FORD

FORD 8000
FORD 8600
FORD 8700
FORD 9000
FORD 9600
FORD 9700
FORD TW - 10
FORD TW - 20
FORD TW - 30

FORD

SHOP MANUAL

MODELS 8000—8600—8700—9000—9600—9700—TW-10—TW-20—TW-30

These Ford tractors are equipped with a six-cylinder diesel engine. The 9000 series, TW-20 and TW-30 models engines are equipped with a turbocharger and due to increased power output, several components on these models have been strengthened in comparison to the 8000 series and TW-10 models. An eight-speed gear type transmission and disc type clutch is standard on all models. A Dual Power planetary gear assembly which provides under-drive ratios in all transmission speeds is standard on TW-30 models and available for all other models.

Identification numbers pertaining to Models 8000, 8600, 9000 and 9600 are located on a plate inside the tool box cover.

Numbers pertaining to Models 8700 and 9700 are located on a plate mounted on the underside of the radiator filler cap access door.

Numbers pertaining to Models TW-10 and TW-20 are on a plate located above the right front corner of the radiator and are accessible after removing the right front grill panel.

Numbers pertaining to Model TW-30 are on a plate located between the radiator and front fuel tank; they are accessible by sliding the right front grill panel forward.

INDEX (By Starting Paragraph)

INDEX CONT.

CONDENSED SERVICE DATA

GENERAL	8000, 8600, 8700	9000, 9600, 9700	TW-10	TW-20	TW-30
Engine Make	Own	Own	Own	Own	Own
No. of Cylinders	6	6	6	6	6
Bore, Inches	4.4	4.4	4.4	4.4	4.4
Stroke, Inches	4.4	4.4	4.4	4.4	4.4
Displacement, Cubic Inches	401	401	401	401	401
Compression Ratio	16.5:1	16.5:1	16.3:1	15.6:1	15.6:1
Pistons Removed From	Above	Above	Above	Above	Above
Main Bearings, Number of	7	7	7	7	7
Cylinder Sleeves	None	None	None	None	None
Generator Make	Own	Own	.....	.....	.....
Alternator Make	Motorola				
Starter Make	Own	Own	Own	Own	Own
Turbocharger Make	See Paragraph 134				
Injection Pump Make	Simms	Simms	Minimec	Minimec	Minimec
Forward Speeds	8	8	8	8	.....
With Dual Power	16	16	16	16	16
Reverse Speeds	2	2	2	2	.....
With Dual Power	4	4	4	4	4

CONDENSED SERVICE DATA CONT.

TUNE-UP	8000, 8600, 8700	9000, 9600, 9700	TW-10	TW-20, TW-30
Firing Order	1-5-3-6-2-4			
Compression, Gage Lbs. at Cranking Speed of 200 Rpm	380-480	380-480	300-400	275-375
Maximum Allowable Variation Between Cylinders, Psi	20	20	20	20
Valve Tappet Gap, Intake, Hot	0.014-0.016 inch			
Valve Tappet Gap, Exhaust, Hot	0.017-0.019 inch			
Engine Low Idle Rpm	700-800	700-800	700-800	700-800
Engine High Idle Rpm	2530-2580	2420-2470	2530-2580	2420-2470
Engine Rpm at Rated Load	2300	2200	2300	2300
Engine Rpm for 540 Pto Rpm	1900	*1900	1873	*1873
Engine Rpm for 1000 Pto Rpm	1935	1935	1918	1918
Injection Timing	23° BTDC			
Battery Terminal Grounded	Neg.			

*540 rpm pto shaft not available on 9000, TW-30 and some 9600 models.

SIZES—CAPACITIES—CLEARANCES [INCHES]				
Crankshaft Journal Diameter	See Paragraph 98			
Crankpin Diameter	See Paragraph 97			
Camshaft Journal Diameter	2.3895-2.3905			
Piston Pin Diameter	1.4997-1.5000	1.6246-1.6251	1.4997-1.5000	1.6246-1.6251
Valve Stem Diameter, Intake	0.3711-0.3718			
Valve Stem Diameter, Exhaust	0.3701-0.3708			
Main Bearing Running Clearance	0.002-0.0045			
Rod Bearing Running Clearance, Aluminum Bearings	0.0025-0.0046			
Copper-Lead Bearings	0.0017-0.0038			
Camshaft Bearing Running Clearance	0.001-0.003			
Crankshaft End Play	0.004-0.008			
Camshaft End Play	0.001-0.007			
Piston Skirt Clearance	See Paragraph 95			
Cooling System, Quarts	18	19	20	20
Crankcase, Quarts, Without Filter Change	10	12	18	18
With Full Flow Filter Change Only	12	14	20	20
With Both Filters Changed	13 (8000 only)			
Rear Axle & Hydraulic Systems, Quarts	See Paragraph 197			
Power Take-Off, Quarts	See Paragraph 217			
Transmission, Quarts	See Paragraph 197			
Fuel, Gallons	43	43	58	**100
Power Steering System, Quarts	4.2	4.2	3.9	3.9

**TW-20 fuel capacity is 58 gallons.

FRONT SYSTEM AND STEERING MODELS 8000—8600—9000—9600

WIDE ADJUSTABLE FRONT AXLE

Exploded view of row crop axle is shown in Fig. 1; all purpose type is similar except center (main) member is reversed. All parts except center steering arm (13) and inner tie rod ends (12) are interchangeable between row crop and all purpose types. Refer to Figs. 2 and 3 for center steering arm and tie rod installation.

1. **R&R FRONT AXLE ASSEMBLY.** To remove either the row crop or all purpose type front axle, proceed as follows: Straighten tabs of locking plates and unbolt center steering arm (13—Fig. 1) from steering motor shaft. Support front end of tractor, unbolt front pivot pin support (21) from front support and roll axle assembly forward. Unbolt and remove rear pivot pin support (16).

Reinstall front axle by reversing

removal procedure, making sure a thrust washer (17) is placed on each pivot pin. Tighten pivot pin support and center steering arm cap screws to a torque of 180-220 ft.-lbs., then bend locking plates against steering arm cap screw heads.

2. **SPINDLE BUSHINGS.** To renew spindle bushings, support front of tractor and remove front wheels. Remove steering arm clamp bolts on models so equipped, pull arms from spindles and remove Woodruff keys (8—Fig. 1). On models equipped with spindles having splined end is shown in Fig. 1, remove retaining nut (24) and pull steering arm from spindle. Withdraw spindles downward out of axle extensions. Remove seals (7) and thrust bearing (3). Remove thrust bearing spacers (2) if worn or damaged. Drive bushings from axle extensions and install new bushings using piloted drift or driver; bushings are presized and should not require reaming if carefully installed. Be sure grease holes are aligned. Pack thrust bearings with grease.

NOTE: Upper ends of early spindles with a key were 1½ inches in diameter whereas late spindles with a key are approximately 1-5/8 inches. Only the large diameter spindle is available. If renewing small spindle, a new large diameter steering arm must also be installed. Be sure correct size spindle seal is installed. Tighten steering arm clamp bolts on models equipped with keyed spindles to a torque of 135-165 ft.-lbs. On models with splined spindles, tighten retaining nuts (24—Fig. 1) to a torque of 200-250 ft.-lbs. Stake spindle threads to nut.

3. **AXLE CENTER MEMBER, PIVOT PINS AND BUSHINGS.** To remove axle center member (20—Fig. 1), support front of tractor, remove clamp bolts from tie rods and unbolt axle extensions from center member. Withdraw axle extensions with spindles and wheels from center member and tie rod sleeves. Unbolt and remove center steering arm with tie rods. Support center member and unbolt front pivot pin support. Move center member and front pivot forward until clear of rear pivot pin and lower to floor. Unbolt and remove rear pivot pin and support.

Pivot pins are integral parts of pivot pin supports; renew the pin and support assembly if pin is excessively worn. Renew bushings (18) in center member if member is otherwise serviceable; bushings are pre-sized and should not require reaming if carefully installed. Be sure grease holes are aligned and install plug (19) in bore through axle tube. Renew thrust washers (17) if worn.

Reinstall by reversing removal procedure. Tighten pivot pin support and center steering arm cap screws to a torque of 180-220 ft.-lbs., then bend locking plates against steering arm cap screw heads. Tighten tie rod clamp bolts to a torque of 25-35 ft.-lbs. and check toe-in as outlined in paragraph 4.

4. **TIE RODS AND TOE-IN.** Tie rod ends are of the non-adjustable automotive type and procedure for renewing same is evident. Tighten clamp bolts on outer tie rod ends to a torque of 25-35 ft.-lbs. and tighten jam nut at inner end of tie rods to a torque of 100-125 ft.-lbs.

Toe-in on both row crop and all purpose models should be ¼- to ½-inch. Position center steering arm at center line of tractor as shown in Fig. 2 or Fig. 3 before checking toe-in at spindle height. If toe-in is not correct, remove

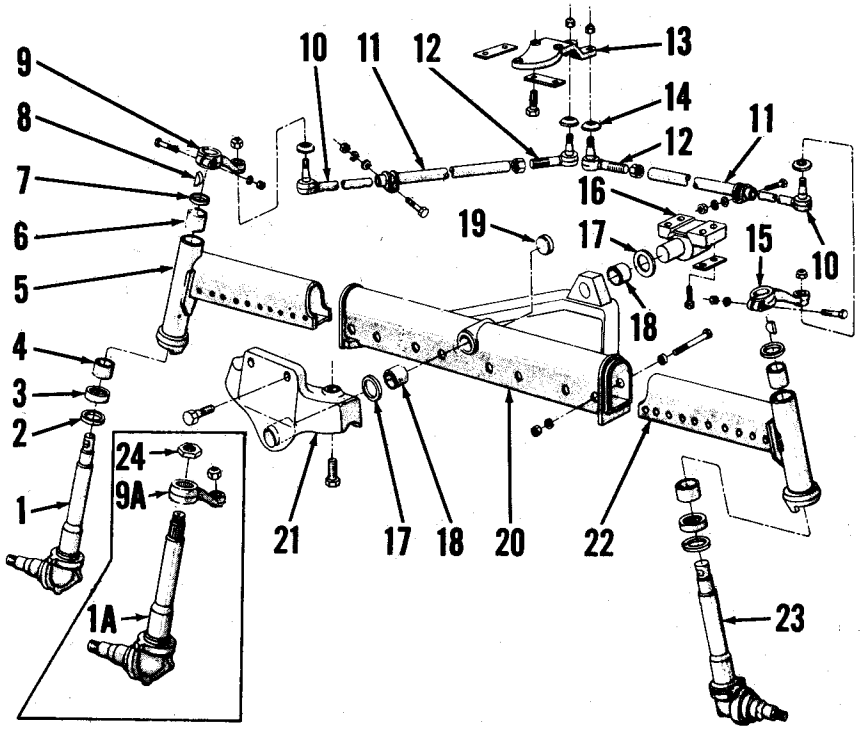


Fig. 1—Exploded view of row crop type wide adjustable front axle. All purpose type front axle is similar except that center member (20) is reversed to provide shorter wheelbase. Note that later models are equipped with spindles (1A) and steering arms are retained by a nut as shown in inset. All parts except center steering arm (13) and inner tie-rod ends (12) are interchangeable between row crop and all purpose types. Refer to Figs. 2 and 3 for center steering arm views.

1. & 1A. Spindle, R.H.
2. Thrust spacer
3. Thrust bearing
4. Lower bushing
5. Axle extension, R.H.
6. Upper bushing
7. Seal
8. Woodruff key
9. & 9A. Steering arm
10. Tie rod ends, outer
11. Tie rod tube
12. Tie rod ends, inner
13. Steering arm, center
14. Dust seals
15. Steering arm, L.H.
16. Rear pivot pin & support
17. Thrust washers
18. Pivot pin bushings
19. Plug
20. Axle center member
21. Front pivot pin & support
22. Axle extension, L.H.
23. Spindle, L.H.
24. Nut

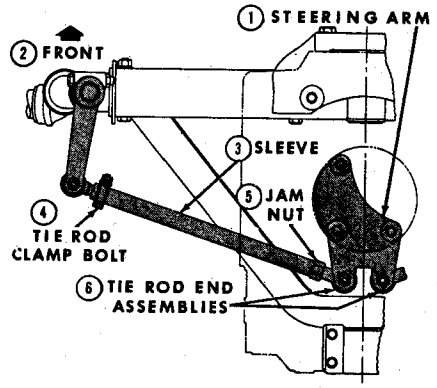


Fig. 2—When checking toe-in on row crop wide adjustable axle, be sure steering arm is centered as shown. View is from top. When installing center steering arm, be sure steering motor is centered and install arm as shown.

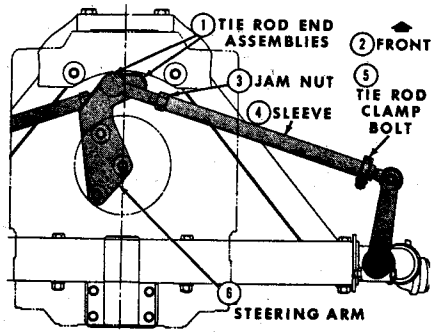


Fig. 3—View showing position of all purpose type center steering arm for checking toe-in. Note that center arm (6) and tie rod inner ends are different than those used on row crop front end. View is from top.

clamp bolts and loosen jam nuts on both tie rods, then turn each tie rod sleeve an equal amount as necessary. Refer to preceding paragraph for tightening torques.

TRICYCLE FRONT SPINDLE

5. The dual wheel tricycle spindle is bolted directly to the power steering motor shaft; procedure for removing and installing spindle is obvious. Tighten spindle to steering motor shaft cap screws to a torque of 209-231 ft.-lbs. Spindle can be installed on steering motor shaft in one position only due to offset bolt holes.

FRONT SUPPORT (PEDESTAL)

6. To remove front support, first remove steering motor assembly as outlined in paragraph 22. Remove wide front axle assembly as outlined in paragraph 1. Unbolt and remove side plates from front support and transmission. Attach hoist to front support, then unbolt front support from engine cylinder block and oil pan; be careful not to lose shims on the two oil pan bolts and label shims for reinstallation, if same pedestal, oil pan and cylinder block are to be reinstalled.

If front support, oil pan, and/or engine cylinder block have been renewed, it will be necessary to select shim thickness for installing front support as follows: Install the three bolts and one cap screw retaining front support to cylinder block and tighten to a torque of 180-220 ft.-lbs. Install the two cap screws retaining front support to oil pan, tighten them to a torque of 180-220 ft.-lbs., then measure gap between front support and oil pan at the two bolting points using a feeler gage. Remove the two front axle support to oil pan cap screws, then reinstall with shims equal to measured gap and tighten cap screws to a torque of 270-330 ft.-lbs. Shims are available in thicknesses of 0.015, 0.018, 0.021, 0.024 and 0.027 inch.

If front support is being reinstalled with same engine cylinder block and oil pan, reinstall shims as removed on the two front support to oil pan cap screws. Tighten the front support to cylinder block bolts and cap screws to a torque of 180-220 ft.-lbs., then tighten the two front support to oil pan cap screws to a torque of 270-330 ft.-lbs.

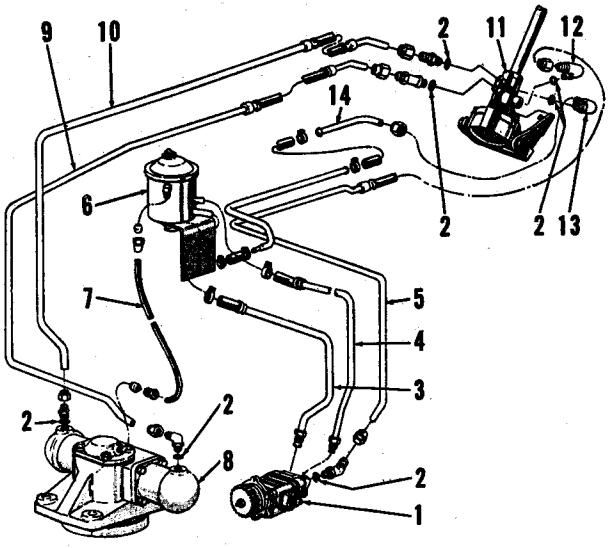


Fig. 4—View showing hydrostatic power steering system used on 8000 and 9000 models and early 8600 and 9600 models. Note that tube (9) from left end of steering motor (8) is connected to lower port on front side of Hydramotor steering unit (11) and is connected by long fitting to offset connecting nuts. Pressure tube (5) from pump is connected to left side port of Hydramotor unit by elbow (12); elbow (13) is fitted in rear port of Hydramotor unit and connects to return tube (14) to reservoir. Refer to Fig. 5 for later system.

1. Pump assy.
2. "O" rings
3. Pump inlet tube
4. By-pass tube
5. Pressure tube
6. Reservoir assy.
7. Return tube
8. Steering motor
9. Left cylinder tube
10. Right cylinder tube
11. Hydramotor steering unit
12. Elbow connector
13. Elbow connector
14. Return tube

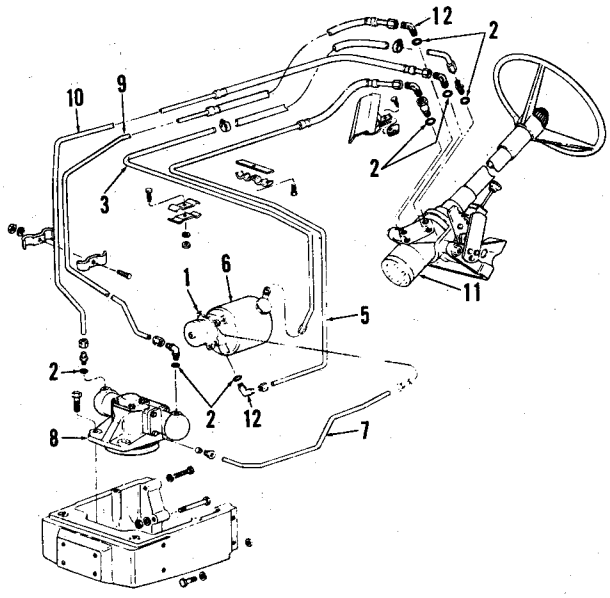


Fig. 5—8600—9600 hydrostatic power steering system with integral hydraulic pump and reservoir. Refer to Fig. 4 for identification of components. Steering motor (11) is pressurized from tube (5) to lower port. Upper port returns unused fluid through tube (3) to reservoir (6). Tubes (9) and (10) are routed to front steering motor (8) from side ports.

HYDROSTATIC POWER STEERING SYSTEM

CAUTION: The maintenance of absolute cleanliness is necessary when servicing the hydrostatic power steering

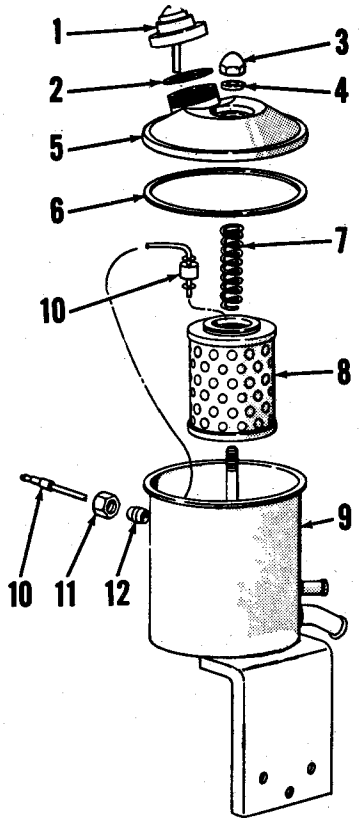


Fig. 6—Exploded view of power steering system reservoir used on 8000 and 9000 models and early 8600 and 9600 models. Oil level switch (10) is connected to warning light on instrument panel. Filter element (8) and oil in reservoir should be renewed after each 600 hours of use.

1. Dipstick & filter cap
2. Gasket
3. Acorn nut
4. Sealing washer
5. Cover
6. Gasket
7. Element retainer spring
8. Filter element
9. Reservoir
10. Warning light switch
11. Nut
12. Ferrule

system. Avoid use of shop towels or rags in wiping internal parts as any lint can cause malfunction of the system.

All 8000 and 9000 models and early 8600 and 9600 models were equipped with a remote power steering oil reservoir, a Saginaw Hydramotor power steering motor and a power steering pump with a flow control valve. The relief valve on pump is accessible from the outside.

Late 8600 and 9600 models were equipped with a Ross power steering motor which uses a spool to control flow. Steering pumps on these models have the reservoir as an integral part of pump. It is necessary to remove this type pump from engine to change filter or relief pressure.

7. **FLUID, BLEEDING AND SYSTEM RESERVOIR.** Recommended power steering fluid is Ford M-2C-41 oil. Maintain fluid level to full mark on dipstick. A low oil level switch assembly (10—Fig. 6) is used on models with remote fluid reservoir and is connected to a warning light on instrument panel. The light (located in Proof-Meter dial) should be on when starter switch is turned to "ON" position and go out when engine is started. If light remains on after engine is started, check for low oil level or malfunction in warning light system.

After each 600 hours of use, renew filter element. On models with remote reservoir, remove all oil from reservoir with suction gun, install new element and refill reservoir with new oil. On models with integral reservoir, remove pump from engine, drain reservoir, remove bolt (1—Fig. 8) and renew filter and "O" rings.

On all models the power steering system is self-bleeding. When any unit has been removed or disconnected, refill reservoir, start engine and cycle system by turning steering wheel from lock to lock. System is fully bled when front wheels respond directly to steering wheel movement and oil stays at level mark. Check fluid level and add oil as required to maintain full reservoir when cycling system.

8. **CHECKING SYSTEM PRESSURE.** On models with remote reservoir the power steering pump assembly incorporates a pressure relief valve and a flow control valve. System relief pressure should be 1450-1550 psi. On later models with integral pump and reservoir, pressure should be 1550-1650 psi.

To check system relief pressure, disconnect fitting and remove elbow in pressure line (5—Fig. 4 or Fig. 5) and connect a 0-2000 psi gage to pump, using an "O" ring on fitting to pump. With the engine running, gage reading should be as stated above. On models with remote reservoir, if pressure is not as specified, remove the pressure relief valve cap (7—Fig. 7) and add or remove shims (6) as required. If adding shims under the pressure relief valve cap will not increase system pressure, clean flow control spool in pump. If pressure is still low remove and overhaul power steering pump as outlined in paragraph 11.

CAUTION: When checking system relief pressure, run engine only long enough to observe gage reading; pump may be damaged if engine is allowed to run for an excessive length of time.

On 8600 and 9600 models, with pump and reservoir as an integral unit, if pressure is not as specified, pump must be removed from engine. Drain reservoir and refer to Fig. 8. Remove reservoir (2) and filter (3). Remove relief valve body (24), shims (25) and spring (26). Shims are available in 0.010, 0.015 and 0.060 inch thicknesses. Each shim will change the pressure by the following approximate values: 0.010 inch—70 psi, 0.015 inch—105 psi, 0.060 inch—420 psi. Tighten relief valve to 30-40 ft.-lbs. torque.

9. **STEERING SYSTEM TROUBLESHOOTING [Models with remote reser-**

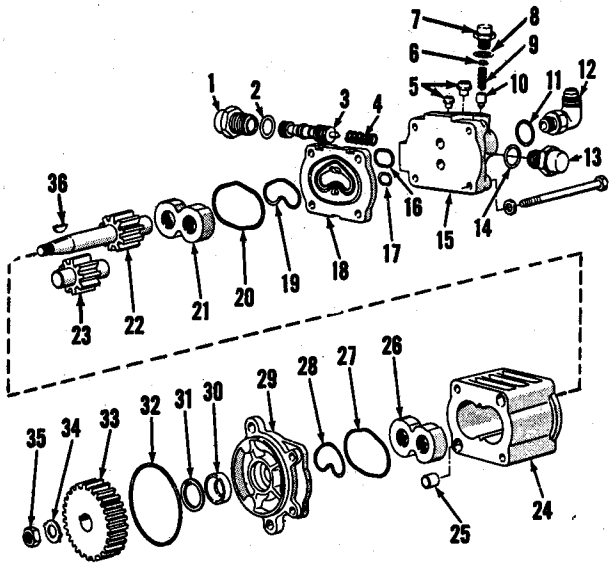


Fig. 7—Exploded view of power steering pump used with remote reservoir. Note position of flow control valve spring (4) and that small tip on valve (3) is towards spring.

1. Cap plug
2. "O" ring
3. Flow control valve
4. Spring
5. Tubing seats
6. Shims
7. Cap plug
8. "O" ring
9. Spring
10. Pressure relief valve
11. Seal ring
12. Outlet elbow
13. Cap plug
14. "O" ring
15. Rear cover
16. "O" ring
17. "O" ring
18. Rear plate
19. Inner seal ring
20. Outer seal ring
21. Bearing block
22. Drive gear & shaft
23. Driven gear & shaft
24. Pump body
25. Dowel rings (2)
26. Bearing block
27. Outer seal ring
28. Inner seal ring
29. Front cover
30. Seal
31. Snap ring
32. "O" ring
33. Drive gear
34. Tab washer
35. Nut
36. Woodruff key

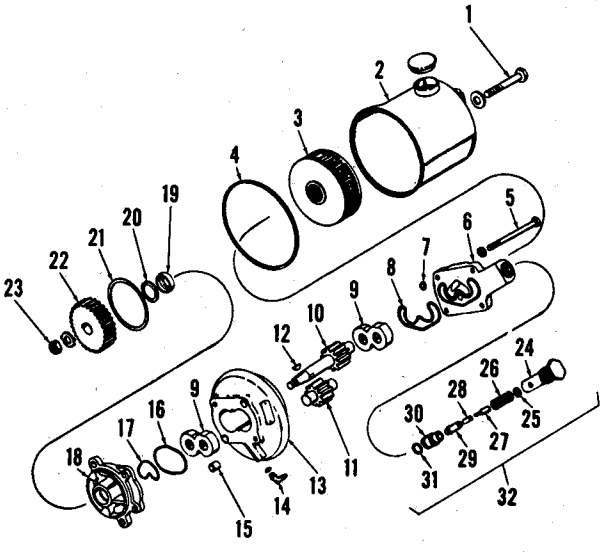


Fig. 8—Exploded view of power steering pump with integral reservoir used on late 8600 and 9600 models.

1. Bolt
2. Reservoir
3. Filter
4. Gasket
5. Through-bolt
6. Cover
7. "O" ring
8. Seal ring
9. Bearing block
10. Driven gear
11. Follow gear
12. Woodruff key
13. Body
14. Outlet elbow
15. Ring dowel
16. Seal ring
17. Seal ring
18. Flange housing
19. Oil seal
20. Snap ring
21. "O" ring
22. Drive gear
23. Shaft nut
24. Valve body
25. Shim pack
26. Spring
27. Spring guide
28. Seal
29. Valve head
30. Valve seat
31. "O" ring
32. Relief valve

voir). Refer to the following paragraphs for checking causes of steering system malfunction:

HARD STEERING. Check column bearings and bearings in Hydramotor unit; renew if rough or damaged. Check ring, rotor and vanes for wear and renew the assembly if necessary. Check for sticking control valve spool or blocking spool in Hydramotor; clean valves or renew Hydramotor parts as required.

EXCESSIVE WHEEL DRIFT. Check blocking spool spring and guide assembly and renew if spring is broken. Check for leakage past blocking valve; if excessive, renew valve body housing assembly. Check seals on steering cylinder pistons and renew pistons and/or cylinders as required.

STEERING WHEEL TURNING UNAIDED. Check the Hydramotor unit for sticking control valve spool, broken valve spool spring, actuator shaft binding or torque shaft (inside actuator shaft) broken. Clean spool and bore or renew valve body housing assembly as required.

STEERING WHEEL SLIPPAGE. Hydramotor control valve spool scored (renew valve body housing assembly) or rotor seals leaking (renew seals).

EXCESSIVE NOISE. Hydraulic lines vibrating against tractor frame or broken control valve spool spring; insulate lines from tractor or renew valve body housing assembly if spring is broken.

ERRATIC MOVEMENT OF FRONT WHEELS. Check Hydramotor ring, rotor or vanes for scoring, wear or binding condition; renew the ring and rotor assembly if necessary.

WILL NOT STEER IN EITHER DIRECTION. The manual steer check ball between pump return and pressure passages in Hydramotor unit may not be seating. Disassemble unit and clean passage with solvent and dry with compressed air. Renew pressure plate assembly if check ball cannot be made to seat.

FRONT WHEELS JERK OR TURN WITHOUT MOVING STEERING WHEEL. Check for sticking rotor vanes, rotor springs out of place or broken, scored pressure plate, scored rotor ring, scored housing, ball check valves in pressure plate leaking, improper assembly causing gap between rotor components. Disassemble the Hydramotor unit, carefully clean and inspect all parts and renew components as necessary.

10. **STEERING SYSTEM TROUBLESHOOTING. (Models with integral pump and reservoir).** Refer to the following paragraphs for checking causes of steering system malfunction:

HARD STEERING. Check column bearings and bearings in steering motor; renew if rough or damaged. Check rotor and stator assembly for wear or damage and renew assembly if necessary. Check for leaks from damaged valve spool; renew steering motor if spool is damaged. Check for binding at all pivot points in steering; free up and lubricate as necessary. Check for jammed valve spool; if unable to free up, renew steering motor assembly.

EXCESSIVE WHEEL DRIFT. Check for leakage past valve spool; if spool is worn or damaged, renew spool assembly.

EXCESSIVE NOISE. Hydraulic lines vibrating against tractor frame. Insulate lines from tractor.

ERRATIC WHEEL MOTION. Rotor vanes sticking or damaged. Check vanes, rotor and stator for free movement; renew if necessary.

WHEELS JERK FROM STOP-TO-STOP. Rotor vane springs jammed; check for proper seating of vane springs, renew complete assembly if damaged.

11. **R&R AND OVERHAUL PUMP. (REMOTE RESERVOIR).** Thoroughly clean pump, lines and surrounding area. Disconnect lines from pump and allow fluid to drain. Cap all openings to prevent dirt from entering pump or lines, then unbolt and remove pump assembly from engine front plate. When reinstalling pump, use new sealing "O" ring and tighten retaining bolts to a torque of 23-30 ft.-lbs. Reconnect lines, fill and bleed system as in paragraph 7.

Refer to exploded view of remote reservoir model pump in Fig. 7 and disassemble pump as follows: Scribe an assembly mark across pump covers and body. Straighten tab on washer (34) and remove nut (35). Pull drive gear (33) from pump shaft and remove key (36). Remove the four through-bolts and separate rear cover assembly (15), plate (18), body (24) and front cover (29). Remove bearing blocks (21 and 26) and gears (22 and 23) from pump as a unit. Remove caps (1, 7 and 13) from rear cover (15) and withdraw flow control valve (3), pressure relief valve (10) and related parts. Remove locating snap ring (31) and the oil seal (30) from front cover. Clean all parts in a suitable solvent, air dry, then lightly oil all machined surfaces.

Inspect bearing blocks (21 and 26) for signs of seizure or scoring on face of journals. (When disassembling bearing block and gear unit, keep parts in relative position to facilitate reassembly). Light score marks on faces of bearing blocks can be removed by lapping bearing block on a surface plate using grade "O" emery paper and kerosene. Examine body for wear in gear running track. If track is worn deeper than 0.0025 inch on inlet side, body must be renewed. Examine pump for excessive wear or damage on journals, journal bores in bearing blocks or teeth. Runout across the gear face to gear tooth edge should not exceed 0.001 inch. If necessary, the gear journals may be lightly polished with grade "O" emery paper to remove wear marks. The gear faces may be polished by sandwiching grade "O" emery paper between gear and face of scrap bearing block, then rotating the gear. New gears are available in matched sets only. If flow control valve (3) or rear cover (15) are scored or damaged, they must be renewed as a matched set only.

When reassembling pump, install all new seals, "O" rings and sealing rings. Insert new drive shaft oil seal (30) in front plate and install locating snap ring. Install flow control valve (3), spring (4) and plugs (1 and 13) with new "O" rings (2 and 14). Install pressure relief valve (10), spring (9) and plug (7), being sure that all shims (6) are in plug and using new "O" ring (8). Assemble pump gears to bearing blocks and insert the unit into pump body. Be sure the two bolt rings (hollow dowels) are in place in pump body, then position the front cover on body. Place the rear plate (18) at rear of body and install rear cover. Tighten the four cap screws (through-bolts) to a torque of 13-17 ft.-lbs. Install the pump drive gear key, drive gear, tab washer and nut. Tighten the nut to a torque of 55-60 ft.-lbs. and bend tab of washer against flat on nut.

12. **R&R AND OVERHAUL INTEGRAL RESERVOIR PUMP.** For exploded view of parts used on models with integral pump and reservoir refer to Fig. 8. Clean pump and surrounding area and disconnect pump pressure and return lines. Remove the two cap screws securing pump to engine front cover and lift off pump and reservoir as a unit. Drain the reservoir and remove through-bolt (1), reservoir (2) and filter (3).

Relief valve cartridge (32) can now be removed if service is indicated. For ac-

cess to shims (25) grasp seat (30) lightly in a protected vise and unscrew body (24). Shims (25) are available in thicknesses of 0.010, 0.015 and 0.060 inch. Starting with the removed shim pack substitute shims, thus varying total pack thickness, to adjust opening pressure. Available shims permit thickness adjustment in increments of 0.005 inch and each 0.005 inch in shim pack thickness will change opening pressure about 35 psi. If parts are renewed, the correct thickness can only be determined by trial and error, using the removed shim pack as a guide.

To disassemble the pump, bend back tab washer and remove shaft nut (23), drive gear (22) and key (12). Mark or note relative positions of flange housing (18), pump body (13) and cover (6); then remove pump through bolts (5). Keep parts in their proper relative position when disassembling pump unit. Pump gears (10 and 11) are available in a matched set only. Bearing blocks (9) are available separately but should be renewed in pairs if renewal is because of wear. Bearing blocks should also be renewed with gear set if any shaft or bore wear is evident. Examine body (13) for wear in gear running track. If track is worn deeper than 0.025 inch on inlet side, body must be renewed. Renew all "O" rings and seals.

When reassembling the pump, tighten through bolts (5) to a torque of 25 ft.-lbs. and drive gear nut (23) and relief valve body (24) to a torque of 30-40 ft.-lbs.

13. **SAGINAW HYDRAMOTOR STEERING UNIT.** Refer to the following paragraphs 14 through 18 for information on removal, overhaul and installation of the Saginaw Hydramotor steering unit which is used on 8000 and 9000 models and early 8600 and 9600 models. If parts are not available for repair of Hydramotor unit, a conversion kit is available to install the later Ross unit on early tractors. Refer to paragraph 9 for troubleshooting information. For the Ross unit used on 8600 and 9600 models, refer to paragraphs 19, 20 and 21.

14. R&R HYDRAMOTOR UNIT. To remove Hydramotor, first remove hood top, right and left side panels, then proceed as follows:

Remove cap (1—Fig. 9) from adjuster knob (4) and remove nut (2) and washer (3). Knob can then be removed from locking rod in shaft (11), then remove steering wheel (7) and shaft (8) as an assembly. Disconnect the four tubes from Hydramotor unit, then cap or plug all openings. Loosen both jam nuts (24) and unscrew the pivot studs (23) from support (21). Then remove steering unit from below the instrument panel.

NOTE: Remove intake manifold air tube if necessary for clearance.

To reinstall, position unit in support with tilt quadrant engaged in lock plunger and turn pivot studs in to support unit. Reconnect the four tubes and reinstall steering wheel and adjuster knob. With steering shaft shortened to full extent and steering wheel in lowered position, attach pull scale to steering wheel rim and release quadrant latch. Tighten pivot studs until a pull of 18-22 pounds will lift steering wheel from lowered position, then tighten jam nuts to a torque of 180-220 ft.-lbs. and recheck pivot stud adjustment.

NOTE: Do not attempt to position steering wheel on shaft as slippage in unit will not allow wheel to remain in any relative position to front wheel movement.

R&R STEERING COLUMN JACKET AND SHAFT ASSEMBLIES (Hydramotor Models). With Hydramotor unit removed as outlined in paragraph 14, proceed as follows:

Loosen clamp (15—Fig. 9) and pull column jacket assembly (10) from control valve housing (16). Unscrew the hex nut (14) until it nearly contacts control valve housing. Nut was staked when assembled and will turn hard. Drive the tapered collar (13) towards nut until collar is loose, then turn collar until hole in collar is over locking ball hole in outer shaft (11) and shake the ball (12) out of hole. The outer shaft, tapered collar and hex nut can then be removed from the Hydramotor actuator shaft.

Reassemble the unit before reinstalling on actuator shaft as follows: Install tapered ring (13) on outer shaft (11), with large I.D. first. Install a new nut (14) just far enough to catch one or two threads of outer shaft. Engage splines of outer shaft on splines of actuator shaft. Align hole in tapered ring, hole in outer shaft and groove around the actuator shaft, then drop locking ball in hole and groove and turn tapered collar ¼-turn. Tighten the hex nut to a torque of 40-50 ft.-lbs. and stake nut into slot in outer shaft as shown in Fig. 11.

16. R&R BLOCKING SPOOL (REACTION) VALVE (Hydramotor Models). The blocking spool valve and related parts can be removed and reinstalled after the Hydramotor steering unit has been removed as outlined in paragraph 14. Refer to Fig. 12 and proceed as follows:

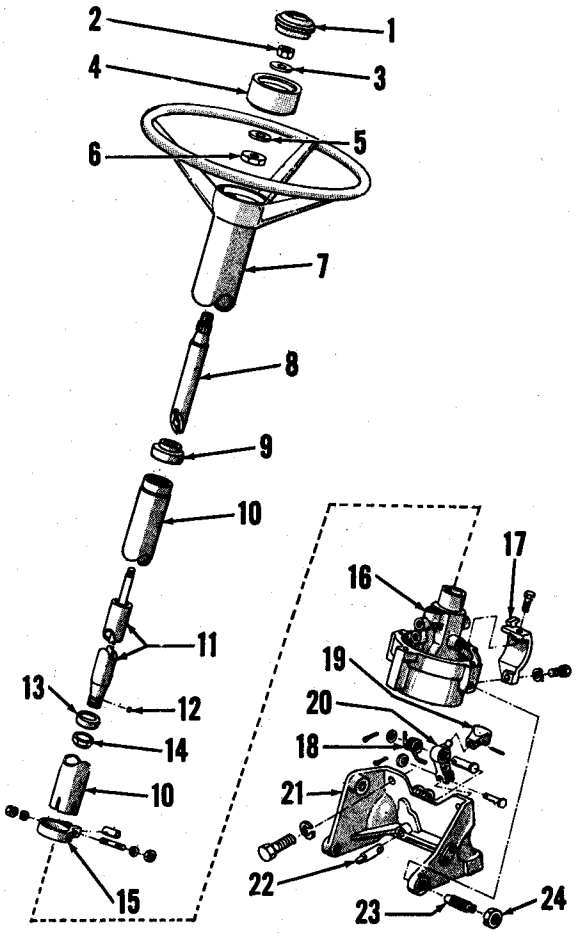


Fig. 9—View showing adjustable length steering shaft and variable position Hydramotor steering unit bracket on 8000 and 9000 models and early 8600 and 9600 models. Lock plunger (22) engages one of eight notches in quadrant (17) to hold steering wheel at desired tilt position. Adjusting knob (4) tightens tapered end of steering shaft (8) against tapered end of lower shaft to lock steering wheel at desired height.

1. Cap
2. Nut
3. Flat washer
4. Adjusting knob
5. Flat washer
6. Nut
7. Steering wheel & outer tube
8. Steering wheel shaft
9. Shaft scraper & seal
10. Steering column jacket
11. Hydramotor outer shaft
12. Steel ball (11/64-inch)
13. Taper ring
14. Nut
15. Clamp
16. Hydramotor unit
17. Tilt quadrant
18. Spring
19. Tilt knob
20. Tilt pivot
21. Support
22. Tilt lock plunger
23. Pivot studs
24. Jam nut

Remove the lockout adjuster nut (1). Plug (3) and spool valve (4) may now be removed by pushing the plug into bore against spring pressure with screwdriver, then quickly releasing the plug to allow spring to pop it out of bore. Remove plug and, if spool sticks in bore, invert the unit and tap housing (12) with soft faced mallet to jar spool out. Invert unit and allow spring (5) and spring and guide assembly (6) to drop from bore.

Spool is not serviced separately, but is available in a complete housing kit, which includes necessary parts to rebuild housing assembly.

NOTE: On some Hydramotor housings, oil leakage around blocking valve adjuster (1) may be due to mismatch of counterbore in valve spool bore and position of "O" ring (2) on plug (3). To stop oil leakage, install plug with part No. C9NN-3R675-A. Note difference in plugs shown in Fig. 14. Later models will all be equipped with the later design plug.

To reassemble, install parts in bore of housing (12—Fig. 12) as shown in exploded view, renewing the "O" ring (2) on plug (3) and tightening adjuster nut to a torque of 10-15 ft.-lbs.

NOTE: The adjuster (1) is not accessible after tractor is fully assembled; thus, the adjuster must be in the down, or closed position when unit is being reinstalled.

17. R&R COVER RETAINING SNAP RING (Hydramotor Models). To remove snap ring (7—Fig. 10) used to retain cover (30) to housing (12) proceed as follows:

With unit removed from tractor as outlined in paragraph 14, check to see that end gap of snap ring is near hole in cover as shown in Fig. 13; if not, bump snap ring into this position with hammer and punch. Insert a pin punch into hole and drive punch inward to dislodge snap ring from groove. Hold punch under snap ring and pry ring from cover with screwdriver. Usually, the coil spring (27—Fig. 10) will push housing from cover; if not, bump cover loose by tapping around edge with mallet.

To reinstall the cover retaining snap ring, housing must be held in cover, against spring pressure. It is recommended that the unit be placed in an arbor press and the housing be pushed into cover with a sleeve as shown in Fig. 15.

CAUTION: Do not push against end of shaft (14—Fig. 10).

Place snap ring over housing before placing unit in press. Carefully apply force on housing with sleeve until flange on housing is below snap ring groove in cover. Note that lug on housing which prevents rotation must enter slot in cover. If housing binds in cover, do not apply heavy pressure; remove unit from press and bump cover loose with mallet.

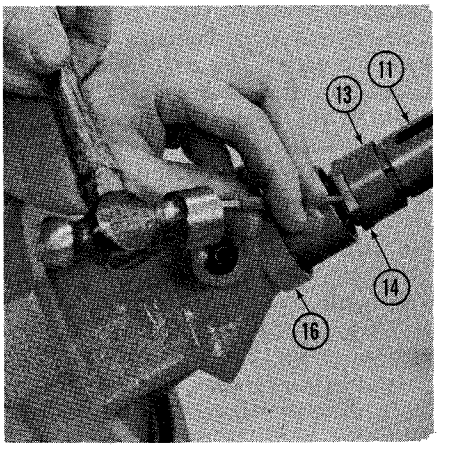


Fig. 11—After installing steering shaft on Hydramotor actuator shaft, stake hex nut to slot in steering (11) with center punch.

11. Outer shaft
13. Tapered ring
14. Hex nut
16. Housing

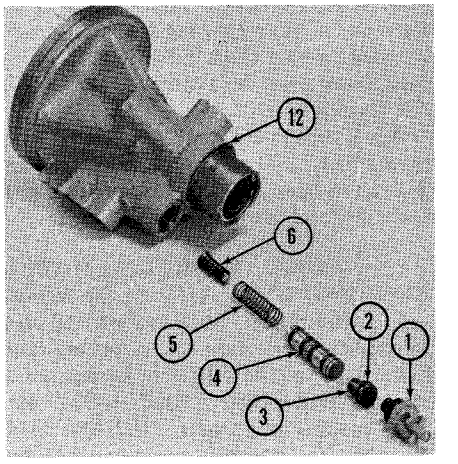


Fig. 12—Exploded view of Hydramotor housing and blocking valve components. Blocking valve can be removed without disassembly of Hydramotor.

1. Lockout
2. "O" ring
3. Plug
4. Blocking valve
5. Spring
6. Spring & guide assy.
12. Housing

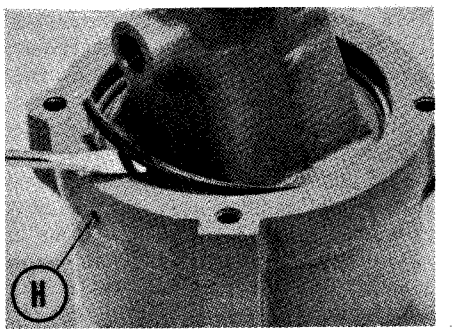


Fig. 13—To remove cover retaining snap ring, drive pin punch through hole (H) in cover to disengage snap ring from groove.

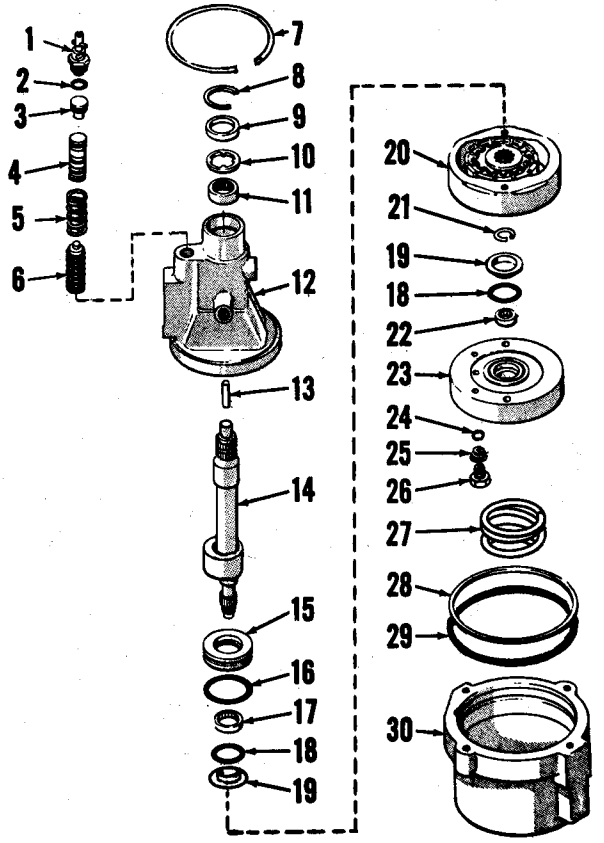


Fig. 10—Exploded view of the Saginaw Hydramotor steering unit. Also refer to Figs. 11 to 27 for photos showing disassembly and reassembly techniques.

1. Blocking valve lockout
2. "O" ring
3. Plug
4. Block valve
5. Spring
6. Spring & guide assy.
7. Snap ring
8. Snap ring
9. Dust seal
10. Oil seal
11. Needle bearing
12. Housing
13. Dowel pins (2)
14. Actuator shaft & control valve spool
15. Bearing support
16. "O" ring
17. Needle bearing
18. "O" ring
19. Rotor seal ring
20. Ring, rotor & vane assy.
21. Snap ring
22. Needle bearing
23. Pressure plate assy.
24. Check valve balls (2)
25. Check valve springs (2)
26. Retaining plugs (2)
27. Pressure plate spring
28. Back-up ring
29. "O" ring
30. Cover

When housing has been pushed far enough into cover, install snap ring in groove with end gap near hole in cover as shown in Fig. 13.

18. OVERHAUL SAGINAW HYDRAMOTOR STEERING UNIT. With the unit removed from tractor as outlined in paragraph 14 and the cover retaining snap ring removed as outlined in paragraph 17, proceed as follows:

Clamp flat portion of Hydramotor housing in a vise and remove cover (30—Fig. 10) by pulling upward with a twisting motion. Remove the pressure plate spring (27), then lift off the pressure plate (23) as shown in Fig. 16. Remove the dowel pins (Fig. 17), then remove snap ring (21) from shaft (14) with suitable snap ring pliers and screwdriver; discard the snap ring. Pull pump ring and rotor assembly (20) up off of shaft as shown in Fig. 18. Tap outer end of shaft with soft faced mallet as shown in Fig. 19 until bearing support (15) can be removed, then carefully remove the actuator shaft assembly from housing as shown in Fig. 21.

NOTE: As the actuator shaft and control valve spool asembly is a factory balanced unit and is not serviceable except by renewing the complete

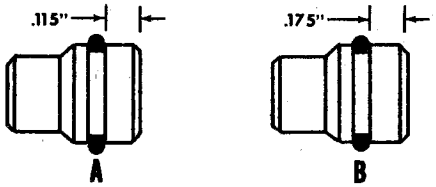


Fig. 14—Note difference in "O" ring position on above plugs. Plug (B) is Ford part No. C9NN-3R675-A and should be installed to stop oil leakage described in paragraph 16.

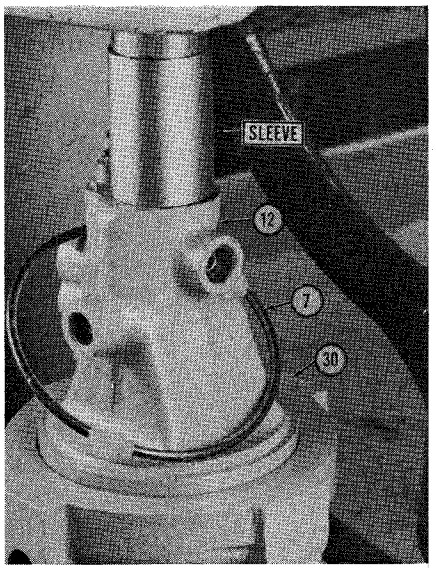


Fig. 15—Using sleeve and arbor press to push housing into cover to allow installation of cover retaining snap ring (7).

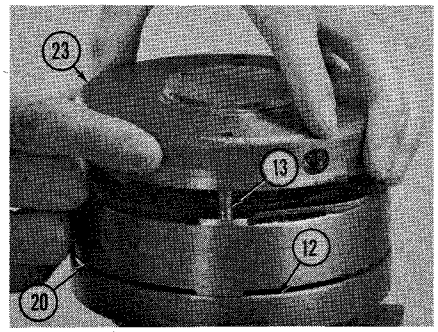


Fig 16—Lifting pressure plate (23) from dowel pins (13).

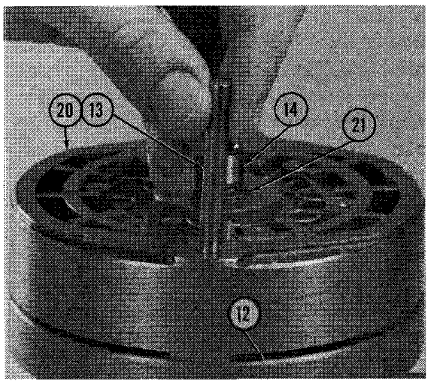


Fig. 17—Removing dowel pins (13) from motor ring and housing. Then, remove the snap ring (21) retaining rotor to actuator shaft (14).

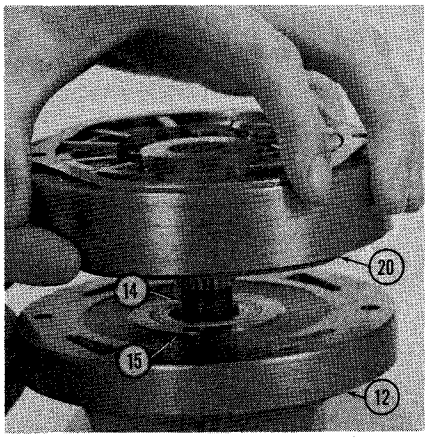


Fig. 18—Lifting the motor ring, rotor and vane assembly (20) from actuator shaft (14) and housing (12).

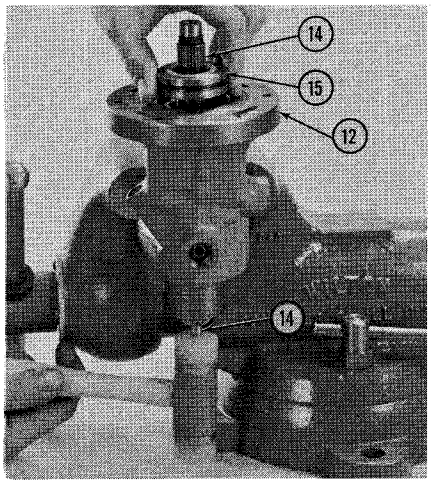


Fig. 19—Tap on outer end of actuator shaft (14) to bump bearing support (15) from the housing (12).

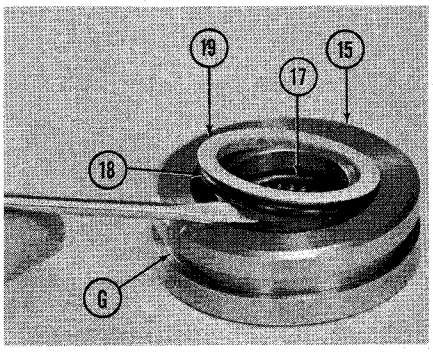


Fig. 20—Lifting the Teflon rotor seal (19) and "O" ring (18) from bearing support (15). Needle bearing (17) is serviced separately from bearing support. Groove (G) is for support sealing "O" ring (16—Fig. 10). Identical seals (18 and 19) are used in pressure plate.

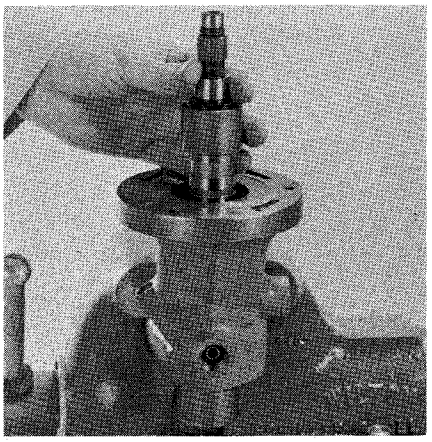


Fig. 21—Removing the actuator shaft assembly from housing. Be careful not to cock control valve spool in bore of housing.

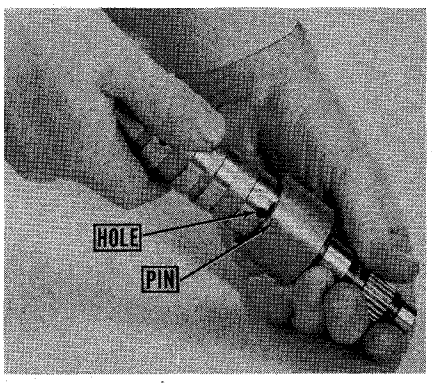


Fig. 22—Pin in actuator sleeve must be engaged in hole in end of control valve spool before actuator assembly is installed. If spool cannot be pulled out of sleeve, pin is engaged.

housing assembly, it is recommended that this unit not be disassembled.

Carefully clean and inspect the removed units. Refer to paragraph 16 for information on the blocking valve assembly. If the housing control valve bore or blocking valve bore are deeply scored or worn, or if the blocking valve spool or the actuator shaft and control valve spool assembly are damaged in any way making the unit unfit for further service, a complete new housing assembly must be installed. If these components (housing, blocking valve and actuator assembly) are serviceable, proceed with overhaul as follows:

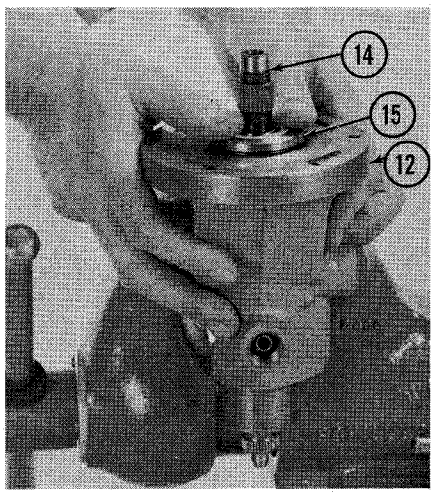


Fig. 23—When pushing bearing support (15) into housing (12), be careful not to damage the "O" ring on outside groove of support.

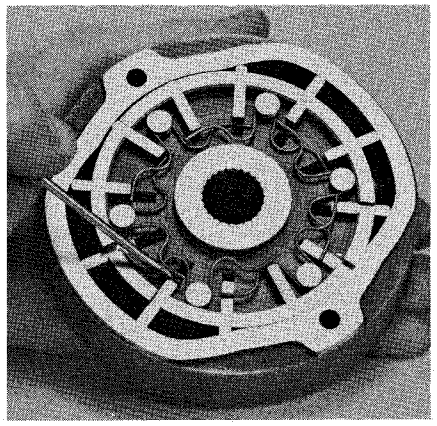


Fig. 25—Be sure all vane springs are engaged behind the rotor vanes. Springs can be pried into place with screwdriver as shown.

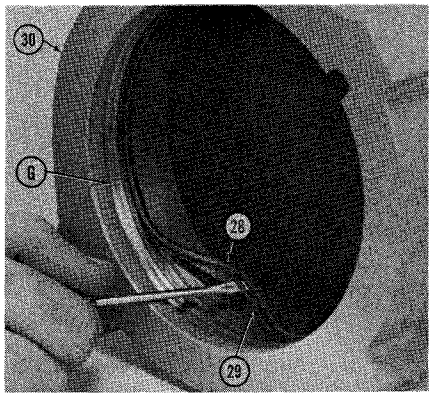


Fig. 26—"O" ring (28) and back-up ring (29) are installed in cover (30); be sure back-up ring is to outside (open side) of cover. Groove (G) is for cover retaining snap ring.

Remove the check valve retainers (26—Fig. 10), springs (25) and check valve balls (24) from pressure plate (23) and blow passages clear with compressed air. Renew the pressure plate assembly if check valve seats or face of plate are deeply scored or damaged. Renew needle bearing (22), springs (25) and/or check valve balls (24) if damaged and pressure plate is otherwise serviceable.

NOTE: Drive or press on lettered (trademark) end of bearing cage when installing new needle bearing.

If bearing support (15) is otherwise serviceable, a new needle bearing (17) may be installed; drive or press only on lettered end of bearing cage.

Remove snap ring (8), dust seal (9) and oil seal (10) and inspect the needle bearing (11); renew needle bearing if worn or damaged. Press only on lettered (trademark) end of bearing cage when installing new bearing. Install oil seal with lip towards inside (needle bearing), then install dust seal and retaining snap ring.

If the motor ring, rotor or vanes are worn, scored or damaged beyond further use, or if any of the vane springs are broken, renew the unit as a complete assembly (20). If unit was disassembled and is usable, reassemble as follows: Place ring on flat surface and place rotor inside ring. Insert six vanes in rotor slots which are in line with large inside diameter of ring. Make sure rounded edges of vane are facing outward. Turn rotor ¼-turn and insert remaining vanes. Hook the springs behind the vanes with a screwdriver as shown in Fig. 25, then turn the assembly over and hook springs behind the vanes on opposite side of rotor.

