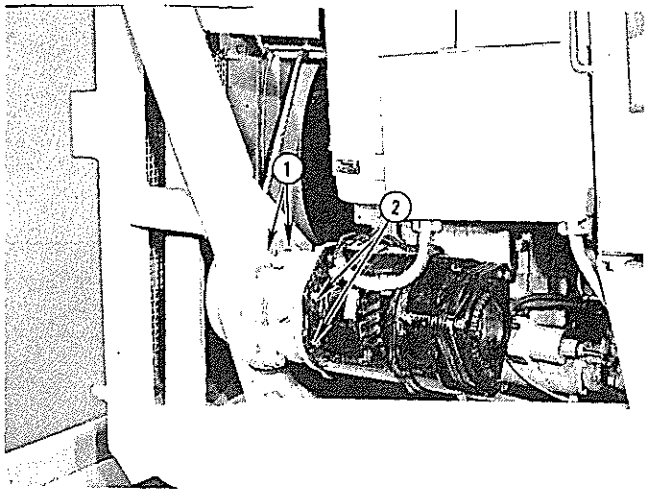

FIGURE Q-6. DOZER MOTOR AND GEAR BOX

1. Gear Box Mounting Capscrews
2. Motor Mounting Capscrews

Dozer

CABLE DRUM

Unwind cable from cable drum. Loosen setscrew in cable dead end and pull cable free.

Remove setscrew from cable drum locknut. Using wrench and extension handle, back off splined locknut from cable drum shaft. Remove cable drum.

MOTOR

Remove capscrews securing motor cover to case.

Remove drain plug and drain lubricant from gear box. Disconnect electric cable from terminal strips on motor and free from cable clamps.

Support motor with rope sling. Place only enough tension on sling to relieve tension on motor mounting capscrews.

Remove capscrews securing motor to gear box. Pry motor away from gear box until motor pinion has cleared bore in gear box. Pull motor straight away from gear box to prevent damaging oil seal in gear box bore.

GEAR BOX

Remove drain plug and drain lubricant from gear box.

Remove cable drum.

Remove capscrews securing motor cover to case. Remove cover. Disconnect electric cables from terminal strip on motor and free from cable clamps.

Support motor and gear box with a rope sling. Place only enough tension on sling to relieve tension on gear box mounting capscrews.

Remove gear box mounting capscrews. Lift motor and gear box from machine. Separate as described for removing motor.

Refer to Section "J" of this manual for motor and gear box disassembly.

AXLE

Removal and Disassembly

Block up side of machine from which axle is to be removed. Remove wheel and tire as described in Section "H" of this manual. Also refer to Section "H" if removal or disassembly of the wheel brake is necessary.

Remove locking setscrew from axle housing cap. Place special wrench over splines on axle housing cap and unscrew cap from housing.

Remove cotter from axle nut. Position special wrench over axle nut and brace it to prevent its turning. Then positioning two capscrews, 180° apart, in the axle flange and using a bar turn the axle and loosen the nut; remove nut.

Using a bar between the axle flange and the housing pry the axle out.

Remove double row ball bearing from bore in axle housing.

Loosen outer bearing race lockbolt in axle housing and pull oil seal, roller bearing and bearing race from housing.

Installation

Clean and inspect all parts thoroughly. Replace all damaged or defective parts. Pack bearing with wheel bearing grease (medium) before reassembly.

Press outer roller bearing race into housing.

Align hole in race with lockbolt in housing. Tighten lockbolt. Replace bearing.

Replace oil seal into housing, lip of seal should be pointing toward centerline of machine.

Replace axle into housing. Position inner double row ball bearing into housing and over the axle. Install locknut and torque to 1000 ft. lbs. Replace cotter.

Replace axle housing cap and locking setscrew.

Remove pipe plug from axle housing and fill housing approximately 1/3 full of wheel bearing grease (medium). If housing is equipped with a grease fitting, lubricate through the fitting.