To reassemble the Hydramotor unit, place housing (12–Fig. 10) (with needle bearing, seals and snap ring installed) in a vise with flat (bottom) side up. Check to be sure that pin in actuator is engaged with hole in valve spool; if spool can be pulled away from actuator as shown in Fig. 22, push the spool back into actuator and be sure pin is engaged in one

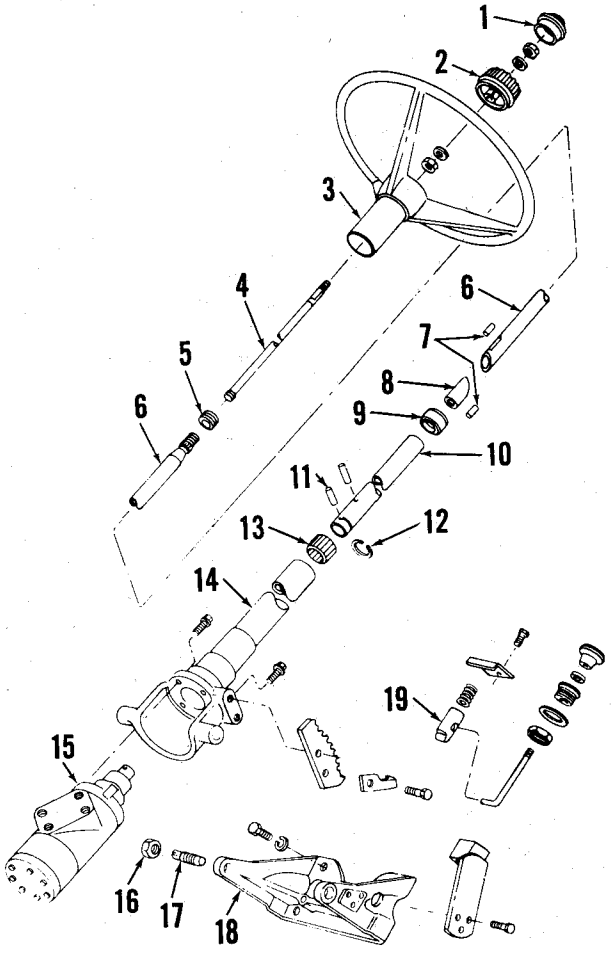


Fig. 27—Exploded view of steering column and motor used on late 8600 and 9600 models. Unit differs from Saginaw models mainly in motor (15).

1. Cap
2. Adjusting knob
3. Steering wheel & tube
4. Shaft lock rod
5. Shaft taper ring
6. Motor inner shaft
7. Retainer pin
8. Motor shaft lock
9. Upper bearing
10. Inner column jacket
11. Motor shaft pin
12. Dowel ring
13. Bearing
14. Column
15. Steering motor
16. Jamnut (2)
17. Pivot stud (2)
18. Support
19. Tilt lock plunger

of the holes in spool. Then, lubricate spool and shaft and carefully insert the assembly into bore of housing. Place bearing support (15) with outside "O" ring and needle bearing installed on shaft, and carefully push the support into housing as shown in Fig. 23. Insert rotor sealing "O" ring and rotor seal into bearing support. Place ring and rotor assembly (20–Fig. 10) on shaft and housing with chamfered outer edge of ring up (away from housing). Install a new rotor retaining snap ring (21) and insert the dowel pins through ring into housing. Using heavy grease, stick the "O" ring and rotor sealing ring (19) into pressure plate, then install the pressure plate and bearing assembly over shaft, pump ring and rotor assembly and the two dowel pins. Place the coil spring on top of pressure plate. Install new "O" ring and backup ring in second groove of cover (Fig. 26), lubricate the rings and push cover down over the pressure plate and ring. While holding the cover on the assembly, place the unit in an arbor press and insert the cover retaining snap ring as outlined in paragraph 17. Reinstall Hydramotor as outlined in paragraph 14.

19. R&R STEERING COLUMN SHAFT AND MOTOR ASSEMBLY (Late 8600-9600 Models). Refer to Fig. 27. Remove cap (1) from adjuster knob (2), remove nut, washer and knob. Use a suitable puller to remove steering wheel and tube assembly from inner shaft (6). Remove left and right hood panels. Disconnect the four tubes from power steering motor (15) and cap or plug all openings. Remove the heat deflector panels below steering motor to allow removal out the bottom. Loosen two jam nuts (16) and unscrew pivot studs (17) from support (18) until assembly can be brought down and out right side of tractor.

To reinstall, reverse removal procedure. Before installing pivot studs (17), lubricate studs and tighten until a pull of 18-22 lbs. will tilt assembly. Tighten jam nuts to a torque of 180-220 ft.-lbs. Reconnect four oil tubes so that all tubes are at right angles to engine when tight. Tighten steering wheel nut to 60-80 ft. lbs. torque. After knob (2) is placed on shaft, use knob to rotate locking shaft counter-clockwise until it stops, then tighten nut to 11-15 ft.-lbs. torque.

20. R&R STEERING COLUMN JACKET AND SHAFT ASSEMBLIES (Late 8600-9600 Models). With steering motor and shaft assembly removed as outlined in paragraph 19, proceed as follows:

Remove four bolts holding column assembly (14—Fig. 27) to steering motor (15). Remove motor and shaft assembly from column and remove motor shaft pin (11).

Reassemble in reverse order of disassembly. Tighten four bolts from column to motor to 18-22 ft.-lbs. torque.

21. **OVERHAUL ROSS STEERING MOTOR UNIT.** Remove column and steering motor assembly as outlined in paragraph 19 and separate motor assembly from column as outlined in paragraph 20. To disassemble the removed motor, refer to Fig. 28 and proceed as follows: Install a fitting in one of the four ports in housing (27), then clamp fitting in a vise so that input shaft (18) is pointing downward. Remove cap screws and end cover (1).

NOTE: Lapped surfaces of end cover (1), commutator set (5 and 6), manifold (7), stator-rotor set (8), spacer (plate) and housing (27) must be protected from scratching, burring or any other damage as sealing of these parts depends on their finish and flatness.

Remove seal retainer (4) and seal (3), then carefully remove washer (2), commutator set (5 and 6) and manifold (7). Lift off the spacer plate (10), drive link (9) and stator-rotor set as an assembly. Separate spacer plate and drive link from stator-rotor set. If the pin in end cover (1) or cover is damaged, cover must be renewed, since pin is not serviced separately.

Remove unit from vise, then clamp fitting in vise so that input shaft is pointing upward. Place a light mark on flange of upper cover (32) and housing (27) for aid in reassembly. Unbolt upper cover from valve body, using a 5/16-inch 12-point socket, then grasp input shaft and remove input shaft, upper cover and valve spool assembly. Remove and discard seal ring (31). Slide upper cover assembly from input shaft and remove spacer (17). Remove shims (11) from cavity in upper cover or from face of thrust washer (13) and note number of shims for aid in reassembly. Remove retaining ring (36), brass washer (34) and seal (33). Retain seal ring (35) and retaining ring (36) for reassembly. Do not remove needle bearing (30) unless renewal is required.

Remove ring (12), thrust washer (13) and thrust bearing (14) from input shaft. Drive out pin in input shaft (18) and withdraw torsion bar (21) and spacer (20). Place end of valve spool on top of bench and rotate input shaft until drive ring (19) falls free, then rotate input shaft clockwise until actuator ball (24) is disengaged from helical groove in input shaft. Withdraw input shaft and remove actuator ball. Do not remove actuator

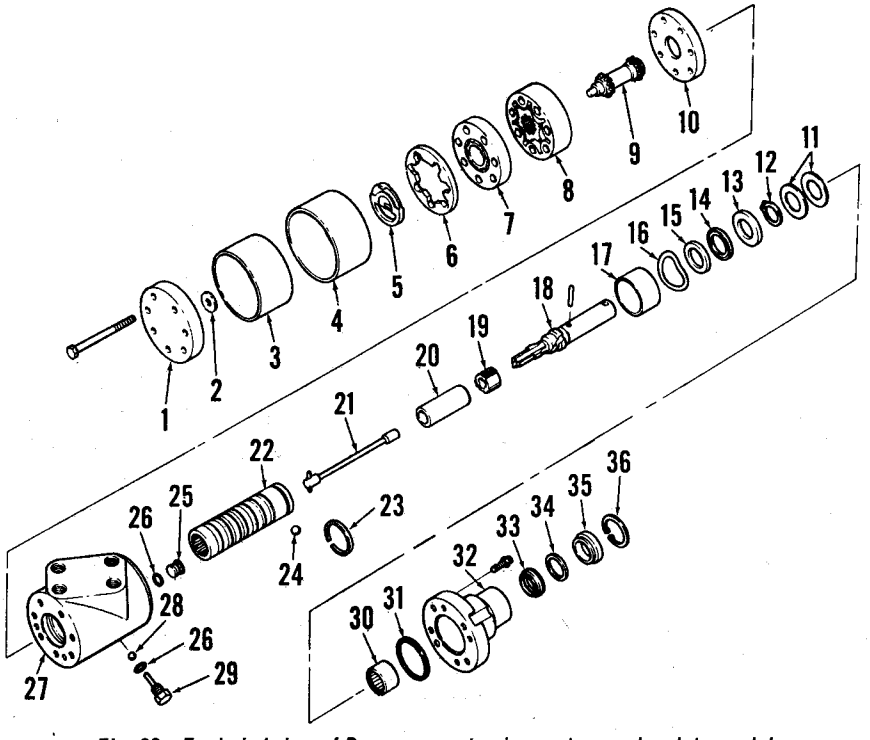


Fig. 28—Exploded view of Ross power steering motor used on late models.

1. End cover w/pin
2. Washer
3. Seal
4. Seal retainer
5. Commutator
6. Commutator ring
7. Manifold
8. Stator-rotor set
9. Drive link
10. Spacer (plate)
11. Shims
12. Retaining snap ring
13. Thrust washer
14. Valve thrust bearing
15. Thrust washer
16. Spring washer
17. Spacer
18. Input shaft
19. Drive ring
20. Spacer
21. Torsion bar
22. Valve spool
23. Ball retaining spring
24. Actuator ball
25. Plug
26. "O" ring
27. Valve body
28. Recirculating ball
29. Plug w/pin
30. Needle bearing
31. Seal ring
32. Upper cover
33. Seal
34. Brass washer
35. Stepped spacer
36. Retaining ring

ball retaining spring (23) unless renewal is required.

Remove plug (29) and recirculating ball from valve body.

Thoroughly clean all parts in a suitable solvent, visually inspect parts and renew any showing excessive wear, scoring or other damage.

If needle bearing (30) must be renewed, press same out toward flanged end of cover. Press new bearing in from flanged end of cover to the dimension shown in Fig. 29. Press only on numbered end of bearing, using a piloted mandrel.

Using a micrometer, measure thickness of the commutator ring (6—Fig. 28) and commutator (5). If commutator ring is 0.0015 inch or more thicker than commutator, renew the matched set.

Place the stator-rotor set (8) on the lapped surface of end cover (1). Make certain that vanes and vane springs are installed correctly in slots of the rotor.

NOTE: Arched back of springs must contact vanes.

Position lobe of rotor in valley of stator as shown in Fig. 30. Center opposite lobe on crown of stator, then using feeler gage, measure clearance between rotor lobe and stator. If clearance is more than 0.006 inch, renew stator-rotor assembly. Using a micrometer, measure thickness of stator and rotor. If stator is 0.002 inch or more thicker than rotor, or vanes are worn to 0.250 inch or less in length, renew the assembly. Stator, rotor and vanes are available only as an assembly.

Before reassembling, wash all parts in clean solvent and air dry. All parts, unless otherwise indicated, are installed dry. Install plug (25—Fig. 28) and new "O" ring in valve body. Install recirculating ball (28) and plug (29) with new "O" ring in valve body and tighten plug to a torque of 10-14 ft.-lbs. Clamp fitting (installed in valve body port) in a vise so that top end of valve body is facing upward. Install thrust washer (15), thrust bearing (14), second thrust washer (13) and snap ring (12) on input shaft (18). If actuator ball retaining spring (23) was removed, install new retaining spring in spool (22). Place actuator ball (24) in its seat from the inside of valve spool (22). Insert input shaft into valve spool, engaging the helix and actuator ball with a counter-clockwise motion. Use the mid-section of torsion bar (21) as a gage between end of valve spool and thrust washer as shown in Fig. 31, to insure assembly in the neutral position of the ball on ramp. Place the assembly in a vertical position with end of input shaft resting on a bench. Insert drive ring (19—Fig. 28) into valve spool until drive ring is fully engaged on input shaft spline. Remove torsion bar gage. Install spacer (20) in valve spool, over drive ring (19). Distance from top of spool (22) to top of spacer (20) should be 11/16 inch. Install torsion bar into valve spool. Align cross-holes in torsion bar and input shaft with a 0.120 inch pin punch and install pin into input shaft (18). Pin must be pressed into shaft until end of pin is about 1/32-inch below flush. Place spacer (17) over spool and carefully install spool assembly into valve body. Position original shims (11) on thrust washer (13) (if the original input shaft and cover are to be used), lubricate new seal ring (31), place seal ring in upper cover (32) and install upper cover assembly. Align the match marks on cover flange and valve body and install cap screws finger tight. Tighten a worm drive type hose clamp around cover flange and valve body to align the outer diameters, (as shown in Fig. 32), then tighten cap screws to a torque of 18-22 ft.-lbs.

NOTE: If either input shaft (18—Fig. 28) or upper cover (32) or both have been renewed, the following procedure for shimming must be used.

With upper cover installed (with original shims) as outlined above, invert unit in vise so that input shaft is pointing downward. Grasp input shaft, pull downward and prevent it from rotating. Engage drive link (9) splines in valve

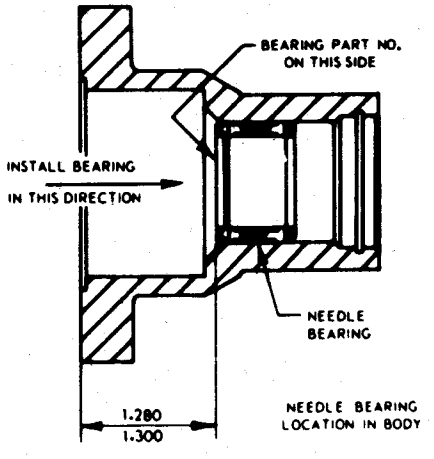


Fig. 29—When installing needle bearing in upper cover, press bearing into dimension (inches) shown.

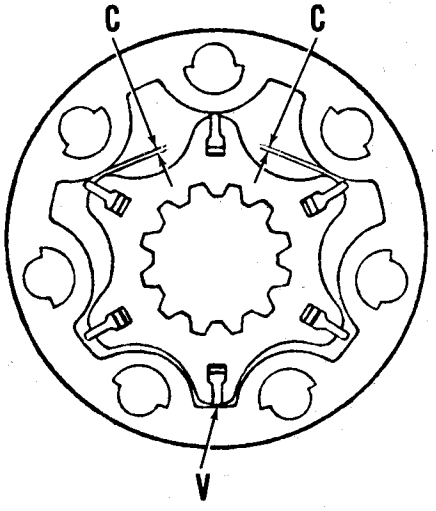


Fig. 30—With rotor positioned in stator as shown, clearance "C" must not exceed 0.006 inch. Refer to text.

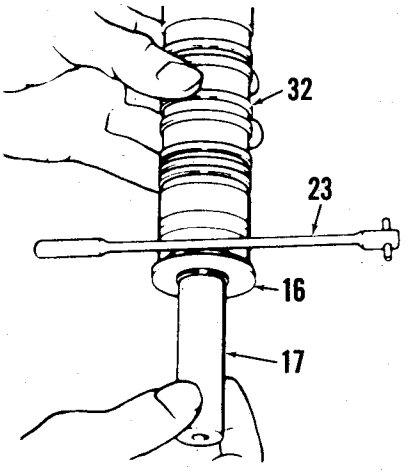


Fig. 31—Use torsion bar as shown between thrust washer and end of spool, to establish neutral position. Refer to Fig. 28 for parts identification.

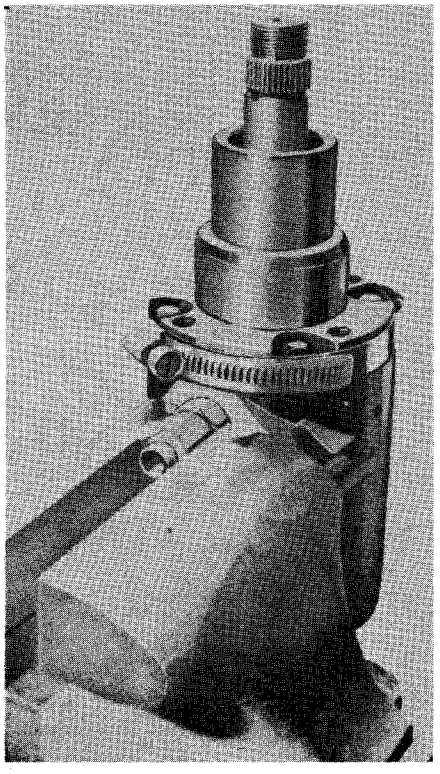


Fig. 32—A large hose clamp may be used as shown to align cover to valve body before tightening cap screws.

spool and rotate drive link until end of spool is flush with end of valve body. Remove drive link and check alignment of drive link and check alignment of drive link slot to torsion bar pin. Install drive link until its slot engages torsion bar pin. Check relationship of spool end to body end. If end of spool is protruding from body and is within 0.0025 inch of being flush with end of body, no additional shimming is required. If not within 0.0025 inch of being flush, remove cover and add or remove shims (11) as necessary. Reinstall cover and recheck spool to valve body position.

With drive link installed, place spacer plate (10) on valve body with plain side up. Install stator-rotor set over drive link splines and align cap screws holes. Make certain vanes and vane springs are properly installed. Install manifold (7) with circular slotted side up and align cap screw holes with stator, spacer and valve body. Install commutator ring (6) with slotted side up, then install commutator (5) over drive link end with counter-bore for washer (2) facing out. Make certain that link end is engaged in the smallest elongated hole in commutator. Install seal (3) and retainer (4). Apply a few drops of hydraulic fluid on commutator (5) and manifold (7). Use a small amount of grease to stick washer (2) in position over pin on end cover (1). Install end cover making sure that pin engages center hole in commutator. Align holes and install cap screws. Alternately and progressively tighten cap screws while rotating input shaft. Final tightening should be 18-22 ft.-lbs. torque.

Relocate the unit in vise so input shaft is up. Lubricate seal (33) and carefully work seal over shaft and into bore with lip toward inside. Install brass washer (34) then install stepped spacer (35) with flat side up. Install retaining ring (36) with rounded edge inward.

Remove unit from vise and remove fitting from port. Turn unit on its side with hose ports upward. Pour clean hydraulic fluid into inlet port, rotate input shaft until fluid appears at outlet port, then plug all ports.

Reinstall unit to steering column by installing motor shaft pin (11—Fig. 27). Tighten the four bolts from column to steering motor to a torque of 18-22 ft.-lbs. and reinstall assembly as outlined in paragraph 19.

22. **R&R FRONT POWER STEERING MOTOR (All Models).** To remove power steering motor from front support, first remove radiator and shell as an assembly as outlined in paragraph 152, then proceed as follows:

On tricycle model, support front of tractor and remove spindle assembly from steering motor shaft. On wide front axle models, unbolt center steering arm from motor shaft. Disconnect power steering tubes from steering motor and cap or plug all openings. Remove engine oil cooler, then unbolt and remove power steering motor from pedestal.

When reinstalling, tighten steering motor retaining cap screws to a torque of 180-220 ft.-lbs. and oil cooler cap screws to 20-26 ft.-lbs. Fill and bleed the power steering system as outlined in paragraph 7.

23. **OVERHAUL FRONT POWER STEERING MOTOR.** With assembly removed as in paragraph 22, proceed as follows:

To renew piston seals, unbolt cylinders (20—Fig. 34) from housing (8) and withdraw cylinders from rack pistons (13). Remove cap screws (18), flat washers (17), pistons and spacer sleeves (16) from each end of rack (7). Remove Teflon ring (15) and "O" ring (14) from pistons. Check to see that the spacer sleeves (16) are not crushed; pistons must be free (except for "O" ring tension) between end of rack and flat washer for alignment to cylinder bores. Reinstall pistons with new "O" rings (12) and tighten retaining cap screws to a torque of 14-20 ft.-lbs. Install new "O" rings (14) in piston grooves. Soften new Teflon rings (15) in hot water, install rings over the "O" rings and force the Teflon rings into groove using a piston ring compressor. Renew cylinder(s) if scored or excessively worn. Lubricate pistons and cylinder bores with power steering fluid, then install cylinders with new "O" rings (19). Tighten cylinder retaining cap screws to a torque of 30-40 ft.-lbs.

To overhaul rack, pinion gear, shaft, bearings and seal assembly, first remove cylinders and pistons as outlined in preceding paragraph, then proceed as follows: Remove cap (1), then unstake and remove nut (3). Press shaft (26) downward out of housing, remove upper bearing cone (4) from housing and remove pinion (22) and spacer (23). In-

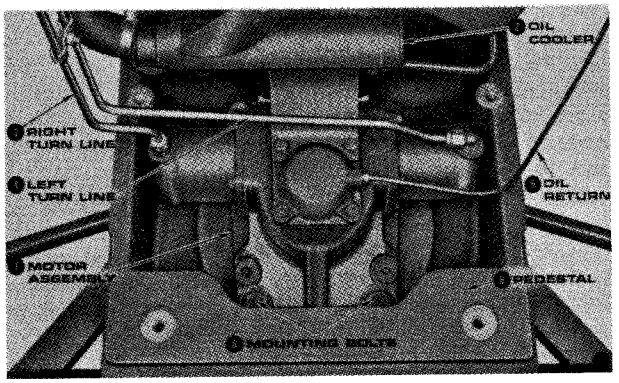


Fig. 33—Power steering motor is accessible after removing shell and radiator assembly. Engine oil cooler is mounted on top of motor. Oil return line carries any leakage past rack pistons back to reservoir.

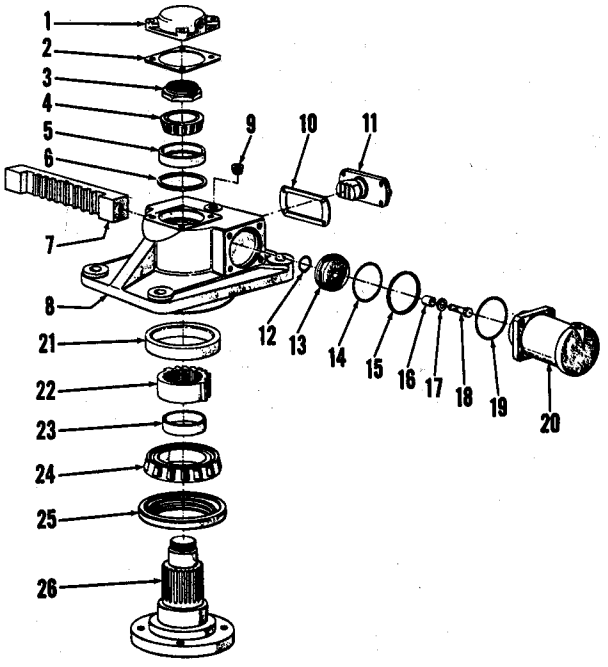


Fig. 34—Exploded view of power steering motor assembly. Motor shaft bearings are adjusted by tightening nut (3). Shims (10) control pressure of rack guide (slipper) (11) against front side of rack (7), pinion (22) and steering motor shaft (26).

1. Cap
2. Gasket
3. Nut
4. Bearing cone
5. Bearing cup
6. Retaining ring
7. Rack
8. Housing
9. Plug
10. Shims
11. Slipper guide
12. "O" ring
13. Piston
14. "O" ring
15. Teflon ring
16. Spacer
17. Flat washer
18. Cap screw
19. "O" ring
20. Cylinder
21. Bearing cup
22. Pinion
23. Spacer
24. Bearing cone
25. Seal
26. Motor shaft

spect bearing cone (24) and if necessary to renew, use a suitable puller to remove from shaft. Remove rack guide (slipper) (11) from housing, taking care not to lose shims (10), and withdraw rack from housing. Remove upper (5) and lower (21) bearing cups from housing, if necessary to renew and remove oil seal (25) from housing and discard.

Carefully clean and inspect all parts and renew any that are scored or excessively worn. Reassemble using new oil seal, gasket, sealing rings and other parts required as follows:

If they have been removed, install snap ring (6), then drive upper bearing cup (5) into housing tightly against snap ring. If removed, install new bearing cup (21) and oil seal (25) in bottom of housing. Use a suitable step plate on bearing cup and make sure it bottoms in bore. Install bearing cone (24), spacer (23) and pinion (22) on shaft, making sure that pinion to shaft timing marks are aligned as shown in Fig. 35. Place housing over spindle, then install rack so that timing marks on rack and pinion are aligned as in Fig. 35, then install guide (11—Fig. 34) with shims as removed; tighten guide retaining cap screws finger tight only. Install upper bearing cone (4) and retaining nut (3). Tighten a ¾-inch cap screw in center hole of shaft flange so that torque wrenches may be used to check effort to turn shaft. Tighten nut (3) so that a torque of 52-62 in.-lbs. is required to turn shaft with guide retaining cap screws loose, then stake nut to shaft and install cap (1) with new gasket. Install rack pistons and cylinders as previously outlined, then tighten rack guide retaining cap screws to a torque of 20-26 ft.-lbs. With rack centered, breakaway torque required to turn shaft with torque wrench should be 20-25 ft.-lbs. If breakaway torque is not within this range, decrease shim pack (10) thickness to increase guide pressure or add thickness to decrease pressure. Shims are available in thicknesses of 0.007, 0.009, 0.010, 0.012, 0.015 and 0.020 inch.

When rack guide is properly shimmed, remove plug (9) and fill housing with power steering fluid. Reinstall unit as outlined in paragraph 22.

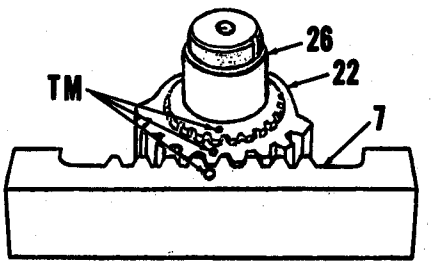


Fig. 35—When reassembling steering motor, be sure that timing marks (TM) on rack (7), pinion (22) and shaft (26) are aligned as shown.

FRONT SYSTEM AND STEERING (MODELS 8700, 9700, TW10, TW20 AND TW30)

Refer to paragraph 44 for front wheel drive models.

28. Models 8700 and 9700 are equipped with a front axle which may be adjusted to track widths from 56 to 84 inches. Axles on Models TW-10, TW-20 and TW-30 may be adjusted from 60 to 84 inches. A short (93.2 inches) or long (109.7 inches) tractor wheelbase may be obtained by reversing front axle and replacing spindle steering arms, tie rod sleeve and anchor for power steering cylinder.

All models are equipped with a tilting steering column and hydrostatic power steering which consists of an engine driven pump with fluid reservoir, a Ross-type steering motor and a steering cylinder.

FRONT AXLE

29. **REMOVE AND REINSTALL.** To remove front axle, remove front weights and support front of tractor. Disconnect and cap steering cylinder hoses. Unbolt and remove front support bracket (21—Fig. 40), then roll front axle assembly away from tractor.

To install front axle, reverse removal procedure. Tighten front support bracket (21) screws to 180-220 ft.-lbs. Cycle steering wheel several times in both directions to bleed steering cylinder and check fluid level in reservoir.

NOTE: Tractor wheelbase may be changed from long to short or vice versa by reversing direction of front axle center member (23—Fig. 40) and replacing steering arms (3 and 7), tie rod sleeve (5) and steering cylinder anchor (11). Steering cylinder hoses must be rerouted and lengthened or shortened.

30. **SPINDLE BUSHINGS.** Spindle bushings (13 and 16—Fig. 40) are presized and can be renewed without removing axle extension. Pull old bushings and install new ones using a piloted driver to prevent damage to bushing and axle bore. Tighten spindle retaining nuts to a torque of 360-440 ft.-lbs. on all TW-30 models and on TW-10 and TW-20 models equipped with a heavy duty front axle. Tighten spindle nuts on all other models to a torque of 100-125 ft.-lbs.

31. **AXLE CENTER MEMBER, PIVOT PINS AND BUSHINGS.** To remove axle center member (23—Fig. 40), support front of tractor, remove tie rod ends and cylinder rod as necessary, then unbolt axle extensions from center member. Withdraw axle extensions with spindles and wheels from center member and tie rod sleeves. Support center member and unbolt front pivot pin support. Move center member and front pivot forward until clear of rear pivot pin and lower to floor.

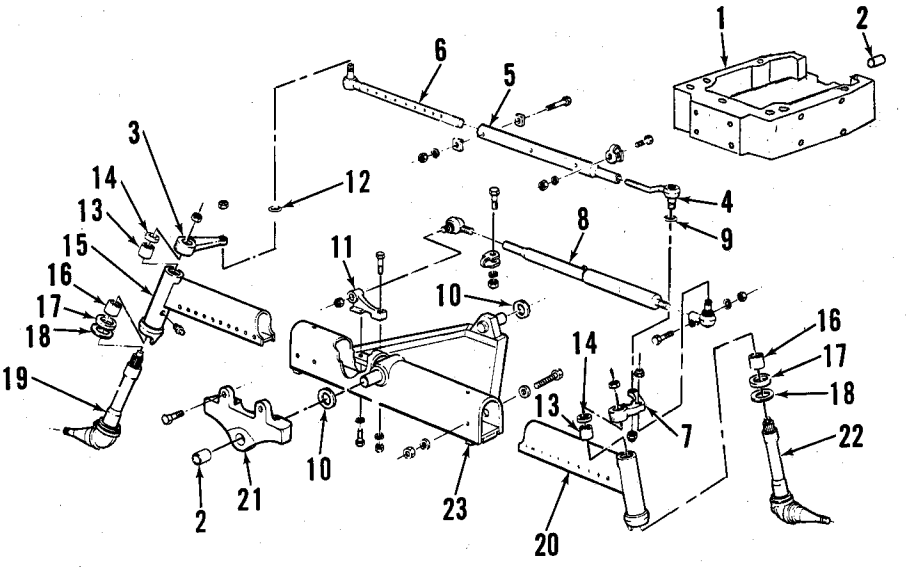


Fig. 40—Exploded view of front axle assembly used on Models 8700, 9700, TW10, TW20 and TW30.

1. Front support
2. Bushing
3. Steering arm, R.H.
4. Tie rod end
5. Tie rod sleeve
6. Tie rod
7. Steering arm, L.H.
8. Steering cylinder
9. Seal
10. Thrust washer
11. Anchor
12. Seal
13. Bushing
14. Seal
15. Axle extension, R.H.
16. Bushing
17. Thrust bearing
18. Spacer
19. Spindle, R.H.
20. Axle extension, L.H.
21. Support bracket
22. Spindle, L.H.
23. Front axle center member

To remove pivot pins and bushings from front support (1—Fig. 40) and bracket (21), remove front axle for access. Renew front axle center member (23) if pivot pins are excessively worn or damaged. Use suitable driving tool to remove bushings. New bushings are presized.

32. **TIE ROD AND TOE-IN.** Recommended toe-in is ¼ to ½-inch. To adjust toe-in, remove bolt securing sleeve (5—Fig. 40) to tie rod (6) and loosen clamp on sleeve. Turn sleeve (5) until desired toe-in is obtained. Tighten clamp, install bolt securing sleeve to tie rod and recheck toe-in measurement.

FRONT SUPPORT (PEDESTAL)

33. **REMOVE AND REINSTALL.** To remove front support casting (1—Fig. 40), remove radiator as outlined in paragraph 152. Remove front axle assembly as outlined in paragraph 29. Attach a hoist or other device to front support casting and unscrew retaining bolts and nuts.

To install front support casting, attach front support casting to engine using four upper bolts and tighten bolts to 180-220 ft.-lbs. Be sure oil pan cap screws are tight and measure gap between front support and oil pan at attaching bolt holes. Loosen the four installed cap screws, then install the two lower screws using shims equal to the measured clearance. Shims are available in thicknesses of 0.014, 0.017, 0.021, 0.024 and 0.027 inch. Tighten front support to cylinder block bolts to 180-220 ft. lbs., then tighten front support to oil pan cap screws to 270-330 ft.-lbs. Install front axle and radiator by reversing removal procedure.

POWER STEERING SYSTEM

These models are equipped with a hydrostatic power steering system consisting of a steering cylinder attached to the front axle, a Ross-type steering motor and a tilting steering gear mechanism.

34. **FLUID AND BLEEDING.** Use Ford M-2C41A fluid in this system. Fluid level should be kept at bottom of reservoir filler neck. System capacity is 7.8 US pints. Reservoir (2—Fig. 41) should be disassembled for cleaning and new filter (3) installed after each 600 hours of operation.

System is self-bleeding. Whenever power steering system has been disassembled for any reason, after reassembly, refill fluid reservoir, start engine to run at low idle rpm and operate steering full right to full left through at least five complete cycles. Replenish reservoir fluid as needed to maintain level. System is free of trapped air when no bubbles appear, steering is firm and reservoir level remains steady at full.

35. **PRESSURE AND FLOW.** System pressure is regulated at 1950-2100 psi on TW-30 or 1550-1650 psi on all other models by the pump pressure relief valve. Rate of flow should be 4.2 gpm at 1000 engine rpm.

36. **R&R AND OVERHAUL PUMP.** For exploded view of pump refer to Fig. 41. Clean pump and surrounding area and disconnect pump pressure and return lines. Remove two cap screws securing pump to engine front cover and lift off pump and reservoir as a unit.

Relief valve is now accessible. Shims (25) are available in thicknesses of 0.010, 0.015 and 0.060 inch to adjust relief valve opening pressure. A change of shim pack thickness of 0.005 inch will alter opening pressure approximately 35 psi.

To disassemble the pump, bend back tab washer and remove shaft nut (23), drive gear (22) and key (12). Mark or note relative positions of flange housing (18), pump body (13) and cover (6); then remove pump through bolts (5). Keep parts in their proper relative position when disassembling pump unit. If necessary, flow control valve components can now be removed. Pump gears (10 and 11) are available in a matched set only. Bearing blocks (9) are available separately but should be renewed in pairs if renewal is because of wear. Bearing blocks should also be renewed with gear set if any shaft or bore wear is evident. Examine body (13) for wear in gear running track. If track is worn deeper than 0.025 inch on inlet side, body must be renewed. Renew all "O" rings and seals.

When reassembling the pump, tighten through bolts (5) to a torque of 25 ft.-lbs. and drive gear nut (23) and relief valve body (24) to a torque of 30-40 ft.-lbs.

37. **R&R STEERING MOTOR.** Remove hood and side panels and braces necessary to gain access to steering motor. Disconnect and tag hydraulic lines leading to steering motor. Hydraulic lines and motor parts should be sealed to prevent contamination. Loosen pinch bolt (4—Fig. 42) in coupler, remove steering column lower bracket screws and remove motor with bracket. Unscrew motor retaining screws and separate motor from bracket.

Reverse removal procedure to install steering motor. Refer to paragraph 34 for bleeding procedure.

38. **OVERHAUL STEERING MOTOR.** Refer to paragraph 21 and Fig. 28 for steering motor overhaul.

FRONT WHEEL DRIVE

44. Front wheel drive is offered as an option on 8700, 9700, TW-10, TW-20 and TW-30 models. Major components are the transfer box, front axle, differential, wheel hubs, final drive planetary units

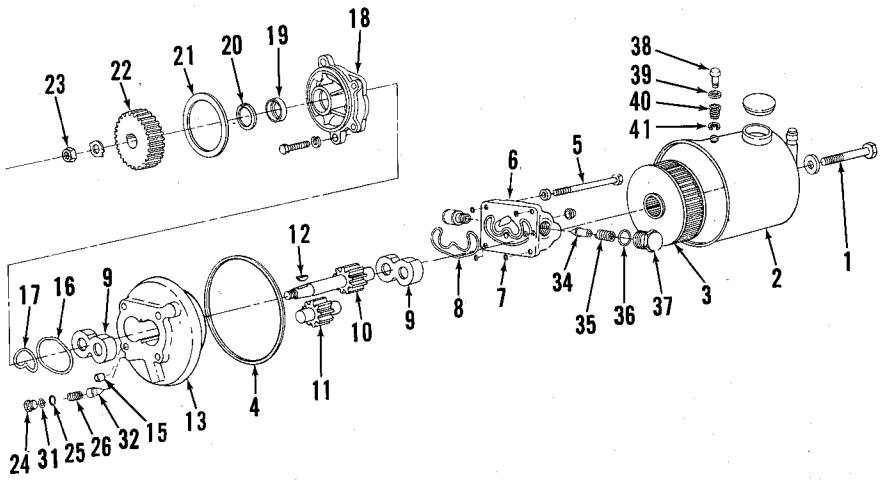


Fig. 41—Exploded view of power steering pump used in Models 8700, 9700, TW10, TW20 and TW30.

1. Bolt
2. Reservoir
3. Filter
4. Gasket
5. Through-bolt
6. Cover
7. "O" ring
8. Seal ring
9. Bearing block
10. Driven gear
11. Follow gear
12. Woodruff key
13. Body
15. Ring dowel
16. Seal ring
17. Seal ring
18. Flange housing
19. Oil seal
20. Snap ring
21. "O" ring
22. Drive gear
23. Nut
24. Plug
25. Shim
26. Spring
31. "O" ring
32. Relief valve
34. Flow control valve
35. Spring
36. Seal
37. Plug
38. Vent
39. Seal
40. Spring
41. "E" ring

and front axle assembly. The front wheel drive transfer box bolts directly onto the transmission handbrake housing assembly and is lubricated by oil overflow from rear axle housing.

There are three axles used on six cylinder tractors equipped with front wheel drive. Axle APL 4053/CK is used on 8700, 9700 models, axle APL 3052/B is used on TW-10 and TW-20 models and axle APL 3054/BK is used on TW-30 models. The axle type number is stamped on an identification plate attached to the rear face of the axle next to the differential housing.

The differential is offset to the left of the axle center line and is driven from the transfer box by a drive shaft having a U-joint at both ends and a sliding coupling at the rear. Late 8700, 9700 models and all TW models are equipped with a limited slip differential.

At each axle end is a hub that contains a planetary reduction gear set. Each hub is held in place by a pair of king pins. Steering is controlled by a single, adjustable tie rod connected between the steering knuckles. The power steering cylinder is bolted to the steering arm on the left-hand steering knuckle.

FRONT AXLE

45. **R&R FRONT AXLE AND PIVOT SUPPORT.** To remove front axle (11—Fig. 47) and pivot support (6), first remove drive shaft. Remove front weights and weight bracket, then support front of tractor and remove bolt securing steering cylinder hose support to rear of pivot support (6). Disconnect steering cylinder from left hand steering arm and pivot support. Temporarily secure steering cylinder to underside of tractor. Support front axle (11), remove bolts securing pivot support (6) to front support, then roll axle assembly (11) away from tractor.

Inspect components for excessive wear or damage and renew as necessary. Install shims (4) to reduce pivot support (6) end play to 0.008-0.016 inch. To install front axle (11) and pivot support (6) assembly, reverse removal procedure. Tighten fasteners to following torques: pivot support to axle housing bolts—302 ft.-lbs.; steering cylinder to steering arm nut—217 ft.-lbs.; drive shaft flange nuts—36 ft.-lbs.

45A. **TOE-IN.** Toe-in is adjusted by detaching tie rod end and rotating end. Correct toe-in is 0-1/8 inch. Check for bent or excessively worn parts if toe-in is not correct.

46. **WHEEL HUB AND PLANETARY CARRIER.** To remove wheel hub (25—Fig. 48) and planetary assembly (12), raise tractor and remove wheel on side requiring service. Drain oil in hub (25) and scribe alignment marks on planetary carrier (12) and hub (25). Remove retaining bolts (11) and remove carrier (12). Detach snap-ring (15) and remove sun gear (16).

To install carrier assembly (12), make sure alignment marks on carrier and hub (25) are aligned, then secure carrier assembly to hub (25). Bolts (11) should be tightened to a torque of 18 ft.-lbs. Fill assembly with clean oil (specification M2C105-A, MIL-L-2105B SAE90 or API GL-5 SAE90), until sight plug hole overflows. Capacity of carrier assembly is approximately 2.1 pints for 8700 and 9700 models, 1.8 pints for TW-10 and TW-20 models and 3.2 pints for TW-30 models.

47. **OVERHAUL.** Unscrew slotted nut (17—Fig. 48) and remove planetary ring gear (18) and carrier (19) from hub

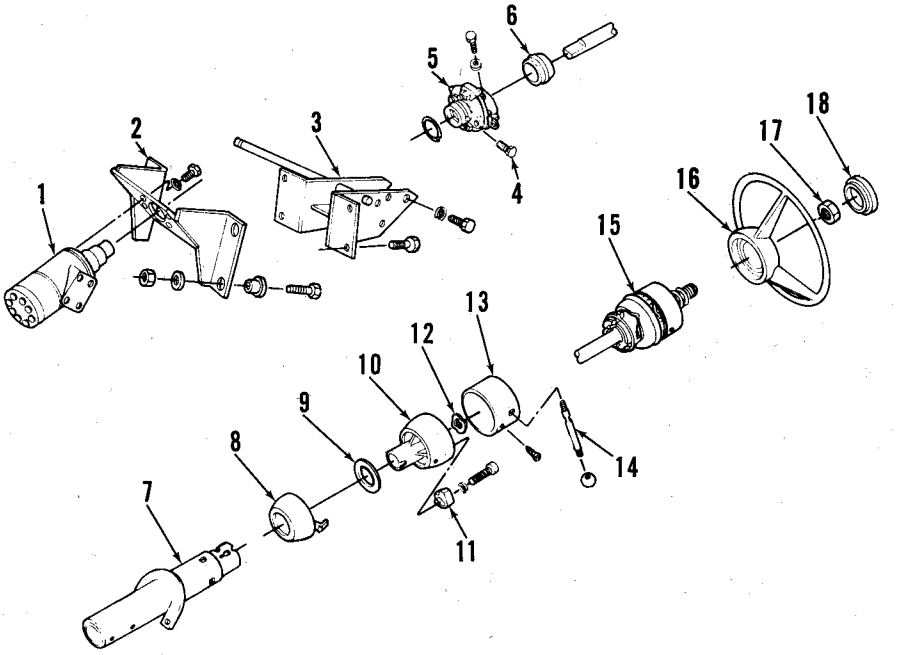


Fig. 42—View of tilting steering column used on Models 8700, 9700, TW10, TW20 and TW30.

1. Motor
2. Lower bracket
3. Upper bracket
4. Pinch bolt
5. Coupler
6. Seal
7. Tube
8. Flange cover
9. Thrust washer
10. Flange extension
11. Retainer
12. Spring washer
13. Cover
14. Tilt lever
15. Tilt mechanism
16. Steering mechanism
17. Nut
18. Cap

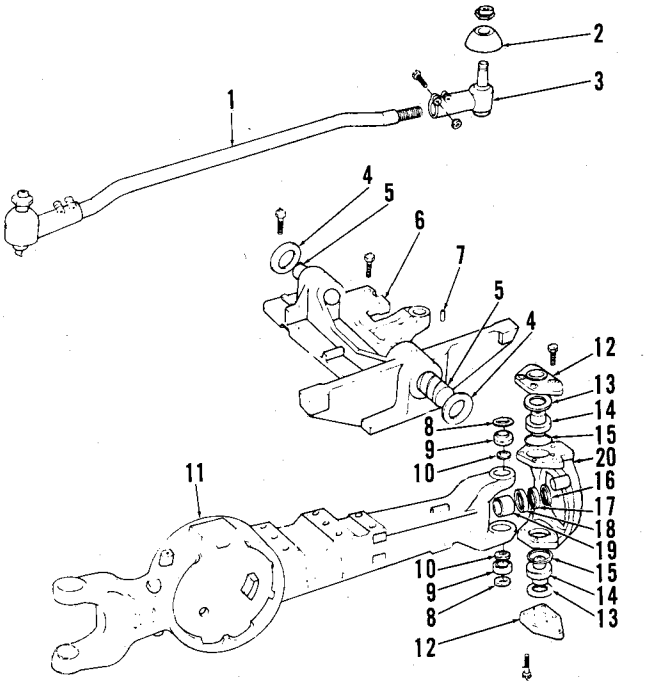


Fig. 47—Exploded view of front axle housing and steering knuckle.

1. Tie rod
2. Cap
3. Tie rod end
4. Shim
5. Pin
6. Pivot support
7. Roll pin
8. Dust cap
9. Bearing
10. Dished cover
11. Axle housing
12. King pin cap
13. Shim
14. King pin
15. "O" ring
16. Retaining ring
17. Ring
18. Shaft seal
19. Bushing
20. Steering knuckle

(25). Remove snap ring (20) from planetary ring gear (18) and remove ring gear carrier (19). Pull hub and bearing assembly (25) carefully off hub carrier (31).

On 8700, 9700, TW-10 and TW-20 models, extract shim (22) from hub carrier. Remove bolts securing hub carrier (31) to steering knuckle and remove carrier. Axle shaft (36) may now be removed from housing. Disassemble planetary carrier (12), inspect components and renew as necessary. Remove oil seal (30), spacer (29—on TW-30 models only), inner bearing (28) cone and dust seal (27) from hub if damaged or worn excessively. If damage or excessive wear is apparent, renew bushing (32) and oil seal (33) using suitable tools. Insert axle shaft (36) into axle housing (11—Fig. 47), then install hub carrier (31—Fig. 48) and secure to steering knuckle (20—Fig. 47) with hex head bolts. Tighten bolts to a torque of 155 ft.-lbs.

NOTE: Two shorter bolts must be installed in two lowest holes to prevent interference between steering knuckle and axle yoke on full lock.

Install bearing (21 and 28—Fig. 48) cups in hub (25) and bearing (28) cone to inboard side of hub (25). On TW-30 models, install washer (29), then on all models install seals (27 and 30). Install hub (25) on hub carrier (31) so carrier contacts hub.

Place ring gear carrier (19) in ring gear (18) and secure with snap ring (20). Position ring gear carrier (19) over splines of hub carrier (31) and push in. Apply grease to slotted nut (17) then install finger tight onto carrier shaft (31).

48. Hub roller bearings (21 and 28—Fig. 48) are preloaded by turning slotted nut (17). Refer to Fig. 49 and measure rolling resistance of hub roller bearings. Wrap a strong cord around wheel stud and hub, then attach a pull scale (S) to cord. Pull scale and note reading as hub rotates. Nut (17) is properly tightened when pulling resistance is between 9-14 lbs. If original bearings are used, reading may be 4.5-7 lbs.

NOTE: If slotted nut (17) locks before proper pulling resistance is obtained on Models 8700, 9700, TW-10 and TW-20, it will be necessary to replace shim (22—Fig. 48). Shim (22) is available in metric sizes from 5.2 to 5.4 mm. On Model TW-30, install a lockwasher and a second slotted nut (17) to serve as a locknut. Bend lockwasher tabs to engage both nuts.

Install sun gear (16) on axle shaft (36) and secure with snap ring (15). To check axle shaft (36) end play, push axle shaft inward. While shaft is being turned by an assistant, turn hub (25) to left and right steering lock positions. With wheel at full lock position, refer to Fig. 50 and measure depth of shaft end (36) from joint face of hub (25). Refer to Fig. 51 and using a similar setup, determine height of detent plug (14 – Fig. 48) above joint face of carrier (12 – Fig. 51). Subtract height of detent plug (14—Fig. 48) from previously measured depth of shaft end to obtain shaft end play. Drive out detent plug (14) and install shims (13) equal to measured shaft end play so end play will be zero with hub at full steering lock. Shims (13) are available in metric thicknesses of 0.3, 0.5, 1.0 and 3.0 mm.

49. **R&R AXLE SHAFTS.** To remove axle shafts (36—Fig. 48), refer to paragraph 46 and remove wheel hub and planetary assembly. Axle shaft can now be removed. Inspect bushings (19—Fig. 47 and 32—Fig. 48) and seals (18—Fig. 47 and 33—Fig. 48) and renew if necessary. To install axle shaft, reverse removal procedure. Refer to paragraph 48 to adjust axle shaft end play and hub bearing preload.

STEERING KNUCKLE AND KING PINS

50. **R&R AND OVERHAUL.** Refer to Fig. 47 for an exploded view of steering

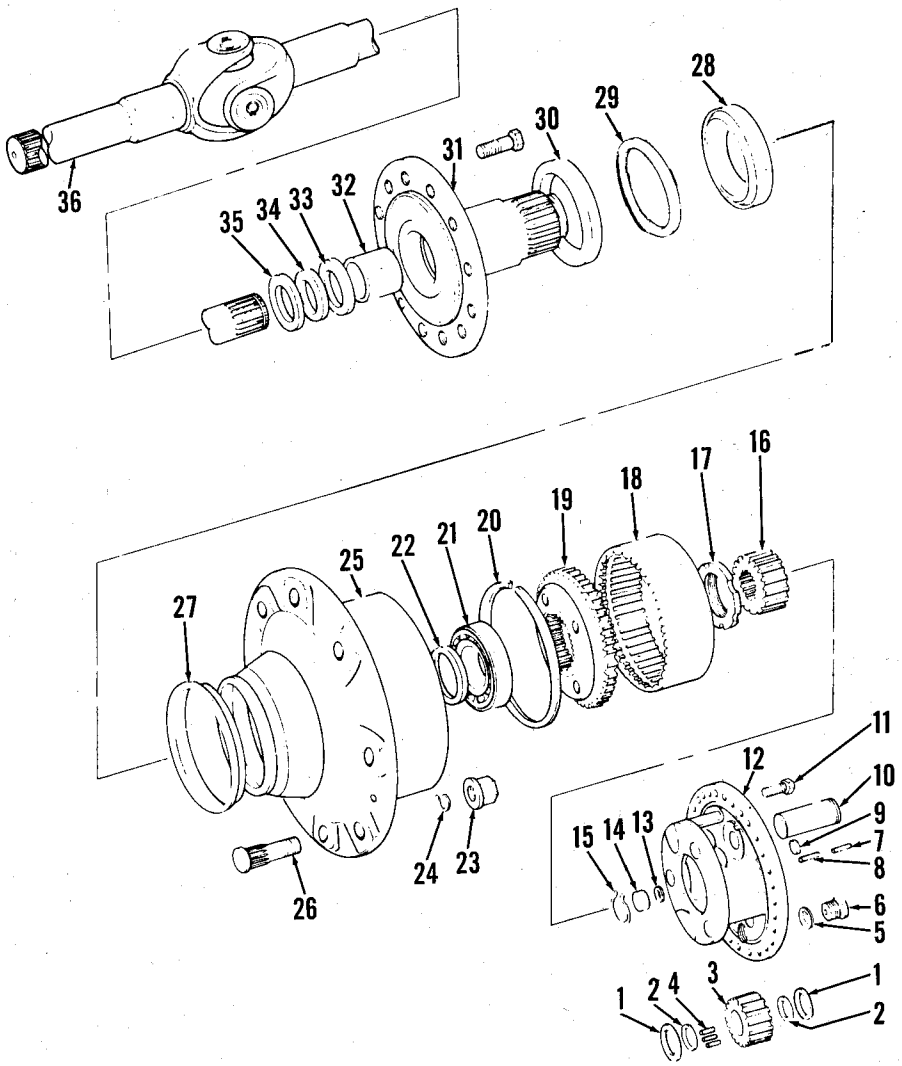


Fig. 48—Exploded view of hub, carrier and planetary drive used in models equipped with front wheel drive. Washer (29) is used in TW-30 models only.

1. Thrust washer
2. Spacer
3. Planetary pinion
4. Needle bearings
5. Sealing ring
6. Screw plug
7. Roll pin
8. Roll pin
9. Sealing cover
10. Pin
11. Cap screw
12. Planetary carrier
13. Spacing washer
14. Detent plug
15. Snap ring
16. Sun gear
17. Slotted nut
18. Ring gear
19. Ring gear carrier
20. Snap ring
21. Bearing
22. Shim (all models except TW-30)
23. Wheel nut
24. Spring washer
25. Hub
26. Wheel bolt
27. Dust shield
28. Bearing
29. Washer (TW-30)
30. Seal
31. Hub carrier
32. Bushing
33. Seal
34. Ring
35. Retaining ring
36. Axle shaft

knuckle assembly. Knuckle (20) may be removed without disassembly of final drive components.

Refer to paragraph 49 for removal of axle shaft. Remove upper and lower king pin caps (12) and tie rod (1). If left knuckle assembly is to be serviced, remove steering cylinder from steering arm. Remove shims (13) and set aside for installation in original location. Remove king pins (14) and bearing cones and mark for return to original location. Remove steering knuckle (20) from axle housing. If renewal is necessary, remove bearing (9) cups from axle housing yoke. Dished covers (10) should be renewed if damaged. Examine all components for burrs, scoring and excessive wear and renew as necessary.

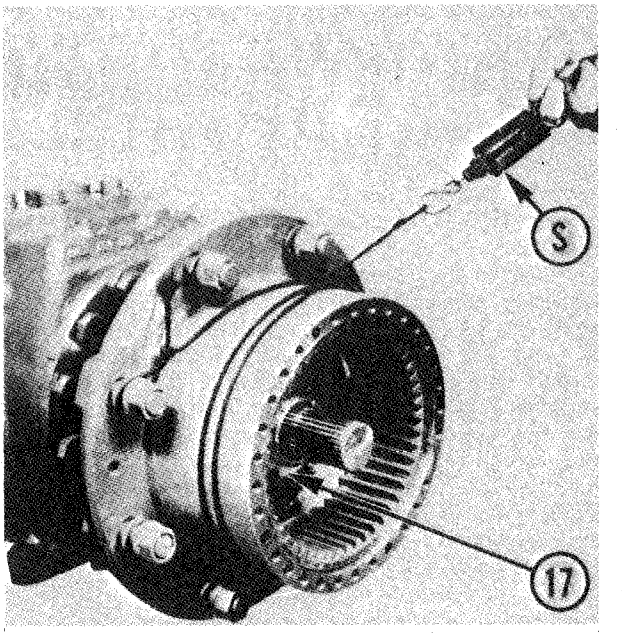


Fig. 49—Measure hub bearing pre-load by measuring rolling torque using a spring scale (S). Turn nut (17) to adjust pre-load. See text.

51. If removed, install dished covers (10) and bearing (9) cups into axle housing yokes. Install "O" ring (15), dust cap (8) and bearing (9) cone to each king pin (14). Mount steering knuckle on axle housing yoke and install upper king pin (14). Coat originally installed shim (13) with grease and position it over king pin (14). Install king pin cap (12) on steering knuckle (20). Tighten socket head screws to 100 ft.-lbs. and hex head screws to 140 ft.-lbs. Repeat procedure on lower king pin assembly. Install axle shaft and hub carrier and tighten hub carrier cap screws to a torque of 155 ft.-lbs. Check steering torque by attaching Ford tool No. T3119 steering knuckle adaptor and a torque wrench to upper cap (12) just above king pin. Measure torque required to turn steering knuckle. If steering torque is not 13.3-15.5 ft.-lbs., install or remove shims (13) as required to obtain desired torque reading. Shims are available in metric thicknesses from 2.6 to 3.3 mm. Thickness of upper and lower shim packs should be equal, however, it may be necessary to transfer shims between shim packs so drive shaft is centered in axle housing. With steering knuckle in straight ahead position, rotate axle shaft and check for binding. Transfer shims between shim packs (13) to remove any binding.

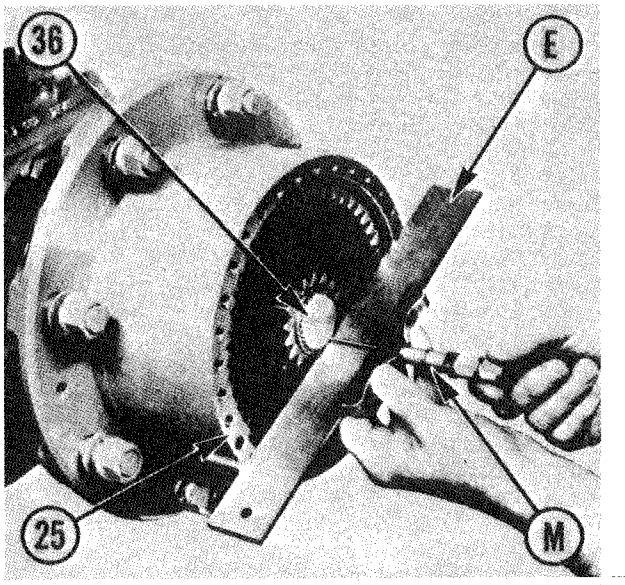


Fig. 50—View showing shaft projection measurement.

E. Straight edge
M. Depth micrometer
25. Hub joint face
36. Axle shaft

DIFFERENTIAL AND BEVEL GEARS

52. **REMOVE AND REINSTALL.** Remove front wheels, disconnect drive shaft from differential input flange and drain axle housing oil. Remove cap screws securing hub carriers (31—Fig. 48) to steering knuckles. Support hubs then pull hubs and front axle drive shafts out far enough to disengage drive shaft inner ends from differential side gears.

NOTE: Remove two differential housing cap screws and replace with

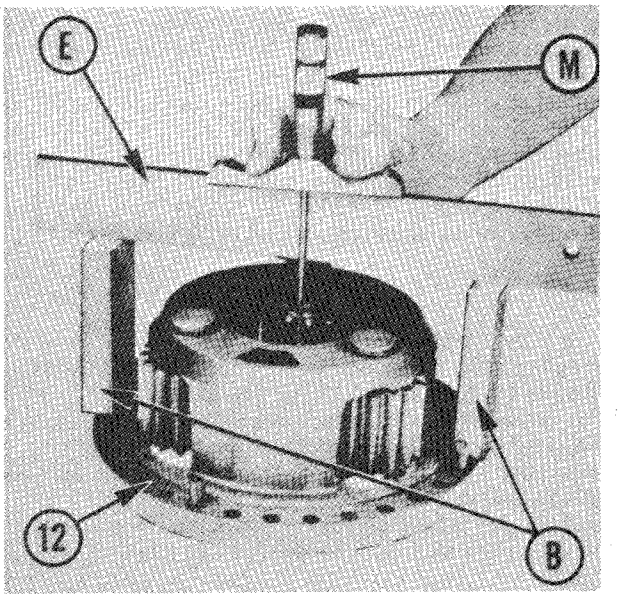


Fig. 51—Measure height of detent plug as outlined in text.