Replace wheel and tire. Torque wheel mounting capscrews to 550 ft. lbs.

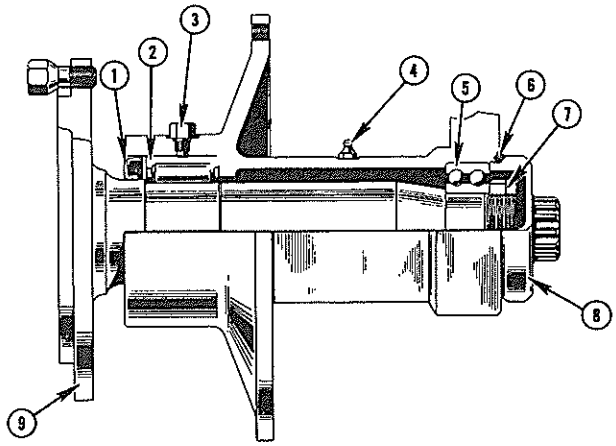

FIGURE Q-7. LOGGING ARCH AXLE

1. Oil Seal
2. Roller Bearing
3. Lockbolt
4. Grease Fitting
5. Ball Bearing
6. Setscrew
7. Locknut
8. Retainer
9. Axle

ELECTROTARDER

The electrotarder is made up of three grid assemblies mounted in a case. Each grid assembly consists of resistance grid plates which are connected in series. The electrotarder is connected to the three phase output terminals on the transformer terminal strip by means of two main switches. The main switches are operated by a toggle type switch on the instrument panel.

When loaded machines are operating down grades, the load has a tendency to push the machine. This will force the machine to overspeed, thus causing the machine to go beyond safe operating speeds unless the wheel brakes are applied to hold the load.

The electrotarder is placed on the arch as an additional means of slowing down the machine. When operated the electrotarder is a resistance which is added to the generator circuit, placing a load on the generator, thereby slowing down the rotor. Since the generator rotor is part of the power train, this will cause the machine to slow down.

The electrotarder is mounted on the right front of the Tournapull case.

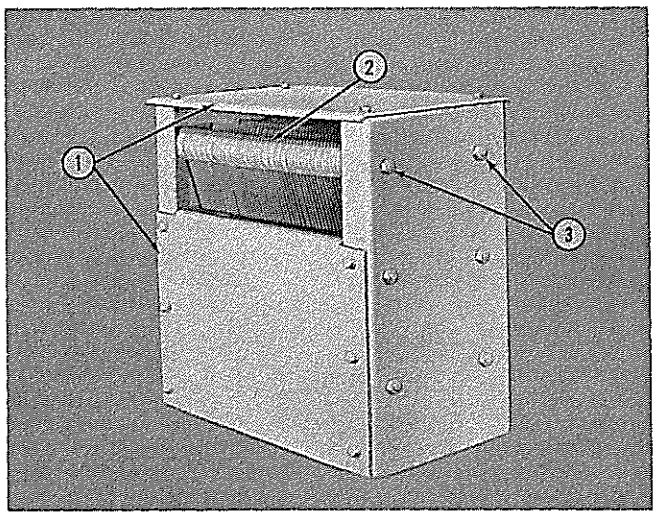

FIGURE Q-8. ELECTROTARDER

1. Cover Plates
2. Grid
3. Support Rods

The electrotarder can be removed after disconnecting the leads to the grids and removing the mounting capscrews.

Disassembly

Remove the top and front cover plates.

Remove the nuts from the support rods which secure the front support plate in position or the rear plate, depending upon whichever is closer to the point of repair.

Remove nuts, steel spacers and insulation from support rods. Slide spacers and resistance grid plates off support rod. Slide mica tube from support rod.

Be sure to note the relative position of the spacers, both mica and steel, and grids so they can be replaced in the same order as removed.

Repeat the same procedure for each grid assembly.

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