B. Gage blocks
E. Straight edge
M. Depth micrometer
12. Hub carrier

guide studs for ease of differential housing removal and installation.

Carefully remove differential housing assembly using a suitable floor jack or hoist. To reinstall reverse removal procedure. Differential housing to axle housing screws should be tightened to a torque of 61 ft.-lbs. Fill axle housing with API GL-5 SAE 90 lubricant. Axle capacity is 14.8 pints on 8700 and 9700, 16.9 pints on TW-10 and TW-20 or 15.8 pints on TW-30.

53. **OVERHAUL (ALL MODELS EXCEPT TW-30).** Mount differential housing in a vise, then unscrew bevel pinion nut (15—Fig. 52) and adjusting nuts (6). Mark bearing caps (2) according to position, remove caps and lift out differential.

Remove bearing (7) cones from differential case halves (4 and 9—Fig. 53), using a suitable puller. Remove bevel ring gear retaining cap screws and separate gear (4—Fig. 52) from differential case halves then separate halves.

Remove washer (14—Fig. 52), drive flange (13), and dust seal (12) from pinion shaft. Using a suitable press or hammer, remove bevel pinion gear (3) from differential housing (8). If required, press bearing (5) cone off bevel pinion shaft (3) and remove bearing (5) cup and shim (17) from differential housing. Remove oil seal (11) and drive bearing (10) out from rear of differential carrier.

Inspect all components and renew as necessary. Bevel ring (4) and pinion gear (3) are available as a matched set only. Identical serial numbers will be stamped on outer edge of bevel ring gear (4) and on end of bevel pinion gear (3).

If gears require renewal, the following procedure must be followed to determine pinion bearing shim (17) thickness: All measurements should be metric or conversion will be necessary. Refer to Fig. 54 and install pinion setting mandrel No. T3123 and dummy pinion No. T3123-3 on Models 8700 and 9700, or pinion setting mandrel No. T3131 and dummy pinion No. T3131-1 on Models TW-10 and TW-20. Apply pressure to mandrel when measurements are taken. Height of dummy pinion (a) + gap between mandrel and dummy pinion (b) + half the diameter of the differential bores (c) = dimension (x).

Note that dummy pinion height (a) is marked on side of tool. Dimension (c), is 1.96 inches for Models 8700 and 9700, 1.93 inches for TW-10 and TW-20 models. Measure overall width of assembled pinion bearing (5—Fig. 52) cone and cup, then add bearing width to etched pinion setting number (in millimeters) next to serial number on gear end of bevel pinion (3). Subtract result from dimension (x—Fig. 54) to obtain required thickness of pinion bearing shim (17—Fig. 52). Shims are available in thicknesses of 0.1 through 0.5 mm. Install shims so tolerance is within plus or minus 0.05 mm of calculated thickness. Install shim (17) and bearing (5) cup in differential housing and press bearing (5) cone on pinion gear shaft until seated against shoulder.

To determine pinion bearing pre-load,

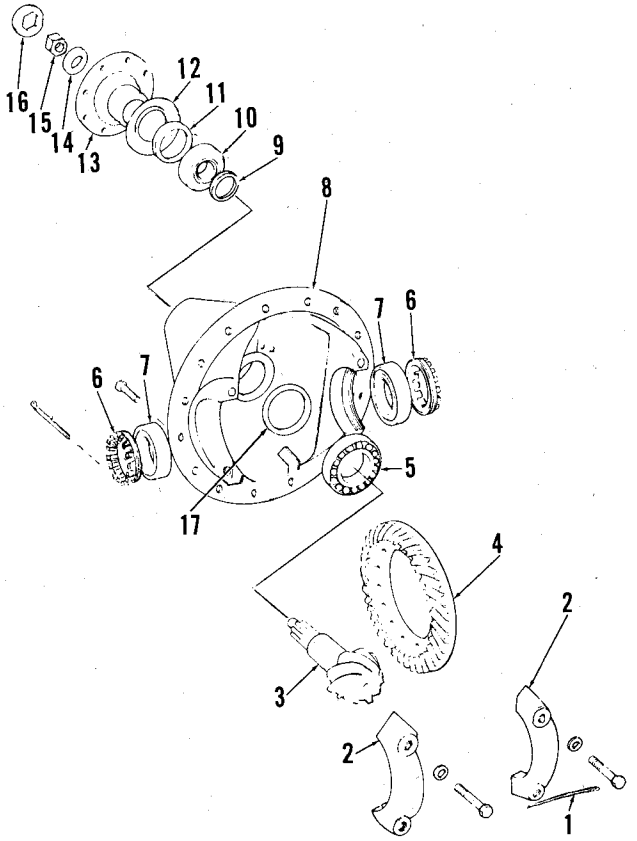


Fig. 52—Exploded view of differential housing for Models 8700, 9700, TW-10 and TW-20.

1. Lock wire
2. Bearing cap
3. Pinion gear
4. Ring gear
5. Bearing
6. Adjusting nut
7. Bearing
8. Housing
9. Shim
10. Bearing
11. Shaft seal
12. Dust shield
13. Drive flange
14. Washer
15. Hex nut
16. Lock plate
17. Shim

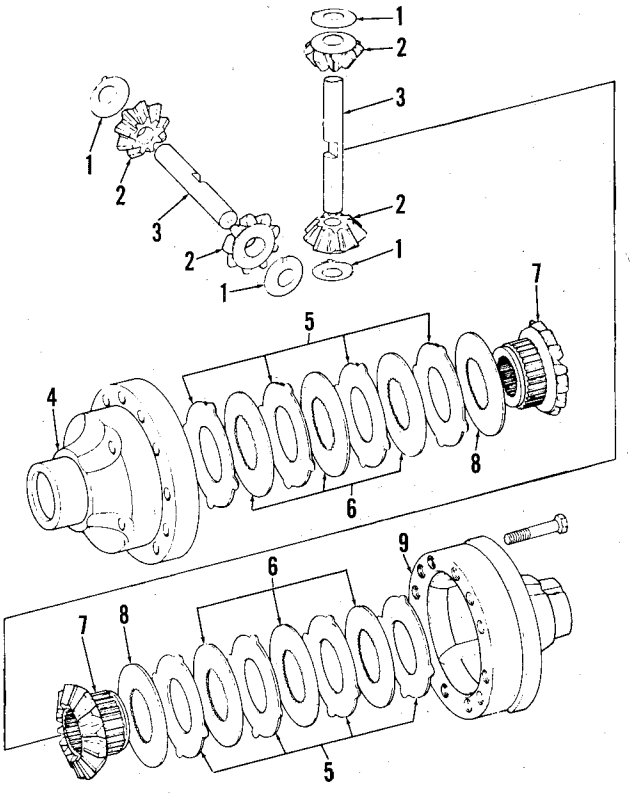


Fig. 53—Exploded view of limited slip differential. Standard differential is similar but clutch plates (5 and 6) are not used and a thrust washer and shim are used in place of pressure plate (8).

1. Thrust washers
2. Pinion gear
3. Shaft
4. Case half
5. Drive plate
6. Driven plate
7. Side gear
8. Pressure plate
9. Case half

install bearing (10) cup without shim (9), into small bore at rear of differential carrier (8). Install pinion shaft (3) into differential carrier, then insert adjustable spacer, tool No. 3120 for 8700, 9700 models or No. T3130 for TW-10 and TW-20 models (T—Fig. 55) so it surrounds pinion shaft (3—Fig. 52). Spacer roll pins should protrude as much as possible. Install bearing (10) cone without oil seal (11), then install drive flange (13), washer (14) and retaining nut (15). Hold drive flange and tighten nut in small increments until torque required to turn pinion (3) is 10-20 in.-lbs. Remove pinion shaft (3) from differential housing (8). Carefully remove adjustable spacer. Using a suitable gage, measure overall height of adjustable spacer. This height will be required thickness of shim (9). Shims are available in thicknesses from 5.6 mm to 6.3 mm.

Reinstall pinion shaft (3) into differential housing (8) and place proper shim (9) on pinion shaft with chamfer towards gear end. Press bearing (10) cone into position. Install new oil seal (11) with lip facing inward. Coat threads of retaining nut (15) with grease, then install drive flange (13), washer (14) and retaining nut (15). While holding flange, tighten retaining nut to a torque of 260 ft.-lbs. Install new cotter key on 8700, 9700 models or new lock plate (16) on TW-10 and TW-20 models.

Install bevel ring gear (4) on differential case half (9—Fig. 53), install bolts and tighten to a torque of 155 ft.-lbs. If equipped with limited slip differential, refer to next paragraph for differential assembly. On models not equipped with limited slip, install new lock plate over differential case to bevel ring gear bolts. Install pinion gears (2) with thrust washers (1) on pinion shafts (3) and install assembly with side gear (7) into differential case half (9). To determine backlash of pinion gears (2), hold three pinion gears and measure backlash of fourth gear. Backlash should be 0.006-0.008 inch. To reduce backlash install a thicker shim behind side gear. Shims are pinned into the differential case half. When new shims are installed, securing pins should be below surface of shim. Shims must be installed with oil grooves facing side gear. Repeat procedure for other case half. After obtaining correct backlash, assemble differential case halves making sure projections on pinion thrust washers are positioned as shown in Fig. 56. Part numbers are stamped on outer edge of both differential case halves (4 and 9—Fig. 53) and should align when halves are assembled.

To assemble limited slip differential on models so equipped, proceed as follows: Refer to Fig. 53 and assemble pressure plate (8) and clutch plates (5 and 6) on side gear (7) being sure that polished side of pressure plate (8) is towards gear. Carefully insert gear and clutch pack assembly into differential case half (4 or 9) so clutch plate (5) tabs engage

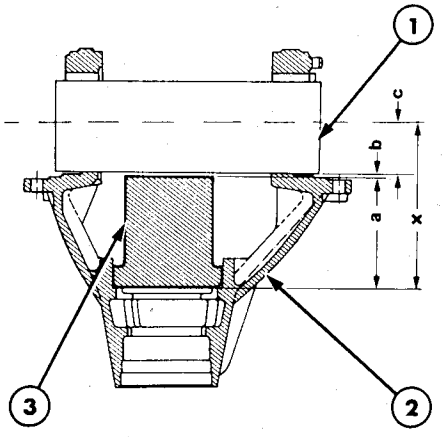


Fig. 54—Diagram of pinion shimming tools and measuring points. Refer to text.

1. Pinion setting mandrel
2. Differential housing
3. Dummy pinion

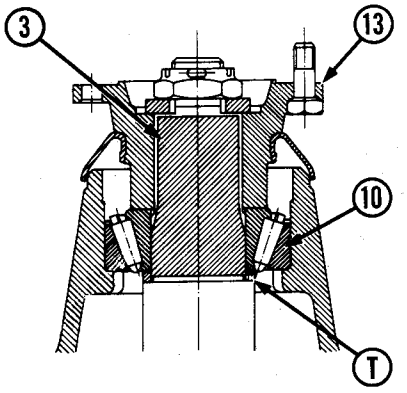


Fig. 55—Refer to text to adjust pinion bearing preload.

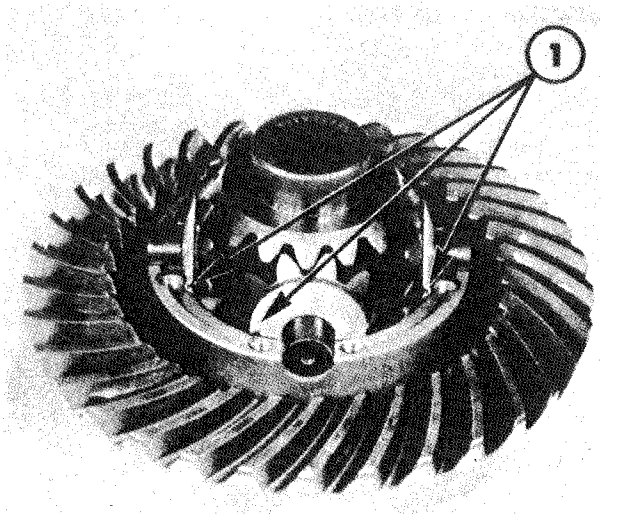


Fig. 56—Projections (1) on thrust washers must mate with differential case half as shown.

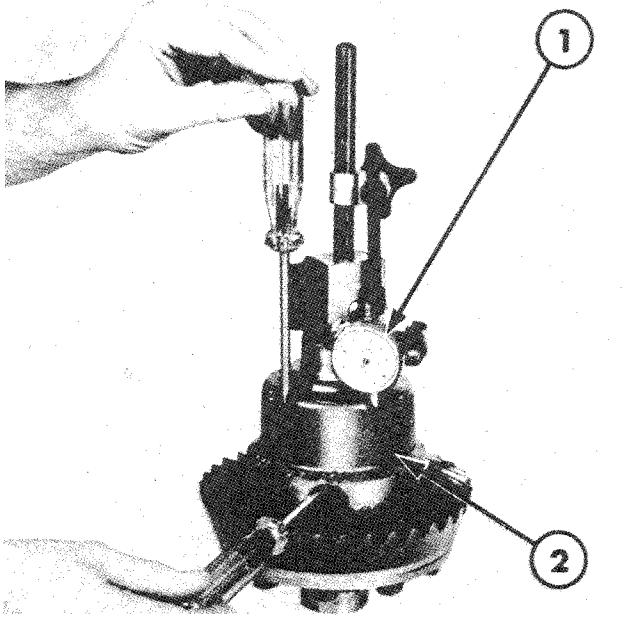


Fig. 57—Measure clutch pack free play by inserting dial gage (1) through case half (2) to contact clutch plate.

slots in case half. Assemble remaining differential case half, side gear and clutch pack. Install bevel pinions (2), thrust washers (1) and differential shafts (3). Assemble differential halves (4 and 9) and tighten retaining screws to a torque of 85 ft.-lbs. To check free play of each clutch pack, refer to Fig. 57 and mount a dial gage on one end of differential case so the plunger contacts the outer clutch plate. Use two screwdrivers to move clutch plate assembly up and down while noting movement of dial gage needle. Allowable free play is 0.004-0.008 inch. If free play is excessive, side gear pressure plate (8—Fig. 53) must be changed. Pressure plates (8) are available in thicknesses of 2.8, 2.9 and 3.0 mm. If after installation of thickest pressure plate free play remains excessive, then a new set of clutch plates (5 and 6) must be installed. Repeat procedure for opposite side of differential.

On all models, note difference in widths of bearings (7—Fig. 52) then install bearing cones on differential case halves (4 and 9—Fig. 53) so wider bearing is on ring gear case half (9). Install differential assembly into housing (8—Fig. 52). Install bearing caps (2) making sure alignment marks (made during disassembly) are aligned. Screw adjusting nuts (6) hand tight, then tighten bearing cap bolts to a torque of 140 ft.-lbs. Bevel ring gear (4) backlash is reduced by moving gear (4) towards pinion (3) by adjustment of slotted nuts (6). Correct backlash is 0.008-0.011 inch. Backlash should be measured with a dial gage mounted to differential case (8).

To check differential bearing (7) pre-load, mount a dial gage so tip of dial gage contacts back (flat) side of bevel ring gear (4). Move differential back and forth while tightening adjusting nuts (6) until no movement of differential is noted on dial gage. Pre-load bearings (7) by tightening adjusting nut (6) opposite bevel ring gear (4) 1½ to 2½ slots, as necessary to align cotter key with a slot in nut (6). Re-check bevel ring gear (4) backlash as previously described. Repeat steps as necessary to obtain proper bearing pre-load and gear backlash. Measure bevel ring gear (4) runout on back surface of gear. If runout exceeds 0.003 inch then gear is seated improperly on differential case and should be removed and inspected.

Refer to Fig. 58 for proper bevel ring and pinion gear tooth contact pattern. If pinion shimming procedure wasn't performed properly, ideal tooth pattern will not be obtained and shimming procedure will have to be repeated.

Insert new cotter keys to secure adjusting nuts (6—Fig. 52). On models without a limited slip differential, safety wire differential case half securing bolts.

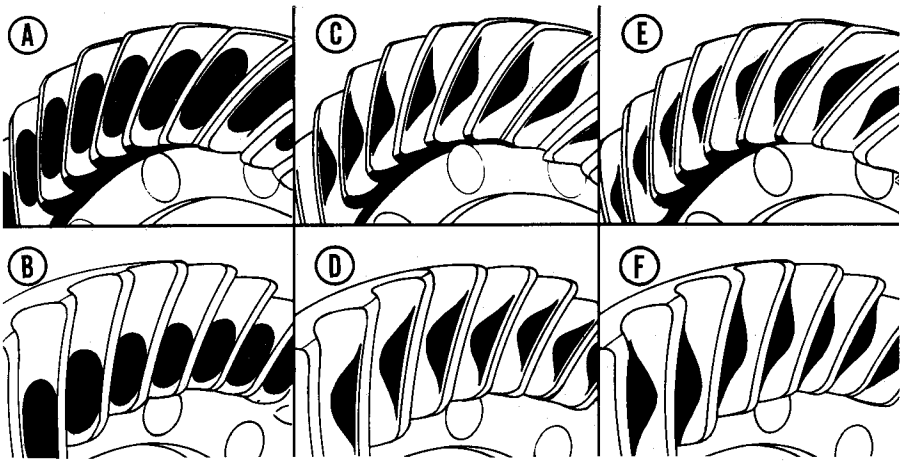


Fig. 58—Views of bevel ring gear tooth contact patterns. Refer to text to determine thickness of shim (17-Fig. 52 or 16-Fig. 59) if appropriate tools are available.

A. Proper tooth contact-coast side pattern
B. Proper tooth contact-drive side pattern
C. Pinion gear requires thicker shim-coast side pattern
D. Pinion gear requires thicker shim-drive side pattern
E. Pinion gear requires thinner shim-coast side pattern
F. Pinion gear requires thinner shim-drive side pattern

To install differential assembly refer to paragraph 52.

54. **OVERHAUL (TW-30 MODELS).** Mount differential housing (7—Fig. 59) in a vise and loosen twelve cap screws that retain bevel ring gear (3) to differential case half (9—Fig. 53). Drive out roll pins that lock adjusting nuts (4—Fig. 59), then unscrew and remove adjusting nuts (4). Remove bearing (5 and 6) cups. Note that differential components must be disassembled in differential housing and cannot be removed as a unit assembly. Remove ring gear retaining screws then reposition housing so pinion shaft is horizontal. Separate differential case halves (4 and 9—Fig. 53) and remove both pinion shafts (3), pinion gears (2) and thrust washers (1). Remove two halves (4 and 9) from housing separately. Separate bevel ring gear (3—Fig. 59) from differential case half. If necessary, remove bearing cones from differential case halves. Remove retaining nut (14), washer (13) and drive flange (12)

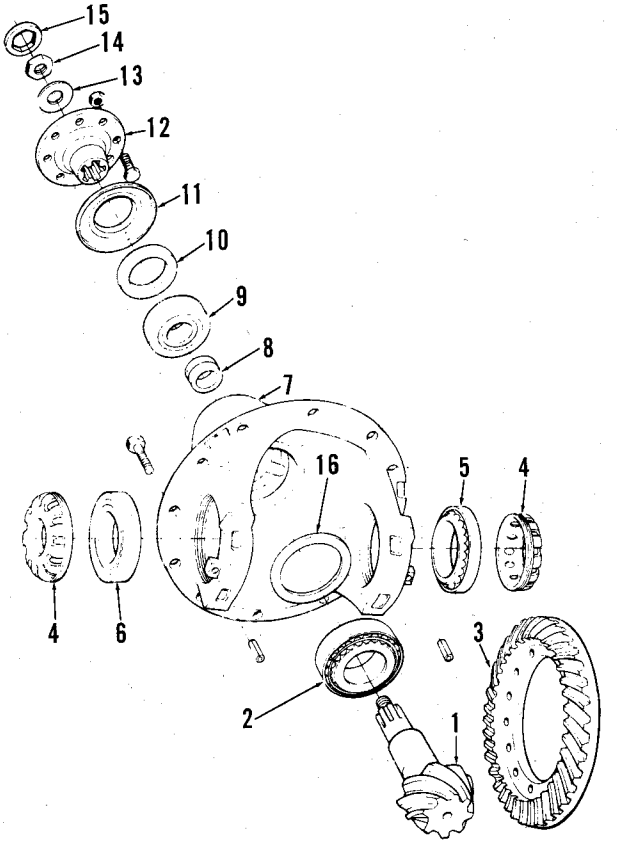


Fig. 59—Exploded view of front wheel drive differential housing for TW-30 models.

1. Bevel pinion gear
2. Bearing
3. Bevel ring gear
4. Adjusting nut
5. Bearing
6. Bearing
7. Housing
8. Sleeve
9. Bearing
10. Shaft seal
11. Dust shield
12. Drive flange
13. Washer
14. Nut
15. Lock plate
16. Shim

from bevel pinion gear (1), then drive or press bevel pinion gear from housing. Remove and discard collapsible sleeve (8). Remove oil seal (10) and bearing (9) cone from rear of housing (7), and if necessary, drive out bearing (2) cup.

Clean and inspect all components and renew as necessary. Bevel ring and pinion gears are available only as a matched set. Identical serial numbers will be stamped on outer edge of bevel ring gear (3) and on end of bevel pinion gear (1). If housing, bearings, differential case or ring and pinion gears have been renewed, then the following shimming procedure must be followed to determine pinion bearing shim (16) thickness: All measurements should be metric or conversion will be necessary. Refer to Fig. 54 and install dummy pinion tool No. T3131 into bore of differential housing, then install pinion setting mandrel, tool No. T3131 into differential bearing bores.

NOTE: Mandrel is smaller at one end, install small end of mandrel tool No. T3131 into bearing bore on bevel ring gear side.

Apply pressure to mandrel as following measurements shown in Fig. 54 are taken: Height of dummy pinion (a) + gap between dummy pinion and mandrel (b) + half the diameter of differential bores (c) = dimension (x).

Dummy pinion height should be 1.93 inches. Measure overall width of assembled pinion bearing (2—Fig. 59) cone and cup, then add bearing width to etched pinion setting number (in millimeters) next to serial number on gear end of bevel pinion (1). Subtract result from dimension (x—Fig. 54) to obtain required thickness of pinion bearing shim (16—Fig. 59). Shims are available in thicknesses of 0.1 through 0.5 mm. Install shims so tolerance is within plus or minus 0.05 mm of calculated thickness. Install shim (16) and bearing (2) cup in housing and press bearing (2) cone on pinion gear shaft until seated against shoulder.

To determine pinion bearing pre-load, install bearing (9) cup into small bore at rear of differential carrier (7) and install pinion gear (1). Install a new collapsible sleeve (8) on bevel pinion shaft, then install bearing (9) cone and oil seal (10). Coat threads of retaining nut (14), install washer (13) and drive flange (12) then install nut (14) finger tight. Before determining pinion (9) bearing pre-load, the resistance of oil seal (10) must be determined. Apply a torque wrench to flange nut (14), turn pinion (1) shaft and record torque required to turn shaft. This result will be oil seal (10) resistance. While holding drive flange (12) with a suitable tool, tighten retaining nut (14) in small increments until torque required to turn assembly is between 10-20 in.-lbs., after adding resistance of oil seal (10). If desired torque reading is exceeded, then bearing pre-load is excessive and a new sleeve (8) must be installed and bearing pre-load readjusted.

Install bevel ring gear (3) onto differential case half (9—Fig. 53). Install pressure plates (8) on side gears so polished side is towards gear and assemble clutch disc plates (5 and 6) on side gears (7). Install gear and clutch components into differential case halves (4 and 9). Refer to Fig. 53 for proper clutch pack assembly sequence. Mate differential halves (4 and 9), install ring gear retaining screws and tighten to a torque of 155 ft.-lbs. Refer to Fig. 57 and check clutch pack free play as follows: Mount a dial gage on differential case so gage plunger contacts outer clutch plate. Use two screwdrivers to move clutch plate assembly up and down and note movement of gage needle. Allowable free play is 0.004-0.008 inch. Adjust free play by changing thickness of pressure plate (18—Fig. 53). Pressure plates (8) are available in 2.8, 2.9 and 3.0 mm sizes. If after installation of thickest pressure plate (8) free play remains excessive, a new set of clutch plates (5 and 6) must be installed. Repeat instructions for opposite differential case half.

Separate case halves (4 and 9) for installation in differential housing (7—Fig. 59). Note that bearing (5) is wider than bearing (6) and bearing (5) must be installed on ring gear differential case half (9—Fig. 53). While supporting differential housing with pinion gear in a horizontal position, install ring gear with differential case half (9) and clutch assembly. Install opposite differential case half and clutch assembly then while holding case half (4), install differential shafts (3) complete with bevel pinion gears (2) and thrust washers (1). Be sure projections on thrust washers mate with case half as shown in Fig. 56. Mate differential halves and install ring gear screws but do not tighten at this time. Install bearing (5 and 6—Fig. 59) cups and adjusting nuts (4). Tighten bevel ring gear cap screws to a torque of 155 ft.-lbs.

Backlash between ring and pinion gears should be 0.008-0.011 inch and is adjusted by turning adjusting nuts (4—Fig. 59). To check differential bearing (5 and 6) pre-load, mount a dial indicator so tip of gage contacts back (flat) side of bevel ring gear (3). While prying differential side to side, turn adjusting nut (4) opposite bevel ring gear just until no movement of differential assembly is noted on dial gage. Pre-load bearings (5 and 6) by tightening adjusting nut (4) opposite bevel ring gear 1½-2½ slots, as necessary, to align locking roll pin with a slot in nut (4). Re-check bevel ring gear to pinion gear backlash. With dial gage tip still contacting back of bevel ring gear, check for ring gear runout. If runout exceeds 0.003 inch then gear is seated improperly on differential case and should be removed and inspected.

Refer to Fig. 58 for proper bevel ring and pinion gear tooth contact pattern. If pinion shimming procedure wasn't performed properly, ideal tooth pattern will not be obtained and shimming procedure will have to be repeated.

To install differential assembly, refer to paragraph 52.

FRONT SUPPORT

56. **REMOVE AND REINSTALL.** To remove front support, refer to paragraph 45 and separate front axle assembly from tractor then refer to paragraph 33 for front support removal and installation.

POWER STEERING SYSTEM

57. The power steering system is the same as used on two wheel drive models. Refer to paragraphs 34 through 38 for service.

DRIVE SHAFT

58. **R&R AND OVERHAUL.** To remove drive shaft, remove eight locknuts at transfer box output flange and lower rear of shaft to ground. Remove eight cap screws and locknuts at differential input flange and lower shaft to ground.

Inspect all components for damage or excessive wear and renew as necessary. If U-joints are renewed, drive shaft must be balanced.

To install drive shaft, reverse removal procedure. Tighten all cap screws and locknuts to a torque of 36 ft.-lbs.

TRANSFER BOX

59. **OPERATION.** The transfer box is mounted on the transmission handbrake housing as shown in Fig. 60. The transfer box output shaft is supported at the rear by needle roller bearing (2) located within the hollow shaft of the transmission handbrake while the front is supported by tapered roller bearing (11). The transfer box assembly is actuated by a control rod that passes through the cab floor and connects to a control valve designed to divert oil from the tractor hydraulic system to clutch piston

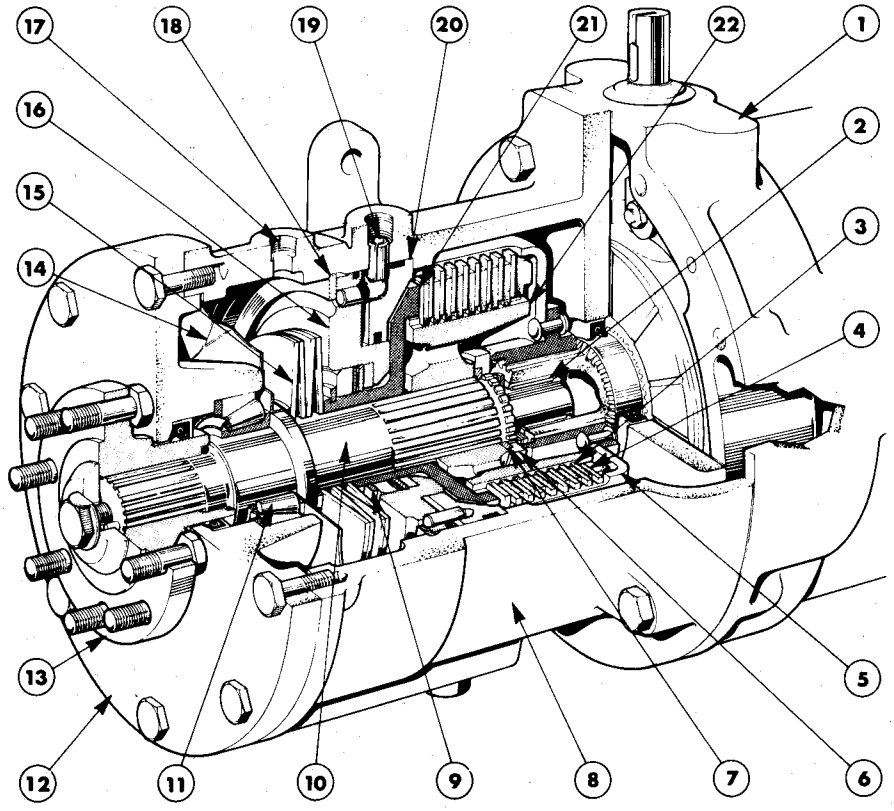


Fig. 60—Sectional view of transfer box assembly.

1. Handbrake housing
2. Roller bearing
3. Driven plates
4. Drive plates
5. Clutch drum
6. Retainer ring
7. Split ring
8. Transfer box housing
9. Snap ring
10. Output shaft
11. Roller bearing
12. Cover
13. Output shaft flange
14. Oil deflector
15. Belleville washers
16. Clutch piston
17. Clutch oil return port
18. Snap ring
19. Roll pin and clutch oil feed port
20. Thrust ring
21. Pressure piece
22. Plate carrier

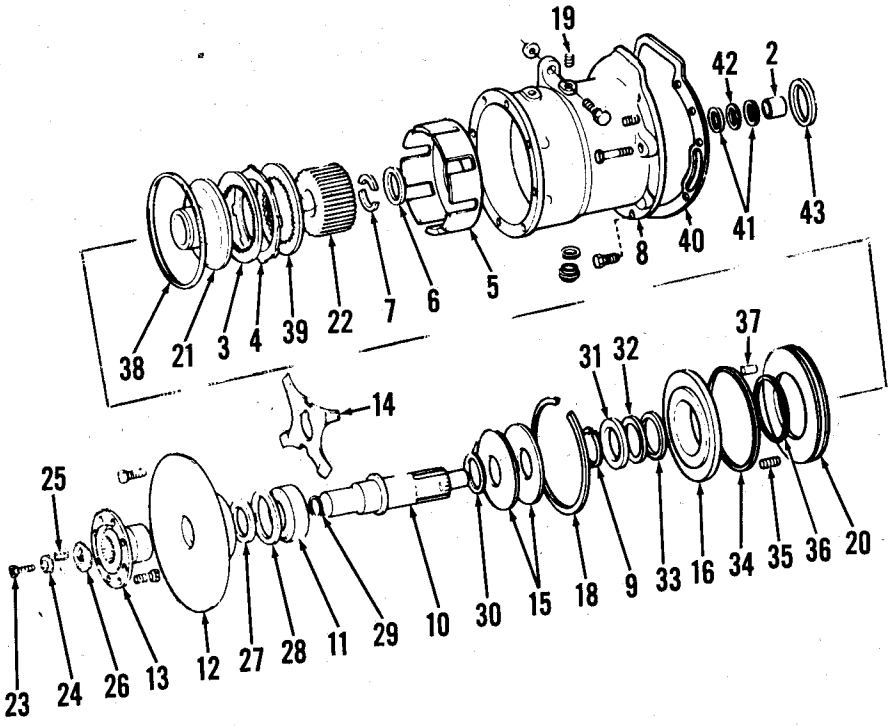


Fig. 61—Exploded view of transfer box.

(16). When the rod is pushed down, the control valve allows hydraulic oil to pressurize clutch piston (16) and disengage the clutch. When the rod is pulled up, the oil will return to the sump through an oil pipe leading from the control valve to the front of the transfer box case. In this position, clutch plates (3 and 4) are engaged as pressure of Belleville washers (15) against pressure piece (21) forces clutch plates together. With clutch plates engaged, plate carrier (22) and output shaft (10) rotate and transfer power to front wheel drive.

60. **R&R TRANSMISSION HANDBRAKE AND TRANSFER BOX.** Jack up left side of tractor to divert transmission oil away from transmission handbrake housing. Remove left rear wheel and drain oil from transfer box. Remove locknuts securing drive shaft rear flange to transfer box output flange. Remove cotter pin, washer and clevis pin from operating rod. Disconnect main oil feed pipe at top of control valve. Disconnect lower end of handbrake cable from control rod. While supporting handbrake/transfer box assembly remove hex head bolts that secure assembly to rear axle center housing. Remove complete unit. To reinstall reverse removal procedure. Refer to paragraph 176 and refill transmission oil as required.

61. **OVERHAUL.** Disconnect clutch oil feed and return lines from transfer box housing ports (17 and 19—Fig. 60). Remove hex head bolts securing control valve retaining plate to housing and remove valve assembly, retaining plate and oil pipes. Remove remaining bolts and separate transfer box from handbrake assembly. Using special tool Ford No. T3122 or equivalent remove hex bolt, lockplate disc and pin (25—Fig. 61) from end of output shaft then remove flange (13). Mark housing and cover for proper alignment during reassembly. Remove cover bolts and transfer box cover (12). It may be necessary to use a hammer and brass drift to aid in

2. Bearing
3. Driven plate
4. Drive plate
5. Clutch drum
6. Retainer ring
7. Split rings
8. Case
9. Snap ring
10. Output shaft
11. Bearing
12. Cover
13. Output flange
14. Oil deflector
15. Belleville washers
16. Piston
18. Snap ring
19. Roll pin
20. Thrust ring
21. Pressure piece
22. Plate carrier
23. Cap screw
24. Lock plate
25. Grooved pin
26. Disc
27. Oil seal
28. Shim
29. "O" ring
30. Shim
31. Thrust washer
32. Bearing
33. Shim
34. Ring
35. Detent spring
36. Ring
37. Dowel pins
38. Seal ring
39. Pressure plate
40. Gasket
41. Thrust washers
42. Bearing
43. Oil seal

removal. Remove clutch and output shaft assembly snap ring (18). Drive roll pin (19) into transfer box housing from outside. Drive or press clutch and output shaft assembly out of housing from rear and remove clutch drum (5). Roller bearings in transfer box may be removed if necessary.

Using suitable tools, remove bearing inner race and oil deflector (14) from output shaft. Remove retainer ring (6) from rear of output shaft. Support output shaft and with Ford tool No. 1312 or equivalent, compress Belleville washers (15) and remove split rings (7). Remove output shaft components. Remove snap ring (9) and disassemble piston (16), springs, dowel pins, seals and thrust ring (20). Remove oil seal at rear face of transfer box case. Remove roller bearing if necessary from front of transfer box handbrake shaft. Inspect transfer box components and renew as necessary.

Control valve must be renewed as a unit assembly if defective.

62. When reassembling, coat periphery of oil seals with sealant meeting Ford specification ESA-M4G129-A or equivalent. Coat inner seal lips and "O" rings with petroleum jelly.

Install quad ring (34) on piston (16) and quad ring (36) and seal ring (38) on thrust ring (20). Install two dowel pins (37) and four springs (35) in piston (16) and mate thrust ring (20) with piston. Install piston and thrust ring assembly on pressure piece (21) and assemble shim (33), thrust bearing (32) and small thrust washer (31) on pressure piece. Compress unit and retain with snap ring (9).

Install clutch plate carrier (22) in clutch drum. Coat drive plates (4) with oil, then insert components in following order: pressure plate (39) with flat side up, drive plate (4) and driven plate (3) then continue alternating installation of plates (4 and 3) until remaining plates are installed. If old Belleville washers are to be installed disregard following paragraph. However, if new Belleville washers are necessary use procedure in following paragraph to determine shim thickness.

To determine shim (30) thickness, place clutch assembly on output shaft with clutch drum up. Remove drum without moving plates. Coat split rings (7) with petroleum jelly and install to secure clutch components. Carefully turn assembly so shaft collar (C—Fig. 62) is facing up and measure gap between pressure piece (21) and underside of output shaft collar (C) using a 0.787 inch long gage block (B). Record this measurement. Note dimension of Belleville washer pack as indicated on packing slip then subtract dimension of washer pack from previously measured gap

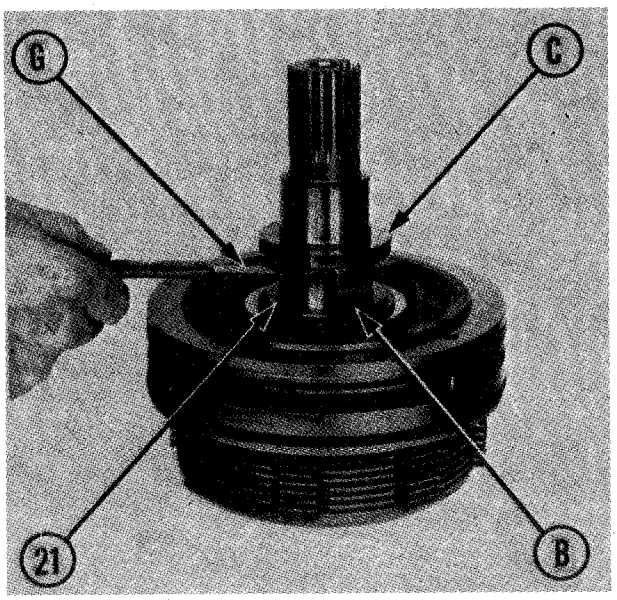


Fig. 62—View showing transfer box clutch shimming procedure.

B. Gage block (0.787-in.)
C. Output shaft collar
G. Feeler gage
21. Pressure piece

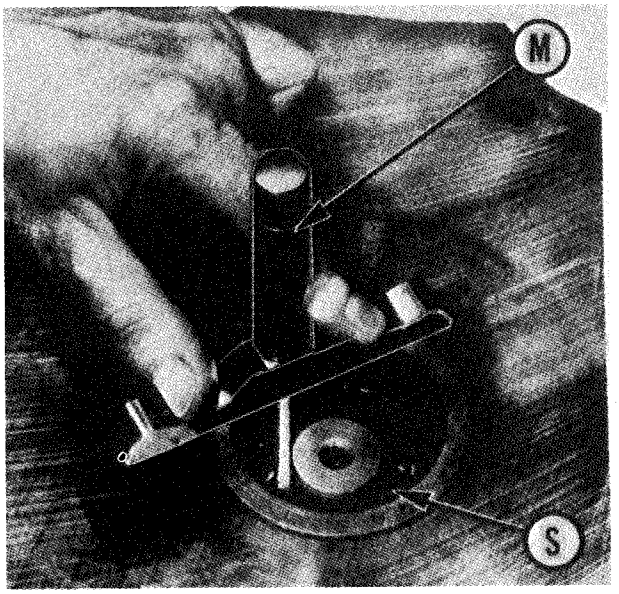


Fig. 63—View checking cover shim thickness.

M. Depth micrometer
S. Output shaft shoulder

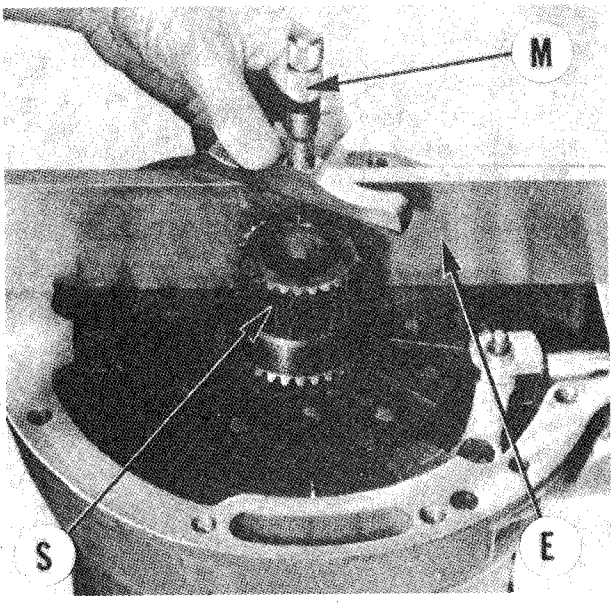


Fig. 64—View showing proper method to check brake shaft projection.

E. Straight edge
M. Depth micrometer
S. Brake driven shaft

between shaft collar and pressure piece. Result is thickness of shim (30—Fig. 61). Shim is available in metric thicknesses from 2.0 mm through 5.0 mm in 0.5 mm increments. Separate output shaft from clutch and piston assemblies. Install oil deflector (14) with lip engaging flat on collar then press roller bearing (11) cone on front of shaft until oil deflector (14) and bearing are seated against shaft collar. Install original or new shim (30) then install Belleville washers (15) with concave sides facing each other. Install clutch and piston assemblies. Remove drum (5) without disturbing components, compress clutch and install split rings (7) on output shaft. Cover retaining ring (6) with petroleum jelly and install over split rings. Reinstall clutch drum.

Install seal (1) in housing (8) using a suitable sealant on seal periphery. Coat transfer box housing bores (where piston and thrust ring are located) with petroleum jelly and lower housing (8) over clutch and output shaft components. Align one recess in outer edge of thrust ring (20) with clutch piston oil pressure feed hole (19—Fig. 60) then drive roll pin into feed hole 0.006 inch from outer edge of hole. Roll pin must engage thrust ring recess to prevent turning. Secure clutch piston with snap ring (18). Coat outer edge of oil seal (43) with a suitable sealant and press into transfer box cover with sealing lip towards roller bearing. If front bearing cover outer race was removed install original size shim. Obtain correct output shaft end play by performing following shimming procedure: Protect front cover oil seal from output shaft splines and install "O" ring (29) on output shaft stem. Coat cover (12) face with sealant then install cover on housing using alignment marks made during disassembly. Tighten cap screws to a torque of 32 ft.-lbs. Mount transfer box assembly on blocks face down. Measure distance from rear face of case to output shaft shoulder as shown in Fig. 63. Distance should be between 2.216-2.232 inches. Install correct thickness of shim (28—Fig. 61) to obtain proper dimension. After shimming cover to proper limits, record measured distance. Install output shaft flange bolts then secure flange (13) to output shaft. Tighten flange retaining screw to 88 ft.-lbs.

63. To determine proper end play between transfer box output shaft and drive shaft in brake housing assembly, remove brake housing gasket and place a straight edge of known height across brake housing face as shown in Fig. 64. Measure distance from face of brake housing to edge of brake driven shaft. Subtract previously measured distance from transfer box rear face to output shaft shoulder (Fig. 63). The result (Dimension C – Fig. 65) is the total thickness of thrust needle bearing (42 – Fig. 61) and two thrust washers (41) needed to obtain desired end play. See Fig. 65 to determine correct bearing/washer thicknesses. Coat thrust needle bearing and thrust washers with petroleum jelly and install on rear of transfer box output shaft. Washer's polished face must face bearing. Install new needle bearing in bore of brake driven shaft if necessary. Apply sealer, Ford specification ESE-M4G-11-A or equivalent to gasket, then install transfer box assembly and control valve plate to brake assembly. Tighten housing cap screws to a torque of 38 ft.-lbs. Tighten control valve retaining plate bolts to a torque of 18 ft.-lbs. Install clutch, oil return lines and transfer case drain plug.

NOTE: Check for proper alignment of drive shaft splines if drive shaft has been separated.

ENGINE AND COMPONENTS

R&R ENGINE WITH CLUTCH

76. To remove engine and clutch assembly, proceed as follows: Remove hood side panels, air pre-cleaner, exhaust pipe and hood top panel. Drain radiator and disconnect radiator hoses. Disconnect transmission oil cooler lines on units with pressure lubricated transmissions. If engine is to be disassembled, drain oil pan. Disconnect engine oil cooler lines from engine and power steering tubes from steering motor in front support or cylinder on front axle. Unbolt side braces from radiator shell and support tractor under front end of transmission. On wide adjustable front axle models, drive a wooden block between front axle and pedestal on both sides, so that front assembly cannot tip sideways. Attach hoist to radiator shell, remove side plates and unbolt front support from engine.

NOTE: Be careful not to lose shims on front support to oil pan bolts. Roll front end assembly away from engine.

Disconnect battery cables (negative cable first), then disconnect power steering tubes from pump and hydramotor steering unit. Disconnect air cleaner hose at intake manifold and muffler from exhaust manifold on 8000, 8600, 8700, and TW-10 models. Disconnect turbocharger oil lines and manifold connections on 9000, 9600, 9700, TW-20 and TW-30 models. Plug all openings on turbocharger, oil lines and manifolds. Attach hoist to air cleaner and hood support, unbolt side braces from instrument panel support and lift assembly from tractor. Remove fuel tank on 8700, 9700, TW-10, TW-20 and TW-30 models. Remove turbocharger intercooler on TW-30 models.

Disconnect electrical wiring, Proof-Meter cable, fuel shut-off cable, fuel line and throttle linkage from engine. Remove battery cables from starter, remove starter motor, then remove flywheel access cover. Attach hoist to engine with lifting fixture attached with cylinder head bolts. Unbolt engine from transmission and lift assembly away with hoist.

To reinstall engine, reverse removal

Dimension 'C' (inch)	0.279-0.284	0.285-0.288	0.289-0.292	0.293-0.296	0.297-0.299	0.300-0.303	0.304-0.309	0.310-0.313	0.314-0.317	0.318-0.324	0.324 0.330
Washer (1) thickness (inch)	0.110	0.110	0.118	0.118	0.110	0.124	0.118	0.124	0.118	0.124	0.124
Washer (2) thickness (inch)	0.0927	0.0984	0.0937	0.0984	0.110	0.0984	0.110	0.110	0.118	0.118	0.129
Needle Bearing thickness (inch)	0.0787	0.0787	0.0787	0.0787	0.0787	0.0787	0.0787	0.0787	0.0787	0.0787	0.0787

Fig. 65—Chart showing bearing-washer combinations available to maintain proper clearance between brake driven shaft and shoulder of transfer box output shaft.

procedures and observe the following: Remove transmission input shaft from transmission and place into clutch splines. As engine is moved toward transmission, the input shaft will swallow pto shaft. Tighten the 5/8-inch engine to transmission bolts to a torque of 95-130 ft.-lbs. and ¾-inch bolts to 180-220 ft.-lbs.

NOTE: If oil pan was removed, refer to paragraph 102.

Refer to paragraph 6, 33 or 56 for installation of front support to engine. Bleed the fuel injection system as outlined in paragraph 115 and bleed the power steering system as outlined in paragraph 7 or 34.

Make connections on 9000, 9600, 9700, TW-20 and TW-30 series turbocharger and prime with oil following procedure in paragraph 137.

ENGINE COMPRESSION PRESSURES

77. Engine compression should be checked at cranking speed of 200 rpm with a maximum allowable variation between cylinders of 20 psi.

NOTE: Considerable variation in compression pressures will be noted at speeds under 200 rpm.

Compression pressure should be 300-400 psi on Model TW-10, 275-375 psi on Models TW-20 and TW-30 or 380-480 psi on all other models.

CYLINDER HEAD

78. **REMOVE AND REINSTALL.** To remove cylinder head, drain cooling system and proceed as follows: Remove engine hood side panels, air pre-cleaner, exhaust pipe and hood top panel. Disconnect power steering tubes from Hydramotor unit, power steering pump and steering motor. On 8000, 8600, 8700 and TW-10 models, disconnect air cleaner hose from intake manifold and muffler from exhaust manifold. Remove turbocharger intercooler on TW-30 models. Disconnect and remove turbocharger oil lines and manifold connections on 9000, 9600, 9700, TW-20 and TW-30 models and remove turbocharger. Plug all openings on turbocharger, oil lines and manifolds. Unbolt side braces from radiator shell and instrument panel support casting. Attach hoist and lift air cleaner and hood support assembly from tractor. Remove fuel tank from 8700, 9700, TW-10, TW-20 and TW-30 models. Disconnect injector lines from injectors and pump and remove lines. Cap all exposed fittings to prevent entry of dirt. Clean area around injectors, remove mounting nuts and if necessary, pry injector gently from head. Remove intake and exhaust manifolds, then remove rocker arm cover, rocker arms assembly and push rods. Disconnect upper radiator hose and temperature gage sender. Unbolt and remove cylinder head assembly.

NOTE: If cylinder head gasket failure has occurred, check cylinder head and block mating surface for flatness. Maximum allowable deviation from flatness is 0.006 inch overall or 0.003 inch in any six inches. If cylinder head is not within flatness specified or is rough, the surface may be machined providing the depth from valve seat inserts to cylinder head surface is not less than 0.117 inch after machining. If the cylinder block is not within flatness specified, it may be machined providing the distance between top of pistons at top dead center and top surface of cylinder block is not less than 0.002 inch after machining. Also, install cylinder head to block without gasket, install rocker arm supports, washer and all head bolts finger tight. Then using feeler gage, measure clearance between underside of bolt heads and cylinder head or rocker arm supports. If clearance is 0.010 inch or more, cut threads of bolt hole deeper in block with a suitable tap.

Models 8700, 9700, TW-10, TW-20 and TW-30 are equipped with 9/16-inch cylinder head bolts while all other models have ½-inch bolts. New cylinder blocks have 9/16-inch bolt holes so a stud kit must be installed to mate an early cylinder head with a new cylinder block When reassembling, make sure head gasket is properly positioned on two dowel pins.

Tighten ½-inch bolts or nuts to 110 ft.-lbs. using steps of 90 and 100 ft.-lbs. Tighten 9/16-inch bolts to 160 ft.-lbs. using steps of 120 and 140 ft.-lbs. Refer to Fig. 69 for tightening sequence.

NOTE: Torque values given are for lubricated threads; tighten cylinder head bolts only when engine is cold.

Adjust intake valve gap of 0.014-0.016 inch and exhaust valve gap to 0.017-0.019 inch. Complete the reassembly of engine by reversing disassembly procedure. Tighten the intake manifold bolts to a torque of 23-28 ft.-lbs., the exhaust manifold bolts to a torque of 25-30 ft.-lbs. Make connections on 9000, 9600, 9700, TW-20 and TW-30 models turbocharger and prime with oil by following procedure in paragraph 137. With reassembling complete, bleed the diesel fuel system as outlined in paragraph 114A or 115A.

VALVES, GUIDES, STEM SEALS AND SEATS

80. Exhaust valves are equipped with positive type rotators and an "O" ring type seal is used between valve stem and rotator body. Intake valve stems are fitted with umbrella type oil seals on 8000, 8600, 8700 and TW-10 engines. On 9000, 9600, 9700, TW-20 and TW-30 engines, no seals are used on intake valve stems. Both the intake and exhaust valves seat on renewable type valve seat inserts that are a shrink fit in cylinder head. Inserts are available in oversizes of 0.010, 0.020 and 0.030 inch as well as standard size.

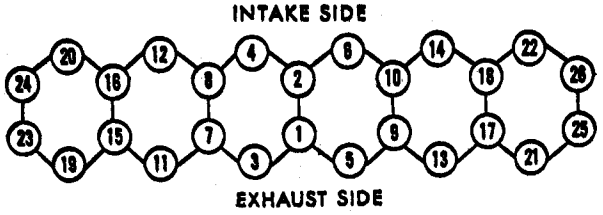


Fig. 69—Tighten cylinder head retaining bolts in sequence shown.

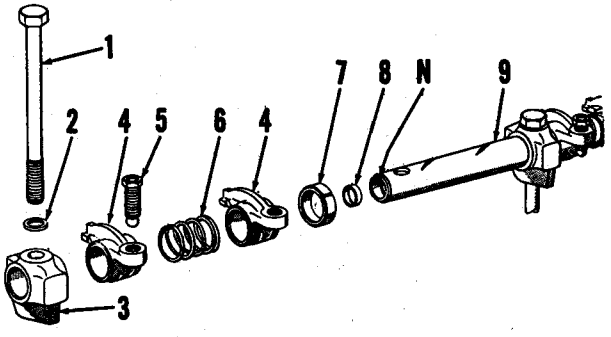


Fig. 70—Exploded view showing rocker arms, spring and rocker arm spacer sequence for No. 1 cylinder; sequence for installation of remaining rocker arms, springs and spacers is identical. Install shaft with notch (N) up and towards front of engine.

N. Notch
1. Cylinder head bolt
2. Flat washer
3. Rocker arm support
4. Rocker arms
5. Adjusting screws
6. Springs
7. Spacers
8. Shaft end plugs
9. Rocker arm shaft

NOTE: Valve seat inserts of 0.010 and 0.020 inch oversize have been installed in some cylinder heads in production. Cylinder heads so fitted are stamped "SO 10/OS" or "SO 20/OS" on exhaust manifold side in line with oversize valve seat. Counterbore in cylinder head for standard exhaust valve seat is 1.597-1.598 inches and for standard intake valve seat is 1.897-1.898 inches.

Refer to Fig. 70A to determine valve face and seat angle. Valve margin is 1/16-inch for intake valves of Models 9600, 9700, TW-20 and TW-30 and 1/32-inch for all other valves.

Valve guides are integral with cylinder head. If wear on guides or valves is excessive, renew valves and ream valve guide bore to nearest oversize if necessary. Desired stem to guide clearance is 0.001-0.0024 inch for intake valves and 0.002-0.0037 inch for exhaust valves. New (standard) stem diameter is 0.3711-0.3718 inch for intake valves and 0.3701-0.3708 inch for exhaust valves. Valves with 0.003, 0.015 and 0.030 inch oversize stems are available as well as reamers for enlarging valve guide bore to 0.003, 0.015 or 0.030 inch oversize.

NOTE: Some production cylinder heads have been fitted with 0.015 inch oversize valve stem. Heads so fitted are stamped "15" or "VO 15/OS" on exhaust side of head opposite the oversize valve stem guide.

VALVE SPRINGS

81. Intake and exhaust valve springs are interchangeable. Valve spring free length should be 2.15 inches. Springs should exert a force of 61 to 69 pounds when compressed to a length of 1.74 inches, and a force of 125-139 pounds when compressed to a length of 1.32 inches. Valve springs should also be checked for squareness by setting spring on flat surface and checking with a square; renew spring if clearance between top end of spring and square is more than 1/16-inch with bottom end of spring against square. Also, renew any spring showing signs of rust or erosion.

VALVE TAPPETS (CAM FOLLOWERS)

83. Valve tappets are semi-mushroom type and can be removed after removing camshaft as outlined in paragraph 91. Tappet diameter is 0.9889-0.9894 inch and bore in cylinder block is 0.990-0.991 inch. Desired tappet to bore clearance is 0.0006-0.0021 inch.

Model	Intake face	Exhaust face	Intake seat	Exhaust seat
8000,8600, 8700,9000	44	44	45	45
9600,9700	29½	44	30	45
TW-10	44½	44½	45	45
TW-20,TW-30	29½	44½	30	45

Fig. 70A—Table listing valve angles.

VALVE CLEARANCE ADJUSTMENT

84. Valve clearance should be adjusted every 600 hours on Models 8000, TW-10, TW-20 and TW-30 and every 300 hours on all others. To adjust valve clearance, rotate engine and adjust intake valves to 0.014-0.016 inch and exhaust valves to 0.017-0.019 inch. Do not adjust valves if engine is over normal operating temperature.

NOTE: Torque required to turn the self-locking adjusting screws in rocker arms should be from 9 to 26 ft.-lbs. If less than 9 ft.-lbs., install a new adjusting screw. If turning torque is still less than 9 ft.-lbs., install a new rocker arm assembly. Refer to paragraph 85.

After valve clearance is properly adjusted, reinstall rocker arm cover using a new gasket and tighten cover retaining cap screws to a torque of 10-15 ft.-lbs.

ROCKER ARMS

85. To remove rocker arms, remove air cleaner on TW-30 or fuel tank on all other models, then remove rocker arm cover. Unscrew the seven cylinder head bolts that retain rocker arm assembly to cylinder head, but do not remove bolts from rocker arm supports. Lift out the rocker arm assembly and head bolts as a unit.

To disassemble, withdraw the cylinder head bolts. Rocker arm to shaft clearance should be 0.002-0.004 inch. Shaft diameter is 1.000-1.001 inches; rocker arm inside diameter is 1.003-1.004 inches. Renew rocker arm if clearance is excessive or if valve contact pad is worn more than 0.002 inch. Torque required to turn valve adjustment screw in rocker arm should be 9 to 26 ft.-lbs.; renew rocker arm and/or screw if torque required to turn screw is less than 9 ft.-lbs.

When reassembling, be sure notch (N—Fig. 70) in end of rocker arm shaft is up and towards front end of engine; this will correctly place the rocker arm oiling holes. Back each rocker arm adjusting screw out two turns, then tighten all retaining bolts evenly until valve springs are compressed and rocker arm supports are snug against the cylinder head; then, tighten all cylinder head bolts as outlined in paragraph 78.

After rocker arm shaft is installed, adjust valve clearance as described in paragraph 84.

R&R TIMING GEAR COVER

86. To remove timing gear cover, first split tractor between front support and engine as outlined in paragraph 76, then proceed as follows:

Drain and remove engine oil pan. Remove cap screw and washers from

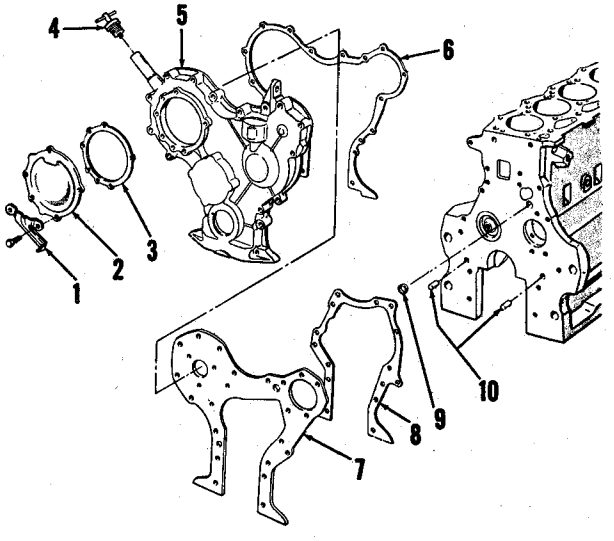


Fig. 71—Exploded view showing fuel injection pump gear cover (2), timing gear cover (5), engine front plate (7), gaskets and related parts.

1. Timing pointer
2. Injection pump gear cover
3. Gasket
4. Oil filler cap
5. Timing gear cover
6. Gasket
7. Front plate
8. Gasket
9. Cup plug
10. Dowel pins

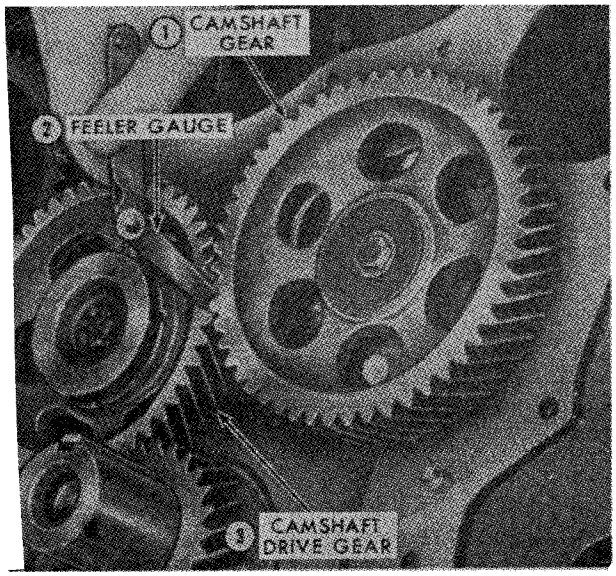


Fig. 72—Checking camshaft drive (idler) gear to camshaft gear backlash with feeler gage.

front end of crankshaft, then remove crankshaft pulley using suitable pullers. The timing gear cover, with fuel injection pump drive gear cover (2—Fig. 71) attached, can then be unbolted and removed from engine.

With timing gear cover removed, the crankshaft front oil seal (5—Fig. 76) and dust seal (6) can be renewed as outlined in paragraph 99.

When reinstalling timing gear cover, tighten cap screws to a torque of 13-18 ft.-lbs. Tighten crankshaft pulley retaining cap screw to a torque of 130-160 ft.-lbs. Install oil pan following procedure outlined in paragraph 102 and refer to paragraph 6, 33 or 56 when reconnecting front support to engine.

TIMING GEARS

87. Before removing any gears in the timing gear train, first remove rocker arms assembly to avoid the possibility of damage to piston or valve train if either the camshaft or crankshaft should be turned independently of the other.

The timing gear train consists of the crankshaft gear, camshaft gear, injection pump drive gear and a camshaft drive gear (idler gear) connecting the other three gears of the train. Refer to paragraph 129 for information on fuel injection pump drive gear.

Timing gear backlash between crankshaft gear and camshaft drive gear, or between camshaft drive gear and camshaft gear (see Fig. 72) should be 0.001-0.009 inch. Backlash between camshaft drive gear and fuel injection pump drive gear should be 0.001-0.012 inch. If backlash is not within recommended limits, renew the camshaft drive gear, gear shaft and/or any other gears concerned.

88. CAMSHAFT DRIVE GEAR AND SHAFT. To remove, unscrew the self-locking cap screw and remove the camshaft drive gear and shaft (see Fig. 73) from front face of cylinder block. Renew shaft and/or gear if bushing to shaft clearance is excessive, or if bearing surfaces are scored. Shaft oil hole must be free of dirt or foreign material. Inspect gear teeth for wear or score marks; small burrs can be removed with fine carborundum stone.

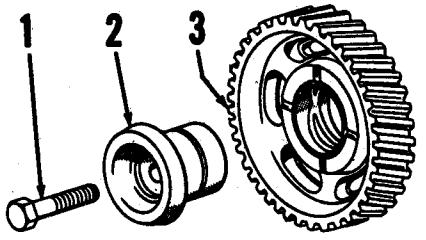


Fig. 73—Camshaft drive (idler) gear and adapter as removed from front end of cylinder block. Bushing in gear is not available separately.

1. Retainer bolt
2. Adapter shaft
3. Gear & bushing assy.

To reinstall the camshaft drive gear, turn crankshaft so that No. 1 piston is at top dead center on compression stroke and turn camshaft and fuel injection pump drive gear so that timing marks point to center of camshaft drive gear location. Place the camshaft drive gear within the other three gears so that all timing marks are aligned as shown in Fig. 74, then install the shaft (2—Fig. 73) and tighten the self-locking cap screw (1) to a torque of 100-105 ft.-lbs.

89. CAMSHAFT GEAR. To remove the camshaft gear, remove cap screw (1—Fig. 75), lockwasher (2) and washer (3) then, pull gear from shaft. Gear should be a hand push fit on shaft. With gear removed, inspect drive key (10), thrust plate (6) and spacer (7) and renew if damaged in any way.

To reinstall gear, first install spacer, thrust plate and drive key, then install gear, washer, lockwasher and gear retaining cap screw. Tighten the cap screw to a torque of 40-45 ft.-lbs.

90. CRANKSHAFT GEAR. If not removed with timing gear cover and seal assembly, slide the spacer (7—Fig. 76)

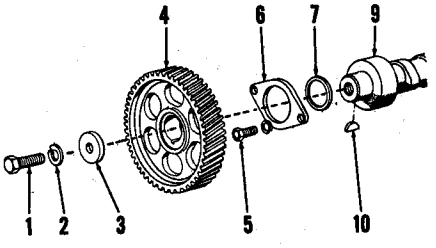


Fig. 75—View showing assembly of camshaft gear to camshaft. Camshaft end play is controlled by plate (6) which fits between shoulders on gear and shaft.

1. Cap screw
2. Lockwasher
3. Flat washer
4. Camshaft gear
5. Cap screw
6. Thrust plate
7. Spacer
9. Camshaft
10. Woodruff key

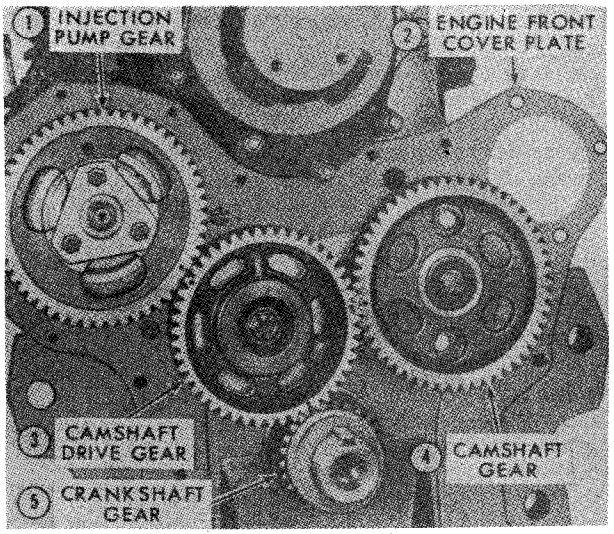


Fig. 74—View showing timing marks aligned on crankshaft gear, camshaft drive gear, camshaft gear and fuel injection pump gear.

from crankshaft; then, using remover-replacer (Ford tool No. 2134) and insert (Ford tool No. 1237) or equivalent tool, pull gear from crankshaft. Inspect the gear and crankshaft pulley drive key (2) and renew if damaged in any way.

To reinstall gear, first drive the key (2) into crankshaft keyway until fully seated, then install the gear with timing mark outward using remover-replacer tools as used in removal procedure, or with bolt threaded into front end of crankshaft, use a nut, large washer and a sleeve.

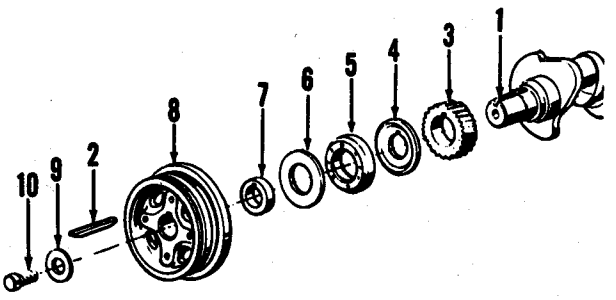


Fig. 76—View showing crankshaft gear, front oil seal and crankshaft pulley installation. Dust seal (6) and oil seal (5) are pressed into timing gear cover from inside and ride on pulley spacer (7).

1. Crankshaft
2. Drive key
3. Crankshaft gear
4. Oil slinger
5. Oil seal
6. Dust seal
7. Pulley spacer
8. Crankshaft pulley
9. Flat washer
10. Cap screw

CAMSHAFT AND BEARINGS

91. To remove camshaft, first remove timing gear cover as outlined in paragraph 86. Turn engine so that the timing marks on crankshaft gear, camshaft gear and fuel injection pump drive gear point to center of idler gear. Remove rocker arm cover, rocker arm assembly and push rods as outlined in paragraph 85. Drive suitable size wood dowels into the hollow valve tappets (cam followers), then lift the tappets up away from camshaft and hold with pincher type clothes pins. On all models except TW-10, TW-20 and TW-30, remove oil filter, plug and oil pump drive gear; refer to Fig. 85.

Desired camshaft end play is 0.001-0.007 inch. If end play is excessive, renew thrust plate (6—Fig. 75) during reassembly. Remove the cap screw (1), lockwasher and flat washer and pull camshaft gear from shaft. Remove the Woodruff key (10), thrust plate and spacer (7). Withdraw camshaft from front end of engine, taking care not to strike camshaft lobes as shaft is removed.

The camshaft is supported in five renewable bearings. Check camshaft and bearings against the following values:

Camshaft journal diameter	2.3895-2.3905 in.
Desired journal to bearing clearance	0.001-0.003 in.
Camshaft end play	0.001-0.007 in.

If excessive bearing wear is indicated, the bearings can be removed and new bearings installed with bearing driver (Ford tool No. 1255) and handle (Ford tool No. 1442) or equivalent tools.

NOTE: It will be necessary to remove engine and remove oil pan, clutch, flywheel, engine rear cover plate and camshaft rear cover plate to remove and install bearings. Pay particular attention that the oil holes in bearings are aligned with the oil passages in cylinder block.

Refer to Fig. 78. Remove camshaft drive (idler) gear, then reinstall gear with timing marks aligned as shown in Fig. 74. Refer also to paragraph 88. New bearings are pre-sized and should not require reaming if carefully installed.

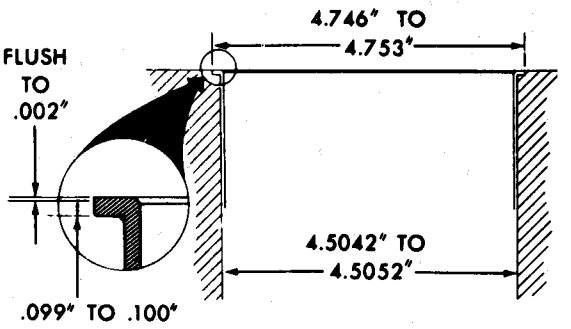


Fig. 77—Diagram showing machining dimensions necessary for installation of service sleeve. Refer to text.

Lubricate tappets and camshaft and reinstall camshaft by reversing removal procedure. Rotate camshaft to be sure there is no binding in new bearings before installing drive gear. Tighten thrust plate cap screws to a torque of 12-15 ft.-lbs. and tighten the camshaft gear retaining cap screw to a torque of 40-45 ft.-lbs.

CONNECTING ROD AND PISTON UNITS

92. Connecting rod and piston units are removed from above after removing the cylinder head and oil pan. Be sure to remove top ridge from cylinder bores before attempting to withdraw the assemblies.

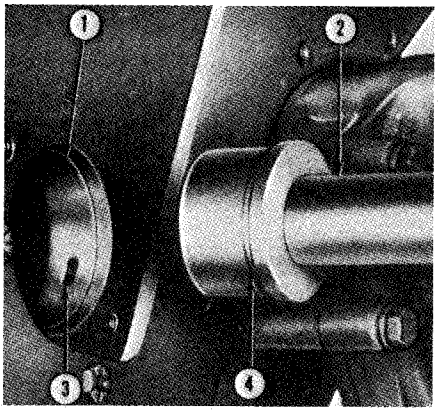


Fig. 78—View showing special tool for camshaft bearing installation. Be sure that bearings are installed with oil holes aligned with oil passages in cylinder block.

1. Bearing
2. Handle no. 1442
3. Oil holes
4. Driver no. 1255

Connecting rod and bearing cap are numbered to correspond to their respective cylinder bores. When renewing the connecting rod, be sure to stamp the cylinder number on new rod and cap.

When reassembling, it is important that the identification notch in top face of piston is towards the front end of engine. Assemble connecting rod to piston with cylinder numbers to right side of engine (away from camshaft). Refer to Fig. 79.

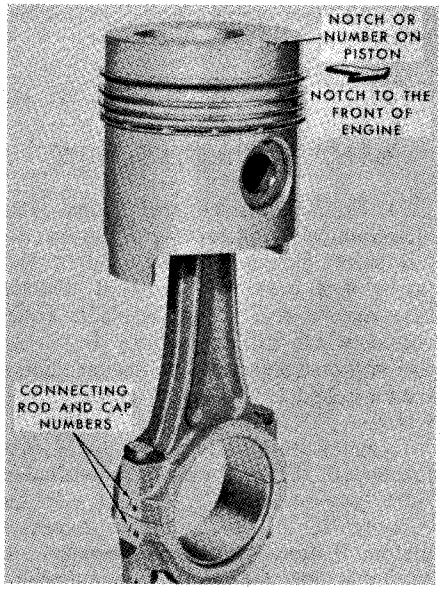


Fig. 79—View showing proper assembly of piston to connecting rod.

When installing connecting rod cap, be sure that bearing liner tangs, and the cylinder identification number, of rod and cap are towards same side of engine. Tighten the connecting rod nuts to a torque of 60-65 ft.-lbs.

PISTON RINGS

93. Pistons are fitted with three compression rings and one oil control ring. The two top compression rings and the oil control ring are chrome plated. All 8000 models and early 9000 models are equipped with a barrel face type top compression ring which must be installed with identification mark up. Later 9000 models and all 8600, 8700, 9600, 9700, TW-10, TW-20 and TW-30 models are equipped with a keystone type top compression ring. Second compression ring is black with chrome edge. Third compression ring is dull gray or black. Both are marked with an "O", which must be installed towards top of piston.

The oil control ring and slotted expander may be installed with either side up. Detailed instructions are packaged with most service ring sets.

Piston ring sets are available in oversizes of 0.020, 0.030 and 0.040 inch as well as standard size. The standard size rings are to be used with standard size pistons and also with 0.004 inch oversize pistons. Refer to the following specifications for checking piston ring fit:

Ring End Gap

Top compression ring	0.012-0.038 in.
Second and third compression rings	0.010-0.035 in.
Oil control ring	0.013-0.033 in.

Ring Side Clearance In Groove

Top compression ring	0.0044-0.0061 in.
Second and third compression rings	0.0039-0.0056 in.
Oil control ring	0.0024-0.0041 in.

PISTONS AND CYLINDERS

94. Engine is fitted with trunk type aluminum alloy pistons with a continuous skirt. Pistons are tapered in the upper land area. Replacement pistons may have a drill point dimple in their crown, which will necessitate the use of the newer, thicker head gasket, since crown height is higher on the new type pistons.

Cylinder bores in engine block are unsleeved. Where excessive cylinder wear has occurred, cylinders can be rebored to fit next larger oversize piston. Pistons 0.004 inch oversize are available for standard size cylinders which must be honed. Where necessary to rebore cylinders, pistons of 0.020, 0.030 and 0.040 inch oversizes are available. If cylinder taper is 0.005 inch or more, cylinders should be rebored or honed to next larger oversize piston. Refer to paragraph 95 for fitting pistons to cylinder bores.

A cylinder sleeve is available for service installation. Sleeve should be chilled to aid in installation. After sleeve is started in bore, use puller in kit No. 2757 to complete installation. Do not drop chilled sleeve into bore as sleeve lip may be cracked. Cylinder is bored to 4.5042-4.5052 inches. Counterbore cylinder to 4.746-4.753 inches at a depth of 0.099-0.100 inch. Depth of lip of sleeve must be no greater than 0.002 inch as shown in Fig. 77. Standard or 0.004 inch oversize pistons must be used in sleeve. Sleeve must not be overbored.

95. **FITTING PISTONS.** Recommended method for fitting piston is as follows: Before checking piston fit, deglaze cylinder wall using a hone or deglazing tool. Using a micrometer, measure piston diameter at centerline of and at right angle to the piston pin bore. Then, using an inside micrometer, measure cylinder bore diameter of cylinder block crosswise with the block at the smallest point. Subtract the piston diameter from the cylinder bore diameter; the resulting piston to cylinder bore clearance should be within range of 0.008 to 0.009 inch for proper piston fit on pistons No. 1 through No. 5. Piston No. 6 should have 0.002 inch more clearance than the others, with the range being 0.010 to 0.011 inch clearance.

NOTE: After honing or deglazing cylinder bore, wash bore thoroughly with hot water and detergent until a white cloth can be rubbed against cylinder wall without smudging, then rinse with cold water, dry thoroughly and oil to prevent rusting.

PISTON PINS

96. A 1.4997-1.5000 inch diameter floating type piston pin is used on 8000, 8600, 8700 and TW-10 engines. Diameter of floating type piston pin on 9000, 9600, 9700, TW-20 and TW-30 engines is 1.6246-1.6251 inches. Piston pins are retained in the piston pin bosses by snap rings and are available in standard size only. Piston pin should have a clearance of 0.0005-0.0007 inch in connecting rod bushing and a clearance of 0.0003-0.0005 inch in piston bosses. After installing new piston pin bushings in connecting rods, the oil hole in bushing must be drilled as shown in Fig. 80 being sure to drill through bushing on 9000, 9600, 9700, TW-20 and TW-30 models to oil passage in rod. Final size bushing with a spiral expansion reamer to obtain the specified pin to bushing clearance. Bushing inside diameter should then be 1.5003-1.5006 inches on 8000, 8600, 8700 and TW-10 engines and 1.6253-1.6256 inches on 9000, 9600, 9700, TW-20 and TW-30 engines. When assembling, identification notch or number in top face of piston must be to front end of engines and the identification number on rod and cap towards right side of engine (away from camshaft).

CONNECTING RODS AND BEARINGS

97. Connecting rods for all models are similar except 9000, 9600, 9700, TW-20 and TW-30 model connecting rod has an oil passage going from big end of rod to small end and a larger pin bore. Connecting rod bearings are of the non-adjustable, slip-in precision type, renewable from below after removing the oil pan and connecting rod bearing caps.

Crankpin bearing liners may be of two different materials, copper-lead or aluminum-tin alloy. The bearings will have an identification marking as follows:

Copper-lead	PV or G
Aluminum-tin	G and AL

NOTE: Copper-lead bearings only are used on 9000, 9600, 9700, TW-20 and TW-30 connecting rods. Bearings for these models have an oil hole which must match oil passage in connecting rod. Standard size bearing liners of each material are available in two different

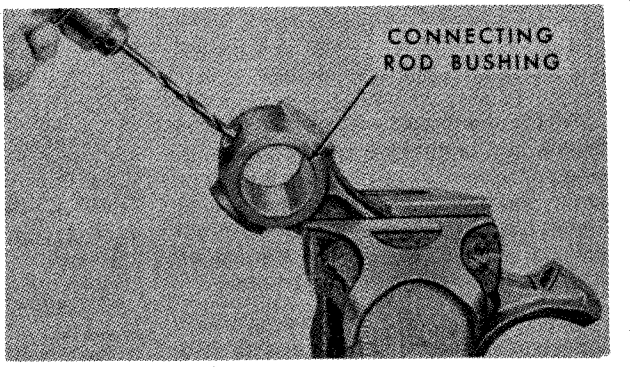


Fig. 80—Oil hole in connecting rod bushing must be drilled after bushing is installed, but before reaming bushing to size. Hole in top of connecting rod is 0.045-0.050 inch and must not be drilled oversize.

thicknesses and are color coded to indicate thickness as follows:

Copper-lead bearing thickness:
Red ..... 0.0943-0.0948 in.
Blue ..... 0.0947-0.0952 in.
Aluminum-tin alloy bearing thickness:
Red ..... 0.0939-0.0944 in.
Blue ..... 0.0943-0.0948 in.

In production, connecting rods and crankshaft crankpin journals are color coded to indicate bore and journal diameters as follows:

Connecting rod bore diameter:
Red ..... 2.9412-2.9416 in.
Blue ..... 2.9416-2.9420 in.
Crankpin journal diameter:
Red ..... 2.7500-2.7504 in.
Blue ..... 2.7496-2.7500 in.

When installing a new crankshaft and the color code marks are visible on connecting rods, the crankpin bearing liners may be fit as follows: If the color code markings on both rod and crankshaft crankpin journal are red, install two red bearing liners; if both color code markings are blue, install two blue coded bearing liners. If color code marks on rod and crankpin do not match (one is red and the other is blue) install one red and one blue bearing liner.

NOTE: Be sure that both bearing liners are of the same material; that is, either both are copper-lead or both are aluminum-tin alloy. If color code mark is not visible on connecting rod or crankshaft, bearing fit should be checked with plastigage for the proper clearance according to bearing material as follows:

Crankpin journal to bearing liner clearance:
Copper-lead bearings ..... 0.0017-0.0038 in.
Aluminum-tin bearings ..... 0.0025-0.0046 in.

As well as being available in either red-coded or blue-coded standard size, bearing liners are also available in undersizes of 0.002, 0.010, 0.020, 0.030 and 0.040 inch. When installing undersize crankpin bearing liners, the crankpin must be reground to one of the following exact undersizes:

Bearing Undersize	Crankpin Journal Dia.
0.002	2.7476-2.7480 in.
0.010	2.7400-2.7404 in.
0.020	2.7300-2.7304 in.
0.030	2.7200-2.7204 in.
0.040	2.7100-2.7104 in.

NOTE: When regrinding crankpin journals, maintain a 0.12-0.14 inch fillet radius and chamfer oil hole after journal is ground to size.

When reassembling, tighten the connecting rod nuts to a torque of 60-65 ft.-lbs.

CRANKSHAFT AND MAIN BEARINGS

98. Crankshaft is supported in seven main bearings. Crankshaft end thrust is controlled by the flanged main bearing liner which is used on the second main journal from rear. Before removing main bearing caps, check to see that they have an identification number so that they can be installed in same position from which they are removed.

Main bearing liners may be of two different materials, copper-lead or aluminum-tin alloy. The bearings will have an identification marking to indicate bearing material as follows:

Copper-lead ..... PV or G
Aluminum-tin alloy ..... G and AL

Standard size bearing liners are available in two different thicknesses and are color-coded to indicate thickness as follows:

Red ..... 0.1245-0.1250 in.
Blue ..... 0.1249-0.1254 in.

In production, main bearing bores in block and main bearing journals on crankshaft are color coded to indicate bore and journal diameter as follows:

Main bearing bore diameter:
Red ..... 3.6242-3.6246 in.
Blue ..... 3.6246-3.6250 in.
Main journal diameter:
Red ..... 3.3718-3.3723 in.
Blue ..... 3.3713-3.3718 in.

When installing new crankshaft and the color code marks are visible in crankcase at main bearing bores, new main bearing liners may be fit as follows: If the color code marks on bore and journal are both red, install two red coded bearing liners; if both marks are blue, install two blue coded bearing liners. If color code mark on bore is not the same as color code on journal (one is blue and the other is red), install one red coded bearing liner and one blue coded bearing liner.

NOTE: Be sure both liners used at one journal are of the same material; however, copper-lead bearing liners may be used on one or more journals with aluminum-tin alloy liners on the remaining journals. If color code marks are not visible at the main bearing bores in block, check bearing fit with plastigage and install red or blue, or one red and one blue liner to obtain a bearing journal to liner clearance of 0.0022-0.0045 inch.

As well as being available in either red-coded or blue-coded standard size, new main bearing lines are also available in undersizes of 0.002, 0.010, 0.020, 0.030 and 0.040 inch. When installing undersize main bearing liners, the crankshaft journals must be reground to one of the following exact undersizes:

Bearing Undersize	Main Journal Dia.
0.002	3.3693-3.3698 in.
0.010	3.3618-3.3623 in.
0.020	3.3518-3.3523 in.
0.030	3.3418-3.3423 in.
0.040	3.3318-3.3323 in.

NOTE: When regrinding crankshaft main bearing journals, maintain a fillet radius of 0.12-0.14 inch and chamfer oil holes after journal is ground to size.

When reinstalling main bearing caps, proceed as follows: Be sure the bearing bores and rear main bearing oil seal area are thoroughly clean before installing bearing liners. Be sure tangs on bearing inserts are in the slots provided in cylinder block and bearing caps. Refer to paragraph 100 for rear cap side seals. Tighten bearing cap bolts to a torque of 115-125 ft.-lbs.

CRANKSHAFT OIL SEALS

99. **FRONT OIL SEAL.** Crankshaft front oil seal is mounted in timing gear cover and cover must be removed to renew seal. Timing gear cover removal procedure is outlined in paragraph 86. To renew seal, drive dust seal (6—Fig. 76) and oil seal (5) out towards inside of timing gear cover. Install new dust seal in timing gear cover, then using a seal installer (Ford tool No. 7536 or equivalent), install new oil seal with spring loaded lip towards inside of cover.

The crankshaft front oil seal rides on pulley spacer (7). Carefully inspect spacer for wear at seal contact surface and renew spacer if wear or scoring is evident.

100. **REAR OIL SEAL.** To renew rear oil seal, engine must be removed from tractor and the clutch, flywheel, engine rear plate, oil pan and rear main bearing cap must be removed.

Production crankshafts are "scrolled" to aid in feeding oil back from the rear oil seal. Whenever necessary to renew rear oil seal, either with a used or new service installed crankshaft, it will be necessary to apply a scroll finish to rear

oil seal contact surface. Refer to Fig. 81; it is very important that only Grade 240 aluminum oxide cloth be used and that the scroll marks be applied at angle shown. Finish accessible area of crankshaft, then turn shaft a little at a time and finish adjacent area until complete circumference of shaft sealing surface is finished.

NOTE: "Scroll" lines should not be apparent to the naked eye.

After "scrolling" shaft, proceed as follows to install rear main bearing and bearing cap: Clean the mating surfaces of block and bearing cap and apply a light coating of gasket sealing compound to both surfaces. Install new side seals in rear main bearing cap with seals projecting slightly beyond block face of cap (see Fig. 82) and install cap with bearing insert and side seals. Tighten bearing cap bolts to a torque of 115-125 ft.-lbs., then trim bottom ends of side seals so that seals project 1/64-inch. Apply a light coating of gasket cement to split lines of bearing cap and block in seal bore, taking care not to allow any cement on shaft. Pack grease between the two lips of the new seal and apply light coat of high temperature grease to seal bore in block and bearing cap and to crankshaft seal journal.

Install new crankshaft seal using special installation tool (Ford tool No. 1301) as shown in Fig. 83. Use flywheel retaining cap screws; tighten cap screws evenly until tool bottoms against crankshaft flange, then tighten each cap screw to a torque of 25 ft.-lbs. to be sure that seal is square with crankshaft centerline.

NOTE: If special tool is not available, use a 4-7/8 inch I.D. sleeve and carefully press seal into block until rear face of seal is 0.060 inch inside rear face of block. Then, using dial indicator mounted on rear end of crankshaft check to see that runout of seal does not exceed 0.015 inch.

Apply a liberal amount of penetrating oil to the cap side seals to cause them to swell, then install engine rear plate using new gasket. Be sure that bottom edge of gasket is parallel to bottom edge of cylinder block and cap. Reinstall flywheel, clutch and oil pan and reinstall engine in tractor.

NOTE: Do not tighten oil pan retaining cap screws until after engine is bolted to transmission; refer to paragraph 102.

FLYWHEEL

101. The flywheel can be removed after splitting tractor between engine and transmission and removing the clutch. Flywheel can be installed in one position only. The flywheel bolts retain the power take-off drive adapter. Before installing flywheel, inspect flywheel to crankshaft cap screws to make sure they are proper type grade 8 screws and in good condition. After applying "Loctite No. 721" or equivalent to threads, tighten screws to a torque of 155-165 ft.-lbs.

Starter ring gear is installed from front face of flywheel; therefore, the flywheel must be removed to renew the ring gear. Heat the gear to be removed with a torch from front side of gear and knock off of flywheel. Heat new gear evenly by applying heat from inside only, so that heat expands out into gear teeth, and only until gear expands enough to slip onto flywheel. Tap gear all the way around to be sure it is properly seated and then quench with water to cool gear rapidly.

NOTE: Be sure to heat gear evenly; if any portion of gear is heated to a temperature higher than 450 degrees F., rapid wear will result. Heat sensing crayons which melt at 400 degrees F. and

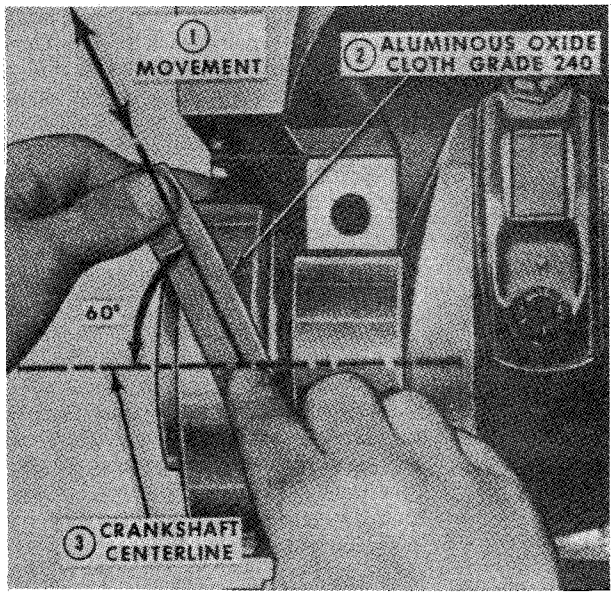


Fig. 81—Whenever necessary to renew crankshaft rear oil seal, crankshaft sealing surface must be "scrolled" using Grade 240 aluminum oxide cloth and at angle shown. Refer to text.

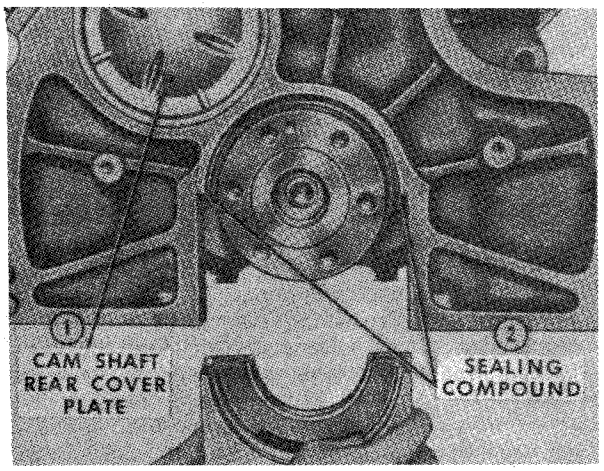


Fig. 82—Installing rear main bearing cap with side seals; seals should protrude slightly above block face of cap as shown. Apply light coat of sealing compound to block and cap mating surfaces.

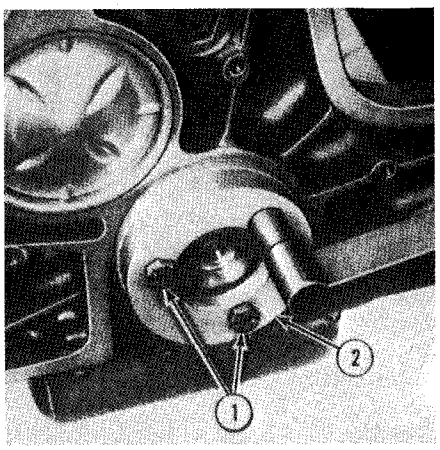


Fig. 83—Using special tool No. 1301 (2) to install crankshaft rear oil seal. Tighten capscrews (1) to 25 ft.-lbs. If special tool is not used, seal rear face must be checked for runout with dial indicator mounted on rear end of crankshaft; maximum allowable runout is 0.015 inch.

450 degrees F., can be used to avoid overheating, if they are available.

OIL PAN

102. To remove oil pan, proceed as follows: One at a time, replace existing cylinder block-to-front support bolts with bolts 8-inches long. Drain oil pan and remove oil level dipstick. Support tractor with a jack under transmission and a hoist at the front support and radiator assembly. Remove hood side panels, air pre-cleaner, exhaust pipe and hood top panel. Remove two bolts securing oil cooler to steering motor housing. Support air cleaner support assembly and remove bolts which secure support assembly to front hood. Remove bolts securing side frame members to front support. Move front support assembly forward until there is sufficient clearance to remove front oil pan bolts. Do not lose shims. Remove the two transmission to oil pan bolts and support oil pan. Unbolt and lower oil pan from engine.

If a new oil pan is being installed, refer to paragraph 6, 33 or 56 for shimming front support to oil pan. To reinstall oil pan, proceed as follows:

If timing gear cover is removed, reinstall cover before installing oil pan. Be sure all gasket surfaces are clean and cement gasket to pan with thin film of gasket sealer. Lift pan into place with floor jack and reinstall oil pan to engine cap screws finger tight only. Install and tighten, then loosen the two transmission to oil pan cap screws. Then, starting from center of pan, tighten the oil pan to engine cap screws to a torque of 30-35 ft.-lbs. Tighten the transmission to oil pan cap screws to a torque of 180-220 ft.-lbs. Reinstall front end assembly by reversing removal procedure, making sure the shims removed from between oil pan and front on disassembly are reinstalled. Tighten the front support to cylinder block bolts and cap screw to a torque of 180-220 ft.-lbs., then tighten front support to oil pan cap screws to a torque of 270-330 ft.-lbs. Fill and bleed the power steering system as outlined in paragraph 7, 34 or 57.

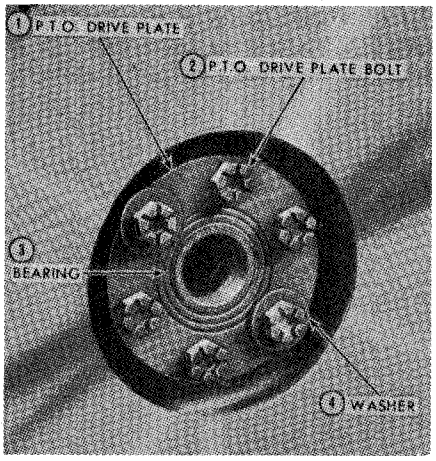


Fig. 84—Flat washers are installed under two of the flywheel and pto drive plate retaining bolts to hold clutch shaft pilot bearing in position.

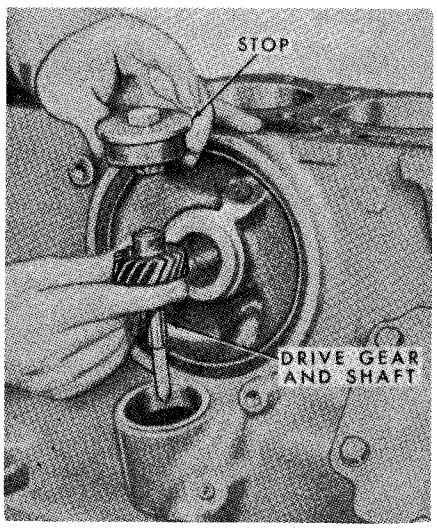


Fig. 85—Removing oil pump drive gear and shaft on all models except TW-10, TW-20 and TW-30. The shaft may remain in oil pump as gear is removed.

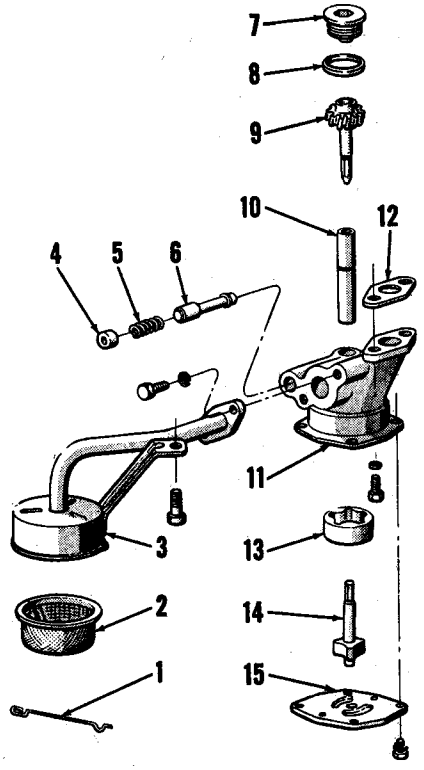


Fig. 86—Exploded view of oil pump assembly, suction (inlet) screen and oil pump drive gear for all models except TW-10, TW-20 and TW-30. Stop (7) and drive gear (9) are removed from above as shown in Fig. 85.

1. Retainer clip
2. Inlet screen
3. Suction tube
4. Plug
5. Relief valve spring
6. Relief valve plunger
7. Stop
8. Gasket
9. Drive gear
10. Floating shaft
11. Oil pump body
12. Gasket
13. Outer pump rotor
14. Inner pump rotor
15. Cover plate

OIL PUMP AND RELIEF VALVE

All Models Except TW-10, TW-20 And TW-30

NOTE: Later oil pumps have a six-flute inner rotor which is thicker than early four-flute inner rotor. All clearances are the same, however it may be necessary to grind away interfering metal on early oil pan if later pump is fitted.

103. To remove oil pump first remove oil pan as outlined in paragraph 102, then unbolt and remove pump and inlet filter screen from cylinder block. Refer to Fig. 86 for exploded view of oil pump and the oil pump drive gear assembly. The floating drive shaft (10) will usually be removed with the pump. To remove drive gear, remove full flow oil filter assembly, then unscrew plug and remove gear as in Fig. 85.

To disassemble pump, remove clip (1—Fig. 86) and screen (2), then remove screws retaining suction tube (3) and pump cover (15) to pump body (11). Remove the covers and pump rotor set (13 and 14), noting which direction outer rotor was placed in pump body. Thread a self-tapping screw into plug (4) and pull plug from pump body. Remove the spring (5) and oil pressure relief valve (6).

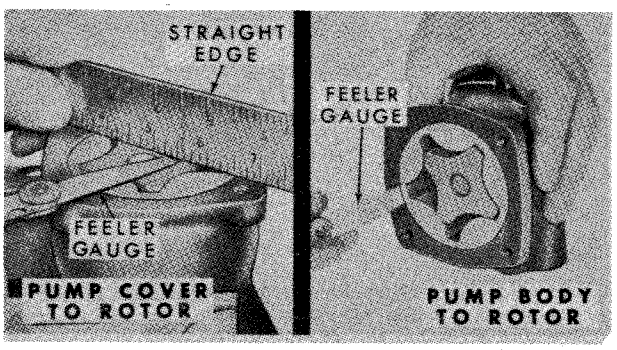


Fig. 87—Checking pump rotor to cover clearance and pump outer rotor to body clearance; refer to text for specifications and to Fig. 88 for checking pump rotors.

Check the pump for wear as shown in Figs. 87 and 88. Pump cover to rotor clearance (rotor end play) should be 0.001-0.0035 inch; pump body to rotor clearance should be 0.006-0.011 inch; and rotor clearance should be 0.001-0.006 inch when measured as shown in Fig. 88. Renew the rotor set and/or pump body if clearances are excessive. Renew pump cover plate if excessively worn or scored. Relief valve spring should exert a force of 10.7 to 11.9 pounds when compressed to a length of 1.07 inches. Engine oil pressure should be 60-70 psi at 1000 engine rpm.

Assemble the oil pump and reinstall by reversing removal and disassembly procedure. Press a new relief valve plug (4—Fig. 86) into pump body so that plug is flush with body. Tighten the oil pump retaining cap screws to a torque of 23-28 ft.-lbs.

Models TW-10, TW-20 And TW-30

104. To remove oil pump on TW-10, TW-20 and TW-30 models, first remove oil pan as outlined in paragraph 102. Oil pump idler gear (4—Fig. 89) and bearing (3) should be checked for excessive end play. If end play exceeds 0.008 inch, renew bearing. Renew bearing whenever gear is renewed. Remove idler gear (4) using tool No. 7537 or equivalent and remove drive gear (11) by hand or use a suitable press. Remove relief valve plug (23) and spring (24). Clean and inspect all parts for excessive wear or scoring and replace as necessary.

Measure clearances as in Figs. 87 and 88. Rotor clearance is 0.001-0.006 inch. Rotor to pump housing clearance is 0.006-0.011 inch. Rotor end play is 0.001-0.0035 inch. Renew shaft and rotor assembly if not within specifications.

NOTE: Prime pump by filling pump inlet with clean oil while rotating pump drive gear and shaft.

Install pump assembly by reversing removal procedure. Tighten pump to block bolts to a torque of 23-28 ft.-lbs. Tighten oil pan bolts to a torque of 30-35 ft.-lbs. Normal oil pump pressure is 60-80 psi at 2200 rpm.

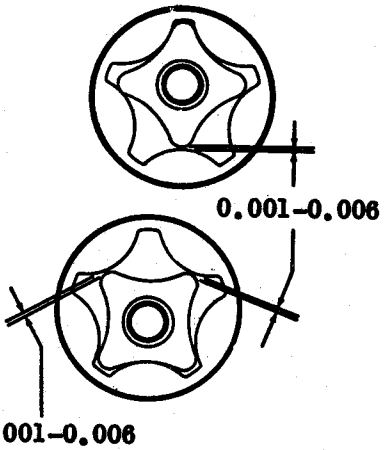


Fig. 88—Measure inner to outer rotor clearance as shown; renew rotors if clearance exceeds 0.006 inch. Refer also to Fig. 87.

DIESEL FUEL SYSTEM

The diesel fuel system consists of three basic components: The fuel filters, injection pump and injection nozzles. When servicing any unit associated with the fuel system, the maintenance of absolute cleanliness is of utmost importance. Of equal importance is the avoidance of nicks or burrs on any of the working parts.

Probably the most important precaution that service pesonnel can impart to owners of diesel powered tractors is to urge them to use an approved fuel that is absolutely clean and free from foreign material. Extra precaution should be taken to make certain that no water enters the fuel storage tanks.

TROUBLESHOOTING

105. If the engine will not start, or does not run properly after starting, refer to the following paragraphs for possible causes of trouble.

106. **FUEL NOT REACHING INJECTION PUMP.** If no fuel will run from line when disconnected from pump, check the following:

Be sure fuel supply valve is open.

Check the filters for being clogged (Including filter screen in fuel supply valve).

Bleed the fuel filters.

Check lines and connectors for damage.

Check for low fuel pump pressure.

107. **FUEL REACHING NOZZLES BUT ENGINE WILL NOT START.** If, when lines are disconnected at fuel noz-

Fig. 89—Exploded view of oil pump used on Models TW-10, TW-20 and TW-30.

1. Idler gear shaft nut
2. Lock washer
3. Idler gear bearing
4. Idler gear
5. Bolt
6. Pin
7. Adaptor shaft
8. Housing
9. Dowel
10. Front bushing
11. Drive gear
12. Plug
13. Rotor and shaft
14. Rear bushing
15. Pump plate
16. Plug
17. "O" ring
18. Outlet tube
19. Gasket
20. Pump inlet
21. Screen
22. Spring
23. Pressure relief plug
24. Relief spring
25. Relief valve

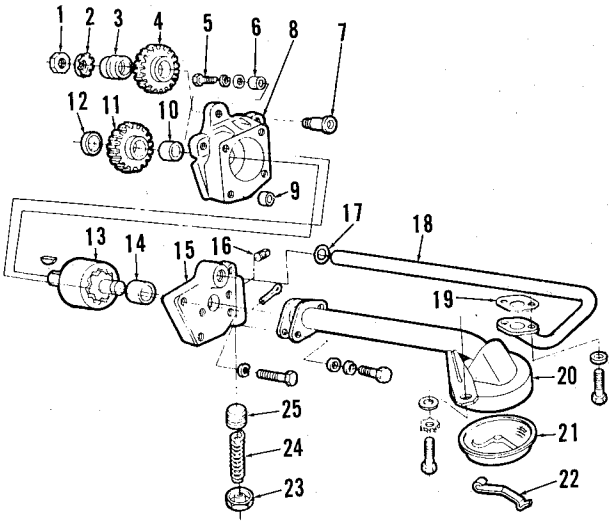
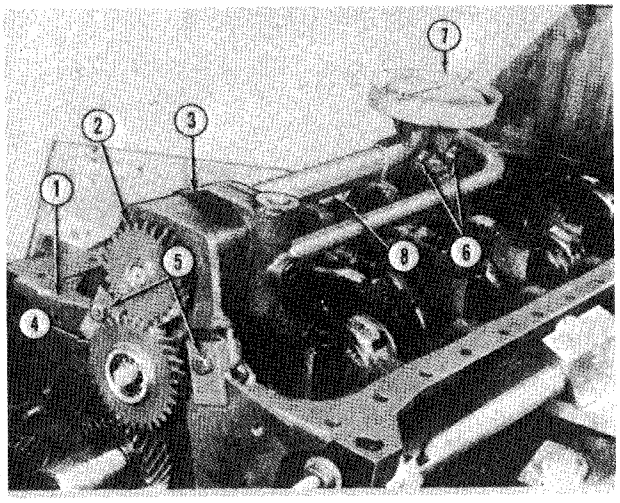


Fig. 89A—Front view of oil pump assembly used on TW-10, TW-20 and TW-30 model tractors.

1. Oil pump support plate
2. Oil pump drive gear
3. Oil pump housing
4. Idler gear
5. Front support bolts
6. Rear support bolts
7. Oil pump and screen
8. Support bolt



zles and engine is cranked, fuel will flow from connections, but engine will not start, check the following:

Check cranking speed.
Check throttle control rod adjustment.
Check pump timing.
Check fuel lines and connections for pressure leakage.
Check engine compression.

108. **ENGINE HARD TO START.** If the engine is hard to start, check the following:

Check cranking speed.
Injection pump timing.
Bleed the fuel filters.
Check for clogged fuel filters.
Check for water in fuel or improper fuel.
Check for air leaks on suction side of fuel lift pump.
Check engine compression.
Injection pump gallery may be draining back to auxiliary tank if there is no fuel in upper tank.

109. **PUMP FAILS TO DELIVER FUEL TO ONE OR MORE INJECTORS.** Check for the following:

Air in fuel lines to injectors.
Plunger spring broken.
Scored barrel.
Control rod stuck in off position.
Delivery valve defective.

110. **ENGINE STARTS, THEN STOPS.** If the engine will start, but then stops, check the following:

Check for clogged or restricted fuel lines or fuel filters.
Check for water in fuel.
Check for restrictions in air intake.
Check engine for overheating.
Check for air leaks in lines on suction side of fuel lift pump.
Check for faulty lift pump.

111. **ENGINE SURGES, MISFIRES OR POOR GOVERNOR REGULATION.** Make the following checks:

Bleed the system.
Check for clogged filters or lines or restricted fuel lines.
Check for water in fuel.
Check pump timing.
Check injector lines and connections for leakage.
Check for faulty or sticking injector nozzles.
Check for faulty or sticking engine valves.
Check for faulty governor.

112. **LOSS OF POWER.** If engine does not develop full power or speed, check the following:

Check throttle control rod adjustment.
Check maximum no-load speed adjustment.
Check for clogged or restricted fuel lines or clogged fuel or air filters.
Check for air leaks in suction line of transfer pump.
Check pump timing.
Check engine compression.
Check for improper engine valve gap adjustment or faulty valves.

113. **EXCESSIVE BLACK SMOKE AT EXHAUST.** If the engine emits excessive black smoke from exhaust, check the following:

Check for restricted air intake such as clogged air cleaner.
Check pump timing.
Check for faulty injectors.
Check engine compression.

FILTERS AND BLEEDING

Models TW-10, TW-20 and TW-30

114. **MAINTENANCE.** These models are equipped with one filter element and a separate sediment bowl. Drain sediment bowl when water or sediment can be seen in separator. Renew fuel filter every 600 hours. Close fuel shut-off valve before removing filter.

114A. **BLEEDING.** Open bleed screw on filter head and operate priming lever until bubble free fuel flows from opening. Close filter bleed screw, then open front bleed screw on injection pump and operate lever until fuel flowing from bleed screw is free of bubbles. Closed bleed screw while operating lever. Loosen fuel injector lines at the injectors and crank engine until fuel appears at all injectors, then tighten the fuel injector line connections and start engine.

All Other Models

115. **MAINTENANCE.** These models are equipped with two spin-on type filter elements as shown in Fig. 90. Water drain plugs (bottom caps) should be removed after 50 hours of operation and any water in sediment bowls drained. Sediment bowls should be drained more often if excessive condensation is noted. Fuel filter elements should be renewed after 900 hours of operation. Close fuel shut-off valve at tank before removing filters.

115A. **BLEEDING.** Refer to Fig. 90. Open rear bleed screw on filter head and operate lever on fuel lift pump until fuel flowing from bleed screw is free of bubbles. Close the rear bleed screw and open front bleed screw on filter head and operate primer lever until bubble free fuel flows from opening. Then, close the fuel filter bleed screw, open front bleed screw on fuel injection pump and operate primer lever until fuel flowing from bleed screw is free of bubbles. Close the pump bleed screw while operating primer lever. Loosen the fuel injector lines at the injectors and crank engine until fuel appears at all injectors, then tighten the fuel injector line connections and start engine.

INJECTION NOZZLES

CAUTION: Fuel leaves the injection nozzles with sufficient force to penetrate the skin. When testing keep your person clear of the nozzle spray.

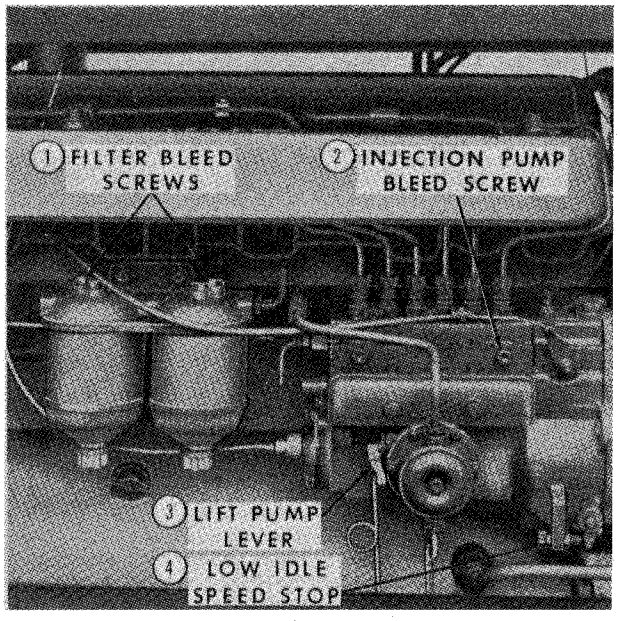


Fig. 90—Operate lever (3) on lift pump to bleed filter and fuel injection pump; refer to text for procedure. Pump on all models except TW-10, TW-20 and TW-30 is fitted with low idle speed stop screw only; high idle speed is adjusted by adjusting throttle linkage; refer to paragraph 130.

116. **TESTING AND LOCATING A FAULTY NOZZLE.** If engine does not run properly and a faulty injection nozzle is indicated, such a faulty nozzle can be located as follows: With engine running, loosen the high pressure line fitting on each nozzle holder in turn, thereby allowing fuel to escape at the union rather than enter the injector. As in checking for faulty spark plugs in a spark ignition engine, the faulty unit is the one which, when its line is loosened, least affects the running of the engine.

117. **NOZZLE TESTER.** A complete job of testing and adjusting the fuel injection nozzle requires use of a special tester such as shown in Fig. 91. The nozzle should be tested for opening pressure, spray pattern, seat leakage and leak back.

Operate the tester until oil flows and then connect injector nozzle to tester. Close the tester valve to shut off pressure to tester gage and operate tester lever to be sure nozzle is in operating condition and not plugged. If oil does not spray from all four spray holes in nozzle, if tester lever is hard to operate or other obvious defects are noted, remove nozzle from tester and service as outlined in paragraph 123. If nozzle operates without undue pressure on tester lever and fuel is sprayed from all four spray holes, proceed with following tests:

118. OPENING PRESSURE. While slowly operating tester lever with valve to tester gage open, note gage pressure at which nozzle spray occurs. This gage pressure should be as follows:

TW-10	2600-2850 psi
TW-20, TW-30	3000-3250 psi
All other models	2720-2794 psi

If gage pressure is incorrect, remove cap nut and turn adjusting screw (Fig. 92) as required to bring opening pressure within specified limits. If opening pressure is erratic or cannot be properly adjusted, remove nozzle from tester and overhaul nozzle as outlined in paragraph 123. If opening pressure is within limits, check spray pattern as outlined in paragraph 123. If opening pressure is within limits, check spray pattern as outlined in following paragraph.

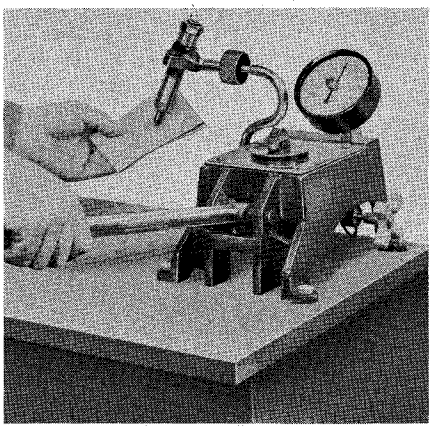


Fig. 91—A fuel injector tester such as the one shown is necessary for checking and adjusting fuel injector assemblies. Nozzle seat leakage check is illustrated; refer to paragraph 120.

119. SPRAY PATTERN. Operate the tester lever slowly and observe nozzle spray pattern. All four (4) sprays must be similar and spaced at approximate intervals of 100°, 90°, 70° and 90°. Each spray must be well atomized and should spread to a 3-inch diameter cone at approximately ⅜-inch from nozzle tip. If spray pattern does not meet these conditions, remove nozzle from tester and overhaul nozzle as outlined in paragraph 123. If nozzle spray is satisfactory, proceed with seat leakage test as outlined in following paragraph.

120. SEAT LEAKAGE. Close valve to tester gage and operate tester lever quickly for several strokes. Then, wipe nozzle tip dry with clean blotting paper and open valve to tester gage. On all models except TW-10, TW-20 and TW-30, push tester lever down slowly to bring gage pressure to 200 psi below nozzle opening pressure and hold this pressure for one minute. On Models TW-10, TW-20 and TW-30, apply pressure to 150 psi below nozzle opening pressure and hold this pressure for six seconds. Apply a piece of clean blotting paper (Fig. 91) to tip of nozzle; the resulting oil blot should not be greater than ½-inch in diameter. If nozzle tip drips oil or blot is excessively large, remove nozzle from tester and overhaul nozzle as outlined in paragraph 123. If nozzle seat leakage is not excessive, proceed with nozzle leak back test as outlined in following paragraph.

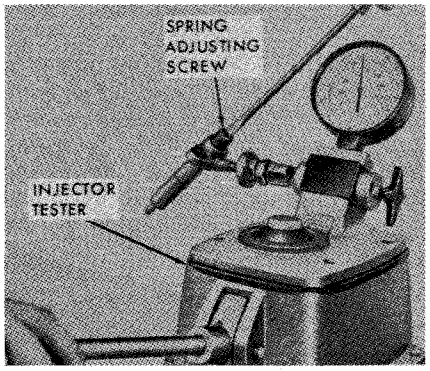


Fig. 92—Adjusting nozzle opening pressure; refer to paragraph 118 for specifications.

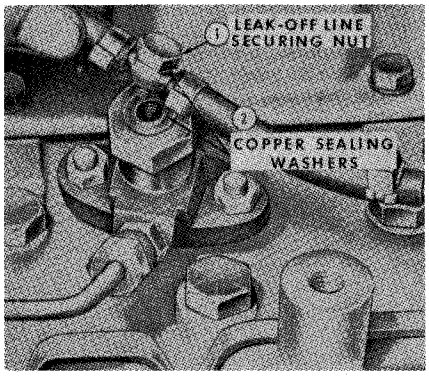


Fig. 93—View showing injector leak-off line disconnected from injector. Note copper sealing washers placed on each side of banjo fitting.

121. NOZZLE LEAK BACK. Operate tester lever to bring gage pressure to approximately 2300 psi, release lever and note time required for gage pressure to drop from 2200 psi to 1500 psi. Time required should be from 10 to 40 seconds. If time required is less than 5 seconds, nozzle is worn or there are dirt particles between mating surfaces of nozzle and holder. If time required is greater than 40 seconds, needle may be too tight a fit in nozzle bore. Refer to paragraph 123 for disassembly, cleaning and overhaul information.

NOTE: A leaking tester connection, check valve or pressure gage will show up in this test as excessively fast leak back. If, in testing a number of injectors, all show excessively fast leak back, the tester should be suspected as faulty rather than the injectors.

122. **REMOVE AND REINSTALL INJECTORS.** Before removing injectors, carefully clean all dirt and other foreign material from lines, injectors and

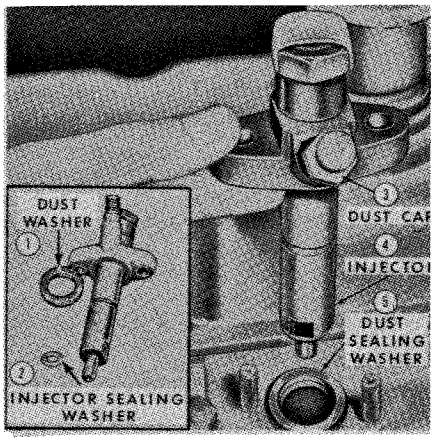


Fig. 94—Cap or plug all openings when removing injector assembly. Dust washer (1) keeps dirt out of injector bore in cylinder head. Be sure seat in bore is clean and install sealing washer (2) when reinstalling injector.

cylinder head area around the injectors. Disconnect the injector leak-off line (Fig. 93) at each injector and at the fuel return line. Disconnect the injector line at the pump and at the injector. Cap all lines and openings. Remove the two retaining nuts and carefully remove the injector from cylinder head (Fig. 94).

Prior to reinstalling injectors, check the injector seats in cylinder head to see that they are clean and free from any carbon deposit. Install a new copper washer in the seat and a new cork dust sealing washer around the body of the injector. Insert the injector in cylinder bore, install retaining washers and nuts and tighten the nuts evenly and alternately to a torque of 10-15 ft.-lbs. Position new leak-off fitting gaskets below and above each banjo fitting and install the banjo fitting bolts to a torque of 5-7 ft.-lbs. Reconnect leak-off line to return line. Check the fuel injector line connections to be sure they are clean and reinstall lines, tightening connections at pump end only. Crank engine until a stream of fuel is pumped out of each line at injector connection, then tighten the connections. Start and run engine to be sure that injector is properly sealed and that injector line and leak-off line connections are not leaking.

123. **OVERHAUL INJECTORS.** Unless complete and proper equipment is available, do not attempt to overhaul diesel nozzles. Equipment recommended by Ford is Ford tool No. 2021-Poptester, No. 1719-Injector Holding Fixture and No. 1720-Injector Cleaning Kit. Tools may be ordered by using Common Tool Order Form, FTO 8091, available at Ford Tractor Dealerships then forwarding order to nearest district office.

Secure injector holding fixture, No. 1719, in a vise and mount injector assembly in fixture. Never clamp injector body in vise. Remove cap nut and back-off adjusting screw then lift off upper spring disc, injector spring and spindle. Remove the nozzle retaining nut using nozzle nut socket (8136), or equivalent, and remove the nozzle and valve. Nozzles and valves are a lapped fit and must never be interchanged. Place all parts in clean fuel oil or calibrating fluid as they are disassembled. Clean injector assembly exterior as follows: Soften hard carbon deposits formed in the spray holes and on needle tip by soaking in a suitable carbon solvent, then use a soft wire (brass) brush to remove carbon from needle and nozzle exterior. Rinse the nozzle and needle immediately after cleaning to prevent the carbon solvent from corroding the highly finished surfaces. Clean the pressure chamber of the nozzle with a 0.043 inch reamer as shown in Fig. 97. Clean the spray holes with the proper size wire probe held in a pin vise as shown in Fig. 98. To prevent breakage of wire probe, the wire should protrude from pin vise only far enough to pass through the spray holes. Rotate pin vise

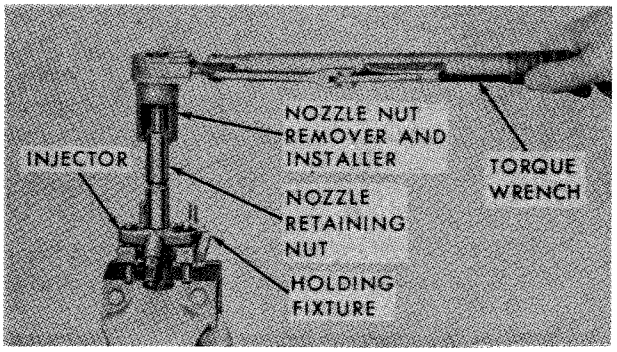


Fig. 95—View showing injector assembly mounted on holding fixture; nozzle retaining nut is being tightened using special wrench and torque wrench.

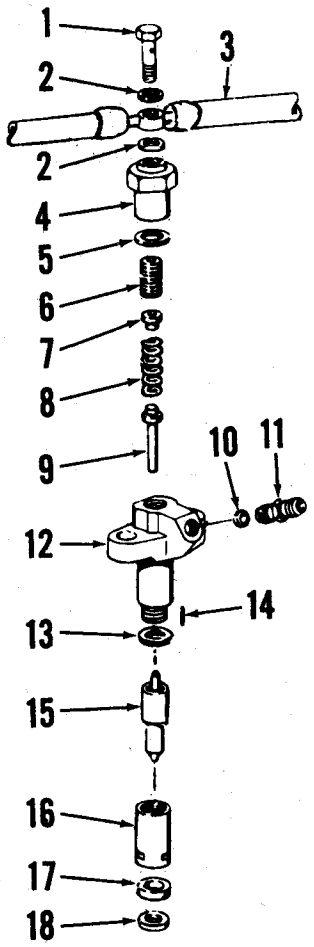


Fig. 96A—Exploded view of early injector. Refer also to Fig. 105.

1. Leak-off bolt
2. Washer
3. Leak-off hose
4. Cap
5. Seal washer
6. Adjusting screw
7. Spring plate
8. Spring
9. Spindle
10. Adapter washer
11. Connector
12. Holder assembly
13. Shim
14. Dowel
15. Nozzle assembly
16. Nozzle nut
17. Seal
18. Sealing washer

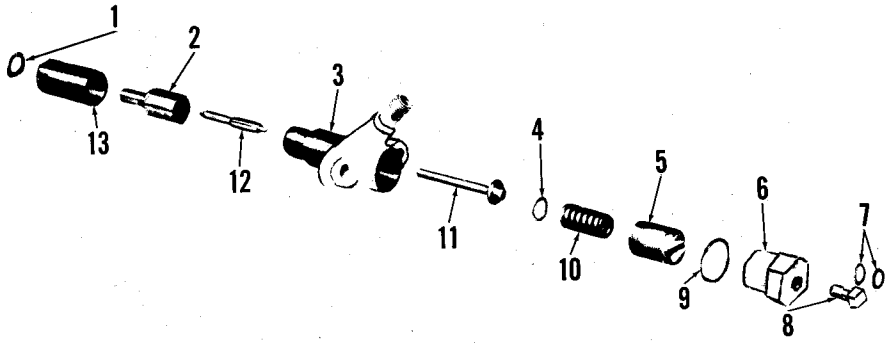


Fig. 96—Exploded view of late model injector.

1. Copper washer
2. Nozzle body
3. Nozzle holder
4. Washer
5. Adjusting screw
6. Cap nut
7. Leak off line washers
8. Leak off line fitting
9. Washer
10. Spring
11. Spindle
12. Needle valve
13. Nozzle retaining nut

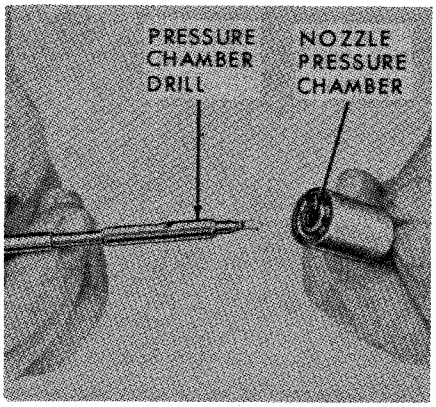


Fig. 97—Cleaning nozzle tip cavity with pressure chamber drill.

without applying undue pressure. Use a 0.012-inch diameter wire probe.

The valve seats in nozzle are cleaned by inserting the valve seat scraper into the nozzle and rotating scraper. Refer to Fig. 99. The annular groove in top of nozzle and the pressure chamber are cleaned by using (rotating) the pressure chamber carbon remover tool as shown in Fig. 100.

When above cleaning is accomplished back flush nozzle and needle by installing reverse flushing adapter (8124) on the nozzle tester and inserting nozzle and needle assembly tip end first into the adapter and secure with knurled nut as shown in Fig. 101. Rotate the needle in nozzle while operating tester lever. After nozzle is back flushed, the seat can be polished by using a small amount of tallow on the end of a polishing stick and rotating stick in nozzle as shown in Fig. 102.

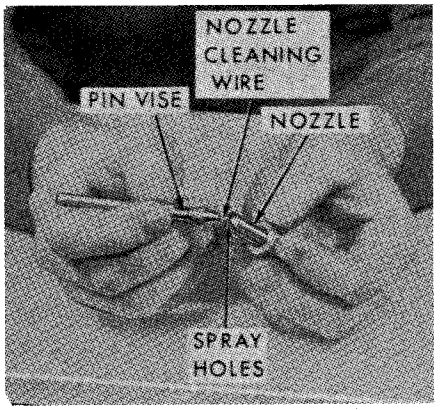


Fig. 98—Cleaning nozzle spray holes with wire probe held in pin vise.

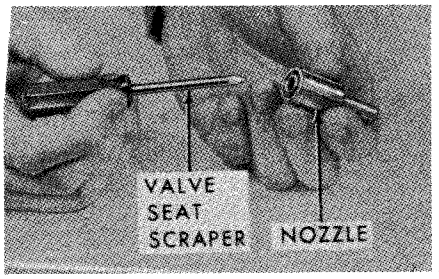


Fig. 99—Use scraper to clean carbon from valve seat in nozzle body.

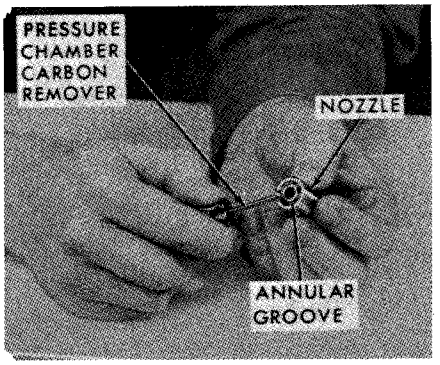


Fig. 100—Pressure chamber carbon remover is used to clean annular groove as well as clean carbon from pressure chamber in nozzle.

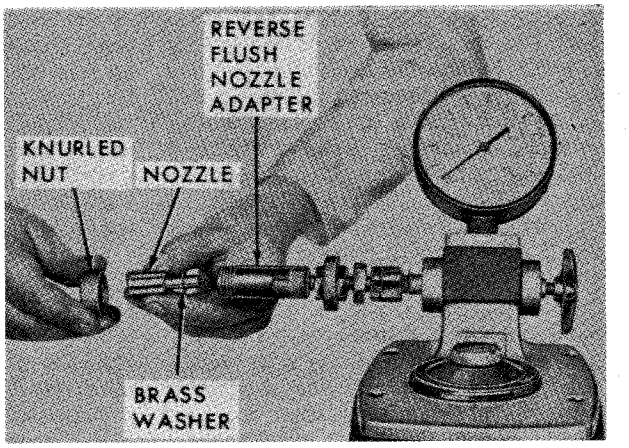


Fig. 101—A back flush attachment is installed on nozzle tester to clean nozzle by reverse flow of fluid; note proper installation of nozzle in the adapter.

If the leak-back test time was greater than 40 seconds (refer to paragraph 121), or if needle is sticking in bore of nozzle, correction can be made by lapping the needle and nozzle assembly. This is accomplished by using a polishing compound (Bacharach No. 66-0655 is suggested) as follows: Place small diameter of nozzle in a chuck of a drill having a maximum speed of less than 450 rpm.

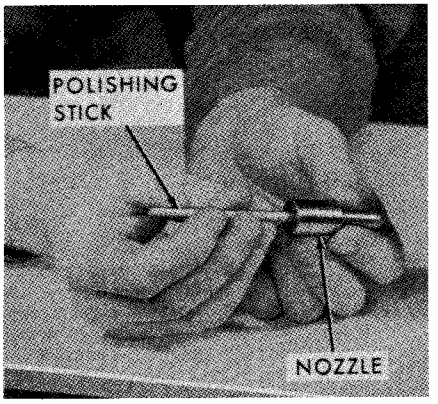


Fig. 102—Polishing needle valve seat with tallow and polishing stick.

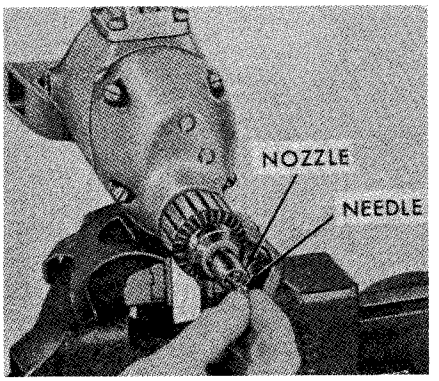


Fig. 103—Chuck small diameter of nozzle in slow speed electric drill to lap needle to nozzle if leak back time is excessive or if needle sticks in nozzle. Hold pin end of needle with vise grip pliers.

Apply a small amount of polishing compound on barrel of needle taking care not to allow any compound on tip or beveled seat portion, and insert needle in rotating nozzle body. Refer to Fig. 103.

NOTE: Do not lap valve for more than five seconds at a time and allow parts to cool between lapping. It is usually necessary to hold upper pin end of needle with vise-grip pliers to keep the needle from turning with the nozzle. Work the needle in and out a few times taking care not to put any pressure against seat, then withdraw the needle, remove nozzle from chuck and thoroughly clean the nozzle and needle assembly using back flush adapter and tester pump.

Prior to reassembly, rinse all parts in clean fuel oil or calibrating fluid and assemble while still wet. Position the nozzle and needle valve on injector body and be sure dowel pins in body are correctly located in nozzle as shown in Fig. 104.

NOTE: Place injector in holding fixture (1719) and tighten nut and new washer with socket (8126).

Install the spindle, spring, upper spring disc and spring adjusting screw. Connect the injector to tester and adjust opening pressure as in paragraph 118. Use a new copper washer and install cap nut. Recheck nozzle opening pressure to

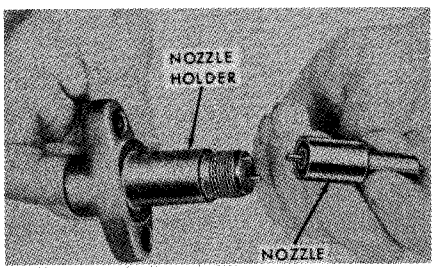


Fig. 104—Be sure dowel pins in nozzle holder enter mating holes in nozzle body.

be sure that installing nut did not change adjustment. Retest injector as outlined in paragraphs 119 through 121; renew nozzle and needle if still faulty. If the injectors are to be stored after overhaul, it is recommended that they be thoroughly flushed with calibrating fluid prior to storage.

FUEL INJECTION PUMP

125. **LUBRICATION.** The Minimec or Simms fuel injection pump is lubricated by oil sump in the pump cambox. After each 300 hours of Simms pump operation, the pump should be drained, the cambox breather cleaned and the cambox refilled to proper level with new, clean engine oil. Periodic oil change is not required on Minimec pump. Use same weight and type oil as for engine crankcase; refer to Fig. 106 for location of drain plug, oil level plug and filler plug.

Whenever installing a new or rebuilt fuel injection pump, be sure the cambox is filled with engine oil before attempting to start engine. There will be some oil dilution with diesel fuel during engine operation and after engine is stopped, some of the fuel-oil mixture may run from overflow tube.

126. **PUMP TIMING.** To check and adjust pump timing, proceed as follows: Remove Proof-Meter drive cable, cover and gasket from rear end of fuel injection pump. Remove cover plate from front side of engine timing gear cover and remove the flywheel timing hole cover plate from right rear side of engine. Turn engine clockwise until punch marked V-notch in rear end of injection pump camshaft points toward timing mark on pump housing (Fig. 107), then continue to turn engine slowly until the 23° BTDC timing mark on flywheel (Fig. 108) is aligned with arrow at edge of timing hole. The timing marks on fuel injection pump should then be exactly aligned as shown in Fig. 109; if not, loosen the three cap screws that retain gear to fuel injection pump drive hub and rotate the pump camshaft until marks are aligned. Tighten the cap screws to a torque of 20-25 ft.-lbs. Recheck timing marks and if aligned, reinstall the injection pump timing gear cover and reconnect Proof-Meter drive.

127. **R&R FUEL INJECTION PUMP.** Thoroughly clean the pump, lines and connections and the area around the pump. Proceed as outlined in paragraph 126 to bring the flywheel and pump timing marks into alignment and shut off the fuel. Remove the pump to injector lines, disconnect the fuel inlet and outlet lines from fuel lift pump and the filter to injection pump line and immediately cap all openings. Disconnect the throttle and fuel shut-off controls. Remove the three cap screws retaining gear to injection pump drive hub and remove the gear clamping plate. Remove the cap screws retaining pump to engine front plate and remove the pump assembly. The pump drive gear will remain in the engine timing gear cover and cannot become out-of-time; however, the engine should not be turned with pump removed. Remove excess leak-off line from pump and plug the opening.

To reinstall the fuel injection pump, reverse the removal procedures and time the pump as outlined in paragraph 126. Tighten the fuel injection pump retaining cap screws to a torque of 26-30 ft.-lbs. and the gear to drive hub retaining cap screws to a torque of 20-25 ft.-lbs. Bleed fuel injection pump as outlined in paragraph 114A or 115A.

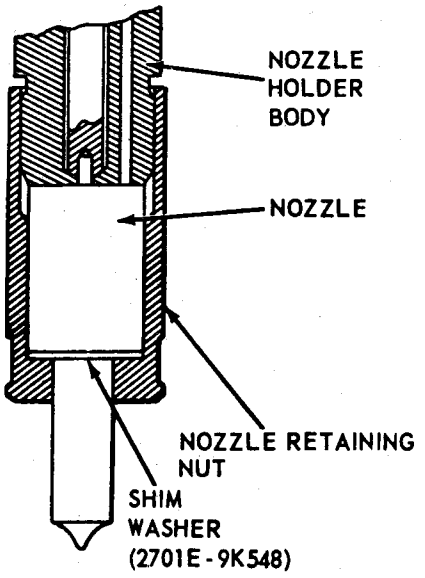


Fig. 105—Cross-sectional view showing shim washer (13—Fig. 96A) installed between nozzle body and nozzle retaining nut.

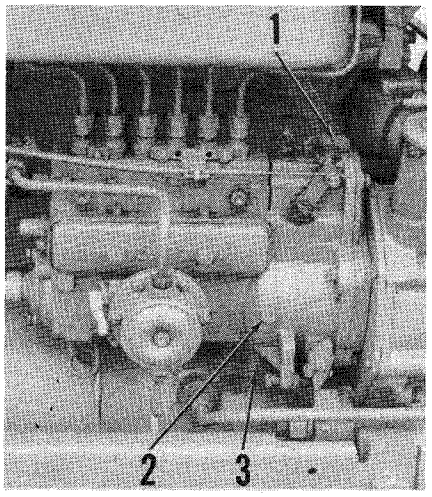


Fig. 106—View showing filler plug (1), level plug (2) and drain plug (3) for fuel injection pump cambox and governor lubricating oil.

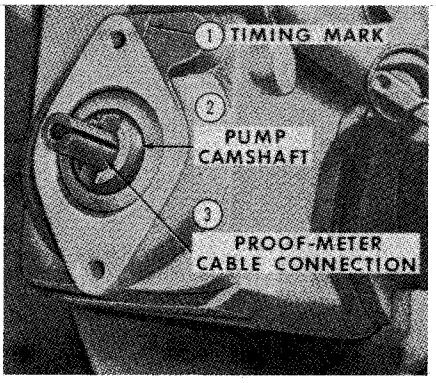


Fig. 107—View of fuel injection pump with Proof-Meter drive cover removed. "V" notch with two punch marks on rear end of pump camshaft should align with timing mark on housing when No. 1 piston is at 23° BTDC on compression stroke.

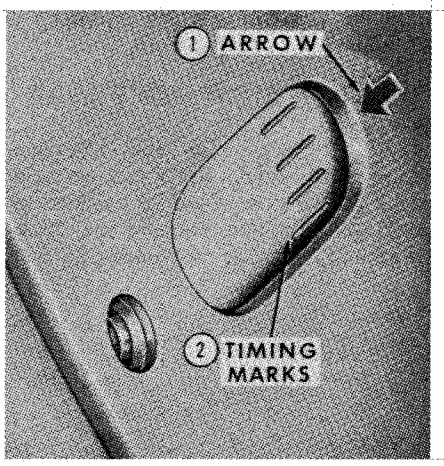


Fig. 108—View with cover plate removed showing timing pointer on engine rear plate and timing marks on flywheel.

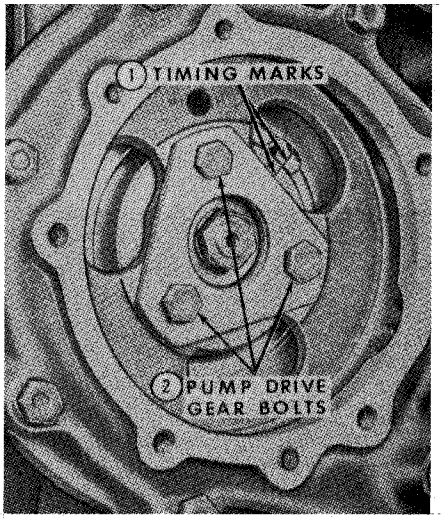


Fig. 109—Pump drive gear cover is removed to show timing marks on drive gear adapter hub and on pump housing.

FUEL LIFT PUMP

128. The fuel lift pump is mounted on the outside of the fuel injection pump and is driven from a cam on the injection pump camshaft. The fuel pump is of the diaphragm type, and the component parts are available for service. Refer to exploded view of the fuel pump assembly in Fig. 110. The inlet and outlet valves (4) are staked into the outer body (3); when renewing valves, insert in body as shown and carefully stake in position. The primer lever retaining pin (12) must be installed with outer end below flush with the machined surface of inner body (7), to prevent damage to diaphragm (5). After inserting pivot pin (10) in inner body, securely stake pin in place.

To test pump, operate the primer lever with lines disconnected and with fingers closing the inlet port; pump should hold vacuum after releasing primer lever. With finger closing outlet port, there should be a well defined surge of pressure when operating primer lever.

INJECTION PUMP DRIVE GEAR

129. To remove the fuel injection pump drive gear, first remove the engine timing gear cover as outlined in paragraph 86. Then, remove the three cap screws, retainer plate and the fuel injection pump drive gear.

Prior to installing gear, turn engine crankshaft so that timing marks on crankshaft gear and camshaft gear point towards center of idler (camshaft drive) gear. Then, remove the self-locking cap screw retaining idler gear to front face of cylinder block, remove the idler gear and reinstall with timing marks aligned with marks on crankshaft gear and camshaft gear. Tighten idler gear cap screw to a torque of 100-105 ft.-lbs.

Place the pump drive gear on adapter hub with timing mark aligned with timing mark on idler gear. Place retainer plate on gear, install socket wrench on nut on front end of pump camshaft and turn pump camshaft until timing mark on adapter is aligned with timing mark (pointer) on pump front plate. Then, turn the pump slowly in a counter-clockwise direction (as viewed from front of engine), if necessary, so that the cap screws can be installed through retainer plate and drive gear into the pump drive adapter. Turn the engine clockwise until No. 1 piston is at the 23 degrees BTDC mark on flywheel, on compression stroke. With pump drive gear retaining cap screws loose, turn the pump camshaft with socket wrench so that pump timing marks are aligned (Fig. 109), then tighten the drive gear retaining cap screws to a torque of 20-25 ft.-lbs.

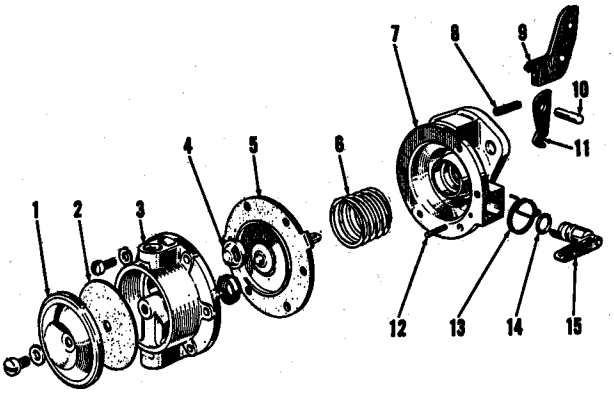


Fig. 110—Exploded view of diaphragm type fuel lift pump.

1. Cover
2. Pulsator diaphragm
3. Outer body
4. Valves
5. Pump diaphragm
6. Diaphragm spring
7. Inner body
8. Cam lever spring
9. Cam lever
10. Pivot pin
11. Diaphragm lever
12. Retaining pin
13. Return spring
14. "O" ring
15. Primer lever

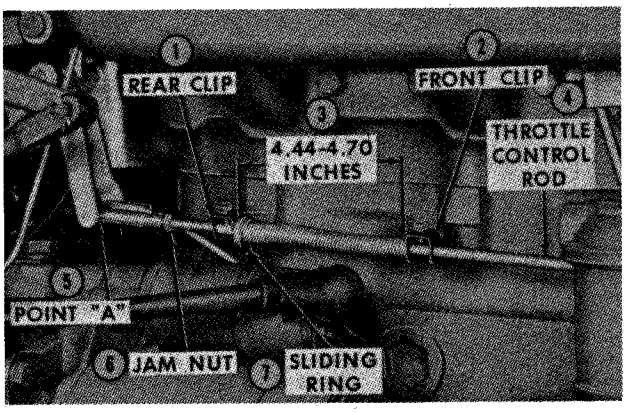


Fig. 111—Adjusting points for throttle linkage are shown for all models except TW-10, TW-20 and TW-30. Linkage is adjusted to obtain desired engine high idle speed; pump is not fitted with high idle speed stop screw.

GOVERNOR AND THROTTLE LINKAGE ADJUSTMENT

130. Idle speed must be adjusted with engine at normal operating temperature. High idle speed for Models 9000, 9600, 9700, TW-20 and TW-30 is 2420-2470 rpm. High idle speed for all other models is 2530-2580 rpm. Low idle speed for all models is 700-800 rpm. To adjust low idle speed on all models, readjust stop screw on fuel injection pump, (4—Fig. 90 or 3—Fig. 112).

To adjust high idle speed on Models TW-10, TW-20 and TW-30, disconnect throttle linkage and turn maximum no load stop screw (1—Fig. 112), until specified idle speed is obtained. To adjust high idle on other models, disconnect throttle rod (POINT "A"—Fig. 111), loosen jam nut (6) and shorten rod to increase speed or lengthen rod to decrease speed. Push hand throttle lever forward against stop and check high idle speed. If not within recommended speed range, loosen rear clip (1) and while holding foot pedal depressed against platform and hand throttle forward against stop, tighten clip. Measure distance between front clip (2) and rear clip; if not within 4.44 to 4.70 inches, loosen front clip, reposition so that distance measures 4½ inches and tighten clip. Recheck high idle speed for both foot throttle and hand throttle operations and readjust if necessary.

On models with hand throttle only, check high idle speed with throttle lever against forward stop. If high idle speed is not within recommended range, disconnect throttle rod (POINT "A"), loosen jam nut (6) and shorten throttle rod to increase speed or lengthen rod to decrease speed. Reconnect throttle rod and tighten jam nut. Recheck high idle speed and readjust if necessary.

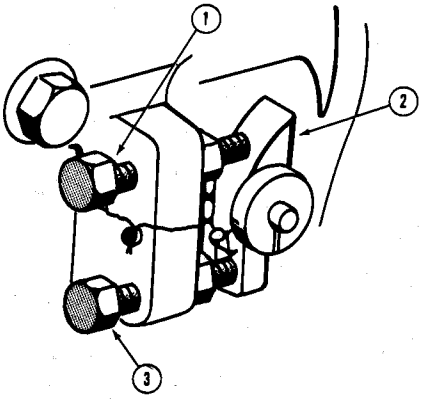


Fig. 112—Pump speed adjustments for Models TW-10, TW-20 and TW-30.

1. Maximum no load stop screw
2. Control stop
3. Low idle speed stop

TURBOCHARGER

134. 9000, 9600, TW-20 and TW-30 models are equipped with a turbocharger. These models will have either a Schwitzer Model 3LD or AiResearch turbocharger. Refer to Figs. 115 or 117 for identification. Major components consist of turbine, turbine housing, compressor, compressor housing and bearing housing. Model TW-30 is equipped with an intercooler as noted in paragraph 142.

TROUBLESHOOTING

135. If turbocharger malfunctions, review following troubleshooting sections to determine cause:

TURBOCHARGER NOISY. If turbocharger is noisy check the following:

Dirty air cleaner.

Foreign material or object in compressor to intake manifold duct.

Foreign object in engine exhaust system.

TURBOCHARGER BINDING OR DRAGGING. If turbocharger binds or drags check the following:

Damaged compressor wheel.

Damaged turbine wheel.

Worn bearings, shaft journals or bearing bores.

Excessive dirt build up in compressor.

Excessive carbon build up behind turbine wheel.

SEAL LEAKS AT COMPRESSOR END OF TURBOCHARGER. Check the following:

Dirty air cleaner.

Restricted duct between air cleaner and turbocharger.

Loose compressor-to-intake manifold duct connections.

Leaks at intake manifold.

Restricted turbocharger oil drain line.

Plugged crankcase breather.

Worn or damaged compressor wheel.

Excessive engine blow-by.

SEAL LEAKS AT COMPRESSOR END OF TURBOCHARGER. Check the following:

Excessive pre-oiling.

Plugged engine crankcase breather.

Restricted turbocharger oil drain line.

Worn bearings, bores or shaft journals.

WORN TURBOCHARGER BEARINGS, BORES OR JOURNALS. Check for:

Inadequate pre-oiling following turbocharger installation or engine lube servicing.

Contaminated or improper grade of engine oil used in engine.

Restricted oil feed line.

Plugged engine oil filter.

Insufficient oil to turbocharger caused by oil lag.

Insufficient oil supply caused by oil pump malfunction.

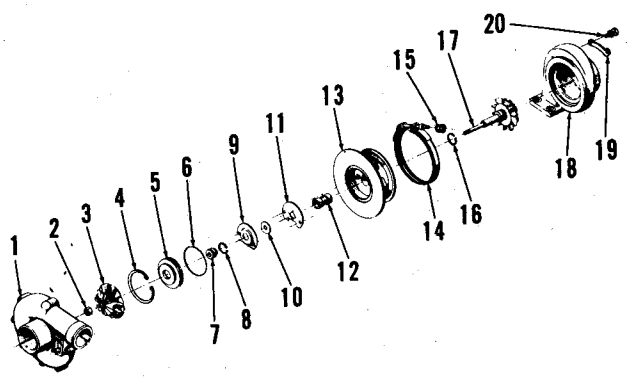
137. **REMOVE AND REINSTALL.** During removal procedure, be sure to cap or plug all manifold, turbocharger and oil tube openings to prevent damage to turbocharger due to foreign matter.

To remove turbocharger, remove hood side panels, exhaust extension, hood top panel, exhaust pipe, exhaust pipe flange and sealing ring. Remove fuel tank on TW-20 models and intercooler on TW-30 models. Disconnect air cleaner and intake manifold tubes from turbocharger. Disconnect oil supply and oil return tubes from turbocharger. Remove oil supply tube adapter. Remove four nuts and lockwashers securing turbocharger to exhaust manifold adapter and remove turbocharger.

To reinstall, place turbocharger on exhaust manifold adapter with a new gasket, use new tabbed lockwashers and tighten nuts to 30-35 ft.-lbs. Install oil supply tube adapter and new gasket and connect oil supply tube. Do not connect oil return tube at this time. Position exhaust seal ring in turbocharger. Install exhaust pipe flange and secure to exhaust manifold adapter. Connect intake manifold tubes to turbocharger and tighten clamp bolts to 15-20 in.-lbs. Be sure there is no strain on compressor cover from intake manifold tube. If necessary, loosen compressor cover bolts and realign cover with intake manifold. Be sure compressor cover is seated properly and tighten cover bolts to 60 in.-lbs. Tighten air cleaner to turbocharger clamp bolts to 15-20 in.-lbs. Install exhaust pipe and tighten exhaust pipe flange bolts to 20-26 ft.-lbs. and the support bracket nuts to 8-12 ft.-lbs.

To prime turbocharger, proceed as follows: With oil return tube disconnected, place a container under the oil return passage of the turbocharger bearing housing and crank engine with diesel engine stop control out until there is a steady flow of oil from oil return passage of bearing housing. Connect oil return tube to turbocharger, install top hood panel, hood side panels and exhaust extension. Retighten all bolts after several hours of operation.

138. **OVERHAUL (Schwitzer).** Remove turbocharger as outlined in paragraph 137. Before disassembling, mark relative positions of compressor cover, bearing housing and turbine housing to aid in reassembly. Remove compressor cover and note that bolts are of a special design and same type must be used if the bolts are to be renewed. Remove clamp band (14—Fig. 115) and separate core assembly from turbine housing. It may be necessary to tap lightly on turbine housing to dislodge core assembly. The turbine wheel and shaft can be conveniently held by mounting a 5/8-inch 12-point box end wrench in a vise, so that turbine shaft can be inserted into wrench, with compressor wheel up. Remove compressor wheel retaining nut (2) being careful not to apply pressure to turbine or



1. Compressor housing
2. Nut
3. Compressor wheel
4. Snap ring
5. Insert
6. "O" ring
7. Flinger sleeve
8. Seal ring
9. Oil deflector
10. Thrust ring
11. Thrust plate
12. Bearing
13. Bearing housing
14. Clamp band
15. Nut
16. Seal ring
17. Turbine wheel & shaft
18. Turbine housing
19. Clamp plate
20. Cap screw

Fig. 115—Exploded view of Schwitzer Model 3LD turbocharger used on 9000, 9600, 9700 tractors.

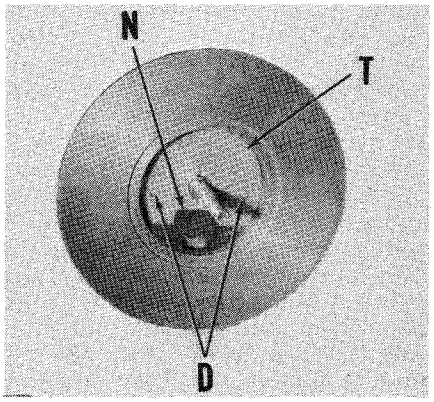


Fig. 116—Thrust plate (T) is installed on dowel pins (D) with bronze face up. Note cut-out (N) in thrust plate for lip of oil deflector.

compressor wheel fins. Remove compressor wheel (3) and withdraw turbine wheel (17) and shaft assembly. Remove bearing (12) and mark bearing so it can be reinstalled in its original position. Remove bearing housing snap ring (4) and using two screwdrivers, lift insert (5) and "O" ring (6) from housing. Remove remainder of components in bearing housing. If sealing rings (8 and 16) are removed, note that they are different in diameter and should be marked to prevent incorrect assembly.

Soak turbocharger components in a suitable solvent and clean using a soft brush, plastic blade or compressed air.

CAUTION: Do not use a wire brush, steel scraper or caustic solution for cleaning as this will damage turbocharger parts.

139. Inspect turbine wheel and compressor wheel blades, which should be renewed if any blades are broken, bent or cracked. If any one blade is bent less than 20°, wheel may be used. If more than one blade is bent discard wheel. Do not attempt to straighten blades.

Inspect all bearing and thrust surfaces for wear, excessive scoring, grooves or heavy scratch marks. Inspect seal rings and grooves, inspect bearing housing for cracks and wear in bearing bore. Inspect oil supply holes in housing and be sure they are clear of obstacles.

To assemble, refer to exploded view in Fig. 115. Install copper-coated seal ring (16) on turbine wheel. Be sure correct sealing ring is installed. Lubricate sealing ring and turbine shaft with engine oil and install in bearing housing, being careful not to damage seal ring recess in bearing housing or bearing bore. Lubricate bearing (12) and install in bearing housing or turbine wheel shaft. If original bearing is being used, it should be reinstalled in its original position. Install thrust plate (11) on dowel pins with bronze face up as shown in Fig. 116. Lubricate and install thrust ring (10—Fig. 115). Install oil deflector (9) on dowel pins so that lip is in towards housing. Install seal ring (8) on flinger sleeve (7) and install flinger sleeve and seal ring in insert (5) so that flat side of sleeve (7) is flush with flat side of insert (5). Lubricate "O" ring and place in groove of insert (5). Install insert (5) in bearing housing with flat side out and press into counterbore until snap ring groove in bearing housing is clear. Be sure flinger sleeve remains in place when installing insert. Install snap ring (4) with beveled side out, and place compressor wheel on turbine wheel shaft. Coat the threads of a new locknut with graphite grease and install locknut on turbine wheel shaft and tighten to 156 in.-lbs. Spin compressor wheel and note any binding or rubbing of components. Assembly must spin freely. Check for turbine wheel shaft end play. Normal end play is 0.006 inch. If end play is excessive, check for abnormal wear on thrust surfaces. If there is no end play, check for carbon build-up on turbine wheel surface.

Reassemble remainder of assembly by reversing disassembly procedure. Tighten clamp band nut to 120 in.-lbs. When installing compressor cover, align cover with reference marks made during disassembly. Tighten compressor cover bolts using a diagonal pattern to 60 in.-lbs. Check that assembly will spin freely and disassemble if any drag is felt. To reinstall turbocharger, refer to paragraph 137.

140. **OVERHAUL (AiResearch).** Remove turbocharger as outlined in paragraph 137. Clean housing and mark for proper alignment during reassembly. Bend lockplate tabs (3 and 20—Fig. 117), remove bolts (4 and 19), clamps (2 and 21) and carefully separate housing assemblies. Remove locknut (18) while supporting center housing in a vertical position. Avoid bending turbine wheel shaft (5) while removing compressor wheel (17) from turbine wheel assembly. Turn over housing and withdraw turbine wheel assembly with piston ring (6). Bend locktabs on lockplate (23) and remove remaining bolts, lockplate (23) and backplate assembly (16). Do not disassemble backplate assembly. Center housing pins (14) should not be removed unless renewal is required.

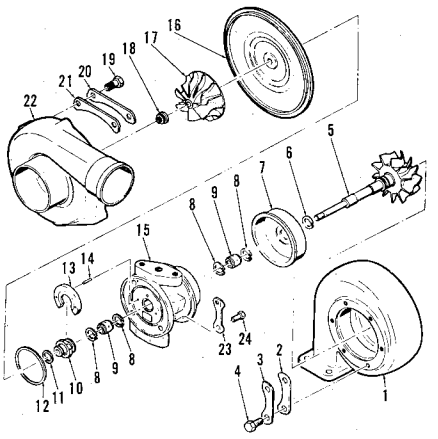


Fig. 117—Exploded view of AiResearch turbocharger.

1. Turbine housing
2. Clamp
3. Lockplate
4. Bolt
5. Turbine wheel assembly
6. Rear piston ring
7. Wheel shroud
8. Snap ring
9. Bearing
10. Thrust collar
11. Front piston ring
12. Seal ring
13. Thrust bearing
14. Spring pin
15. Center housing
16. Backplate assembly
17. Compressor wheel
18. Locknut
19. Bolt
20. Lockplate
21. Clamp
22. Compressor housing
23. Lockplate
24. Bolt

Small parts should be inspected for burns, rubbing, scoring and other damage before cleaning, then clean parts in a non-caustic solution using a soft bristle brush, plastic scraper and dry compressed air. To make sure oil squirt hole (1—Fig. 118) isn't plugged, insert a 0.053-0.060 inch diameter wire into oil squirt hole of center housing. Refer to paragraph 139 for component inspection procedure.

The following parts should be renewed whenever turbocharger is overhauled or disassembled: Bolts (4, 19 and 24—Fig. 117), lockplates (3, 20 and 23), sealing ring (12), piston rings (6 and 11), snap rings (8), and bearings (9).

Refer to Fig. 117 to assemble turbocharger. Reassembly procedure is the reverse of disassembly, however the following steps should be taken: Fill piston ring groove with high vacuum silicon grease manufactured by Dow-Corning or equivalent. Install piston ring (6) and shroud (7) on turbine wheel assembly (5), then guide wheel assembly shaft through bearings (9). Slide shaft into center housing (15) as far as it will go. Place serrated end of turbine wheel assembly in a suitable socket or box end wrench clamped in a vise. Install thrust collar (10) on turbine wheel assembly (5) and slide the assembled parts down against center housing (15) so pins (14) engage thrust bearing holes. Install backplate (16) over turbine wheel shaft (5) and guide piston ring (11) into backplate bore. Install screws (24) and lockplate (23) then tighten screws to a torque of 75-90 in.-lbs. Install compressor wheel (17) on turbine wheel shaft.

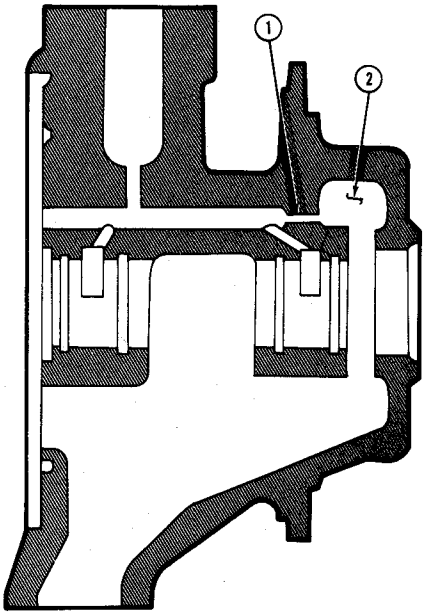


Fig. 118—Sectional view of turbocharger center housing.

1. Oil squirt hole
2. Turbine end oil cavity

After oiling washer face and threads of locknut (18), install locknut on shaft and tighten to a torque of 18 in.-lbs. then turn nut an additional 90 degrees. Apply high temperature sealer to threads of housing screws and attach turbine housing (1) to center housing (15). Tighten screws (4) tight enough to prevent turbine wheel from contacting housing. Install compressor housing (22) on backplate (16) and install clamps (21), lockplates (20) and screws. Tighten screws only enough to prevent housing contact with compressor wheel. If alignment marks are positioned properly, tighten screws to a torque of 100-130 in.-lbs. and bend lockplate tabs.

INTERCOOLER

142. Model TW-30 is equipped with a turbocharger intercooler. Air from the turbocharger is cooled before it enters the intake manifold. This process increases air density and permits increased fuel delivery to the engine, resulting in an increase in horsepower. Main parts of the intercooler are: Tip turbine fan and housing, pre-cleaner and heat exchanger. Components may be removed as necessary for repair after tractor hood and side panels are removed.

143. **OVERHAUL TIP TURBINE FAN.** Mark both housings for proper alignment during reassembly. Remove fan connector (4–Fig. 119), with check valve flapper (5) from turbine housing (8) then separate valve and connector. Remove gasket (6) and bridge (7) from housing. Remove baffle assembly (22) from inlet housing. Remove inlet housing screws, lockwashers and separate inlet housing (21) from turbine fan assembly (8).

NOTE: It may be necessary to break face of seal by tapping with a brass mallet.

Remove locknut (20) while using suitable tools to keep the shaft from turning. Remove cover (19) and fan wheel (18) from turbine and discharge housing (1).

NOTE: It is not necessary to separate the turbine housing and discharge housing if there is no damage.

To disassemble discharge housing shaft and bearing assembly remove snap ring (9) and grease retainer (10) then remove shaft far enough so "O" ring (14) can be removed. Remove "O" ring, withdraw retainer (11) and shims (12) from shaft. Remove bearing spacer (15). It is not necessary to remove washer shields (16) and spring (17) unless spring is damaged.

Inspect parts before cleaning, then clean all parts in a non-caustic solution using a soft bristle brush, plastic scraper and compressed air.

144. After cleaning, inspect housing (21), wheel (18), and turbine housing (8), for wheel rubbing. Turbine housing should be inspected for nozzle blade erosion (both blade edges must be round).

Inspect shaft (13) for worn, crossed or stripped threads. Bearings and shaft assembly should be separated only if installing new components. Shaft diameter at bearing location should be 0.4725 inch and at wheel location 0.4717 inch. Fan wheel (18) bore diameter shouldn't exceed 0.4724 inch and bearing bores of discharge housing assembly (1) should not exceed 1.2604 inches.

Inspect turbine and cooling air passages for salt build up and flapper valve (5) for dirt. Replace if outer rim is bent more than 0.150 inch. Inspect bearing assemblies (13), snap ring and grease retainer (10) for excessive wear. Renew parts as necessary.

145. Reassembly procedure is the reverse of disassembly, however the following steps should be taken: Install shaft and bearing components after first applying all grease supplied in bearing and shaft kit, Ford part No. D8NN-6N839-AA, to free area between bearings.

Assemble discharge (1) and turbine (8) housings with marks aligned and tighten retaining screws to a torque of 100-120 in.-lbs. Install locknut (20) but do not tighten until shim (12) thickness is determined. With fan, bearings and shaft components assembled, mount a dial gage on mating surface of turbine housing as shown in Fig. 120. Zero dial gage on mating surface (M) then reposition dial gage to read difference in height between housing mating surface and fan wheel at surface (F). Rotate fan wheel and take at least four readings. Average the readings and the result will be thickness of shim (12—Fig. 119).

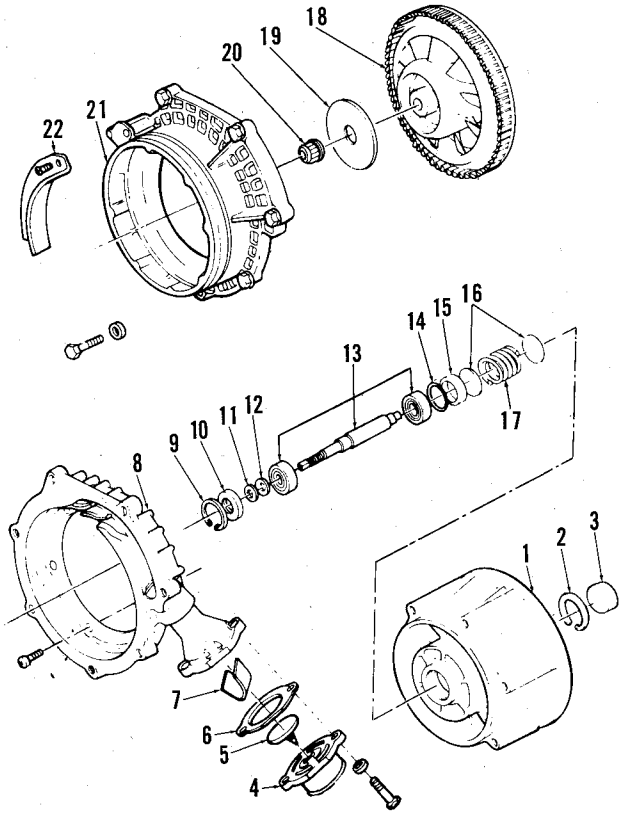


Fig. 119—Exploded view of heat exchanger fan.

1. Fan discharge housing
2. Snap ring
3. Fan housing cup plug
4. Fan connector
5. Check valve flapper
6. Housing gasket
7. Bridge
8. Turbine housing
9. Snap ring
10. Grease retainer
11. Bearing retainer
12. Shim
13. Bearing and shaft
14. "O" ring
15. Bearing spacer
16. Washers
17. Shaft spring
18. Fan wheel
19. Cover
20. Locknut
21. Inlet housing
22. Baffle assembly

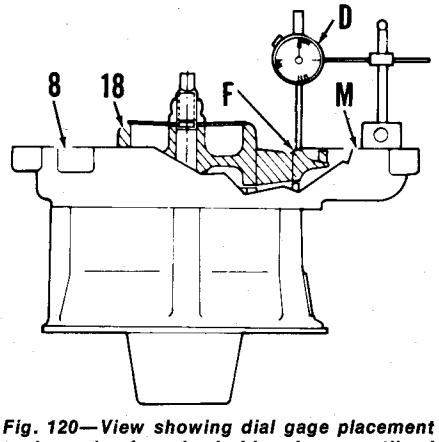


Fig. 120—View showing dial gage placement to determine fan wheel shim size as outlined in text.

D. Dial gage
F. Fan wheel surface
M. Housing mating surface
8. Turbine housing
18. Fan wheel

Shims are available in thicknesses of 0.002, 0.005 and 0.010 inch. With fan wheel properly positioned on shaft, tighten locknut (20) to 140-160 in.-lbs. If wheel drag is noticed when turning by hand, recheck clearance. Replace fan if housing rub can't be eliminated by shimming. Press bridge (7—Fig. 119 and 121) into turbine housing (8) so top of bridge is 0.05-0.06 inch below surface (M—Fig. 121). Reinstall all remaining components.

147. **OVERHAUL HEAT EXCHANGER.** General maintenance may be performed with unit on engine. Remove tip turbine fan for inspection of fan side of intercooler. Accumulated dirt and oil should be removed. Replace gaskets whenever heat exchanger is removed. Before disassembly, mark top of cooler core for proper alignment during reassembly.

Remove intercooler from intake manifold to prevent dirt from entering intake system. Remove old gaskets, steam clean, rinse with water and blow dry.

NOTE: Do not use petroleum based solvents for cleaning cooler on engine.

Clean any remaining gasket material from surface of unit. Use Dow-Corning No. 732 or equivalent sealer to secure new gaskets. After gasket installation, let unit stand until sealer has cured. Reinstall intercooler assembly.

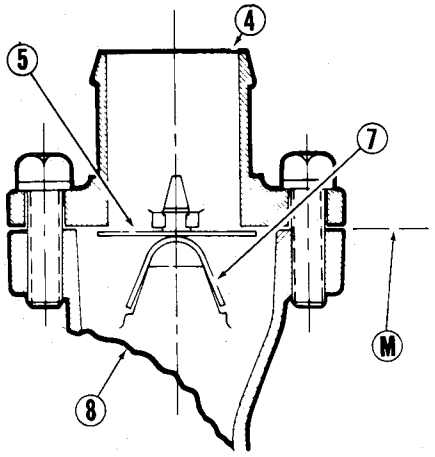


Fig. 121—View showing bridge (7-Fig. 119) installation. Press bridge (7) into turbine housing so top of bridge is 0.05-0.06 inch below surface M. Refer to text and Fig. 119.

COOLING SYSTEM

RADIATOR PRESSURE CAP AND THERMOSTAT

151. A 7 psi radiator pressure cap is used on 8000, 9000, 8600 and 9600 models. All other models use a 13 psi radiator cap. TW-10, TW-20 and TW-30 models are equipped with two thermostats. All other models have one thermostat. Thermostats on Models TW-10, TW-20 and TW-30 are located in a thermostat housing at front of cylinder head, while the thermostat on all other models is located in front of cylinder head. Thermostat opening temperature on TW-10, TW-20 and TW-30 models is 178°F. Thermostat opening temperature on all other models is between 168°F. and 178°F. Thermostat(s) may be removed after draining radiator and removing water outlet connection.

RADIATOR

152. To remove radiator, first drain cooling system and proceed as follows: Evacuate a/c system if so equipped, disconnect lines to condenser then remove grille from radiator shell for access to bolts. Remove engine hood side panels and unbolt hood top panel and side braces from radiator shell. Disconnect radiator hoses, oil cooler and hydraulic lines then unbolt radiator shell from front support. Attach hoist to radiator shell and lift the radiator, a/c condenser (if equipped) and shell unit from tractor. Remove shroud nut and radiator from shell. Reinstall by reversing removal procedure.

WATER PUMP

153. Water pump can be unbolted and removed after draining cooling system, removing pump and alternator or generator drive belt and disconnecting hose from pump.

Using standard two-bolt puller, remove pulley from shaft. Remove rear

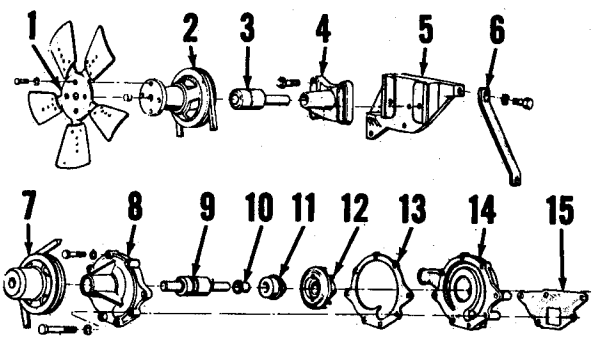


Fig. 122—Exploded view of fan and bracket assembly (top) and water pump assembly (bottom).

1. Fan assembly
2. Fan pulley
3. Shaft & bearing assy.
4. Fan bracket
5. Fan support
6. Brace
7. Water pump pulley
8. Pump housing
9. Shaft & bearing assy.
10. Water slinger
11. Water pump seal
12. Water pump rotor
13. Gasket
14. Pump rear cover
15. Gasket

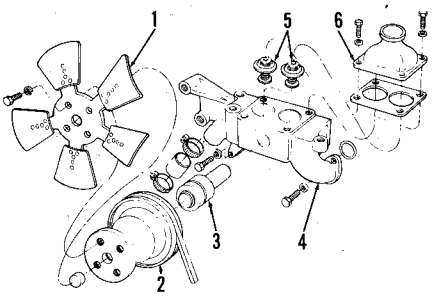


Fig. 122A—Exploded view of thermostat housing and fan drive assembly on Models TW-10, TW-20 and TW-30.

1. Fan
2. Pulley
3. Shaft and bearing assy.
4. Thermostat housing
5. Thermostats
6. Outlet housing

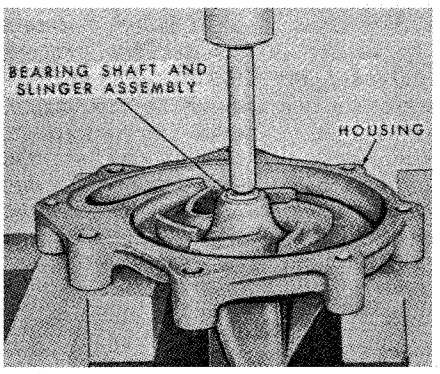


Fig. 123—Press bearing, shaft and slinger assembly from rotor and pump housing.

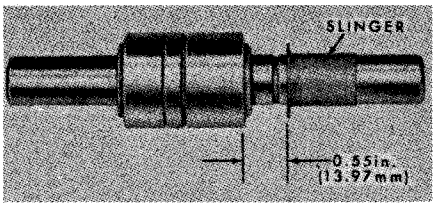


Fig. 124—Press new slinger onto shaft so that distance from edge of bearing outer race to slinger is 0.55 inch.

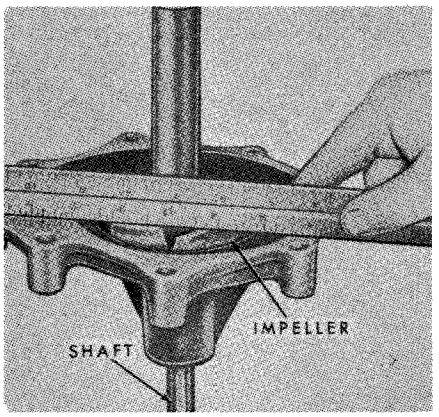


Fig. 125—Press impeller onto shaft with ¾-inch I.D. pipe so that impeller is flush with rear face of housing.

cover (14—Fig. 122) and press the shaft and bearing assembly (9) out towards front of housing as shown in Fig. 123. Drive the seal (11—Fig. 122) out towards rear of housing.

Using a length of 1-5/16-inch I.D. pipe, press new seal into housing. Check to see that flange on water slinger (10) is located 0.55 inch from edge of bearing race as shown in Fig. 124, then press shaft into front of housing until outer bearing race is flush with front end of housing. Using a length of ¾-inch I.D. pipe, press impeller onto shaft as shown in Fig. 125 so that impeller is flush with rear end of housing. Press pulley onto shaft so that center of belt groove in pulley is 2½ inches from rear face of housing as shown in Fig. 125A, for 8000, 9000, 8600 and 9600 models and 3½ inches for all other models. Install rear cover with new gasket and tighten retaining cap screws to a torque of 18-22 ft.-lbs.

Reinstall water pump by reversing removal procedure and tighten retaining cap screws to a torque of 23-28 ft.-lbs. Drive belt is properly adjusted when a force of 25 pounds applied midway between pulleys will deflect belt 5/8 to 7/8 inch.

ENGINE OIL COOLER

155. A water jacketed oil cooler (3—Fig. 126) is attached to top of power steering motor behind the radiator on all models except 8700, 9700, TW-10, TW-20, and TW-30. Oil flows to the cooler from the main oil gallery of engine and returns to the oil pan via right side of cylinder block. On 8000 and 8600 models only, the fitting (6) that connects return tube (2) to cooler contains a relief valve to maintain oil pressure in the engine oil gallery at low engine speeds. This relief valve is not required on 9000 and 9600 models.

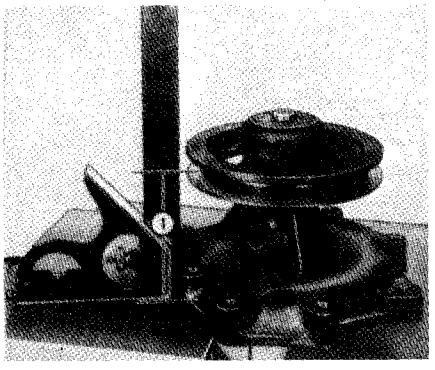


Fig. 125A—View showing water pump pulley position.

1. 3.5 inches—Models 8700, 9700, TW-10, TW-20 and TW-30
   2.5 inches—Models 8000, 9000, 8600, 9600

Engine oil on Models 8700, 9700, TW-10 and TW-20 is cooled by an oil cooler located in the radiator lower tank.

Engine oil on TW-30 models is cooled by an oil cooler located on the left side of cylinder block. Two spin on oil filters are attached to it.

FAN AND FAN BRACKET

All Models Except TW-10, TW-20 And TW-30

156. To remove fan and fan bracket assembly, unbolt fan from pulley (2—Fig. 122) hub, then unbolt bracket (4) from support (5) and remove the bracket, bearing and pulley as an assembly. Remove fan from radiator shroud.

To renew fan bearing and shaft assembly (3), remove fan guide plug and insert driver through pulley center hole to press bearing and shaft assembly from pulley. Press bearing and shaft assembly from bracket. Reassemble and reinstall by reversing removal and disassembly procedure.

Fan drive belt is properly adjusted when a force of 25 pounds applied midway between pulleys will deflect belt 5/8 to 7/8 inch.

Models TW-10, TW-20 And TW-30

156A. The fan shaft and bearing assembly is carried in the thermostat housing (4—Fig. 122A). which is attached to front of the cylinder head. Refer to Fig. 122A for an exploded view of thermostat housing and fan shaft and bearing. Adjust fan belt tension so belt will deflect approximately 5/8 to 7/8 inch when a force of 25 pounds is applied midway between pulleys.

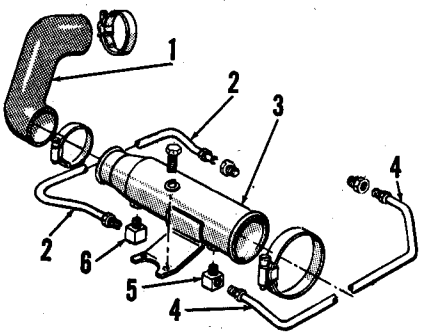


Fig. 126—Engine oil cooler (3) is mounted on steering motor and is connected by lower radiator hose (1) to cooling system. Hose connecting cooler to radiator is not shown. Note that outlet fitting (6) contains a relief valve to maintain engine oil pressure on 8000 and 8600 models only.

1. Cooler to engine hose
2. Oil return line
3. Oil cooler
4. Oil pressure line
5. Inlet fitting
6. Outlet fitting & relief valve assembly

ELECTRICAL SYSTEM

GENERATOR AND REGULATOR

157. A Ford C7NN-10000-C 22-ampere generator and a Ford D0NN-10505-A regulator are used on earlier 8000 models without cab. The generator is a two-pole shunt wound type with type "B" circuit; that is, one field coil terminal is grounded to generator frame and the other field coil terminal is connected to armature terminal through the regulator. Output may be tested as follows: Make sure belt is tight and terminals are tight and clean. Disconnect the two wires from generator and connect a jumper wire across the two terminals. Run engine at idle, connect positive lead of a voltmeter to either generator terminal and the negative lead to the generator frame. As engine speed is increased, voltage should rise rapidly. Do not allow voltage to reach 20 volts. Overhaul generator if voltage will not rise, or is not steady. Specifications are as follows:

C7NN-10000-C Generator

Max. output (hot) at 1350 Engine rpm and 15 volts	22 amps
Renew brushes if shorter than	13/32-inch
Min. brush spring tension with new brushes	18 ounces
Field coil current	2 amps
Field coil resistance	6 ohms
Commutator min. diameter	1.450 inch
Max. commutator runout	0.002 inch
Max. armature shaft runout	0.002 inch

If generator output was tested and voltage rise was rapid and steady, the voltage regulator is probably defective. Regulator is a sealed unit and adjustment or disassembly is not recommended.

ALTERNATOR AND REGULATOR

CAUTION: An alternator (A.C. generator) is used to supply charging current on earlier 8000 models with steel cab, later 8000 models without cab and all other models. Due to the fact that certain components of the alternator can be seriously damaged by procedures that would not affect a D.C. generator, the following precautions must be observed.

1. Always be sure that when installing batteries or connecting a booster battery, the negative posts of all batteries are grounded.
2. Never short across any of the alternator or regulator terminals.

3. Never attempt to polarize the alternator.

4. Always disconnect all battery ground straps before removing or replacing any electrical unit.

5. Never operate the alternator on an open circuit; be sure that all leads are properly connected and tightened before starting the engine.

158. A Motorola alternator (Ford part No. C7NN-10300-B 55 amp, D5NN-10300-D 51 amp or D7NN-10300-B 72 amp), and transistorized voltage regulator (Ford part No. C7NN-10316-A, D1NN-10316-A, D7NN-10316-B or D8NN-10316-AA) are used. Service specifications follow:

All Alternators

Max. output at 160°F., 2400 engine rpm and 14.4 volts	*47 amps
Minimum brush length	3/16-inch
Min. brush spring tension with new brush	4 ounces
Field current	1.8-2.4 amps
Field resistance	6 ohms

*Max. output for D7NN-10300-B alternator is 67 amps.

All Regulators

Voltage regulation with 10 ampere load:

Ambient Temperature	Output Terminal Voltage
40°F	14.2-15.0
60°F	14.1-14.9
80°F	13.9-14.7
100°F	13.8-14.6
120°F	13.6-14.4

STARTING MOTOR

159. Engine is equipped with a Ford starting motor and relay assembly. Closing the starter switch energizes the solenoid; movement of the solenoid plunger engages the drive pinion and closes a two-stage switch. If the teeth of the drive pinion butt against teeth on flywheel, only the first stage of the

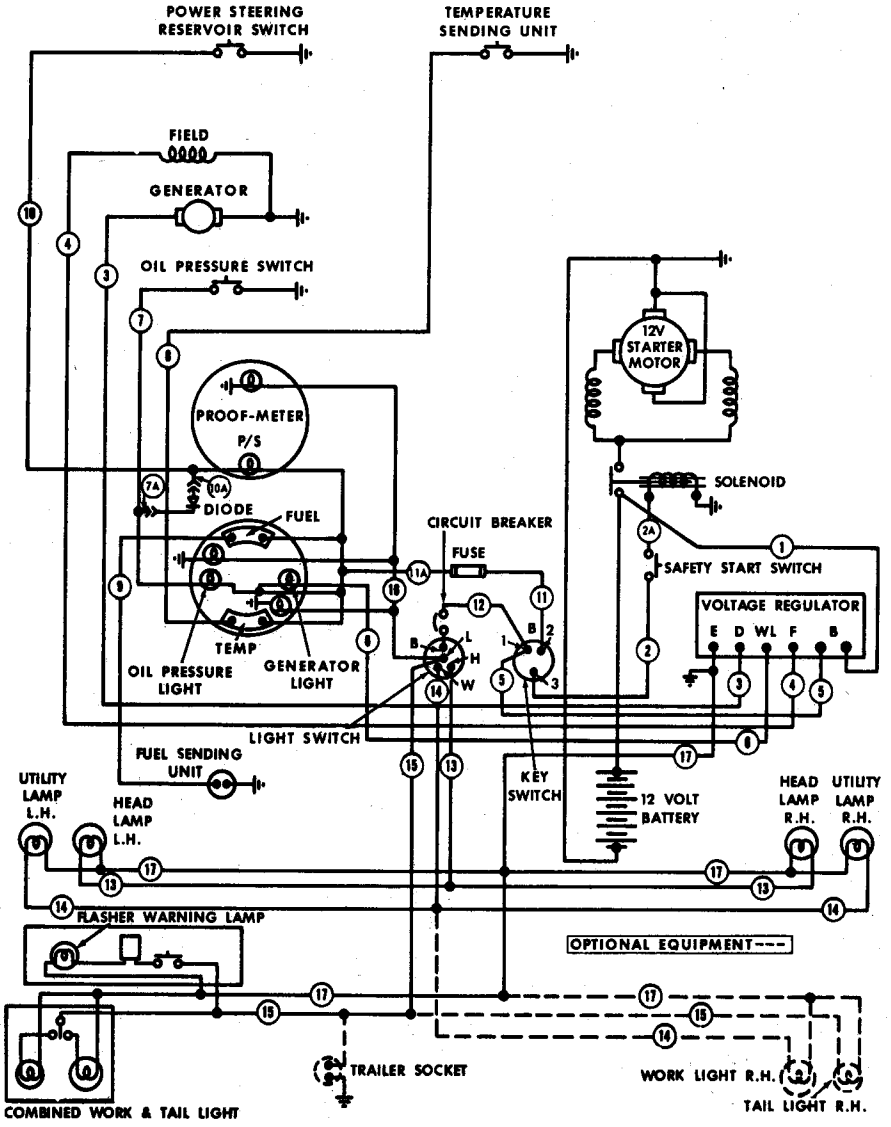


Fig. 128—Wiring diagram for models with generator. Refer to Fig. 130 for models with alternator. Code for regulator connections are as follows: (E) ground, (D) armature, (WL) warning light, (F) field and (B) battery. Color code for wiring is given in legend.

1. Brown
2A. Red
3. Yellow-black stripe
4. Blue
5. Brown-white stripe
6. Yellow-black stripe
7A. White
8. Red-white stripe
9. Orange
10A. Green-blue stripe
11A. Black-green stripe
12. Yellow
13. Green
14. Red
15. Blue-white stripe
16. Blue-red stripe
17. Black

switch is closed which will allow current to flow to one field coil. This will provide enough power to turn starter until drive pinion is in position to engage flywheel ring gear teeth; then, full engagement of drive pinion will close second stage of switch energizing all four field coils.

When drive pinion is in engaged position, there should be a clearance of 0.010-0.012 inch between drive pinion and thrust collar. To check clearance, first energize solenoid with 12-volt power source, then check clearance with feeler gage as shown in Fig. 133. If clearance is not within 0.010 to 0.020 inch, refer to Fig. 134, loosen locknut and turn eccentric pivot pin as required to obtain proper clearance. Then, tighten locknut and recheck clearance.

Service specifications are as follows:

Starting Motor And Relay Assembly

Brush spring tension (min. with new brushes) ..... 42 ounces
Min. brush length 5/16-inch
Commutator min. diameter ..... 1.50 inches
Max. armature shaft end play . 0.025 inch
Max. armature shaft runout . . 0.005 inch
Drive pinion clearance (engaged) ..... 0.015-0.025 inch
No-load test:
Volts 12
Amps 117
Rpm 5500-8000
Loaded test (with warm engine):
Amps 250-300
Engine rpm 150-200

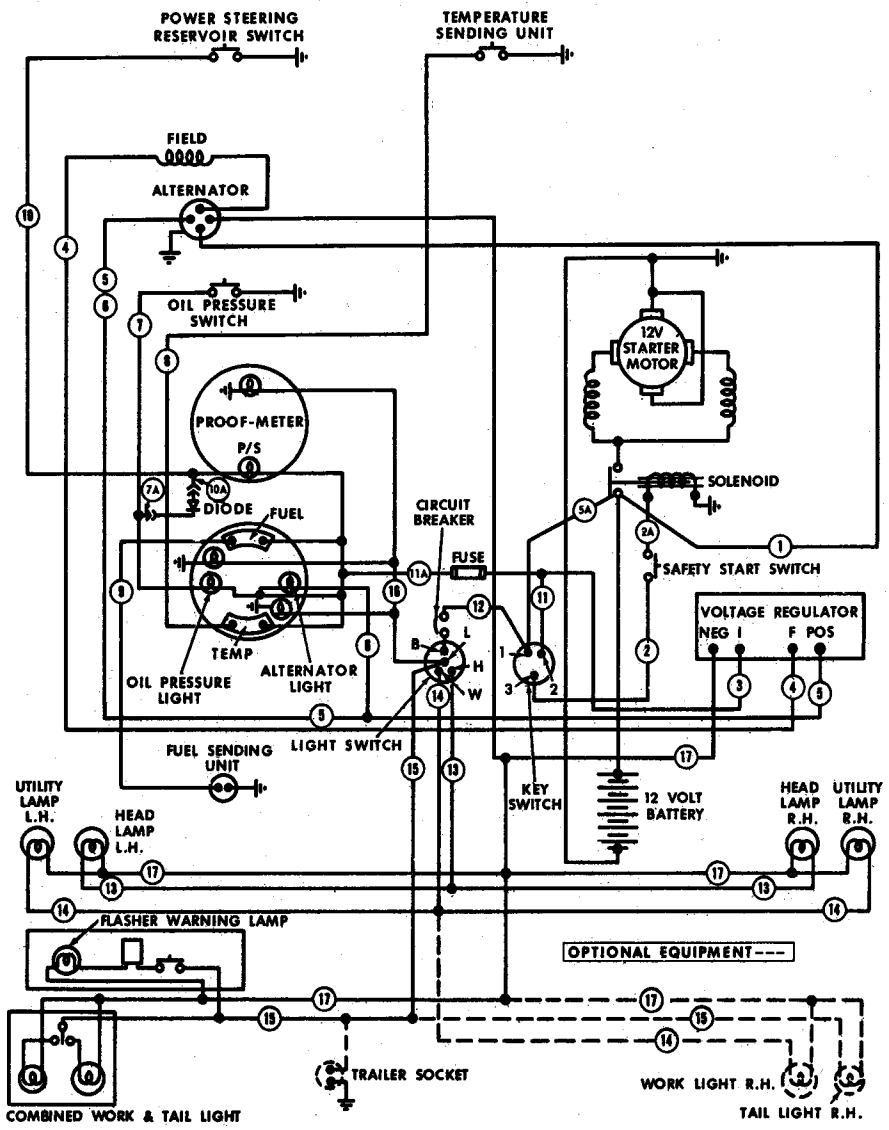


Fig. 130—Wiring diagram for tractor equipped with alternator; refer to Fig. 128 for models with generator. Voltage regulator is pre-wired with plug-in type pigtail. Color code for wiring is given in legend.

1. Brown
2A. Red
3. Yellow
4. Green
5. Red
5A. Brown-white stripe
6. Yellow-black stripe
7A. White
8. Red-white stripe
9. Orange
10A. Green-blue stripe
11A. Black-green stripe
12. Yellow
13. Green
14. Red
15. Blue-white stripe
16. Blue-red stripe
17. Black

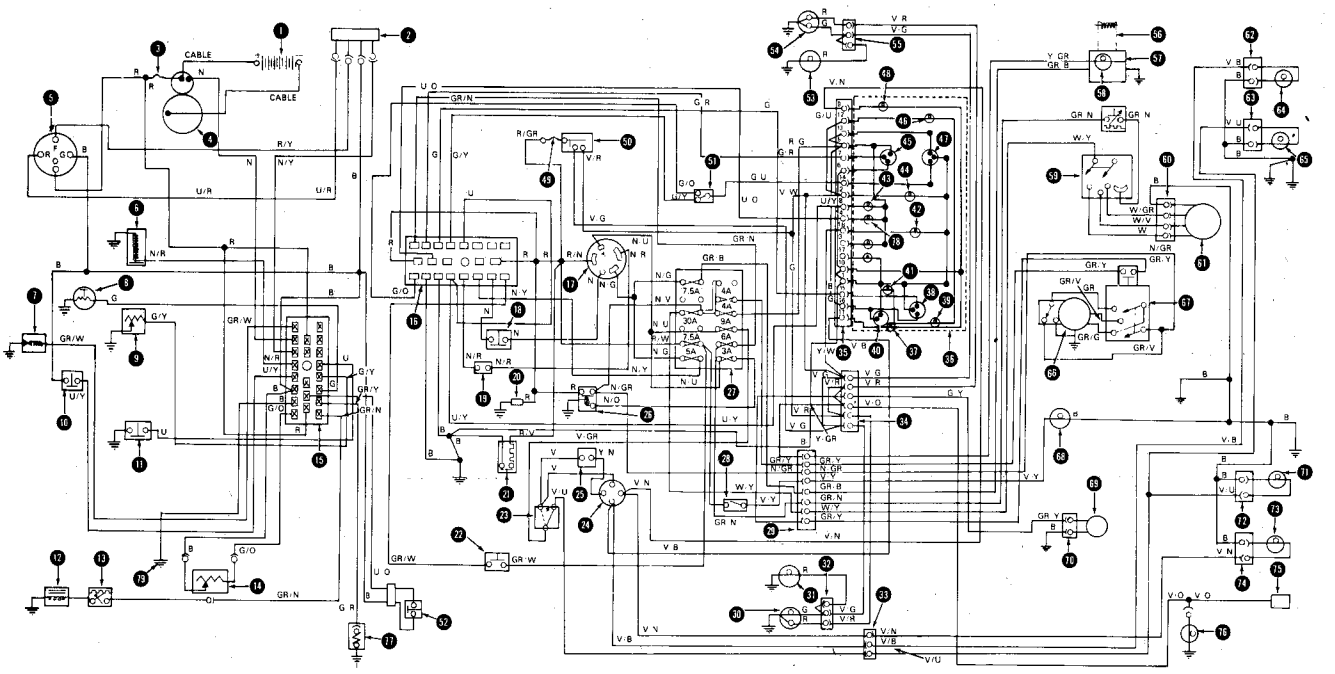


Fig. 132—Wiring schematic for Models 8700, 9700, TW-10, TW-20 and TW-30 equipped with a cab. Note that TW models are equipped with instrument panel gages while 8700-9700 models are equipped with a temperature gage and warning lights. Component (52) is a diode on 8700-9700 models and an oil pressure sender on TW models. Models 8700 and 9700 aren't equipped with components (77, 78 or 79).

B. Black
G. Green
GR. Gray
N. Brown
O. Orange
R. Red
U. Blue
V. Violet
W. White
Y. Yellow
1. Battery
2. Regulator
3. Fuse link
4. Starter motor
5. Alternator
6. Ether solenoid
7. Horn
8. Temperature sender
9. Main fuel level sender
10. Air cleaner restriction switch
11. Oil pressure sender
12. Air compressor clutch
13. De-icing switch
14. Auxiliary fuel level sender
15. Front main harness connector
16. Rear main harness connector
17. Ignition switch
18. Safety start switch
19. Ether start button
20. Condenser
21. Cigar lighter
22. Horn button
23. Implement/hazard light switch
24. Turn signal switch
25. Flasher unit
26. Ignition relay
27. Fuse block
28. Dome light switch
29. Cab roof harness connector
30. Hi-lo beam lamp, L.H.
31. Work lamp, L.H.
32. Work & headlamp connector
33. Implement & flasher lights connector, rear
34. Main extension harness connector
35. Instrument cluster connector
36. Instrument cluster
37. Turn signal indicator, R.H.
38. Temperature gage
39. Panel light
40. Alternator warning light or gage
41. Panel light
42. Hi-lo beam indicator
43. Air cleaner warning light
44. Panel light
45. Oil pressure warning light or gage
46. Panel light
47. Fuel gage
48. Turn signal indicator, L.H.
49. Fuse
50. Headlight switch
51. Fuel selector switch
52. Diode or oil sender
53. Work lamp, R.H.
54. Hi-lo beam lamp, R.H.
55. Work & headlamp connector
56. Speaker
57. Radio
58. Radio dial light
59. Blower motor switch
60. Blower motor connector
61. Blower motor
62. Flasher connector, R.H.
63. Implement lamp connector, R.H.
64. Flasher light, R.H.
65. Implement lamp, R.H.
66. Wiper motor
67. Wiper/washer switch
68. Dome light
69. Washer pump motor
70. Washer pump connector
71. Implement lamp, L.H.
72. Implement lamp connector, L.H.
73. Flasher light, L.H.
74. Flasher light connector, L.H.
75. Trailer socket
76. Tail light
77. Trans. oil pressure switch
78. Trans. oil pressure warning light
79. Front hood R.H. support

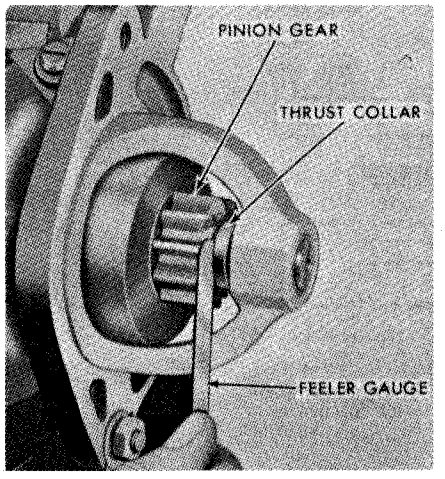


Fig. 133—Measuring starting motor drive pinion clearance. Refer to text for procedure and to Fig. 134 for adjustment of clearance.

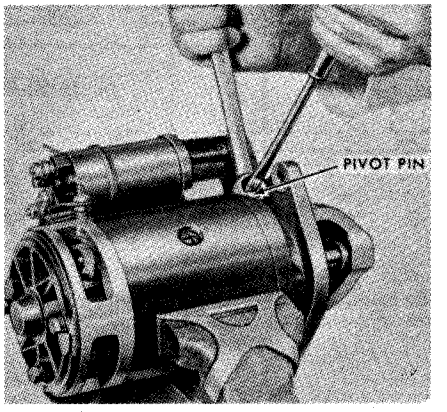


Fig. 134—Adjusting drive pinion clearance; refer also to Fig. 133 and to text.

CLUTCH

All except TW-20 and TW-30 models are equipped with a 13-inch diameter single plate clutch assembly; TW-20 and TW-30 models are equipped with a 14-inch diameter clutch. The clutch friction disc on 8000 models is fitted with five cera-metallic pad inserts, while 8600, 9000 and TW-10 models have six cera-metallic pad inserts. 8600 model discs can be used on prior 8000 models. The disc used on 8700, 9600 and 9700 models is equipped with nine pad inserts and can be used on earlier 9000 models. The disc used on TW-20 and TW-30 models has eight cera-metallic pad inserts. Clutch disc is renewable as an assembly only. The clutch cover, thrust plates, pressure springs and adjusting nuts are available separately. There are 12 pressure springs in pressure plate and

cover assembly on 8000, 8600 and 8700 models, while 9000, 9600, 9700 and TW-10 models have 16 pressure springs. TW-20 and TW-30 models have 15 pressure springs. The clutch pressure plate and release levers are available as a sub-assembly or in complete clutch cover and pressure plate assembly only.

PEDAL FREE TRAVEL ADJUSTMENT

All Models Except 8700, 9700, TW-10, TW-20 And TW-30

160. Clutch pedal free play is measured at pedal as shown in Fig. 135. Clutch pedal free travel should be 1-3/8-1-5/8 inches. To adjust free travel, disconnect clutch pedal rod from release lever, loosen locknut and turn clevis to lengthen rod until correct free travel is obtained. Left hood panel on some tractors must be removed for access to clevis. On tractors with cabs, remove left step assembly, tool box side panel and door, and cab support bracket in order to adjust clevis.

Models 8700, 9700, TW-10, TW-20 And TW-30

161. Measure clutch pedal free play at pedal as shown in Fig. 136. Clutch pedal free play should be 1-3/8-1-5/8 inches. To adjust free play, loosen locknut (L) and rotate turnbuckle (T) on clutch pedal control rod (R).

NOTE: If the difference between clutch control rod exposed threads exceeds 0.010 inch, clutch control rod is not assembled properly. See Fig. 137.

R&R CLUTCH ASSEMBLY

162. **SPLIT TRACTOR.** To split tractor for clutch removal, proceed as follows: On tricycle models, attach support braces to keep front end assembly from tipping. On wide front axle models, drive wood wedges between front axle and front support. Remove tool box and battery covers and disconnect battery cables from battery, ground cable first. Remove hood side panels, air pre-cleaner, exhaust pipe and hood top panel. Disconnect clutch pedal return spring, then unbolt and remove side plates. Disconnect throttle linkage from bell-crank at instrument panel support. Disconnect electrical wiring, engine stop cable, fuel supply line and Proof-Meter cable at engine. On models with pressure lubricated transmissions disconnect lines to oil cooler. Unbolt and remove starting motor. Disconnect power steering fluid lines from steering motor and unbolt hood side braces from instrument panel (rear hood) support.

On wide front axle or front wheel drive models, support rear end of engine with rolling floor jack and front end of transmission with safety stand. On tricycle models, place the rolling floor jack under front end of transmission. Unbolt engine from transmission and separate tractor.

163. To reconnect tractor, first remove clutch shaft from transmission and insert it into clutch friction disc and pilot bearing, then complete reassembly by reversing split procedures. Tighten the 5/8-inch engine to transmission bolts to a torque of 95-130 ft.-lbs. and the ¾-inch bolts to a torque of 180-220 ft.-lbs. Bleed the fuel injection system as outlined in paragraph 114A or 115A and bleed power steering system as in paragraph 7 or 34.

164. **R&R CLUTCH.** With tractor split as outlined in paragraph 162, alternately and evenly loosen the cap screws retaining clutch cover to flywheel to avoid distortion of cover. Remove clutch cover and pressure plate assembly, taking care not to drop the clutch friction disc.

The clutch shaft pilot bearing can now be removed from flywheel by removing the two cap screws and flat washers; refer to Fig. 84.

To reinstall clutch assembly, lightly lubricate splines with a high temperature silicone grease and align clutch disc to pilot bearing with transmission input shaft. Determine which is the larger

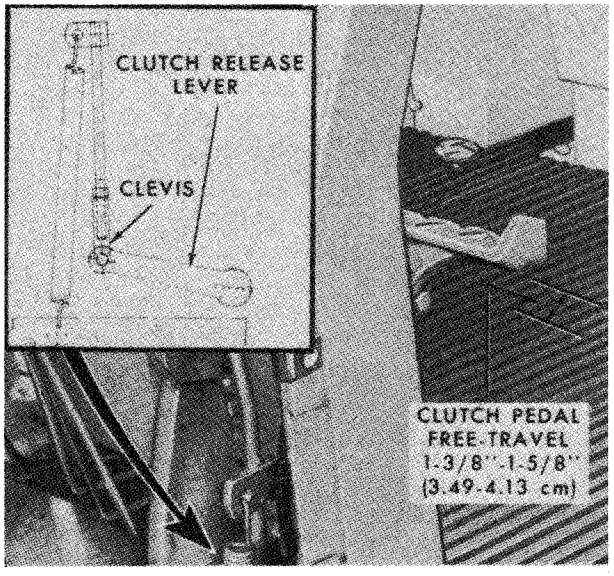


Fig. 135—Clutch pedal free travel should be 1-3/8 to 1-5/8 inch when measured at pedal. Adjust by turning clevis on pedal to clutch release lever rod.

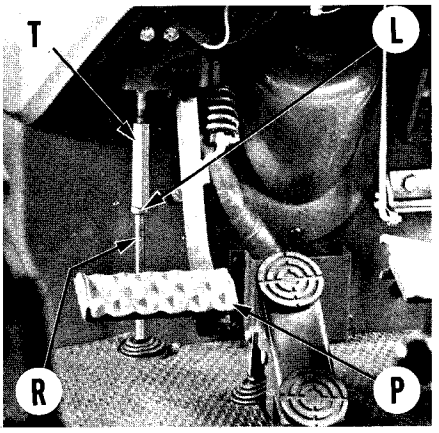


Fig. 136—Clutch pedal free play on 8700, 9700, TW-10, TW-20 and TW-30 models should be 1-1/8—1-5/8 inches. Rotate turnbuckle (T) to adjust free play.

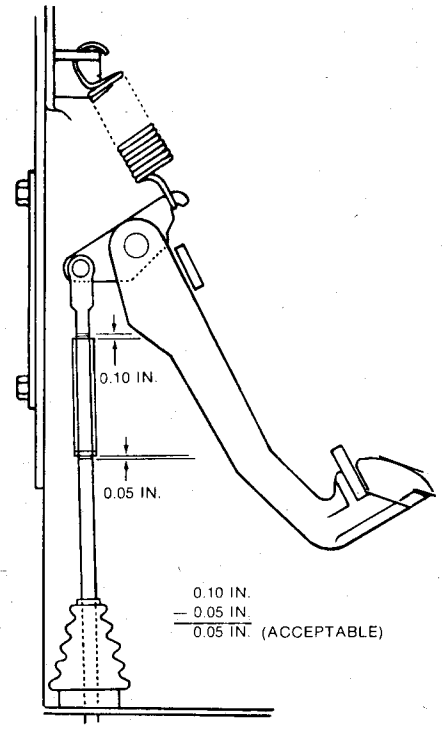


Fig. 137—If control rod and adjusting nut are properly assembled, the difference between exposed threads of upper and lower rods will be 0.010 inch or less. See above example.

dowel pin in flywheel so clutch cover can be installed correctly. Alternately and evenly tighten clutch cover retaining cap screws, taking care that the cover seats correctly on the dowel pins in flywheel, until cover contacts flywheel. Then, alternately and evenly tighten cover cap screws to 26-35 ft.-lbs. on TW-10, 20-30 ft.-lbs. on TW-20 and TW-30, or 20-27 ft.-lbs. on all other models. Reconnect engine to transmission as outlined in paragraph 163.

NOTE: If a new clutch disc is installed on 8000, 8600 or 8700 model tractor, place new disc on flywheel to be sure hub rivets on disc do not contact inner diameter of flywheel. If contact exists, flywheel must be removed and machined out to 6.44 inch I.D. to clear hub rivets.

OVERHAUL CLUTCH

165. With clutch cover and pressure plate assembly removed as outlined in paragraph 164, place assembly in press and position a square, flat steel plate over cover so that adjusting nuts and thrust plates are accessible (Fig. 138). Compress the assembly until release levers are free, then unbolt and remove the thrust plates and unscrew the adjusting nuts from the finger yoke studs. Release cover assembly and remove cover and springs from the pressure plate and release lever assembly. Note positions of springs on 8000, 8600 and 8700 models, before removing springs.

Inspect all parts and renew as necessary. Heat discoloration of the clutch disc friction pads is normal; friction pad thickness (new) is 0.463 inch for Models TW-20 and TW-30, or 0.405 inch for all other models. Renew the pressure plate and release lever assembly if levers are damaged or excessively worn, or if pressure plate is cracked, distorted or excessively scored. Check the clutch springs against the following specifications:

Models TW-20 & TW-30

Part number	D8NN-7572-AA
Color code	None
Lbs. pressure at 1.539 in.	220-210

All Other Models

Part number	C7NN-7572-C
Color Code	Pink with black stripe
Free length, inches	2¾
Lbs. pressure at 1.539 inches	135.5-145.5

When reassembling clutch on 8000, 8600 and 8700 models, refer to Fig. 138 for placement of springs on the pressure plate and note that second boss ("X") in clockwise direction from each release lever is not fitted with a spring. On all other models, there is an equal number of springs and locating bosses. See Fig. 139 for view of clutch and flywheel used on Models TW-20 and TW-30. Reassemble by reversing disassembly procedure, but on all models except TW-20 and TW-30, tighten thrust plate retaining cap screws finger tight only until the release levers are adjusted. To adjust release levers, mount cover and pressure plate assembly on flywheel with new friction disc or with several equally placed 0.405 inch thick spacers between pressure plate and flywheel. Models TW-20 and TW-30 will require 0.463 inch spacers. Release lever height on Models TW-20 and TW-30 is adjusted by turning adjusting screws at lever ends, while lever height on all other models is adjusted by turning adjusting nuts (Fig. 138). Adjust release lever height above friction surface of flywheel to 1.969-2.031 inches on 8000, 8600 and 8700 models, 2.125-2.187 inches on 9000, 9600, 9700 and TW-10 models, and 2.26-2.56 inches on TW-20 and TW-30 models. On all models except TW-20 and TW-30, stake adjusting nuts in position and tighten thrust plate retaining cap screws to a torque of 15 ft.-lbs.

DUAL POWER

Dual Power consists of a planetary gear set and two clutch assemblies enclosed in a housing and mounted in forward compartment of transmission case. Dual Power is hydraulically actuated to provide either direct drive or

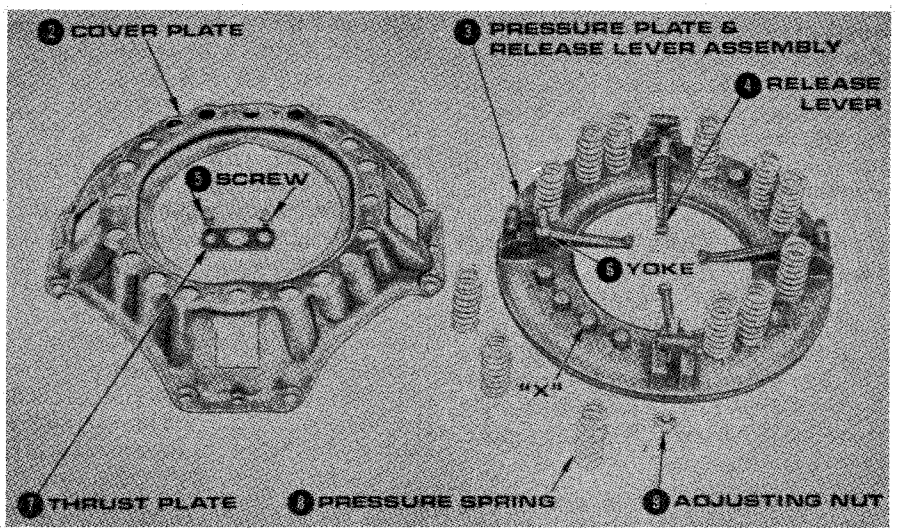


Fig. 138—Exploded view of the clutch pressure plate and cover assembly. Note that on 8000, 8600 and 8700 models, second boss ("X") in a clockwise rotation from each release lever is not fitted with a pressure spring. Pressure plate and release levers are serviced as an assembly only.

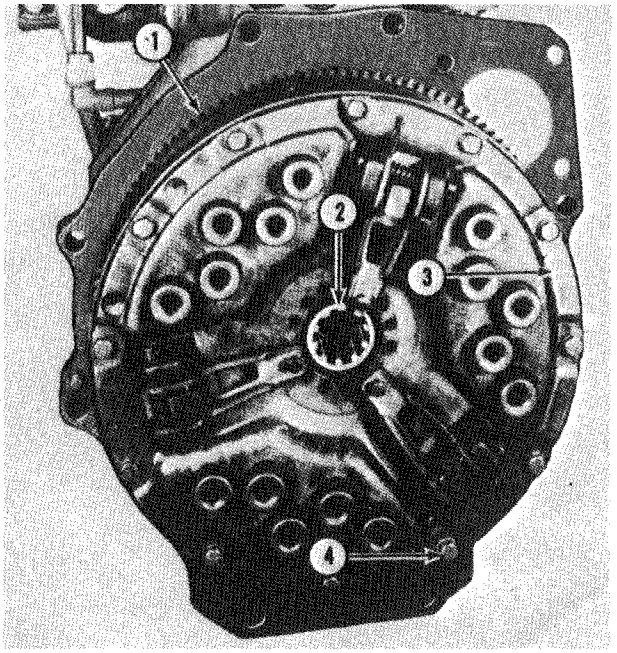


Fig. 139—Assembled view of clutch and flywheel used on Models TW-20 and TW-30.

1. Flywheel
2. Clutch disc
3. Clutch cover
4. Cover to flywheel bolts

underdrive to transmission input shaft. Dual Power is controlled by pedals and linkage from operator's position to hydraulic control valve on side of Dual Power housing.

LUBRICATION

167. Dual Power assembly is used on pressure lubricated transmissions. On all models except TW-10, TW-20 and TW-30, lubricating oil is directed from transmission oil cooler to control valve on side of Dual Power housing and into oil passages of housing. Oil exits into transmission by tube connecting Dual Power housing and transmission case and through common passages. Lubrication pressure for Models TW-10, TW-20 and TW-30 is provided by the low pressure oil system. Refer to paragraph 174.

HYDRAULIC OIL PRESSURE

168. Clutch assemblies of Dual Power unit are engaged by hydraulic pressure against their repective pistons. To check hydraulic oil pressure, first operate tractor until oil is at normal operating temperature (120° F.). Stop engine and tee a pressure gage into the ¼-in. pressure line at the hydraulic pump cover and hydraulic system oil filter adapter plate. Start engine and set engine speed at 1000 rpm. Engage direct drive of Dual Power then engage underdrive. On models except TW-10, TW-20 and TW-30, pressure gage should read 150-180 psi with Dual Power in direct drive and 155-185 psi when in underdrive. Pressure gage readings on TW-10 and TW-20 models should be between 185-220 psi. The difference in readings should not exceed 10 psi.

On TW-30 models, check pressure reading with dual power in direct drive and pto engaged. Apply left brake, check pressure then apply right brake and check pressure. Gage reading at 2200 rpm with dual power in direct drive should be 185-235 psi.

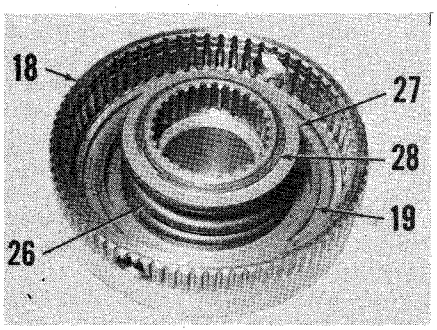


Fig. 140—Special Nuday tool No. 1312 is used to press against spring retainer (27) to reduce spring tension on snap ring (28) so that it may be removed. Refer to Fig. 142 for identification.

If pressure is as stated and trouble exists, the hydraulic system and Dual Power control valve can be considered satisfactory and Dual Power assembly should be inspected.

If pressure is higher than specified in both direct drive and underdrive operation, then remove hydraulic pump adapter plate as outlined in paragraph 233, remove Dual Power regulating valve and inspect valve for sticking during operation. The regulating valve threads into inner side of adapter plate. If unable to free up valve, renew as an assembly. A cross section of valve is shown in Fig. 144A. Valve is also shown in Hydraulic Section (10—Fig. 212). If oil pressure is lower than specified in both direct drive and underdrive operation, inspect hydraulic pump and pto system relief valve. Also check for a weak or broken spring in Dual Power regulating valve, or valve stuck open. If oil pressure is below specified pressure in either direct drive or underdrive, but normal for the other operation, check for a leaking control valve spool or for a leaking gasket between control valve and Dual Power housing. If direct drive operation has low oil pressure, disassemble Dual Power unit as outlined in paragraph 171 and inspect direct drive clutch assembly for leaking seals or a broken or cracked piston. If underdrive operation has low oil pressure, disassemble Dual Power unit and inspect underdrive clutch assembly for leaking seals or broken or cracked piston.

LINKAGE

169. Dual Power pedal or buttons are connected by a control rod to the control valve on the Dual Power housing. Length of control rod is adjusted by disengaging clevis end of rod, backing off locknut and turning clevis. Length of control rod should be adjusted so that both underdrive and direct drive operation is obtained when the corresponding operator's pedal is depressed. Adjust control rod on Models 8700, 9700, TW-10, TW-20 and TW-30 so control pedal heel is 3/8-5/8 inch from floor when in Low range. If control rod length is improperly adjusted, either underdrive or direct drive operation will be absent. If rod is too long, underdrive will not function. If rod is too short, direct drive will not function. If rod adjustment will not cure problem, refer to control valve, paragraph 173, or to Dual Power paragraph 171, for overhaul of defective assembly.

R&R DUAL POWER

170. To remove Dual Power assembly, drain lubricant from transmission and rear axle center housing (approximately 17 to 23 gallons depending on model; see paragraph 176) and split tractor between engine and transmission as outlined in paragraph 162. Disconnect clevis pin from yoke on Dual Power control pedal linkage. Mark and remove lubrication (upper) and hydraulic pressure (lower) tubes from control valve. Unplug transmission oil switch wires on TW-10, TW-20 and TW-30 models. Oil return tube has been eliminated on these models. Remove clevis pins from clutch release fork and remove clutch fork cross shaft, clutch release bearing and clutch fork. Disconnect and remove control valve control rod.

To remove Dual Power housing from transmission, proceed as follows: Remove housing cover (41—Fig. 143), ring gear (36), planetary gear set (33), shaft (31) and sun gear (29). Remove direct drive clutch assembly (18) and thrust washer (16).

NOTE: Do not allow transmission mainshaft (16—Fig. 160) to move forward when removing Dual Power housing or thrust bearing (38) may dislodge. Fabricate a tool made of pipe which bears against mainshaft and is secured to pto shaft.

Remove five retaining bolts and separate Dual Power housing from transmission case. Lubrication supply tube from housing to transmission case may be removed by pulling straight out.

To reassemble Dual Power unit, reverse disassembly procedure. Install lubricating tube (2—Fig. 143) with new "O" rings on tube and a new gasket on housing before attaching housing to transmission case. Be sure housing outlet is aligned with tube when installing housing. Tighten Dual Power housing-to-transmission case bolts in a diagonal pattern to 65-90 ft.-lbs. on TW-10, TW-20 and TW-30, or to 50-60 ft.-lbs. on all other models. Tighten lubrication inlet tube (upper tube) fitting to 8-10 ft.-lbs. Tighten pressure inlet tube (lower tube) fitting to 50-67 inch-pounds. Tighten housing cover (41) bolts in a

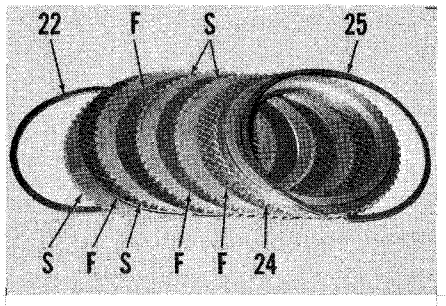


Fig. 141—View of direct drive clutch pack showing order of friction plates (F), steel plates (S), feathering spring (22), plate (24) and snap ring (25).

diagonal pattern to 27-37 ft.-lbs. Before installing control valve actuating rod, check length of rod to be sure there is 7½ inches from center to center of attaching points. Place thrust washer (16) in housing (1) with tab up and toward rear. Hold new gasket (40) to housing with grease and be sure drilled oil passage in cover (41) is up when installed. With installation complete, refer to paragraph 169 for further adjustment if required.

OVERHAUL DUAL POWER

171. To overhaul Dual Power unit, remove unit as outlined in paragraph 170, separate major assemblies and proceed as follows: Disassemble direct drive clutch by removing snap ring (25—Fig. 143) and withdraw plate (24), clutch pack (23) and feather spring (22).

NOTE: To reduce a complexity of Dual Power drive clutch, feathering spring was deleted and piston modified starting in November, 1979.

Note order of plates in clutch pack when removing. Place housing in a press and using Ford tool No. 1312 or equivalent, compress the piston return spring (26—Fig. 140) and remove retaining snap ring (28). Gradually release spring pressure making sure spring retainer (27) does not catch in snap ring groove, and remove retainer and spring. Remove piston (19—Fig. 143) by applying air pressure to hole between second and third sealing rings (17) on clutch housing hub. Carefully clean and inspect all parts. Inspect sealing rings for imperfections. Inspect sealing ring bore for damage. Check splines for cracked, broken or missing teeth. Renew any parts not suitable for further service.

To disassemble underdrive clutch, remove outer snap ring (15—Fig. 143) and clutch pack components (8 through 14). Note position of clutch pack plates. Remove piston (5) and seal rings. Clean and inspect all parts for wear. Check for broken clutch springs. Renew any part not suitable for further service. During assembly, the locating dowel pins (10) must be evenly spaced and installed so there is a dowel pin in every fifth notch.

Use a suitable puller to remove pilot bearing (34) from shaft (31) and separate planetary gear assembly (33) from shaft. Planetary gear assembly (33) is available as a unit only and should be serviced as a unit assembly. Using a suitable puller, remove bearing (38) from ring gear (36) being careful not to damage shims (37). Shims are used to adjust ring gear shaft (36) end play.

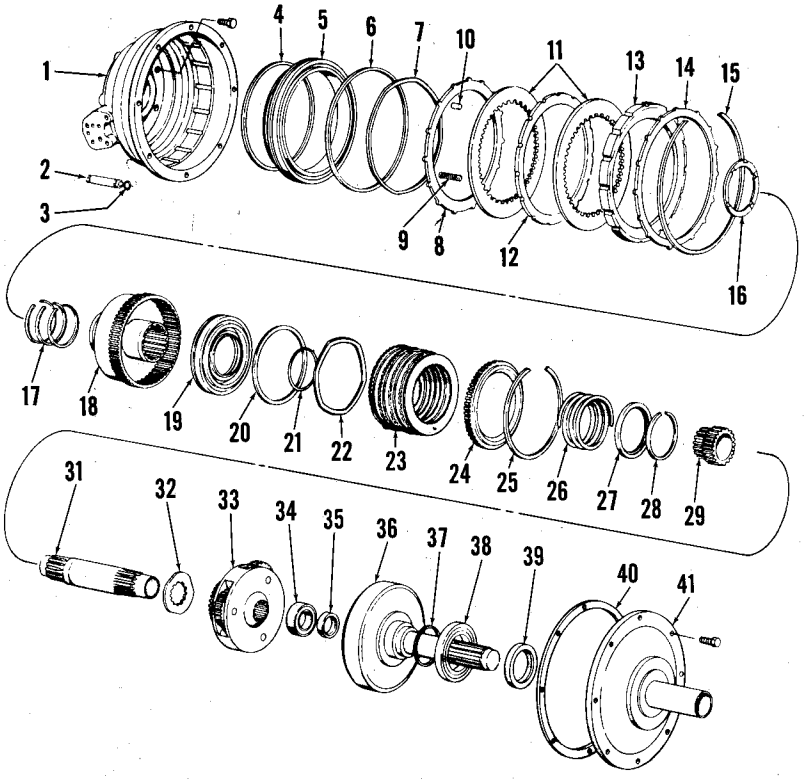


Fig. 143—Exploded view of Dual Power assembly. Refer to Fig. 141 for view of direct drive clutch pack assembly. Note: clutch feathering spring (22) deleted in Nov., 1979.

1. Dual Power housing
2. Lubrication tube
3. "O" ring
4. Piston seal
5. Piston
6. Piston seal
7. Clutch feathering spring
8. Pressure plate
9. Spring
10. Locating pin
11. Clutch plate
12. Center plate
13. Pressure plate
14. Front plate
15. Snap ring
16. Thrust washer
17. Seal rings
18. Direct drive housing
19. Piston
20. Seal
21. "O" ring
22. Clutch feathering spring
23. Direct drive clutch assembly
24. Plate
25. Snap ring
26. Spring
27. Spring retainer
28. Snap ring
29. Sun gear
31. Input shaft
32. Washer
33. Planetary gear
34. Bearing
35. Seal
36. Ring gear
37. Shims
38. Bearing
39. Seal
40. Gasket
41. Cover

172. To reassemble Dual Power unit, lubricate components with transmission oil and proceed as follows: Install underdrive piston and clutch pack in housing being sure not to damage piston seals. Refer to Fig. 143 for sequence of clutch plates. Install locating dowel pins (10) in every fifth notch of housing.

To assemble direct drive clutch, reverse disassembly procedure. Refer to Fig. 141 for view of clutch pack. Be careful not to damage seal rings of piston when installing. Renew main bearing in housing (1—Fig. 143) if worn. Install thrust washer (32) and planetary gear assembly (33) on shaft (31) and press bearing (34) on shaft (31).

To determine correct size of shims (37) to obtain correct end play of 0.004-0.020 inch for ring gear shaft (36), assemble all components except ring gear and cover in housing (1) without attaching housing to transmission. Install ring gear without shim (37) and bearing (38). Place tool No. 1303 on step of ring gear shaft in place of shims and bearing. Make sure all components are properly seated in housing and place cover (41) on housing. At three equi-distant points, measure gap between cover and housing and average the three measurements. If average dimension is 0.046-0.060 inch, no shims are needed. If gap is less than 0.046-0.060 inch, refer to following table for correct shim size. (Dimensions are in inches.)

Average Gap Measurement	Required Shim Thickness
0.001-0.013	0.041-0.049
0.014-0.026	0.030-0.034
0.027-0.032	0.022-0.030
0.033-0.045	0.011-0.015

If tool No. 1303 is not available, assemble Dual Power unit with bearing (38) and original shim (37) on ring gear shaft (36). Install cover (41) being sure components are seated in housing and measure end play of ring gear shaft (36). End play should be 0.004-0.020 inch. Install needed size of shims (37) to obtain correct end play. Shims are available in sizes of 0.013 and 0.032 inch.

To reinstall Dual Power unit on transmission, remove cover, ring gear, shaft and planetary gear assembly, sun gear and direct drive assembly. Dual Power unit may now be installed as outlined in paragraph 170.

CONTROL VALVE

173. The Dual Power control valve directs flow of lubricating oil and oil from the pto hydraulic pump to engage either direct drive clutch pack or underdrive clutch pack.

To remove control valve on Models TW-10, TW-20 and TW-30, disconnect hydraulic line and remove access plate on right side of transmission center housing just forward of transmission shift cover. On all other models, access to control valve is obtained after splitting tractor between engine and transmission as outlined in paragraph 162.

With control valve removed, pull valve spool (2—Fig. 144) to full out position. Unscrew sleeve (9) from valve body (7) and pull sleeve from end of spool (2) being careful not to lose detent cups (4) and spring (3) in end of spool. Remove valve spool (2) by pulling from bottom of valve body. Remove "O" rings (5) and (8).

Inspect spool (2), body (7) and sleeve (9) for scratches, wear or other damage. Inspect "O" rings, detent cups and spring. To reassemble, reverse disassembly procedure. Tighten sleeve (9) to a torque of 25-30 ft.-lbs. Tighten control valve mounting bolts to a torque of 27-37 ft.-lbs.

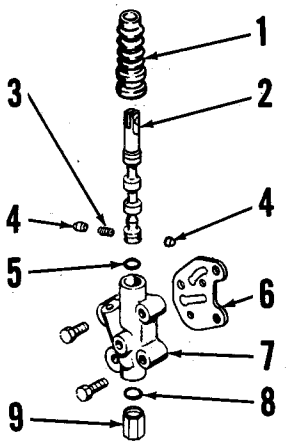


Fig. 144—Exploded view of Dual Power control valve.

1. Boot
2. Spool
3. Spring
4. Detent cups
5. "O" ring
6. Gasket
7. Body
8. "O" ring
9. Sleeve

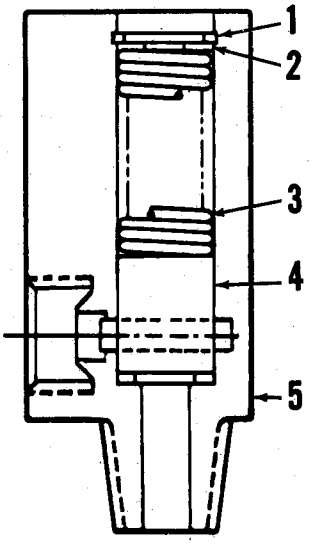


Fig. 144A—Cross-sectional view of Dual Power regulating valve.

1. Snap ring
2. Washer
3. Spring
4. Valve
5. Body

LOW PRESSURE OIL SYSTEM

174. All TW-10, TW-20 and TW-30 models are equipped with a low pressure oil system. An eight gpm gerotor hydraulic pump supplies low pressure oil, drawn from the rear axle center housing, to all tractor hydraulic functions except the hydraulic power lift and remote cylinders. See schematic in Fig. 145. The pump also provides low pressure oil to operate the power assist brakes on the TW-30 models. The pump (71—Fig. 160) is mounted on the transmission rear cover and is driven by the main pto shaft. If the pump is damaged or worn excessively, it must be replaced as a complete unit. Pressure is regulated by a pressure regulating valve mounted on the transmission housing just above the shift cover. The pressure valve used on TW-30 models differs from the valve used on TW-10 and TW-20 models as TW-30 models are equipped with power brakes and the TW-30 pressure valve uses a brake priority valve (2—Fig. 145B) that maintains a minimum pressure of 150 psi to the power assist brake valve. Refer to Fig. 183.

174A. **PRESSURE TESTING (ALL MODELS).** Refer to paragraph 213 for low pressure system pressure testing.

GEROTOR PUMP

175. **R&R AND OVERHAUL GEROTOR PUMP.** Refer to paragraph 191 for removal of gerotor pump. If

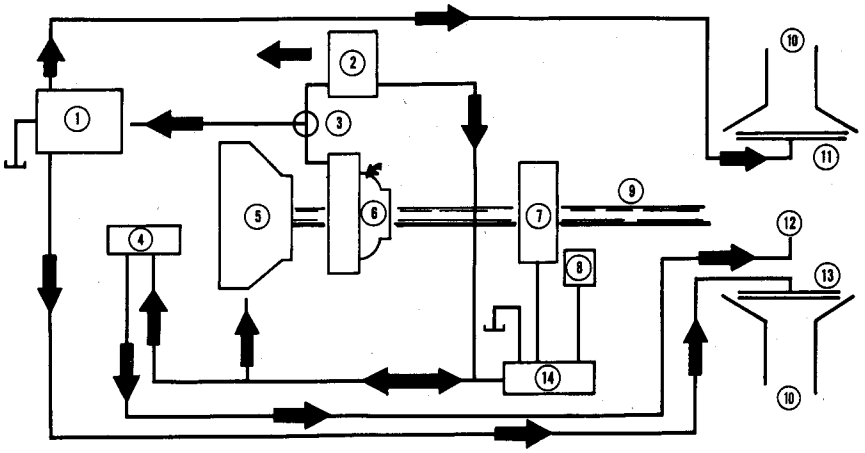


Fig. 145—View showing low pressure hydraulic system for TW-10, TW-20 and TW-30 models.

1. Power brake valve (TW-30 only)
2. Pressure regulating valve
3. Brake priority valve (TW-30 only)
4. Differential lock valve (TW-30)
5. Dual power clutch pack
6. Gerotor pump
7. Pto clutch
8. Pto brake
9. Pto shaft
10. Axle housing
11. Brakes
12. Differential
13. Differential lock valve (TW-10 and TW-20)
14. Pto valve

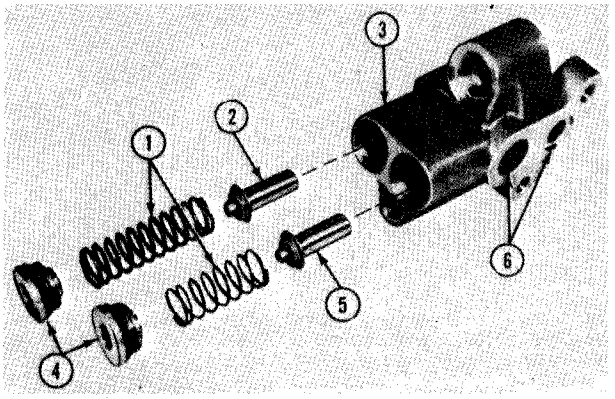


Fig. 145A—Exploded view of hydraulic system regulating valve used on TW-10 and TW-20 models.

1. Valve springs
2. System pressure valve
3. Housing
4. Plugs and seals
5. Lubrication pressure valve
6. "O" ring seals

pump is worn or damaged, it must be replaced as a complete unit.

PRESSURE REGULATOR VALVE

175A. **R&R AND OVERHAUL PRESSURE REGULATOR VALVE.** Valve is located above transmission shift cover. To remove valve, first remove oil lines to valve then remove cap screws retaining valve to tractor. Refer to Fig. 145A for exploded view of regulating valve used on TW-10 and TW-20 models and to Fig. 145B for exploded view of valve used on TW-30 models.

When overhauling valve, tag spools and springs for later identification. Note that spool (2—Fig. 145A or 5—Fig. 145B) has an 0.031 inch orifice while remaining valve spool(s) does not have an orifice. The lubrication pressure valve spring is 1.30 inches long with 7½ coils while the system pressure valve spring is 2.09 inches long with 9½ coils. The brake priority valve spring used on Model TW-30 is 1.37 inches long with 8½ coils.

Inspect components for excessive wear, scoring, burrs and binding in valve bores and renew as necessary. Clean valve housing and components with a suitable solvent and blow dry. Make sure all orifices and passageways are clean. Reassembly procedure is reverse of disassembly procedure. Install new "O" rings in valve, then install valve assembly onto tractor and tighten cap screws to a torque of 20-26 ft.-lbs. Reconnect oil lines to valve.

TRANSMISSION

The gear type dual range transmission provides eight forward and two reverse speeds. Refer to Fig. 146 for view showing all transmission gears except reverse idler. On Models 8700, 9700, TW-10, TW-20 and TW-30 transmission speeds are selected using shift levers which actuate shift forks on a shift rail. On all other models, transmission speeds are selected by shift rails being moved by a cam wheel (see Fig. 156). An indexing roller holds the cam wheel in selected gear, but does not provide a neutral position. Neutral is provided by holding the range shift collar (109—Fig. 146) disengaged from both the low range (111) and high range (106) gears. A pawl type transmission brake (see Fig. 161) can be engaged with teeth on range shift collar to hold tractor stationary.

LUBRICATION

176. Transmission on later 8000 models and all other models is pressure lubricated and an oil cooler is located in front of engine radiator. The oil reservoir is common with oil reservoir in rear axle center housing. On all models except TW-10, TW-20 and TW-30, oil is pumped from rear axle center housing by the main hydraulic pump to the oil cooler then to the transmission or to the Dual Power housing on models so equipped. TW-10, TW-20 and TW-30 models are equipped with a low pressure oil system which uses a gerotor pump mounted on transmission rear cover and driven off pto mainshaft. Refer to paragraph 174.

Lubricant capacity for transmission and rear axle is as follows: Models except TW-10, TW-20 and TW-30 with Dual Power, 69 quarts, without Dual Power, 64 quarts; Models TW-10 and TW-20 with Dual Power, 79 quarts, without Dual Power, 73 quarts; All TW-30 models require 92 quarts. Recommended lubricant is Ford lubricant No. ESN-M2C53-A or M-2053-B and should be changed every 1200 hours of operation (or once every 12 months).

Transmissions on earlier 8000 models are splash lubricated and have an

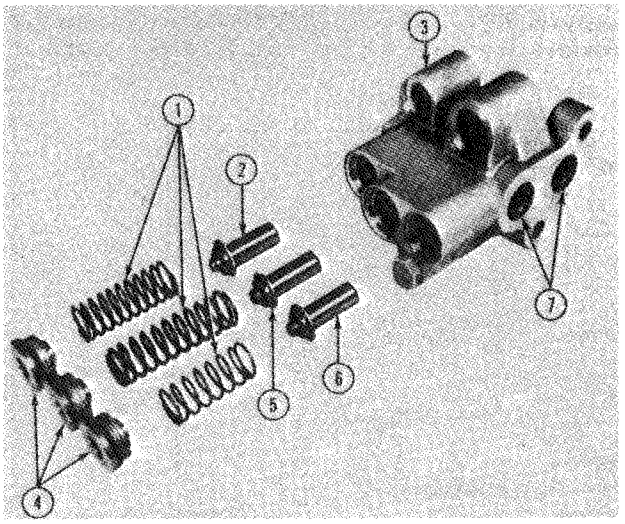
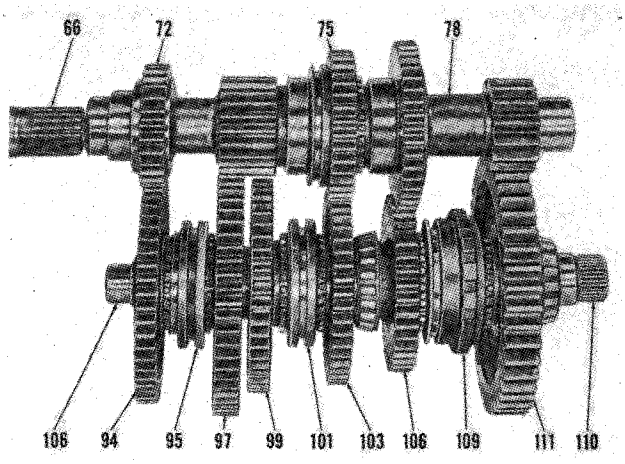


Fig. 145B—Exploded view of low pressure hydraulic system regulating valve used on TW-30 models.

1. Valve springs
2. Brake priority valve
3. Housing
4. Plugs and seals
5. System pressure valve
6. Lubrication pressure valve
7. "O" ring seals



66. Input shaft
72. Main shaft
75. Sliding gear/coupling
78. Secondary countershaft
94. 2nd/6th gear
95. Sliding coupling
97. 1st/5th gear
99. Reverse gear
101. Sliding coupling
103. 3rd/7th gear
106. Main countershaft
109. Sliding coupling
110. Output shaft
111. Output shaft gear

Fig. 146—View showing all transmission gears except reverse idler. Refer also to exploded view in Fig. 160. Sliding coupling (109) incorporates dog teeth for transmission brake pawl. Front end of main countershaft (106) and top shafts and gears are supported in needle roller bearings.

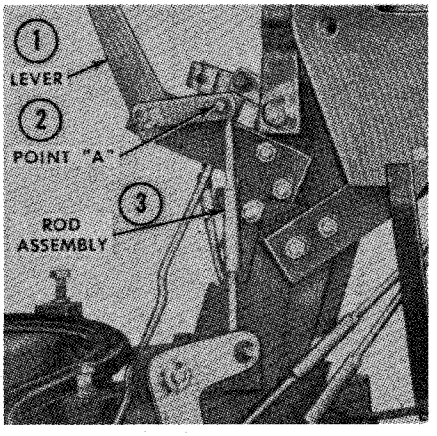


Fig. 147—On 8000—9000 models, adjust length of transmission brake rod assembly (3) so that lever (1) clears ends of slot in console in both "ON" and "OFF" detent positions. Disconnect rod at point "A" (2) to make adjustment.

independent oil reservoir within the transmission case. Splash lubricated transmissions are identified by an external filler plug in the top cover, a vent plug in the side of the case and an oil level plug in the cam cover. Transmission lubricant capacity is 12 quarts. Recommended lubricant is SAE 80-EP gear lube (Ford specification No. M-4864-A or ESN-M2C77-A); lubricant should be changed after each 1200 hours of operation. On splash lubricated transmissions, oil level plug is located in gearshift cover plate; refer to Fig. 154. On early models, a pipe (5—Fig. 157) extended filler opening plug (4) to hole in operator's platform. On later models, filler plug (4A) threads directly into top cover (8) and is accessible after removing center plate from platform. On pressure lubricated transmissions, filler plug for hydraulic system common reservoir is located at top rear center of hydraulic lift cover. Drain plug is located in center rear of transmission housing.

LUBRICATION PRESSURE

177. To check oil pressure of pressure lubricated transmissions, proceed as follows: Operate tractor until hydraulic oil is at normal operating temperature. Stop engine and connect 0-150 psi gage to outlet tube from oil cooler located in front of radiator. Start engine and set speed at 1000 rpm. Oil pressure for all models except TW-10, TW-20 and TW-30 tractors should be 20-35 psi. Pressure for TW-10, TW-20 and TW-30 models should be 130 psi. If pressure is too low cause may be clogged or restricted oil cooler or a weak oil pressure regulating valve spring. Regulating valve (10—Fig. 212) for all models except TW-10, TW-20 and TW-30 threads into back of hydraulic pump adapter plate (39—Fig. 216). Regulating valve for TW-10, TW-20 and TW-30 models is located on the right hand side of the transmission; refer to paragraph 175A for service.

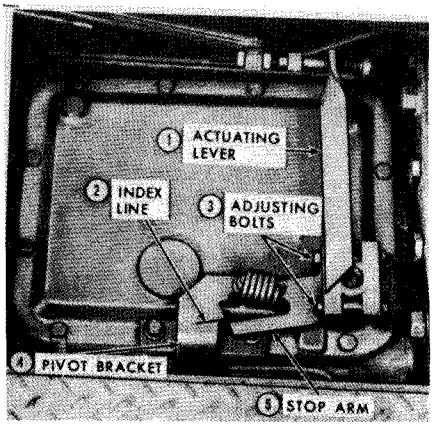


Fig. 148—On 8600—9600 models, parking brake is properly adjusted when stop arm is aligned with index line as shown (with park pawl not engaged). Refer to paragraph 179.

PARKING BRAKE

Models 8000 and 9000 are equipped with a separate parking brake lever, while 8600, 8700, 9600, 9700, TW-10, TW-20 and TW-30 models have the parking brake and High-Low shift lever on the same lever. Models 8000 and 9000 must have the High-Low shift lever in neutral before parking lever can be engaged. Models 8600, 8700, 9600, 9700, TW-10, TW-20 and TW-30 can not be shifted to "PARK" unless High-Low shift lever is in neutral. Refer to appropriate following paragraph for linkage adjustments.

178. **8000-9000 MODELS.** The pawl type parking brake can be engaged only when the tractor is stopped and range (high/low) shift lever is in neutral position. The brake detent ball (15—Fig. 153 or 10—Fig. 157) should engage detent hole in transmission cover in both the "ON" and "OFF" position. Also, shift lever should clear end of slot in console in both detent positions. If necessary to adjust parking brake linkage, remove right fender and refer to Fig. 147. Disconnect rod assembly from lever at "point A" and adjust length of rod so that when disconnected, detent will be fully engaged and lever will not contact end of slot in both the "ON" and "OFF" positions. Reinstall right fender.

Any necessary overhaul of the parking brake external linkage can be made after removing right fender and center plate from operator's platform. Overhaul procedure is obvious from inspection of unit.

179. **8600-9600 MODELS.** The parking brake lever is also the High-Low shift lever. When tractor is stopped and lever is moved to "PARK" position, parking brake actuating lever (Fig. 148) moves parking pawl (23—Fig. 157) into engagement with lugs on sliding coupler (51—Fig. 160). If parking pawl contacts the top of a lug on sliding collar, spring on parking brake rod (12—Fig. 150) will compress until tractor moves far enough to allow parking pawl to drop into full engagement with sliding collar.

To adjust for internal parking brake engagement, remove right hood panel, floor mat and center platform on operator's platform. One rear wheel (or both) must be jacked up enough to rotate. Rotate rear wheel until parking lever can be moved into "PARK" position without fully engaging parking pawl inside transmission. When proper adjusting position has been reached, the parking brake actuating lever stop arm (Fig. 148) should align with index line on pivot bracket, with spring on parking

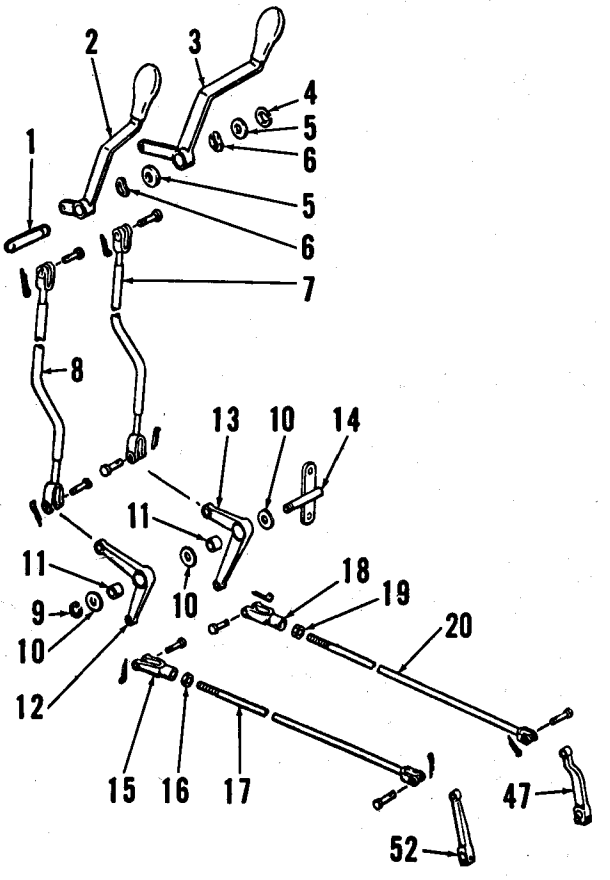


Fig. 149—Exploded view of 8000—9000 transmission shift levers and linkage. Shift lever pivot pin (1) is mounted in power steering Hydramotor support bracket. Control levers are synchronized to detent positions of shift levers (47 and 52) by adjusting length of lower rods (17 and 20).

1. Pivot pin
2. High/low lever
3. Main shift lever
4. Snap ring
5. Flat washer
6. Wave (spring) washers
7. Main shift rod (21.4 in.)
8. High/low shift rod (20.3 in.)
9. Snap ring
10. Washers
11. Bushings
12. High/low bellcrank (4.2 x 4.2 in.)
13. Main shaft bellcrank (3 x 5¾ in.)
14. Bellcrank pivot
15. Yoke, high/low shift rod
16. Jam nut
17. High/low shift rod (28.5 inches)
18. Yoke, main shift rod
19. Jam nut
20. Main shift rod (21.88 in.)
47. Main shift lever
52. High/low shift lever

brake control rod compressed. When rear wheel is rotated, parking pawl should drop into full engagement and stop wheel from rotating further. Spring on parking brake control rod MUST be compressed with index line and stop arm aligned, and parking pawl on top of lug on sliding coupler. To adjust to index line, alternately loosen one adjusting bolt on actuating lever then tighten the other until stop arm is aligned with index line on pivot bracket. This adjustment must be made anytime transmission cover is removed.

If necessary to adjust the parking brake rod so that the neutral-park lever (1—Fig. 150) will be centered in the neutral slot of quadrant on instrument panel, loosen the two adjusting nuts (13) and adjust rod (12) longer or shorter as necessary. When properly adjusted, the spring on end of rod (12) should measure 1⅝-1¾ inches, with park lever in neutral position. Nut (17) can be adjusted to obtain proper length.

On all models, the parking brake detent can be serviced after removing transmission top cover as outlined in paragraph 184. To renew parking brake pawl or the high-low shift coupling, refer to transmission overhaul procedure.

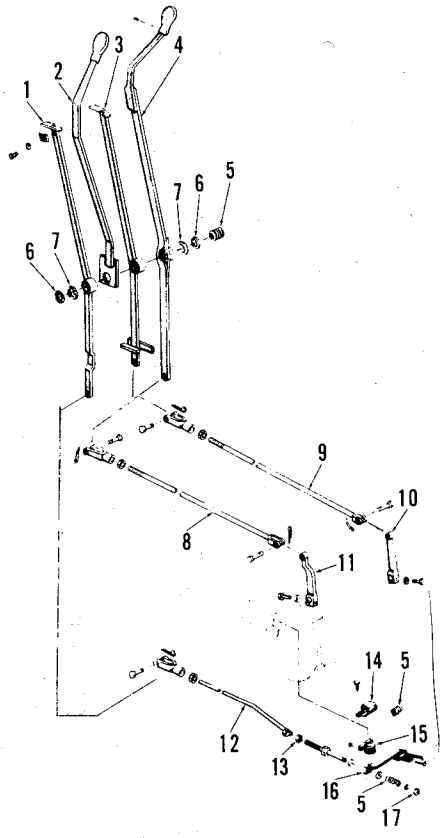


Fig. 150—Exploded view of 8600—9600 transmission shift linkage and parking brake linkage. Bushings in levers (1, 3 and 4) are not serviced separately. Control lever (2) must engage either parking brake lever (1) or high-low range lever (3). Parking pawl override spring on end of rod (12) was inside transmission on 8000—9000 models. Items (15 and 16) replace item (1—Fig. 157), on 8000—9000 models. (Item 16 is shown reversed.) Item (15) was not used on some early models.

1. Park lever
2. Park, high/low shifter
3. High/low lever
4. Gear shift lever
5. Spring
6. Snap ring
7. Washer
8. Gear shift rod
9. High/low shift rod
10. High/low arm
11. Gear shift arm
12. Parking brake rod
13. Adjusting nut
14. Pivot bracket
15. Brake shaft hub
16. Actuating lever
17. Adjusting nut

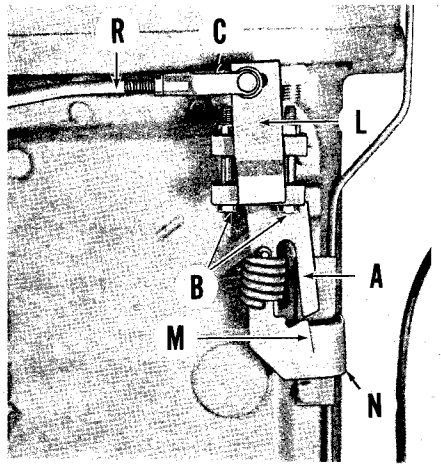


Fig. 151—View of Model 8700, 9700, TW-10, TW-20 and TW-30 parking brake linkage. Refer to text for adjustment.

180. **8700-9700, TW-10, TW-20 and TW-30 MODELS.** The High-Low shift lever on Models 8700, 9700, TW-10, TW-20 and TW-30 is also used to engage parking brake in transmission. When lever is moved to park position, park pawl (23—Fig. 157) engages lugs on sliding coupler (51—Fig. 160).

To adjust parking brake linkage, jack up rear of tractor so one or both rear wheels may be rotated. Remove transmission access cover. Move shift lever to park position so that park pawl rests on top of a tooth on sliding coupler. Rotate a rear wheel if necessary to position pawl on coupler. Index mark (M—Fig. 151) should be aligned with inside edge of stop arm (A). If not, alternately loosen then retighten each adjusting bolt (B) until stop arm (A) is aligned with index mark (M). Move shift lever out of park position. Detach control rod (R) from lever (L) and turn clevis (C) to obtain maximum rod length but still be able to attach rod (R) to lever (L).

TRANSMISSION SHIFT LEVERS AND LINKAGE

181. **8000-9000 MODELS.** Refer to Fig. 149 for exploded view of transmission shift levers and linkage on 8000 and

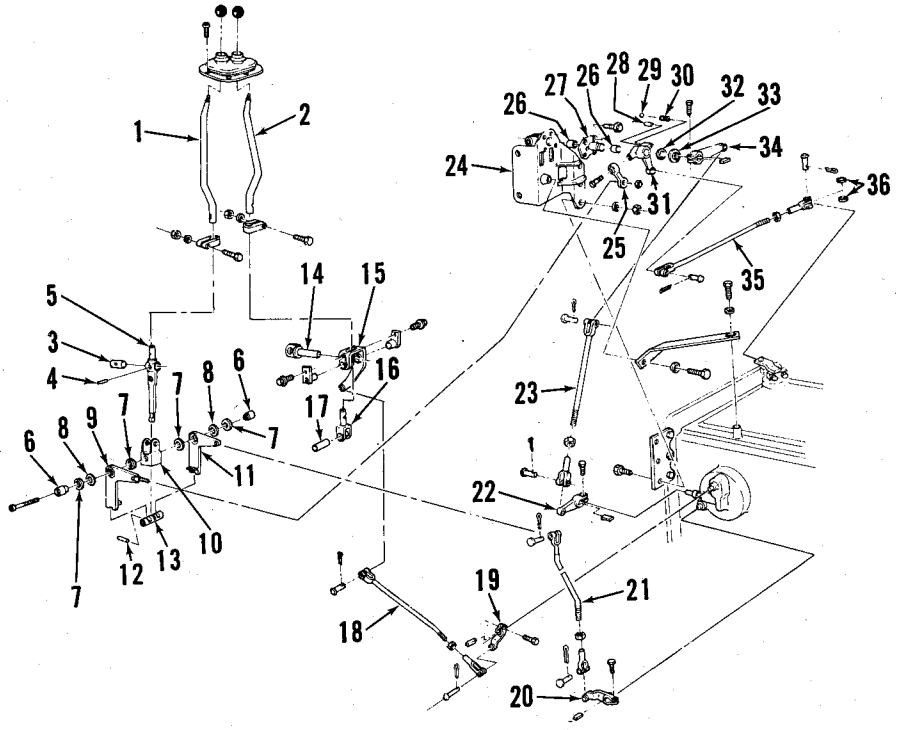


Fig. 152—Exploded view of shift linkage on Models 8700, 9700, TW-10, TW-20 and TW-30.

1. High/low shift lever
2. Gearshift lever
3. Pivot pin
4. Pin
5. High/low shift finger
6. Trunnion
7. Washer
8. Shim
9. Park bellcrank
10. Yoke
11. High/low bellcrank
12. Pin
13. Interlock pin
14. Pivot shaft
15. Gearshift bellcrank
16. Yoke
17. Pin
18. Gearshift rod
19. Gearshift arm
20. High/low arm
21. High/low rod
22. Interlock arm
23. Interlock rod
24. Shift bracket
25. Park arm
26. Bushing
27. Support
28. Pin
29. Detent ball
30. Spring
31. Park brake bellcrank
32. Washer
33. Snap ring
34. Interlock arm
35. Park brake rod
36. Washer

9000 models. The high-low shift lever (2) should be aligned with neutral (N) position and main shift lever should be at 4th-8th gear position when the levers on transmission are aligned with reference marks on transmission housing as shown in Fig. 154. Also, the high-low shift lever should not strike end of slot in instrument panel when in either high (H) or low (L) position; main shift lever should not strike end of slot when in either reverse or 4-8th speed position. If necessary to adjust shift linkage, remove the pins connecting yokes (15 and/or 18—Fig. 149) on lower shift rods to bellcranks (12 and/or 13) and loosen jam nut (16 and/or 19). Shorten or lengthen lower rods as necessary to obtain proper shift action, then secure yoke pins with cotter pins and tighten jam nuts.

If shift linkage cannot be properly adjusted, either the linkage has been improperly assembled or overhaul of linkage is indicated. Wear of pins and pin holes in shift levers, shift rod ends and/or bellcranks, or bearing wear in shift levers and/or bellcranks will cause improper shift action. Bushings (11) in bellcranks are renewable.

When assembling linkage, note the measurements of shift rods given in legend of Fig. 149 and observe the following: Early models were not fitted with wave (spring) washers (6); installing the wave washers on models not so equipped will help eliminate free play of shift arms. The high-low shift bellcrank (12) arms are the same length. On main shift bellcrank (13), connect the 3-inch arm to upper shift rod (7) and the 5¾-inch long arm to lower rod yoke (18). Pivot (14) is installed on instrument panel support with pin side to rear (against support); foot throttle bellcrank pivots in the hollow bracket pin.

182. **8600-9600 MODELS.** Refer to Fig. 150 for exploded view of transmission shift levers and linkage for 8600-9600 models. High-low shift lever (2) engages high-low intermediate lever (3) when shift lever is in the high-low slot in instrument panel. When shift lever (2) is moved through neutral and over to the park slot, intermediate lever (1) is engaged. Gear shift lever (4) and the two intermediate levers (1 and 3) are equipped with non-renewable bushings. When adjusting shift levers on linkage, the reference marks on transmission case must NOT be used. Fig. 155 shows dimensions for installing high-low lever arm and gearshift cam lever arm if arms were removed or if they are out of adjustment. After lever arms are positioned correctly, tighten retaining bolts to 11-15 ft.-lbs. torque. Adjust the forward yokes on rods (8, 9 and 12—Fig.

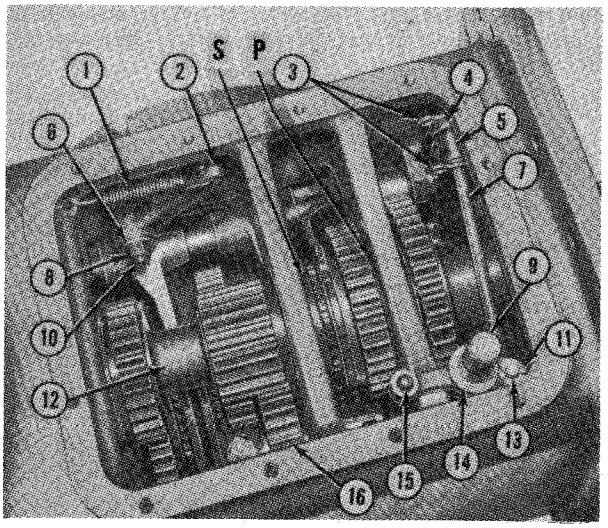


Fig. 153—View of transmission with top cover removed. Brake lever (14) and rod (7) are removed with cover and are shown installed for illustration only. Note that a spacer ring is installed at (S) on splash lubricated transmissions or at (P) on pressure lubricated transmissions. Refer to text. Numbers following legend indicate identical parts in Fig. 157.

1. Index lever spring (27)
2. Index lever (33)
3. Spring (hair) pins (15 & 22)
4. Brake pawl (23)
5. Sleeve (18)
6. Washer (16)
7. Brake rod (14)
8. Index arm retaining nut (30)
9. Brake lever shaft (3)
10. Pivot bolt (37)
11. Cotter pin
12. Mainshaft
13. Flat washer
14. Brake lever (1)
15. Detent ball (10)
16. Reverse idler

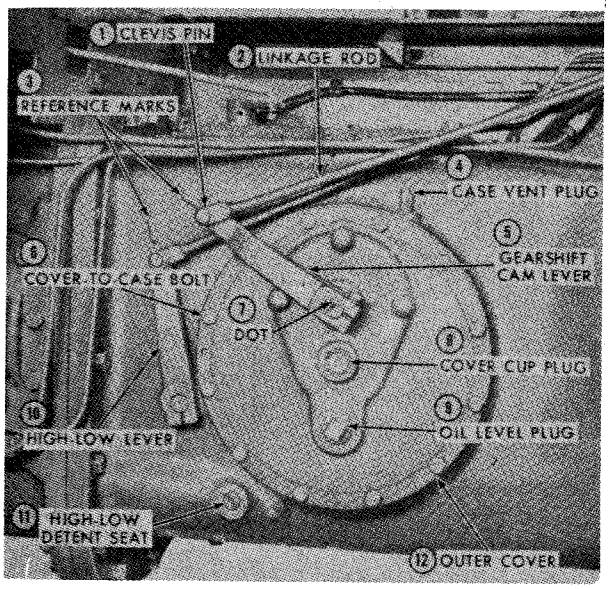


Fig. 154—On 8000—9000 models, reference marks (3) on transmission housing and dot mark (7) on cam drive gear shaft are necessary for proper reassembly of shift cam and shift levers. Note case vent plug; inspect vent to be sure that it is not plugged whenever servicing transmission. Refer to Fig. 155 for 8600—9600 models.

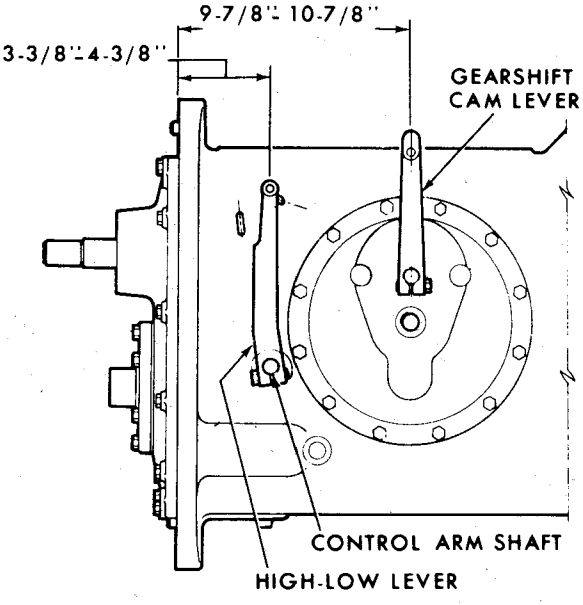


Fig. 155—On 8600—9600 models. DO NOT use reference marks on transmission housing. Adjust levers to dimensions shown, with gearshift cam lever in first gear position and high-low lever in neutral. Refer to Fig. 154 for 8000—9000 models.

150) so gearshift lever (4) is in 1st-5th position and intermediate levers (1 and 3) are exactly in neutral position in slots in instrument panel.

183. **8700, 9700, TW-10, TW-20 and TW-30 MODELS.** Refer to Fig. 152 for exploded view of transmission shift levers and linkage used on Models 8700, 9700, TW-10, TW-20 and TW-30.

To remove shifter assembly, unscrew boot retaining screws, slide boot up shift levers (1 and 2) and detach shift levers. Disconnect shift rods; unbolt and remove shift bracket (24). Remainder of disassembly is evident after inspection of shift assembly. Do not lose shims (8), detent ball (29) or spring (30).

Renew any components causing sloppiness or binding in shift action. Use trial assemblies to locate shifting malfunctions.

Reverse disassembly procedure to assemble shifter components. Install sufficient shims so end play of bellcranks (9 and 11) in shift bracket (24) is 0.000-0.009 inch.

To adjust shift linkage, proceed as follows: Detach shift rod (21—Fig. 152) from high/low shift arm (20) and place shift arm in neutral. Center high/low shift lever (11) over interlock pin (13) then adjust length of shift rod (21) by turning clevis so clevis pin will fit easily through clevis and shift arm (20). Adjust length of interlock control rod (23) by turning clevis so center to center distance between rod ends is 11-3/8 inches. Adjust length of gearshift control rod (18) by turning clevis so center to center distance between rod ends is 13-7/8 inches. Check clearance between gearshift lever (2) and guard with lever in 4th gear. Minimum clearance is ½ inch; loosen gearshift lever and rotate lever to obtain clearance. Clearance between high/low shift lever (1) and guard should be at least ½ inch while in high range and ¼ inch when in park position. Loosen lever clamp and rotate lever to obtain desired clearance.

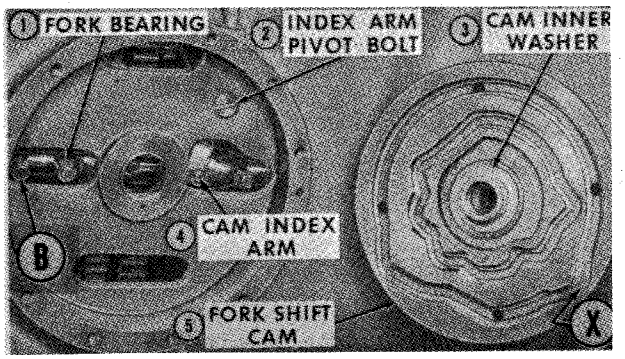


Fig. 156—When installing shift cam, align lobe "X" with fork bearing "B"; refer to text for complete fork and index lever alignment procedure and for cover plate and cam drive gear installation.

TRANSMISSION TOP COVER

184. **8000-9000 MODELS.** To remove

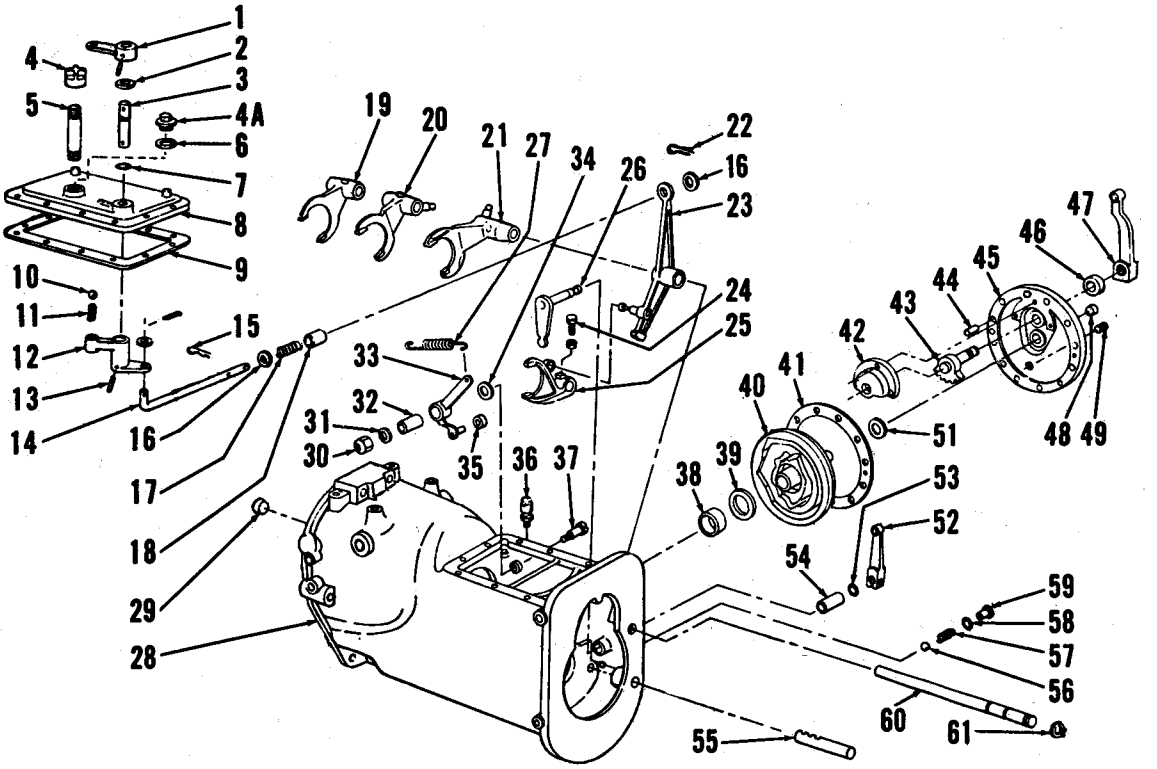


Fig. 157—Exploded view showing transmission housing, top cover and brake linkage, shift cover, shift cam, shift forks and rails. Refer to Fig. 160 for exploded view of gears and shafts with rear cover, bearings and seals and front bearing supports. Index lever (33) acts as detent for shift cam (40); there is no neutral detent position for the shift cam. Three detent notches in high-low shift rail (55) provides transmission neutral position as well as high and low range detent positions.

1. Brake lever
2. Flat washer
3. Brake lever shaft
4. Filler cap (early)
4A. Filler plug (late)
5. Extension (early)
6. Gasket
7. "O" ring
8. Top cover
9. Gasket
10. Detent ball
11. Detent spring
12. Brake lever
13. Roll pin
14. Brake rod
15. Spring (hair) pin
16. Flat washer
17. Spring
18. Sleeve
19. 1st/2nd gear fork
20. 3rd/reverse shift fork
21. 4th gear shift fork
22. Spring (hair) pin
23. Brake pawl
24. Set screw
25. High/low shift fork
26. High/low shift lever
27. Index arm spring
28. Transmission housing
29. Shift rail bore plug
30. Nut
31. Flat washer
32. Pivot bushing
33. Index arm
34. Thrust washer
35. Cam roller bearing
36. Transmission vent
37. Index arm pivot bolt
38. Bushing
39. Thrust washer
40. Shift cam
41. Gasket
42. Inner cover
43. Shift cam drive gear
44. Dowel pin
45. Shift cam cover
46. Seal
47. Main shift lever
48. Plug
49. Oil level plug
51. Thrust washer
52. High/low shift lever
53. "O" ring
54. Bushing
55. High/low shift rail
56. Detent ball
57. Detent spring
58. Gasket
59. Detent plug
60. Main shift rail
61. Snap ring

transmission top cover, first remove center plate from operator's platform, then proceed as follows: Disconnect transmission brake linkage rod from lever (1—Fig. 157) on top of transmission cover.

NOTE: Some 8000—9000 models may have been changed over to the later parking brake lever assembly, similar to items 14 and 16 (Fig. 150); Item 15 was not used in the changeover.

Unbolt cover from transmission housing, pivot front end of cover to left only far enough to gain access to right end of brake rod (14—Fig. 157). Pivoting center too far will disengage detent ball (10). Remove the spring (hair) pin (15) and slide washer (16), spring (17) and sleeve (18) towards left end of rod, then reinstall pin (15) in rod. Remove outer pin (22) and flat washer (16), disengage the brake rod from brake pawl (23) and lift cover from transmission.

Drive roll pin from lever (1) and shaft (3) and remove shaft and lever (12) out bottom of cover; take care not to lose detent ball (10) and spring (11). Install new "O" ring (7) in groove on shaft and renew detent ball and/or spring if necessary. Lubricate shaft, "O" ring and bore in cover and install shaft and lower lever (12) with detent spring and ball. Place flat washer (2) on shaft, install lever (1) aligned with detent arm of lever (12) and secure with roll pin.

Reinstall cover with new gasket as follows: Insert left end of rod (14) through pawl and install flat washer and "hairpin" (22). Remove "hairpin" (15), slide spring, sleeve and washer against pawl and reinstall "hairpin" (15) through hole in rod. Swing cover back into position, taking care not to dislodge detent ball, and tighten retaining cap screws to a torque of 12-18 ft.-lbs. Reinstall center plate in operator's platform.

185. **8600-9600 MODELS.** To remove transmission top cover, remove operator's platform mat and center platform, then proceed as follows: Shift high-low range shift lever to neutral, slightly loosen the two bolts on pivot bracket (Fig. 148). Shift high-low lever to park position, use a suitable pry bar or adjustable wrench on pivot bracket while front bolt is removed.

CAUTION: Spring on pivot bracket is under tension and may jump out if bracket is removed without holding bracket against spring pressure.

Shift high-low lever to neutral and remove the other bolt on pivot bracket and remove spring and spacer. Remove the two adjusting bolts holding actuating lever to brake lever shaft, remove actuating lever and lay lever aside without disturbing adjustment on spring end of lever. Unbolt cover from transmission housing, pivot front end of cover to the left far enough to remove "hairpin" spring clip (22—Fig. 158), and washer from end of brake rod (14). Cover and brake rod may now be removed. With cover off, drive out roll pin at top of brake lever shaft (3) and remove actuating lever hub from top of shaft. Tap shaft (3) out bottom of cover. "O" ring (7) should be renewed at this time and brake lever (12), brake rod (14) and shaft (3) inspected for wear, as well as shaft bore in transmission cover. Lubricate shaft, bore and "O" ring before reinstalling in cover. Reinstall actuating lever hub on top of shaft (3) and reinstall roll pin.

Install a new cover gasket, insert end of brake rod (14) into parking brake pawl (23) and reinstall washer and "hairpin" (22). Swing cover back into position, install all but the two center bolts on left side of cover and tighten to a torque of 12-18 ft.-lbs. Place the pivot bracket strap spacer over the two remaining bolt holes, so that the offset holes align properly and loosely install actuating lever adjusting bolts onto hub on top of brake shaft (3). Start rear bolt into pivot bracket, swing pivot bracket away from transmission and install spring. Using a suitable pry bar or adjustable wrench, force pivot bracket against spring pressure until front bolt hole aligns with strap spacer and transmission cover, and install front bolt.

NOTE: To avoid excessive spring tension when installing pivot bracket, place high-low shift lever in park position and make sure parking brake pawl (23) falls into full engagement in collar in transmission.

Tighten the two pivot bracket bolts to a torque of 24-30 ft.-lbs. Adjust parking brake linkage as outlined in paragraph 179.

186. **8700, 9700, TW-10, TW-20 AND TW-30 MODELS.** To remove transmission top cover, remove operator's platform mat and center platform, then proceed as follows: On TW-30 models, disconnect brake system return to sump

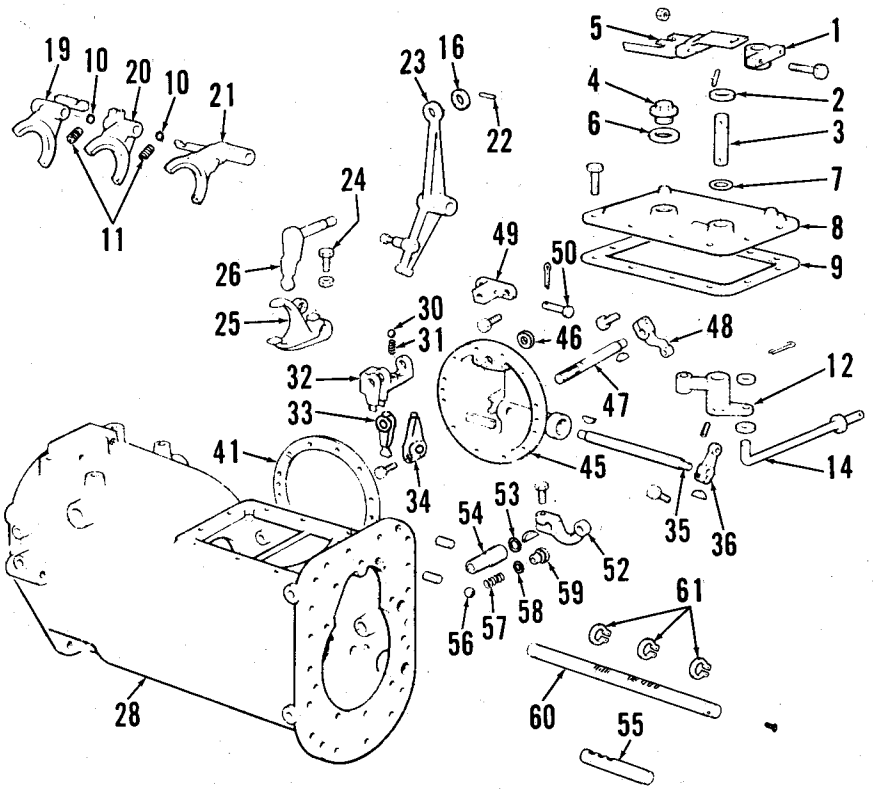


Fig. 158—View showing transmission housing, gearshift and parking brake components.

1. Brake actuator hub
2. Washer
3. Brake lever shaft
4. Filler plug
5. Parking brake lever
6. Gasket
7. "O" ring
8. Top cover
9. Gasket
10. Detent ball
11. Spring
12. Brake lever
14. Brake rod
16. Washer
19. 1st/2nd gear fork
20. 3rd/reverse shift fork
21. 4th gear shift fork
22. Pin
23. Brake pawl
24. Set screw
25. High/low shift fork
26. High/low shift lever
28. Transmission housing
30. Detent ball
31. Spring
32. Interlock
33. Gearshift finger
34. Interlock finger
35. Shaft
36. Interlock lever
41. Gasket
45. Shift cover
46. Seal
47. Gearshift shaft
48. Gearshift arm
49. Support
50. Clevis pin
52. High/low shift lever
53. "O" ring
54. Bushing
55. High/low shift rail
56. Detent ball
57. Spring
58. Gasket
59. Detent plug
60. Main shift rail
61. Snap rings

hydraulic line and rear axle lubrication line, cap lines and fittings, then on all models, detach parking brake control rod clevis (C—Fig. 151) from lever (L). Use a suitable pry bar or wrench against anchor (N) and remove anchor retaining screws.

CAUTION: Spring on stop arm (A) is under tension and may jump out if anchor is removed without holding against spring pressure.

Unscrew bolts (B) and remove actuator assembly. Unbolt transmission housing cover, pivot front end of cover to the left far enough to remove pin (22—Fig. 158) and washer (16) from brake rod (14). Cover and brake rod may now be removed. With cover off, drive out roll pin at top of brake lever shaft (3) and remove actuating lever hub from top of shaft. Tap shaft (3) out bottom of cover. "O" ring (7) should be renewed at this time and brake lever (12), brake rod (14) and shaft (3) inspected for wear, as well as shaft bore in transmission cover. Lubricate shaft, bore and "O" ring before installing in cover. Reinstall actuating lever hub (1) on top of shaft (3) and reinstall roll pin.

Install a new cover gasket, insert end of brake rod (14) into parking brake pawl (23) and reinstall washer (16) and pin (22). Swing cover back into position, install all but the two center bolts on left side of cover and tighten bolts on 8700-9700 models to a torque of 12-18 ft.-lbs. Tighten cover bolts on TW-10, TW-20 and TW-30 models to a torque of 27-37 ft.-lbs. Install actuating lever assembly onto hub (1). Start rear bolt into anchor (N—Fig. 151), swing anchor away from transmission and install spring. Using a suitable pry bar or adjustable wrench, force anchor against spring pressure until front bolt hole aligns with strap spacer and transmission cover, and install front bolt.

NOTE: To avoid excessive spring tension when installing anchor, make sure parking brake pawl (23—Fig. 158) falls into full engagement in collar in transmission.

Tighten the two anchor bolts to a torque of 24-30 ft.-lbs. On TW-30 models reconnect brake hydraulic line and rear axle lubrication line. Adjust parking brake linkage as outlined in paragraph 180.

R&R TRANSMISSION ASSEMBLY

All Models Except 8700, 9700, TW-10, TW-20 And TW-30

NOTE: The following transmission removal procedure, by deleting removal of rear hood (instrument panel) support and operations outlined in paragraph 162, will also apply to splitting tractor between transmission and rear axle center housing.

187. To remove transmission, drain lubricant (approximately 17 gallons) from transmission and rear axle center housing, split tractor between engine and transmission as outlined in paragraph 162, then proceed as follows:

Disconnect lower shift rods at forward end and the clutch rod at crossshaft end. Remove center plate from operator's platform and disconnect the four brake lines at top of transmission; plug all openings and identify lines for reasssembly. Disconnect wiring at disconnect plug at left side of transmission. Remove tool box, battery and battery box. Unbolt instrument panel (rear hood) support and remove the support assembly from tractor. On models with Dual Power, control pedal assembly and linkage should be removed and disconnected to prevent damage. Disconnect lower shift rods from transmission and brake rod from lever on top of transmission cover, on 8000 and 9000 models. On 8600-9600 models, do not remove park brake rod at end of actuating lever, to prevent disturbing adjustment. Make a reference mark across actuating lever and hub and remove adjusting bolts to parking brake hub. Lay actuating lever aside. To avoid possible breakage of pto clutch locating pin (18—Fig. 197), remove pin from upper left side of rear axle center housing.

Support rear axle center housing, both under front end next to transmission housing and under drawbar to keep rear unit from tilting backward or forward when transmission is removed. Attach hoist to transmission, unbolt transmission from rear axle center housing and remove the transmission assembly or separate tractor between transmission and rear axle center housing.

To facilitate reconnecting transmission to rear axle center housing, remove the hydraulic pump and adapter plate assembly following procedure outlined in paragraph 233. Place new gasket on face of rear axle center housing and be sure that pto clutch hub is fully engaged in the clutch discs. Lift transmission into position with hoist and working through hydraulic pump opening, guide pto input shaft into clutch hub and coupling and onto output shaft of transmission. Tighten the ½-inch cap screws at each side of housing to a torque of 50-65 ft.-lbs. and the 5/8-inch cap screws at top and bottom of housing to a torque of 95-130 ft.-lbs. Install pto clutch locating pin with new "O" ring and tighten pin to a torque of 70-95 ft.-lbs. Reinstall hydraulic pump as outlined in paragraph 234 or 235, reconnect engine to transmission as in paragraph 163. Reinstall 8600-9600 park brake actuating lever on brake shaft hub on top of transmission cover, with reference mark aligned. If unable to match reference mark to obtain original adjustment of parking brake, adjust as outlined in paragraph 179.

Complete remainder of assembly by reversing disassembly procedure.

Models 8700, 9700, TW-10, TW-20 And TW-30

188. Prior to transmission removal, drain transmission lubricant (approximately 17 gallons on 8700-9700 models, 20 gallons on TW-10 and TW-20 models and 23 gallons on TW-30 models) and split tractor between engine and transmission as outlined in paragraph 162.

Remove screws retaining gearshift boot, raise boot, loosen gearshift lever clamps and detach gearshift levers. On models with Dual Power, control pedal assembly and linkage should be removed and disconnected to prevent damage. Disconnect and cap brake lines. Detach engine clutch linkage. It is not necessary to remove the cab or cabless platform in order to remove the transmission if the sides of cab or platform are properly supported. If cab or platform removal is desired, disconnect wires, hoses, tubing or linkage which will interfere with separation of platform or cab from tractor. On cab equipped models, remove scuff plates in door openings, remove access plates and unscrew front cab mounting bolts being careful not to lose shims. Remove bolts securing front of platform on models not equipped with cab. Unscrew bolts securing rear of cab or platform to rear axle housings and use a suitable hoist to lift cab or platform away from tractor.

Remove brake lines from transmission housing. Detach shift rods and remove gearshift assembly from housing. Remove Dual Power oil tube. Support front of rear axle center housing to prevent tipping. Attach hoist to transmission, unbolt transmission from rear axle center housing and remove transmission.

If transmission or pto shafts will not engage during reassembly, remove hydraulic pump and adapter plate assembly as outlined in paragraph 233. Tighten ½-inch cap screws on each side of housing to 65-90 ft.-lbs. and 5/8-inch cap screws at top and bottom of housing to 140-170 ft.-lbs. Tighten platform retaining bolts to 100-120 ft.-lbs. Tighten cab retaining bolts to 200-220 ft.-lbs.

TRANSMISSION OVERHAUL

All Models

189. **SHIFT CAM, INDEX ARM AND SHIFT COVER (ALL MODELS EXCEPT 8700, 9700, TW-10, TW-20 AND TW-30).** Shift cam, index arm, shift fork rollers and shift cover can be removed without removing transmission from tractor; proceed as follows:

Remove battery cover, disconnect ground cable and remove battery, battery box and center plate from operator's platform. Drain transmission lubricant. Remove transmission top cover as outlined in paragraph 184 or 185. Disconnect lower shift rod from gearshift cam lever; refer to Fig. 154. Unbolt and remove the shift cover (45—Fig. 157), then unbolt inner cover (42), remove gearshift cam lever (47) and withdraw cam drive gear (43). Remove seal (46) from cover.

Remove washer (51) from cam (40), remove cam from transmission and remove inner washer (39). Remove the rollers (35) from index arm (33) and shift forks (19, 20 and 21).

Carefully clean and inspect all parts, renewing any that are excessively worn or damaged. Bushing (38) in transmission housing may be renewed if excessively worn. After installing new bushing, it must be line reamed to an inside diameter of 1.5020-1.5045 inches. The index arm can be removed after removing arm pivot bolt; refer to Figs. 153 and 156.

To reinstall shift cam and cover, proceed as follows: Install index arm and tighten pivot bolt nut to a torque of 48-64 ft.-lbs. Using proper size driver, install new seal in cover with lip of seal inward. Lubricate cam drive gear and carefully install gear shaft through housing bore and seal. Install inner cover and tighten retaining cap screws to a torque of 20-27 ft.-lbs. Place the two sliding couplings (95 and 101—Fig. 146) in neutral position and engage sliding gear (75) with secondary countershaft. Refer to Fig. 156 and place inner washer on cam and the bearings on shift forks and index arm. Working through top cover opening, move upper end of index arm rearward to align index roller with cam, then install cam with lobe (X) engaging rear shift fork and release index arm when cam is properly seated. Using new gasket, install cover. On 8000-9000 models, be sure to have dot (or stake mark) on outer end of cam drive gear shaft pointing up as shown in Fig. 154. Tighten cover retaining cap screws to a torque of 27-32 ft.-lbs. following a diagonal pattern. Install gearshift cam lever so that it is aligned with reference mark on transmission housing; refer to Fig. 154. On 8600-9600 models, place transmission main countershaft front coupling to the rear and high-low coupling in neutral. Tighten cover retaining cap screws to a torque of 27-32 ft.-lbs. following a diagonal pattern. Refer to Fig. 155 and install levers to dimensions shown. DO NOT use reference marks on outside of housing. Tighten lever clamp bolts to a torque of 11-15 ft.-lbs. Refill transmission and complete remainder of reassembly by reversing disassembly procedure.

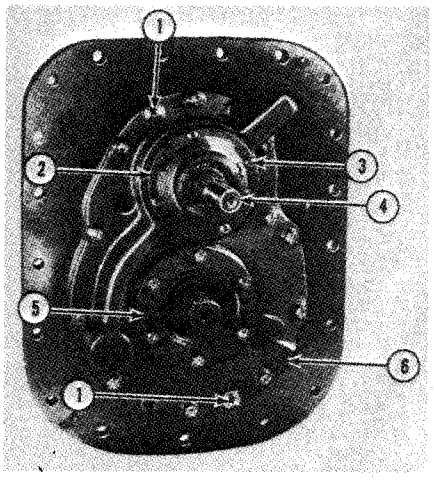


Fig. 159—View showing rear of transmission on Models TW-10, TW-20 and TW-30.

1. Jack screw holes
2. Low pressure pump
3. Pump retaining screws
4. Pto shaft
5. Output shaft bearing retainer
6. Rear cover

190. **SHIFT LEVER, INTERLOCK AND SHIFT COVER (MODELS 8700, 9700, TW-10, TW-20 AND TW-30).** Shift cover with shift lever and interlock can be removed without removing transmission from tractor by using following procedure:

Drain transmission lubricant and remove battery and box. Shift transmission to neutral. Remove oil cooler inlet tube and torque amplifier tube. On TW-30 models, remove Dual Power hydraulic oil pressure line from regulating valve and "tee" fitting. Disconnect lube cooler inlet line from regulating valve, loosen clamps and reposition line. On all models, plug openings to prevent contamination. Detach lower ends of interlock rod (23—Fig. 152) and gearshift rod (18). Be sure transmission is in neutral, remove shift cover screws and remove shift cover.

Remove interlock finger (34—Fig. 158) and key from shaft (35) then withdraw shaft from shift cover. Remove gearshift arm (48) and key from shaft (47). Extract clevis pin (50) from support (49) and pull out shaft (47) just enough to remove shift control finger (33). Do not pull out shaft more than necessary to remove finger as shaft splines may damage bushing and seal in cover. Remove shift control finger (33) then withdraw shaft (47) from inside of shift cover being careful not to lose detent ball (30) or spring (31). Remove interlock (32) and support (49).

Inspect components for damage or excessive wear which may affect function of gearshift or interlock mechanisms. Inspect shift cover for cracks and distortion.

To assemble gearshift, interlock and shift cover components, reverse disassembly procedure while noting the following: Install shift control finger (33) with chamfer in bore towards shift cover. Finger (33) should travel an equal amount forward and rearward of fingers on interlock (32). If travel is unequal, reposition finger (33) on shaft (47) splines. Tighten interlock finger (34) clamp bolt and gearshift arm clamp bolt to 20-26 ft.-lbs. Tighten shift cover screws to 20-27 ft.-lbs. in a diagonal pattern on 8700-9700 models. Shift cover bolts on Models TW-10, TW-20 and TW-30 should be tightened to a torque of 27-37 ft.-lbs.

191. **OIL PUMP, REAR COVER, REAR OIL SEALS AND HIGH-LOW GEARS.** The low pressure oil pump, transmission rear cover, high-low gears and shift rail can be removed after splitting tractor between transmission and rear axle center housing or with transmission removed as outlined in paragraph 187 or 188.

On TW-10, TW-20 and TW-30 models, remove four screws (3—Fig. 159) securing low pressure oil pump to rear cover (6). Carefully withdraw pto shaft (4) and

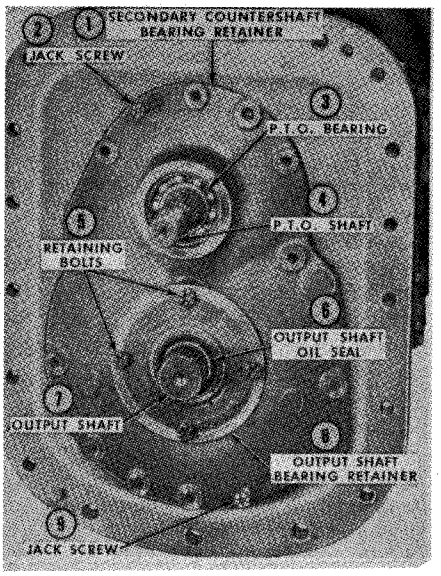


Fig. 159A—View showing transmission rear cover with two retaining cap screws threaded into jack screw holes. Pto shaft is removed with rear cover (secondary countershaft bearing retainer).

oil pump. Remove outer snap ring and drive pto shaft and bearing out of pump housing. Oil pump is available as a unit only and must be serviced as an assembly.

On all models, refer to Fig. 159 or 159A and unbolt then carefully pry output shaft bearing retainer off rear cover to avoid damaging output shaft bearing adjustment shims. Remove the cap screws retaining rear cover to transmission housing and thread two of the cap screws into jack screw locations shown. Evenly tighten the two cap screws to force rear cover from housing, then remove the rear cover and, on all models except TW-10, TW-20 and TW-30, the pto shaft assembly. Remove jack screws from cover. On splash lubricated transmissions pry oil seal (68—Fig. 160) from retainer (70) and on all models, if bearing cup (61) is scored or otherwise damaged, remove the cup. Remove snap ring (66) and bump pto shaft (42) and bearing (65) out rear of cover, then remove pto shaft oil seal (63) (splash lubricated transmissions only). Inspect bearing (45) in rear cover and remove the needle roller bearing if worn or damaged. Withdraw output shaft (52) with gear (58) out rear of transmission; press shaft from gear and rear bearing cone (60) and remove front bearing cone (50) if worn or scored. Shift high-low sliding coupling (51) to rear and remove coupling from shift fork. Withdraw secondary countershaft (41) from rear of transmission, taking care not to drop thrust bearing (38). Inspect needle roller bearing (39) in web of transmission housing; if bearing is excessively worn or damaged, it can be removed and a new bearing installed providing care is taken to remove any dislodged needle rollers from housing when removing old bearing. Inspect bearing cup (49) in rear end of main countershaft (47) and remove if scored or excessively worn. Inspect ball bearing (65) on pto shaft (42); remove snap ring (67) and press bearing from shaft if bearing is worn or rough.

To remove high-low shift fork, remove detent plug (59—Fig. 157), spring (57) and ball (56) and unscrew set screw (24) from fork (25). Remove shift rail (55) out rear of transmission housing, then disengage fork from transmission brake pawl (23) and remove fork from housing.

Excessive wear of gears, bearings and other components in rear section of transmission would indicate that the transmission should be completely disassembled and inspected.

192. To reassemble transmission, proceed as follows: Using suitable drivers, install new needle roller bearing (39—Fig. 160) in transmission web and new bearing cup (49) in rear end of main countershaft (47). Place high-low shift fork (25—Fig. 157) on pin in transmission brake pawl (23), then insert shift rail (55) and fork retaining set screw (24). Align single indentation in shaft with screw, then tighten screw and locknut to 23-30 ft.-lbs. on Models TW-10, TW-20 and TW-30 and 12-18 ft.-lbs. on all other models. Install detent ball (56), spring (57) and retaining plug (59) with new gasket (58). Place high-low sliding coupling (51—Fig. 160) in fork with brake teeth to rear, then shift coupling forward to engage with dog teeth on main countershaft (47). Refer also to Fig. 161.

NOTE: Transmission gear shift sliding connector and coupling assemblies are furnished as matched sets on TW-10, TW-20 and TW-30 models. When removing countershaft, make sure forward connector and coupling assembly and rearward connector and coupling assembly each remain together as matched sets. If installing new connectors and couplings, make sure etched timing marks are aligned. During transmission reassembly, position connector and coupling assemblies with chamfered end of connector bores facing rearward for ease of countershaft installation.

NOTE: When installing new coupling (51—Fig. 160) on 8000—9000 models, install spacer C9NN—7N445—A between countershaft gear dog teeth and gear face.

Using grease, stick thrust bearing (38—Fig. 160) to front end of secondary countershaft (41). On pressure lubricated transmission, except TW-10, TW-20 and TW-30, install spacer ring (20) in groove adjacent to sliding coupling splines on secondary countershaft as

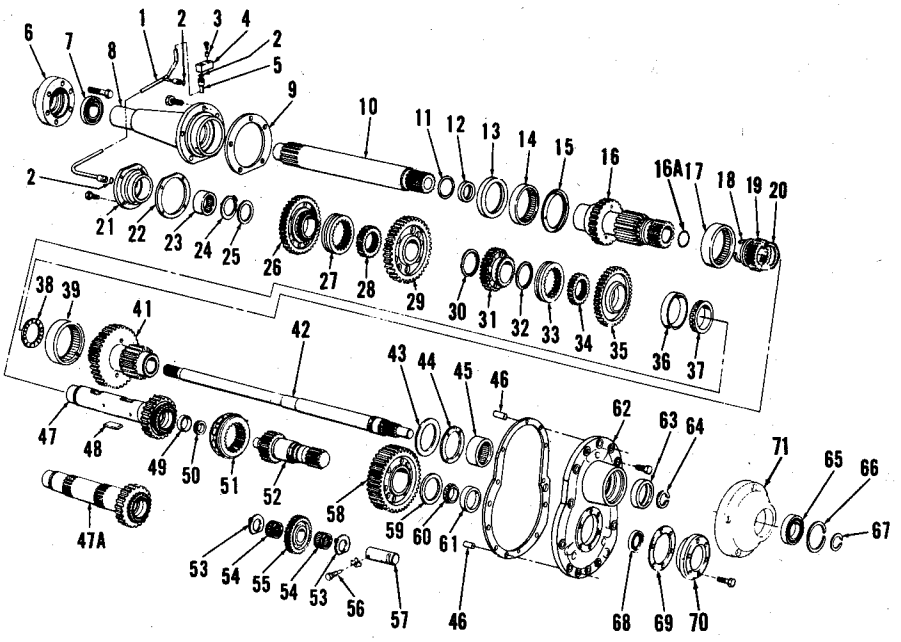


Fig. 160– Exploded view of transmission gears, shafts and bearings with rear cover and bearing supports. Refer to Fig. 157 for exploded view showing transmission housing, top and shift covers, shift forks and rails and transmission brake linkage. Note rear cover differences in Figs. 159 and 159A. On later models except TW-10, TW-20 or TW-30, third gear (35) face is recessed and a thrust washer is fitted. Seals (63 and 68) are not used in pressure lubricated transmissions. Snap ring (64) is not used in splash lubricated transmissions. "O" ring (16A) is installed in mainshaft (16) on models without Dual Power. Oil pump (71) is only used on TW-10, TW-20 and TW-30.

1. Oil inlet tube
2. "O"ring
3. Spacer
4. Manifold
5. Tube fitting
6. Pto drive flange
7. Pilot bearing
8. Clutch release bearing support
9. Gasket
10. Input shaft
11. Snap ring
12. Pto shaft seal
13. Mainshaft seal
14. Needle roller bearing
15. Thrust washer
16. Mainshaft
16A. "O" ring
17. Needle roller bearing
18. Spacer
19. Sliding gear/coupling
20. Spacer
21. Bearing support
22. Gasket
23. Needle roller bearing
24. Snap ring
25. Thrust washer
26. Second gear
27. Sliding coupling
28. Connector
29. First gear
30. Thrust washer
31. Reverse gear
32. Thrust washer
33. Sliding coupling
34. Connector
35. Third gear
36. Bearing cup
37. Bearing cone
38. Thrust bearing
39. Needle roller bearing
41. Secondary counter shaft
42. Pto shaft
43. Washer
44. Thrust washer
45. Needle roller bearing
46. Dowel pin
47. Main countershaft
47A. Main countershaft
48. Key
49. Bearing cup
50. Bearing cone
51. Sliding coupling
52. Output shaft
53. Thrust washer
54. Bearing
55. Reverse idler
56. Idler shaft bolt
57. Idler shaft
58. Output shaft gear
59. Thrust washer
60. Bearing cone
61. Bearing cup
62. Rear cover
63. Oil seal
64. Snap ring
65. Ball bearng
66. Snap ring
67. Snap ring
68. Oil seal
69. Shim
70. Bearing retainer
71. Low pressure oil pump

shown at (P—Fig. 153). Note shape of spacer in Fig. 162. Lubricate needle bearing in housing and position secondary countershaft in the needle bearing in housing. Install new bearing cone (50—Fig. 160) on front end of output shaft (52), place gear (58) on shaft with dog teeth forward, then install thrust washer (59) and rear bearing cone (60) on rear end of shaft. Insert output shaft assembly so that splines on front end of shaft enter sliding coupling (51) and bearing cone is seated in cup in main countershaft.

Using suitable drivers, install new needle roller bearing in rear cover and bearing cup in bearing retainer (70). On splash lubricated transmissions, renew seals (63 and 68). These seals are not used on pressure lubricated transmission, since a common reservoir is used. Drive or press new bearing onto pto shaft and secure with snap ring. Lubricate shaft and oil seal if so equipped, in rear cover, then install shaft and bearing assembly, taking care not to damage oil seal. Install snap ring in rear cover at rear side of pto shaft bearing. Position new gasket on dowel pins on rear face of housing. Install steel washer (43) and thrust washer (44) on rear end of secondary countershaft (41) with tab on thrust washer (44) pointing to rear and up. Note that on early 8000 models, steel washer (43) is absent. On all models except TW-10, TW-20 and TW-30, insert pto shaft through secondary countershaft, taking care not to damage oil seal (12) in front end of main shaft (16) as pto shaft is moved forward. Turn shaft as necessary to align splines with drive plate (6) at flywheel and be sure dowel holes are aligned as cover contacts rear face of housing. Tighten rear cover retaining cap screws alternately and evenly to a torque of 20-27 ft.-lbs.

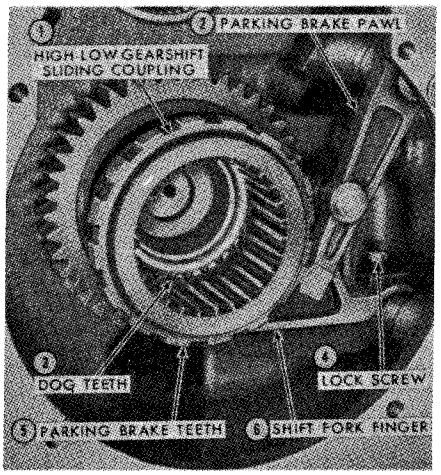


Fig. 161—View of rear end of transmission with output shaft and secondary countershaft removed. Note brake pawl engaged with high/low sliding coupling.

On Models TW-10, TW-20 and TW-30, install bearing (65) and snap ring (67) on pto shaft (42) then install oil pump (71) on shaft and bearing and install snap ring (66). Install rear cover on transmission housing and tighten rear cover retaining screws alternately and evenly to 27-35 ft.-lbs. Insert pto shaft with oil pump into transmission and tighten oil pump retaining screws to 21-29 ft.-lbs.

On all models, install output shaft bearing retainer (70) with sufficient thickness of shims (69) to adjust output shaft bearing preload. With retainer cap screws tightened to the proper torque, measure torque required to turn output shaft with pull scale attached to cord wrapped around shaft. Bearings are correctly adjusted when a pull of 12 pounds or less is required to steadily rotate shaft and there is no end play of shaft in bearings. Remove shim thickness to remove end play or add shim thickness if pull required to turn shaft is greater than 12 pounds. Shims are available in thicknesses of 0.002/0.006 and 0.012/0.014 inch.

194. **RENEW INPUT SHAFT OIL SEALS.** Oil leakage into clutch compartment can be from damaged or worn oil seal (13—Fig. 160) in clutch release bearing support (8) or pto shaft oil seal (12) in front end of transmission main shaft (16). The following procedure for input shaft oil seal renewal does not apply to Dual Power as seal is not used with Dual Power unit. Refer to paragraph 195 for renewal of pto shaft oil seal on all models including Dual Power models.

Oil seal (13) in release bearing support can be renewed after splitting tractor between engine and transmission housing as outlined in paragraph 162; proceed as follows: On pressure lubricated transmissions, disconnect oil supply tube going to clutch release hub and countershaft bearing retainer by pulling tube straight out. Withdraw input shaft (10), remove pins from clutch fork and remove cross shaft, fork and release bearing, then unbolt and remove clutch release bearing support from transmission. Take care not to lose thrust washer (15) from front end of mainshaft.

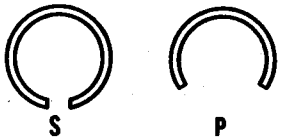


Fig. 162—Note difference in shape of spacer rings used on splash lubricated (S) and pressure lubricated (P) transmissions, except TW-10, TW-20 and TW-30 which are not equipped with spacers (18 or 20-Fig. 160). Refer to paragraphs 192 and 195 and to Fig. 153 for placement.

Remove and discard the needle roller bearing and oil seal from rear end of release bearing support. Refer to Fig. 163 and install new oil seal with flat side first (lip to rear); drive seal in until it lightly contacts shoulder in support. Install new needle roller bearing by driving on lettered side of bearing (flat end) only until bearing is 1/8-inch below flush with thrust face of support.

To reinstall support, stick thrust washer (15—Fig. 160) on front end of mainshaft using grease and position tab on washer up and forward. Lubricate needle bearing and oil seal, then carefully install support with new gasket (9), placing flat side of gasket and support down, and tighten retaining cap screws to a torque of 20-27 ft.-lbs. on splash lubricated transmissions, 27-37 ft.-lbs. on TW-10, TW-20 and TW-30 models and 30-40 ft.-lbs. on all other models. Install cross shaft, clutch release bearing and fork and insert transmission input shaft into clutch disc and flywheel. Reconnect engine to transmission as outlined in paragraph 163.

195. To renew pto shaft oil seal in transmission mainshaft, first remove Dual Power unit on models so equipped, as outlined in paragraph 170, or remove clutch release bearing support on all other models as outlined in paragraph 194. Remove transmission top cover as in paragraph 184, 185 or 186, then proceed as follows:

Remove cap screw (56—Fig. 160) and locking washer, then slide reverse idler shaft (57) rearward and remove the idler. Remove countershaft bearing

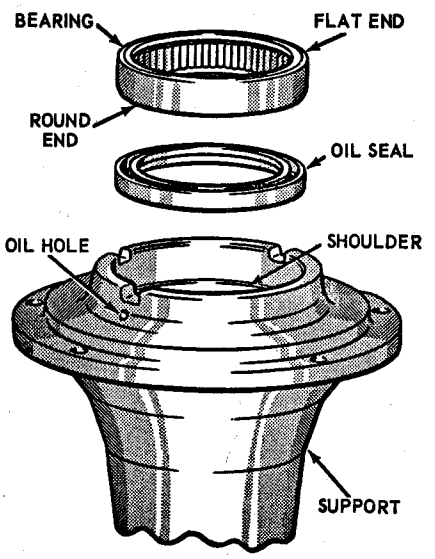


Fig. 163—View showing proper installation of oil seal and needle roller bearing in clutch release bearing support. If bearing is driven in too far on splash lubricated transmissions, it will close off oil hole in support.

support (21) from front end of transmission housing to allow countershaft to drop down. Engage sliding gear/coupling (19) with dog teeth on front end of secondary countershaft (41), then remove the mainshaft (16) from front end of transmission. Splash lubricated transmissions have a thrust washer (15) at front of mainshaft. Refer to Fig. 164, remove old seal and install new seal (12) with lip towards bushing as shown.

CAUTION: Take care not to damage bushing as it is not available separately from mainshaft.

NOTE: On splash lubricated transmissions, install spacer ring (18—Fig. 160) on mainshaft between sliding coupling splines and bearing (17) as shown at (S—Fig. 153). Spacer ring chamfer should be towards front. Ring prevents sliding coupling from contacting bearing web and should be installed on all splash lubricated transmissions.

Lubricate bushing, oil seal and pto shaft, then carefully reinstall mainshaft over pto shaft and be sure it engages with sliding gear. Working through input shaft opening in housing, pry countershaft gear up with screwdriver, then install countershaft bearing support, oil screen up, with new gasket and tighten retaining cap screws to a torque of 27-37 ft.-lbs. on TW-10, TW-20 and TW-30 or to 20-27 ft.-lbs. on all other models. On pressure lubricated transmissions, install thrust washers (53—Fig. 160) between reverse idler gear (55) and transmission case walls. Reinstall reverse idler with step in hub to front and shaft with notch to rear and up. Tighten shaft retaining cap screw to a torque of 12-18 ft.-lbs. and secure with locking washer. Reinstall clutch release bearing support or Dual Power assembly and reassemble tractor.

195A. **OVERHAUL COMPLETE TRANSMISSION.** With disassembly completed as outlined in paragraphs 189 through 195, proceed as follows:

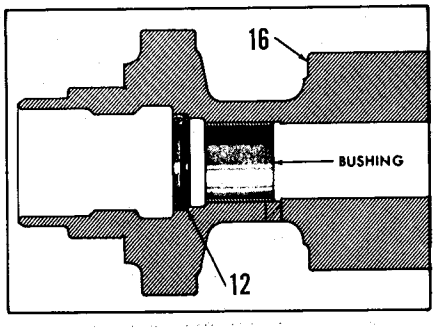


Fig. 164—Cross-section of mainshaft (16) showing proper installation of pto shaft oil seal (12). Bushing is not available separately from mainshaft.

Refer to Fig. 165 and remove snap ring and thrust washer from front end of countershaft. To remove countershaft (47A—Fig. 160) from 8000 models, withdraw countershaft from rear of transmission and remove gears, spacers, couplings and connectors as countershaft is withdrawn.

To remove single key countershaft on TW-10, TW-20 and TW-30 models, remove shift rail and shifter detent balls and springs. Remove 1st-5th, 2nd-6th, the 3rd-7th rev gear, shift fork and parking brake pawl from transmission. The 4th-8th shift fork must be removed following countershaft removal. Reinstall main countershaft bearing retainer (70—Fig. 160) loosely to support front end of countershaft then install in retainer screw holes, substitute bolts or studs that are at least ½ inch longer than original. Extra length studs will allow countershaft to move forward for key (48) removal. Move front sliding gear coupling (27) forward to engage dog teeth of 47 tooth gear (26). Using a long screwdriver, move connector (28) forward so front countershaft key will be accessible. Separate gears until 55 tooth gear (29) is fully rearward. Make sure 47 tooth gear (26) is fully forward contacting front bulkhead. Rear face of 43 tooth gear (35) should remain in contact with countershaft bearing and rear bulkhead. Remove front countershaft key with a magnet. Move rear sliding gear coupler (33) forward to engage dog teeth of 51 tooth gear (31). Move connector forward using a long screwdriver so rear countershaft key will be accessible. Separate gears until 43 tooth gear (35) contacts rear of bulkhead and countershaft bearing. Remove rear countershaft key with magnet. Withdraw countershaft (47) through rear of transmission.

To remove countershaft (47—Fig. 160) on all other models, slide the 55 tooth gear (26) as far forward as possible then slide coupler forward to engage dog teeth of 55 tooth gear. With a long screwdriver, evenly move the connector (28) until retaining keys (48) are removable. Using same procedure, move 49 tooth gear (31) forward and remove gear keys (48) in countershaft by moving connector (34). Withdraw countershaft through rear of transmission. Disengage snap rings on shift rail and on 8700 and 9700 models, turn shift rail so detent balls and springs may be removed through passages in shift forks. Withdraw shift rail from rear of transmission while removing shift forks and brake pawl from shift rail.

Carefully clean and inspect all parts and thoroughly clean transmission housing. Check all bearings and renew any scored, excessively worn or damaged tapered roller bearing cones and cups or needle roller bearing assemblies.

NOTE: When installing new needle roller bearing assemblies, be sure to select size of driver that will fully contact flat (lettered) face of bearing cage and take care not to drive inner (rounded) end of cage against shoulder in bearing bore.

Inspect all gear teeth for chipping, excessive wear or scoring, and renew any not suitable for further service. Also inspect bearing and thrust surfaces of gears and shafts for scoring or excessive wear.

Prior to reassembling transmission, temporarily assemble gears, thrust spacers, connectors and couplings in proper assembly order on the transmission countershaft, then install front thrust washer and snap ring; refer to Fig. 160 for assembly guide. Check clearance between front thrust washer (25) and snap ring (24); if clearance is not within limits of 0.0073-0.0143 inch, select new thrust washer (25) of thickness to provide proper clearance. Thrust washers are available in thicknesses of 0.091/0.093, 0.101/0.103, 0.111/0.113 and 0.121/0.123 inch. Then, with countershaft and gears disassembled, proceed as follows:

On splash lubricated transmissions, turn transmission housing up on end, clutch housing end down. Place countershaft gears, connectors, couplings and thrust washers in housing in proper order. On later models, third gear (35) face is recessed and a thrust washer is fitted. Insert countershaft down through the gears until tapered roller bearing cone is seated in cup in transmission housing web. It may be necessary to rotate countershaft back and forth to align all splines on components. Carefully turn housing back upright and install previously selected thrust washer and snap ring on front end of the countershaft.

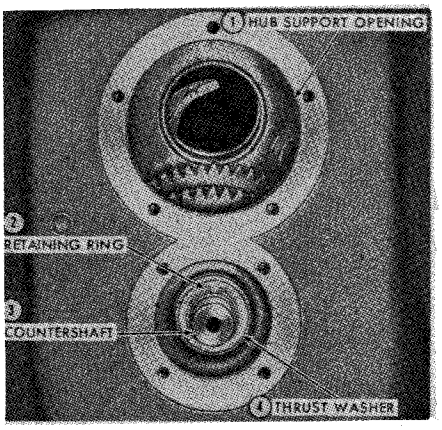


Fig. 165—View showing front end of transmission with mainshaft and main countershaft bearing retainer removed.

To install countershaft assembly in pressure lubricated transmissions, place countershaft gears, connectors, couplings and thrust washers in proper order in transmission case. On later models, third gear (35) face is recessed and a thrust washer is fitted. Insert countershaft in gears until taper roller bearing on shaft is seated in bearing cup in transmission case web. Position countershaft so that keyways are on top and bottom of shaft. With transmission case positioned so that top cover opening is up, install a transmission cover bolt in opposite sides of the cover opening so that the bolts are aligned as close as possible with the rear keyways on countershaft and keyways are accessible. Install a key, beveled edge up, in the rear upper keyway. Move the sliding connector partially over the key and rotate the countershaft until the installed key is on the under side of the shaft. Using a wire of sufficient length, pass the wire under the installed key and tie ends of wire to bolts in top cover opening.

Wire should hold key on shaft as connector is slid off key. Install key with beveled edge up, in upper keyway being careful not to dislodge previously installed key. Slide coupling connector over installed keys. Repeat procedure to install keys in forward keyways of shaft. Install previously selected thrust washer and snap ring on front end of countershaft.

Insert shift rail through rear face of transmission while installing snap rings, brake pawl and shift forks. On Models 8700, 9700, TW-10, TW-20 and TW-30, align detent ball and spring holes in shift rail and shift forks. Install detent balls and springs then rotate shift rail so tapped hole in forward end of shift rail is at three o'clock position. Be sure the shift forks engage the two sliding couplings on countershaft and the shift fork for 4th-8th gear sliding gear/coupling is properly positioned, as shown in Fig. 153. With snap ring at rear end of shaft seated against housing, move the pawl snap rings until they engage proper grooves in rail to hold pawl in position.

Complete remainder of reassembly as outlined in paragraphs 189 through 195. Fill transmission with lubricant designated in paragraph 197. Oil level plug is found on cam cover on splash lubricated transmissions as shown in Fig. 154. Pressure lubricated transmissions have common sump with rear axle. Oil level plug for 9000 models is just forward of left rear axle housing. Oil level dipstick for 8600, 8700, 9600, 9700, TW-10, TW-20 and TW-30 models is at upper left rear axle housing.

TRANSMISSION HANDBRAKE

An auxiliary transmission handbrake is optional on Models 8700, 9700, TW-10, TW-20 and TW-30 and standard on all models equipped with front wheel drive. The transmission handbrake is a parking brake only and should not be used to slow or stop tractor movement.

R&R AND OVERHAUL

196. To remove unit on models equipped with front wheel drive, refer to paragraphs 60 and 61 and remove transmission housing then separate handbrake and transfer box assemblies. On models not equipped with front wheel drive, transmission handbrake components may be serviced with unit mounted on transmission housing. Prior to disassembly, raise left side of tractor to divert transmission oil away from transmission handbrake housing.

To overhaul transmission handbrake, remove rear cover (19—Fig. 167) and brake shaft (15). Heat idler shaft retaining screw (21) to loosen Loctite then remove screw. Withdraw idler shaft (7) while removing idler gear (4), bearings (1) and shim (2). On models so equipped, remove front cover (12). On all models remove brake components (8 through 10).

Inspect brake housing oil seal (22) renew as necessary. Coat outer edge of new seal with Ford sealer ESA-M4G-129-A or equivalent. Inspect and renew the following components as necessary: Brake discs (10), actuators (11) and braking surfaces in housing and rear face of transfer box. Roller bearings, brake shaft assembly (15) and idler (4) should be inspected and renewed as necessary.

NOTE: Lubricate components in reduction gear side of transmission handbrake housing before assembly. Do not lubricate handbrake components.

Install bearing outer races on idler gear (4) if removed. Install inner races. Install idler gear assembly into housing without shaft or shim (2). Measure gap between idler gear bearing and housing. Install shim (2) to reduce end play to zero. Shim (2) is available in thicknesses from 1.00 mm to 1.50 mm in increments of 0.05 mm. Reinstall idler gear and shaft assembly. Apply a suitable locking compound to shaft retaining screw (21).

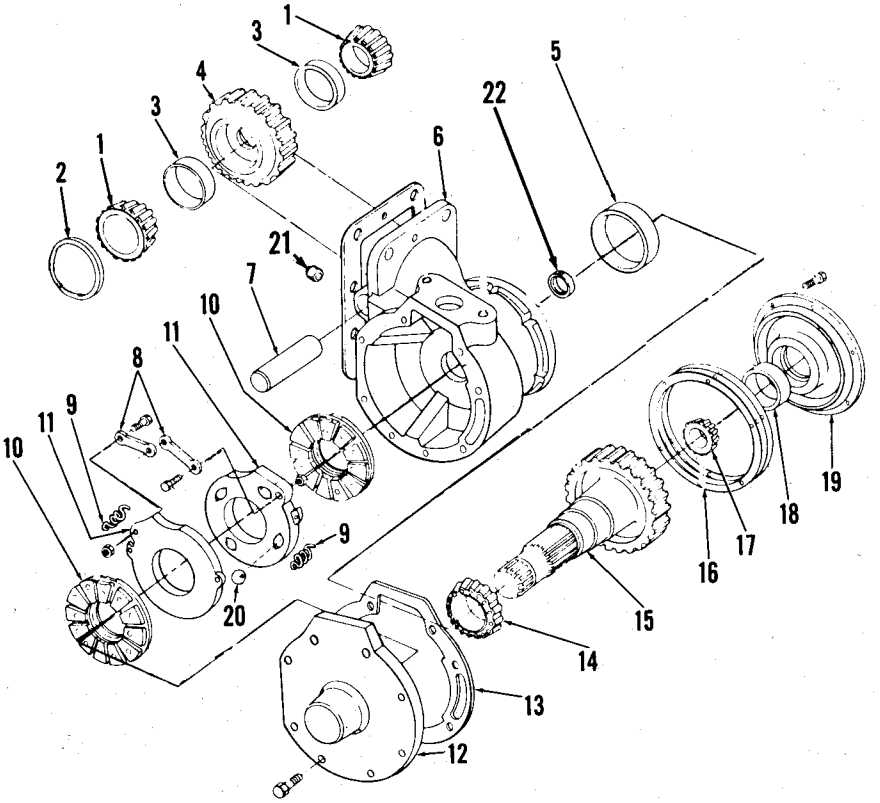


Fig. 167—Exploded view of transmission handbrake.

1. Idler gear bearing
2. Shim
3. Bearing cup
4. Idler gear
5. Bearing cup
6. Housing assembly
7. Idler shaft
8. Brake actuating disc link
9. Disc return spring
10. Disc
11. Brake actuating link
12. Front cover
13. Housing gasket
14. Bearing cone
15. Brake shaft
16. Rear cover shims
17. Bearing cone
18. Bearing cup
19. Rear cover
20. Brake actuating ball
21. Shaft retainer screw
22. Oil seal

Install oil seal (22) and bearing outer race in housing. Press front and rear bearing inner races on brake shaft (15). Wrap tape around splines to avoid damaging oil seal then install brake shaft assembly.

Install rear cover (19) without shims (16) located between cover flange and housing. Rotate cover and apply pressure to seat bearing. Measure gap between cover and housing at three places around circumference. Note average measurement and select proper shim(s) for installation. Refer to following chart to determine thickness and quantity of shims (16). Be sure to measure shim pack to verify actual thickness equals desired thickness.

MEASURING GAP [Inch]	SHIMS [Inch]		
	0.007	0.009	0.012
0.009-0.011	...	1	...
0.012-0.013	1	1	...
0.014-0.015	...	2	...
0.016	1	...	1
0.017-0.018	...	1	1
0.019-0.021	...	...	2
0.022-0.023	...	3	...
0.024-0.025	...	2	2
0.026	1	...	2
0.027-0.029	...	1	2
0.030-0.031	...	...	3
0.032	2	...	2
0.033	...	3	1
0.034	1	1	2
0.035	3	1	1
0.036	...	2	2
0.037	1	...	3
0.038	3	...	2
0.039	...	1	3
0.040	3	3	...
0.041	...	4	1

Install shims (16) and rear cover (19) so dipstick elbow tube on cover is at bottom then tighten cover retaining screws to 32 ft.-lbs. Install remainder of brake assembly by reversing disassembly procedure. Refer to paragraph 176 and refill transmission oil as required.

If tractor is equipped with front wheel drive and brake shaft (15), housing (6), cover (19) or shaft bearings were renewed, then refer to paragraph 63 to adjust end play between brake and transfer box shafts.

DIFFERENTIAL AND BEVEL GEARS

NOTE: Although outward appearance is similar, components may vary in size between models due to differences in power output. Service procedures are the same except as called out in text.

LUBRICATION

197. Early model 8000 tractors are equipped with separate transmission and rear axle lubricating oil sumps. Rear axle lubricating oil capacity for these models is 40 quarts. All other models are equipped with pressure lubricated transmissions having a common sump with the rear axle housing. Rear axle oil capacity for these models equipped with Dual Power, except TW-10, TW-20 and TW-30, is 69 quarts; without Dual Power capacity is 64 quarts. TW-10 and TW-20 models equipped with Dual Power require 79 quarts; models without Dual Power require 73 quarts. TW-30 models require 92 quarts. Recommended rear axle lubricant is Ford specification No. ESN-M2C53-A.

DIFFERENTIAL LOCK

198. The differential lock consists of a hydraulically actuated multiple disc brake located in differential housing. When applied, the brake locks right differential side gear to differential housing, causing both rear wheels to be driven at the same speed, regardless of traction. The fluid pressure for operating the brake is taken from pto hydraulic circuit; refer to paragraphs 212 and 213 for troubleshooting information on the differential lock hydraulic circuit. Service of the differential lock brake components is covered by procedure for servicing the differential; refer to paragraph 199. Refer to paragraph 240 for servicing differential lock valve and to 237, 238 or 238A for pump.

DIFFERENTIAL AND BEVEL RING GEAR

199. **REMOVE AND REINSTALL.** To remove the differential and bevel ring gear assembly, first remove the hydraulic lift cover as outlined in paragraph 245, the pto drive shaft and gears as in paragraph 217 and both rear axle housing assemblies as in paragraph 204, then proceed as follows:

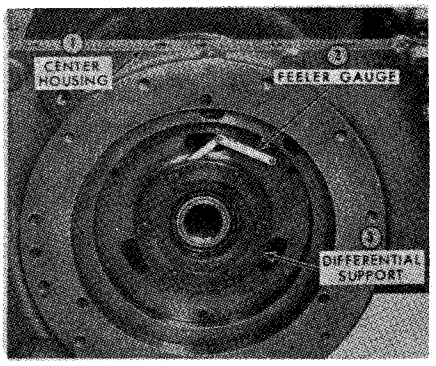


Fig. 169—Using feeler gage to determine proper shim pack thickness required for adjustment of differential carrier bearings; refer to text.

Disconnect differential lock hydraulic line from top of right differential bearing support (27—Fig. 170). Place a rope sling around differential housing, attach hoist to sling and take weight of differential assembly on hoist. Unbolt and remove the differential bearing supports, taking care not to damage shims (2 and 26) and to keep the shims from under each support separate and identified for reassembly. Lift differential assembly from rear axle center housing.

To reinstall lower differential into rear axle center housing, then reinstall bearing supports with same shims as removed. Tighten support retaining cap screws to a torque of 50-60 ft.-lbs. and reconnect differential lock hydraulic line to right bearing support. Reinstall pto drive shaft as outlined in paragraph 217, the hydraulic lift cover as in paragraph 245 and the rear axle assemblies as in paragraph 204.

NOTE: If differential housing, carrier bearings, bearing supports, rear axle center housing or the bevel ring gear and pinion set have been renewed, it will be necessary to check and adjust carrier bearing preload and bevel gear backlash as in paragraph 200.

200. **ADJUST CARRIER BEARING PRE-LOAD AND BEVEL GEAR BACKLASH.** Carrier bearing pre-load is adjusted by varying shim thickness between bearing supports and rear axle center housing. Main bevel gear backlash is adjusted by transferring shims from under one bearing support to under opposite support. While some backlash must be maintained while adjusting bearing preload, backlash should be rechecked or adjusted after adjusting bearing preload as follows:

Support differential assembly in rear axle center housing with rope sling and hoist. Install left bearing support with same shims removed on disassembly and tighten retaining cap screws to a torque of 50-60 ft.-lbs. Install right bearing support **without** shims and tighten cap screws only enough to remove end play of differential in carrier bearing, but **do not** preload the bearings. Measure gap at several points between right bearing support flange and rear axle center housing using feeler gage as shown in Fig. 169. Loosen and tighten opposite cap screws until measurement is equal at all points. Check to be sure some backlash exists between bevel pinion and ring gear; decrease shim thickness under left bearing support if no backlash is noted, then retighten right bearing support cap screws to just remove end play of differential and obtain measurement between bearing support flange

and center housing. Remove right bearing support, then reinstall support with shim pack of total thickness 0.001-0.006 inch **less** than measured gap. Tighten retaining cap screws to a torque of 50-60 ft.-lbs.

NOTE: Measure shim thickness with micrometer; thickness of individual shims may vary up to 0.004 inch. Shims are available in thicknesses of 0.002/0.006, 0.006/0.010, 0.010/0.014 and 0.018/0.022 inch.

With carrier bearing preload properly adjusted, measure backlash of bevel ring gear to bevel pinion with dial indicator. Make backlash measurement at several points around ring gear to be sure backlash is within limits at all points.

NOTE: Dial indicator plunger should be against outer ends of ring gear teeth and at right angle to radius of ring gear.

Backlash should be within limits of 0.010-0.020 inch; transfer shims from under left bearing support flange to under right bearing support flange if backlash is less than 0.010 inch; or from under right support to under left support if backlash is more than 0.020 inch. Tighten bearing retaining cap screws to a torque of 50-60 ft.-lbs. before rechecking backlash.

201. **OVERHAUL DIFFERENTIAL OR RENEW BEVEL RING GEAR.** With differential assembly removed as outlined in paragraph 199, remove the cap screws retaining cover (22—Fig. 170) to differential case (6) and ring gear (4). Separate cover from case and remove the differential lock discs (16 and 17), thrust washer (15) and differential side gear (14).

To renew ring gear, support outer edges of gear in bed of press and press differential case out of the gear. To install new gear, support gear on wood blocks (Fig. 171) and insert differential case in gear with bolt holes in case and gear aligned. Thread all retaining cap screws through case into gear as shown, then press case downward into gear. Remove assembly from press and remove the cap screws.

NOTE: When installing new ring gear, refer to paragraph 202 and install mating bevel pinion.

To remove differential pinions and left side gear, drive the roll pin (13—Fig. 170) out of case and pinion shaft (12). Remove the pinion shaft, pinions (10), pinion thrust washers (11), side gear (9) and the thrust washer (8). Bushings (7 and 21) in case and cover may be renewed if excessively worn or scored. Bushings are pre-sized and should not require reaming if carefully installed.

Inspect the differential lock fluid sealing rings (23) on hub of cover (22) and renew if worn or broken. To remove differential lock piston (18) from cover, apply air pressure to hole between sealing ring grooves in hub of cover. Renew the piston seal "O" rings (19 and 20) and inspect cover and piston for any damage. Lubricate piston, rings and bore in cover before installing piston. Check differential lock friction discs (16 and 17) for warpage or excessive wear and inspect friction surface of differential case; renew case and/or discs if necessary.

To reassemble, lubricate all parts and reverse disassembly procedure. Refer to Fig. 170 for installation of differential lock discs; insert disc (16) with internal splines first. Tighten cover retaining cap screws to a torque of 160-200 ft.-lbs. Renew carrier bearing cones and cups if excessively worn or scored.

MAIN DRIVE BEVEL PINION

202. **REMOVE AND REINSTALL.** To remove main drive bevel pinion,

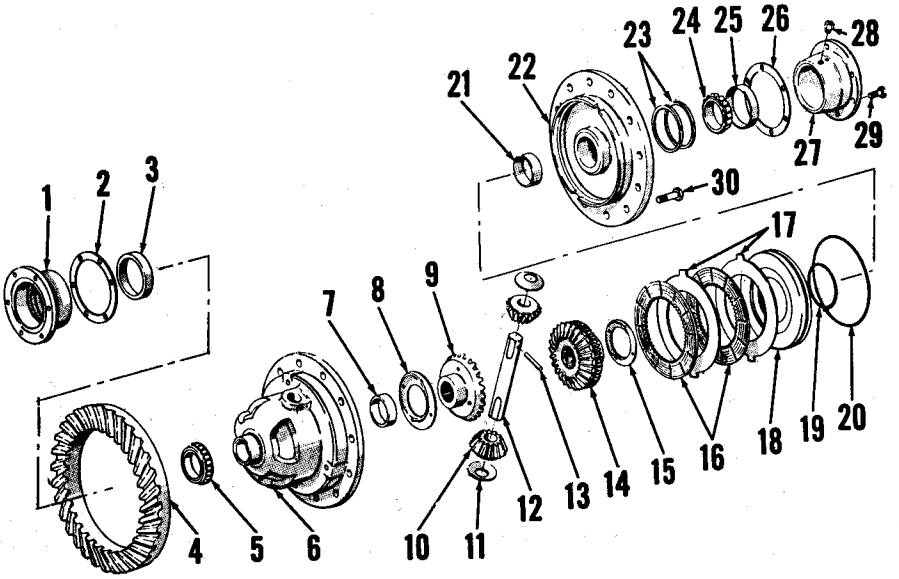


Fig. 170—Exploded view of differential showing lock components and carrier bearings. Cap screws (30) retain cover (22) to differential case (6) and also retain main drive bevel ring gear (4) to differential case; refer to Fig. 171 for installation of ring gear. Fluid for operation of differential lock piston (18) enters right carrier bearing support through fitting (28) and is transmitted to cover (22) through bore in hub of cover. Sealing rings (23) fitted in grooves in cover hub are located at each side of oil passage in bearing support (27) and hub.

1. Left carrier bearing support
2. Shims
3. Bearing cup
4. Bevel ring gear
5. Bearing cone
6. Differential case
7. Bushing
8. Thrust washer
9. Left differential side gear
10. Differential pinions (2)
11. Thrust washers (2)
12. Pinion shaft
13. Roll pin
14. Right side gear & disc hub
15. Thrust washer
16. Differential lock discs
17. Differential lock plates
18. Differential lock piston
19. Inner "O" ring
20. Outer "O" ring
21. Bushing
22. Cover plate
23. Sealing rings
24. Bearing cone
25. Bearing cup
26. Shims
27. Right carrier bearing support
28. Fitting
29. Support cap screws
30. Cover & case to ring gear cap screws

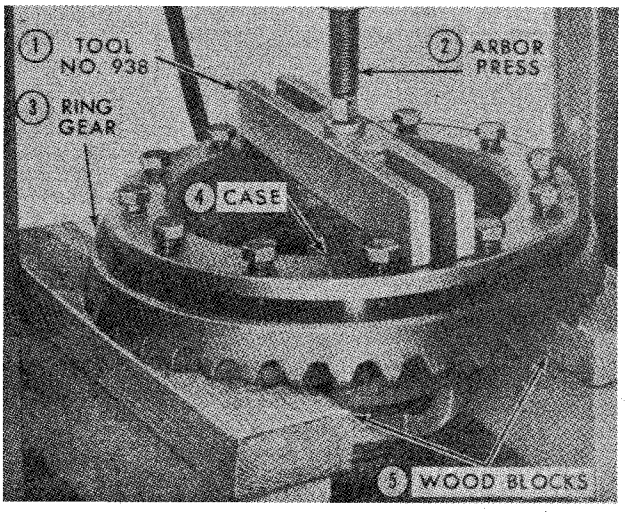


Fig. 171—Installing bevel ring gear to differential case. Gear is aligned by installing all retaining cap screws, then case is pressed into gear.

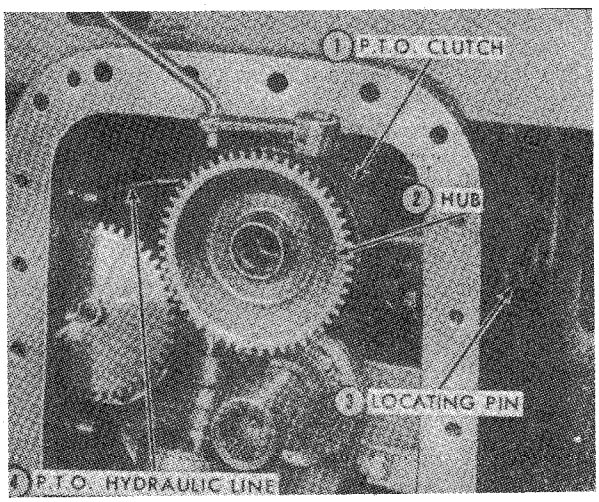


Fig. 172—Remove pto clutch hub for access to pto hydraulic line. Remove locating pin (cap screw) to remove pto clutch and valve assembly.

remove differential as outlined in paragraph 199.

Straighten tabs on washer (3—Fig. 173) and remove the pinion bearing adjusting nuts (2 and 4). Using a soft drift pin, drive pinion rearward until free of front bearing cone (5), then remove pinion with rear bearing cone (11) from center housing.

Inspect bearing cups (6 and 10) and renew cups if excessively worn or scored. Note that cups are mounted in removable sleeves (7 and 8). Pinion mesh position is controlled by shim spacers (9) between rear sleeve (8) and bearing cup (10); take care not to lose or damage the spacers when removing rear cup. If a new rear axle center housing is being installed, or if spacers are lost or damaged, refer to paragraph 203 for selection of new spacers.

To reinstall bevel pinion, or install new pinion and/or bearings, proceed as follows: Install rear bearing cup and sleeve in housing with same spacers as were removed. Install front bearing cup and sleeve and install rear bearing cone on pinion. Insert pinion and rear bearing cone assembly through rear bearing cup and hold in position with hydraulic jack and two wood blocks as shown in Fig. 175. Then, using a suitable sleeve, drive front bearing cone onto pinion until seated in front bearing cup. Install rear adjusting nut (4—Fig. 173) and tighten to obtain proper bearing preload when checked as follows: Wrap a cord around pinion shaft between the front and rear bearings. Attach pull scale to cord and turn pinion steadily with cord and pull scale; bearing adjustment is correct when a steady pull of 10 to 20 pounds is required.

NOTE: If pull required is greater than 20 pounds, it may be necessary to bump front end of pinion shaft after loosening the adjusting nut, then re-tighten nut as required.

With bearings properly adjusted, install locking washer (3) and front adjusting nut (2); tighten front nut securely and recheck bearing adjustment. If adjustment remains within specification, bend tabs of washer into notches of adjusting nuts and install drive coupling (1) on pinion shaft.

To reassemble tractor, reverse disassembly procedure. Do not install pto clutch locating pin until splines of transmission pto shaft and splines of pto clutch are aligned. This will prevent possible shearing of locating pin if splines do not match. Tighten ½-inch housing cap screws to 50-65 ft.-lbs. and 5/8 inch cap screws to 95-130 ft.-lbs. Tighten pto clutch locating pin to 70-95 ft.-lbs.

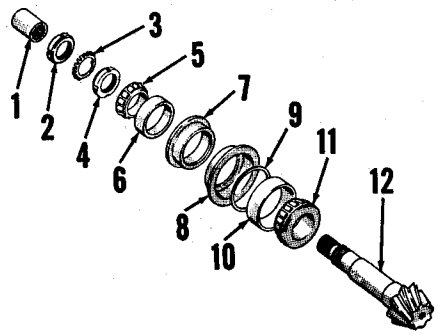


Fig. 173—Exploded view of bevel pinion assembly. Pinion bearing cups (6 and 10) are supported in sleeves (7 and 8) which fit in bores of rear axle center housing. Bearings are adjusted by nuts (2 and 4); refer to text.

1. Drive coupling
2. Adjusting nut
3. Locking washer
4. Adjusting nut
5. Bearing cone
6. Bearing cup
7. Bearing sleeve
8. Bearing sleeve
9. Shims
10. Bearing cup
11. Bearing cone
12. Bevel pinion

Fig. 174—Normal shim (9—Fig. 173) thickness for pinion mesh adjustment is 0.041 inch. If other than this thickness is required, it is indicated by stamping on rear axle center housing in location shown. Refer to text.

203. **PINION MESH POSITION.** Mesh position of the main drive bevel pinion is controlled by shim spacers (9—Fig. 173) located between pinion rear bearing cup (10) and shoulder inside bearing sleeve (8). Thickness of spacers

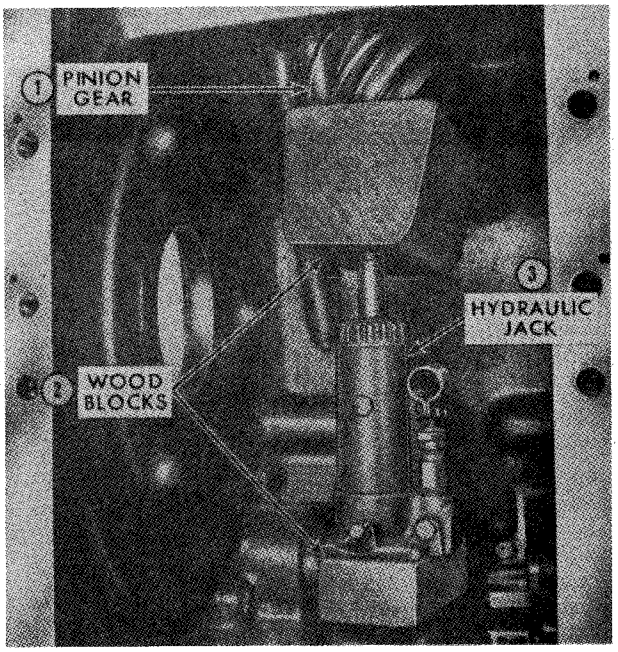


Fig. 175—Hold bevel pinion with hydraulic jack and wood blocks as shown when installing front bearing cone (5—Fig. 173); refer to Fig. 176.

required is determined by measurement of rear axle center housing and pinion gear shoulder at factory. Normally, required spacer thickness if 0.041 inch; if required thickness is different than 0.041 inch, difference is stamped on rear axle **center housing** in location shown in Fig. 174. In the example shown, required spacer thickness is 0.041+, 0.012, or 0.053 inch. If a negative sign (-) appears in front of number, subtract the value from 0.041 inch.

NOTE: Number in parenthesis marks (.304 inch) below "0.12" marking shown in Fig. 174 is metric (mm) equivalent of 0.012 inch; disregard number in parenthesis when working with decimal inches. Rear axle center housings requiring spacer thickness of 0.041 inch are not marked.

Look at the front of pinion gear just behind splines. If no mark appears on gear, no further spacer adjustment is require. If pinion gear is marked with a figure, such as +0.007 or MD +0.007, that thickness of spacer is to be removed from between bearing cup and gear shoulder. If number on gear is -0.007 inch, that thickness of spacer is to be added to basic (0.041 inch) spacer pack between bearing cup and gear.

Spacers are available in thickness of 0.018/0.022, 0.022/0.026, 0.026/0.030, 0.030/0.034 and 0.033/0.037 inch.

NOTE: As thickness of individual spacer may vary up to 0.004 inch, it will be necessary to select spacers by measuring thickness with micrometer.

In the preceding example, total spacer thickness required was 0.053 inch; this would require a combination such as one 0.033 inch thick spacer and one 0.020 inch thick spacer or any other combination of two spacers that would provide total thickness of 0.053 inch.

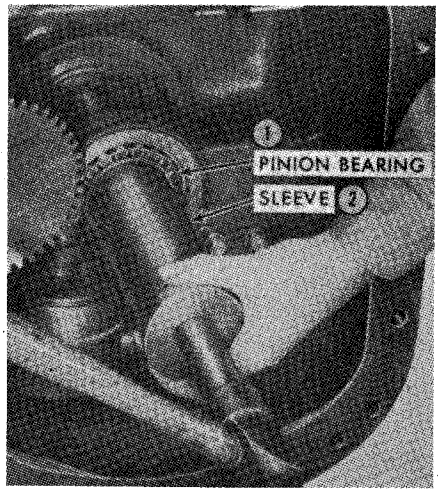


Fig. 176—With pinion supported as shown in Fig. 175, install front bearing cone with proper sized sleeve driver as shown.

FINAL DRIVE AND REAR AXLES

NOTE: Although outward appearance is similar, components may vary in size between models due to difference in power output. Service procedures are the same except as called out in text.

204. **R&R REAR AXLE AND FINAL DRIVE ASSEMBLY.** If removing both assemblies, provide adequate braces for front end of tricycle model, or drive wood wedges between front axle and front support on wide front axle models. Drain lubricant. On Models 8700, 9700, TW-10, TW-20 and TW-30 support rear of platform or cab. Support tractor under rear axle center housing and remove the wheel, hub and tire assemblies from axle shafts. Attach hoist at a point which will balance rear axle housing, then unbolt axle housing from center housing. Move housing outward until clear of dowel pins and the inner axle shaft (planetary drive sun gear). Take care not to allow brake discs or inner axle shaft to fall out as the axle, housing and final drive assembly is removed.

To reinstall, proceed as follows: Insert inner axle shaft into the differential side gear. Remove brake disc guide pins (17—Fig. 177) from rear axle housing and insert them in holes in rear axle center housing. Place the brake discs on the inner axle shaft and guide pins as shown. Place new gasket on the dowel pins, then lift axle housing assembly into place with hoist, align holes in axle housing with brake disc guide pins and align teeth on planetary gears with sun gear teeth on inner axle shaft. Install the axle housing retaining cap screws and tighten to a torque of 100-120 ft.-lbs. Refill rear axle center housing with proper lubricant; refer to paragraph 197.

205. **REAR AXLE SHAFT AND BEARINGS.** With the rear axle and final drive assembly removed as outlined in paragraph 204, remove axle shaft as follows:

Drill a hole in the flat outer face of axle shaft oil seal (25—Fig. 177) and pry seal out of housing; take care not to damage new seal surface of shaft or seal bore in housing. Remove the lock plate (6) from rear axle cap screw (7), then remove the cap screw, retaining washer (5), shims (4) and planetary carrier (3) with gears. Bump axle shaft out towards outer end of housing and remove bearing cone (32) from inside housing. Remove bearing cups (28 and 31) from housing and outer bearing cone (27) from axle shaft. Inspect oil seal contact ring (26) and install new ring if seal contact surface is scored or rough.

To reassemble, press new oil seal ring tightly against shoulder on axle shaft, then press outer bearing cone tightly

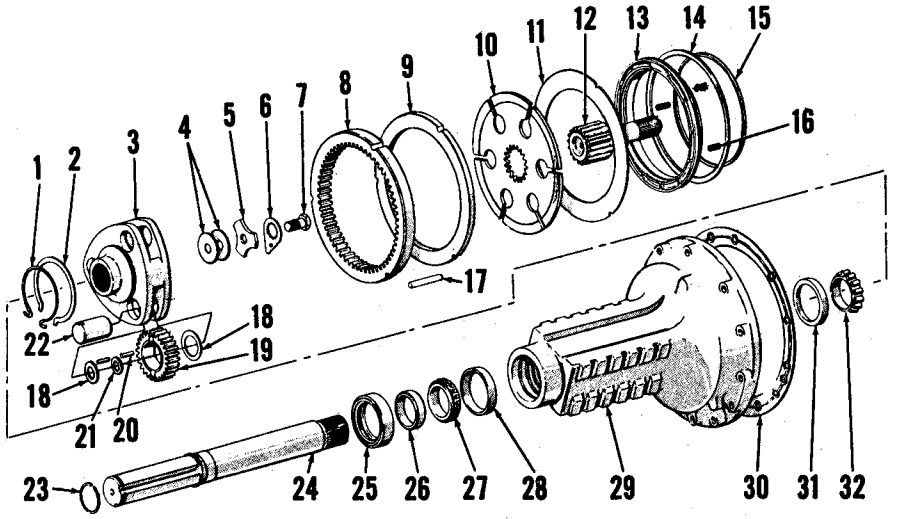


Fig. 177—Exploded view of final drive and rear axle assembly. Hydraulic brake piston (13) is fitted in side of rear axle center housing. Three pins (17) are fitted in mating holes in axle housing (29) and rear axle center housing and hold the planetary ring gear (8), brake outer disc (9) and brake inner disc (11) stationary. Planetary sun gear teeth are machined on outer end of inner shaft (12). Planetary gear carrier (3) is splined to inner end of wheel axle shaft (24). TW-30 models are equipped with four planetary gears and two brake inner discs (11) and two brake friction discs (10) per side.

1. Locking wire
2. Retaining ring
3. Planetary carrier
4. Shims
5. Retainer
6. Cap screw lock
7. Axle cap screw
8. Planetary ring gear
9. Brake outer disc
10. Brake friction disc
11. Brake inner disc
12. Axle inner shaft (planetary sun gear)
13. Brake piston
14. Sealing ring, large
15. Sealing ring, small
16. Brake piston springs
17. Steel pins
18. Thrust washers
19. Planet gears
20. Needle rollers
21. Spacers
22. Planet gear shafts
23. Wheel hub snap ring
24. Axle shaft
25. Oil seal
26. Oil seal ring
27. Bearing cone
28. Bearing cup
29. Axle housing
30. Gasket
31. Bearing cup
32. Bearing cone

against seal ring. Install inner and outer bearing cups in axle housing, then insert axle shaft and install inner bearing cone. Install planetary carrier and gear assembly, then install axle retaining cap screw and washer with thickest shim available. Tighten retaining cap screw to a torque of 396-484 ft.-lbs. and measure end play of axle shaft with dial indicator. Remove cap screw, retainer and shim, measure shim with micrometer and subtract measured end play from shim thickness. Select a spacer shim of thickness nearest to result obtained by subtracting end play from shim thickness, then install selected shim, retainer and cap screw. Tighten cap screw to a torque of 396-484 ft.-lbs. and install cap screw lock.

206. **OVERHAUL PLANETARY DRIVE.** With the axle and final drive assembly removed as outlined in paragraph 204 and the planetary carrier and gear assembly removed as in paragraph 205, proceed as follows:

Cut the locking wire (1—Fig. 177) (refer also to Fig. 178), then pull wire from under planet gear shaft retaining snap ring (2—Fig. 177). The snap ring can then be disengaged from the planet gear shafts by pulling ends of ring together which will allow the shafts to be driven out snap ring side of carrier. There are 54 loose needle rollers (20), two thrust washers (18) and a spacer (21) in each planet gear. Remove snap ring from carrier.

Carefully clean and inspect all parts and renew any that are excessively worn, scored or otherwise not suitable for service. Needle rollers are available in sets of 54 rollers only and should be renewed only as a complete set for each planet gear and shaft.

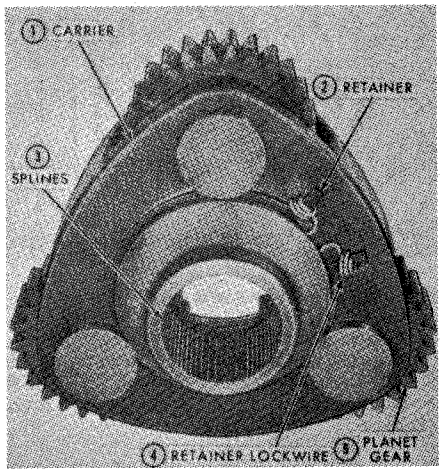


Fig. 178—Planet gear shaft retainer is held in place with lockwire inserted under the retainer and secured by wrapping ends of wire around ends of retainer ring as shown. TW-30 models are equipped with four planetary gears; other models have three gears.

To reassemble, stick the spacer and the two rows of 27 rollers each in the planet gear using thin layer of heavy grease. Position planet gear in carrier and insert gear shaft from snap ring side of carrier. Push the shafts in flush with bore, then install snap ring, compress the snap ring and align notches in shafts with ring. Push a new locking wire under the ring and secure wire by wrapping ends around snap ring projections as shown in Fig. 178.

Inspect ring gear (8—Fig. 177) and sun gear teeth on inner axle shaft (12) and renew if teeth are chipped or excessively worn. Insert the pins (17) in axle housing to align ring gear when installing gear in housing. If a new ring gear is installed, it may have an identification groove, which should be installed toward center housing.

BRAKES

All Models Except TW-30

207. **ADJUSTMENT.** The rod connecting trunnion in brake pedal to master cylinder piston must be adjusted in length to provide a pedal free travel of 1/8-inch on 8700, 9700, TW-10 and TW-20 models or 3/16 to ¼-inch on 8000, 9000, 8600 and 9600 models measured at pedal stop pad as shown in Fig. 180. To adjust rod length, loosen jam nut (Fig. 180) and turn rod in or out of trunnion to obtain correct free travel, then tighten jam nut. Right side hood panel must be removed on Models 8000, 8600, 9000 and 9600 for access to linkage.

NOTE: If pedal is spongy, bleed the brakes as outlined in paragraph 208 prior to adjusting. Insufficient free travel will cause brakes to drag.

208. **FLUID AND BLEEDING.** On some early Model 8000 and 9000 tractors, lubricant from rear axle center housing is utilized as brake hydraulic fluid. On these models, a line connects brake reservoir to hydraulic lift sump return line which supplies master cylinder with fluid. A second line returns excess fluid to the rear axle center housing. Whenever servicing brake master cylinder, or if cylinder has been drained, refill with proper lubricant (see paragraph 197), then bleed brakes as follows:

With engine running to keep master cylinder supplied with fluid, follow normal hydraulic brake bleeding procedure to remove all air from the system for both master cylinders and brake piston units. Bleeder fitting is located in rear axle center housing at top of rear axle housing on both sides of tractor as shown in Fig. 181.

Later 8000 and 9000 models and 8600, 8700, 9600, 9700, TW-10 and TW-20 models use a separate reservoir for brake fluid. Hydraulic system fluid is NOT USED. The manufacturer recommends that commercial grade brake fluid not be used in these models. Ford part No. IQ-M6C34-A fluid ONLY should be used, to prevent formation of gases in the system, and loss of braking action. If any other fluid has been used, it is recommended that the entire system be thoroughly flushed and approved fluid added.

To bleed these models, follow normal hydraulic brake bleeding procedure to remove all air from system. On models with auxiliary fluid reservoir, make sure that brake fluid is maintained at a visible level while bleeding. On models with dipstick in master cylinder, add fluid while bleeding to maintain adequate fluid level. Refer to Fig. 181 for brake bleeder fitting location.

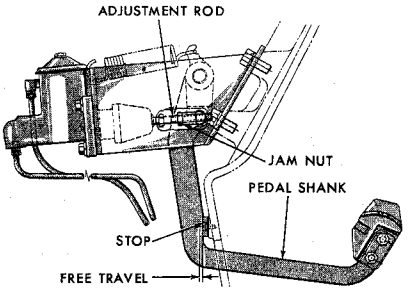


Fig. 180—Adjust master cylinder to brake pedal rods to obtain desired free travel of brake pedal at stop as shown. If free travel is less than specified brakes may drag or seize.

209. **OVERHAUL MASTER CYLINDER.** For access to brake master cylinder, remove engine hood right side panel. On 8600, 8700, 9600, 9700, TW-10 and TW-20 models, remove enough of heat shield to allow removal of master cylinder. The master cylinder assembly can then be unbolted and removed from

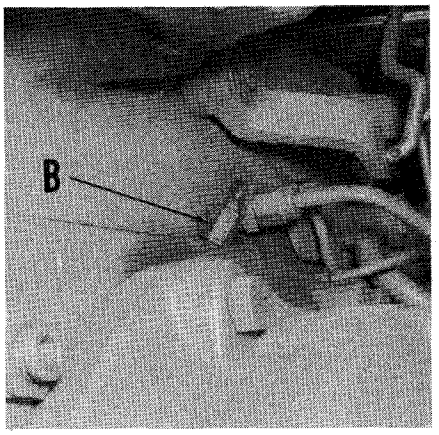


Fig. 181—Brake bleeder fittings (B) are located at each side of rear axle center housing just above axle housing flange.

support after disconnecting the fluid supply and return lines (early models only) and the two pressure lines to wheel pistons.

Refer to exploded view of assembly in Fig. 182 and remove the two rubber boots (not shown), snap (retaining) rings, pistons, piston primary seals and return springs from cylinder bores. Remove reservoir cover and thoroughly clean the cylinder bores and reservoir. Be sure that both the orifice and port in bottom of reservoir are open and clean.

Reservoir and cylinder casting is serviced as a complete master cylinder assembly only. All other parts are available separately or as a master cylinder repair kit which includes parts for servicing both cylinders of unit. Piston secondary seal is integral part of piston.

Lubricate master cylinder parts with recommended rear axle lubricant on early 8000 and 9000 models only. On all other models, lubricate parts with approved Ford brake fluid only and reassemble by reversing disassembly procedure.

TW-30 Models

Power to actuate brakes on TW-30 models is provided by the low pressure oil pump. Refer to paragraph 174. Pressurized oil is routed to power brake valve shown in Fig. 183 then to individual rear brakes.

210. **ADJUSTMENT.** To adjust power brakes on TW-30 models, shut off engine, depress both brake pedals and insert Ford tool No. 7446 (1—Fig. 184) between rocker arm links (2) and power brake valve housing as shown in Fig. 184. Loosen adjusting nuts and locknuts on both pedals then adjust one pedal at a time. Tighten adjusting nut until pedal begins to move. Check corner of gage for movement. If gage can be moved with a heavy drag, adjustment is correct. Gage must be movable without depressing pedal. Tighten locknut, then repeat procedure for other pedal.

210A. **FLUID AND BLEEDING.** With engine running and hydraulic system oil at normal operating temperature, depress one pedal, loosen corresponding bleed screw in rear axle center housing near top of axle housing (Fig. 181), to expel air from system. Tighten bleed screw while maintaining pedal pressure. Repeat procedure for other brake. Refer to paragraph 176 and replenish transmission oil as required.

210B. **R&R AND OVERHAUL POWER BRAKE VALVE.** To remove power brake from tractor, remove oil tubes (2, 9, 12—Fig. 183), valve mounting bolts (13) and rocker arm retaining pin (10). To overhaul valve, remove check valve (13—Fig. 185) and ball (13A) from housing (10). After removing housing cap screws and cap (23), remove rocker arm assembly (1) by removing retaining rings (8) and retaining pins (7). Withdraw spool assembly (11). Heat valve retainers (3) to break Loctite seal and remove retainers using Ford tool No. 7445. Remove valve plungers (4) then force directional valve needles (6) and "O" rings (5) from housing (10) with a small punch.

Inspect all parts including housing (10) for excessive wear, damage or cracks and renew as necessary. During reassembly apply two or three drops of a suitable locking sealer to threads of retainers (3) making sure no sealer contacts plungers (4) or inside diameters of retainers (3). Tighten retainers to a torque of 10-15 ft.-lbs. Remainder of reassembly procedure is reverse of disassembly procedure. Bleed brakes as outlined in paragraph 210A then adjust brakes as outlined in paragraph 210.

211. **BRAKE PISTONS AND DISCS.** To remove brake pistons and discs on all models, refer to procedure for removing rear axle and final drive assembly outlined in paragraph 204. The brake discs can then be removed from guide pins and the piston from rear axle center housing. Refer to Fig. 177 for ex-

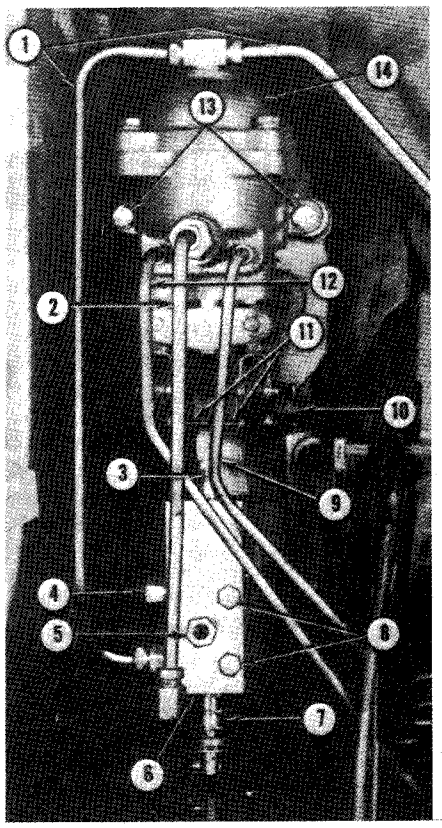


Fig. 183—View of power brake valve and differential lock valve on Model TW-30.

1. Differential lock valve to sump tubes
2. Brake valve oil inlet tube
3. Differential lock valve adjusting bolt
4. Valve inlet port
5. Valve outlet port
6. Differential lock valve
7. Valve spool
8. Valve mounting bolts
9. Brake tube to left brake
10. Rocker arm pin
11. Release pins
12. Brake tube to right brake
13. Mounting bolts
14. Brake valve assembly

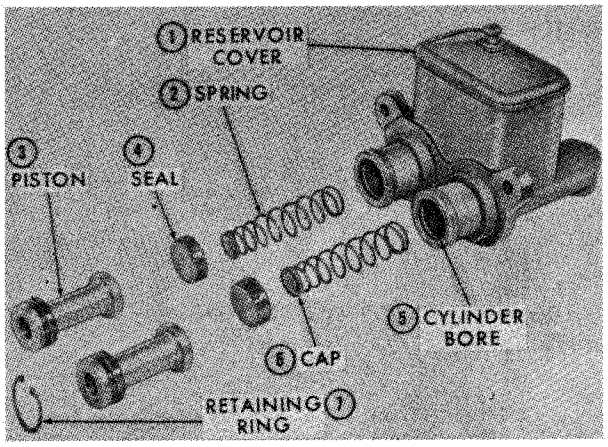


Fig. 182—Exploded view of brake master cylinder assembly. Piston and secondary seal are available as an assembly only. Master cylinder reservoir is kept filled by supply line from hydraulic system and excess oil is returned to rear axle center housing on early 8000—9000 models only.

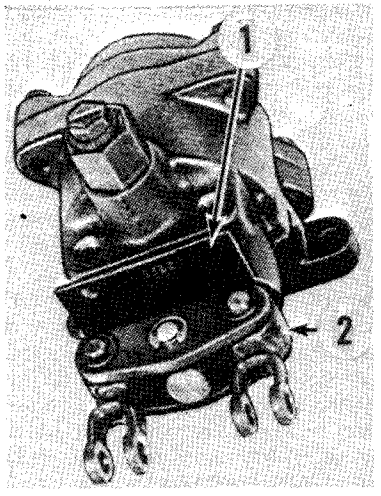


Fig. 184—View of Ford brake adjusting tool No. 7446 (1) installed between rocker arm links (2) and valve body. See text for brake adjustment on Model TW-30.

ploded view showing brake piston and discs. Inspect piston (13) for warpage, scoring or cracks. If piston is serviceable, renew the seal rings (14 and 15). Inspect brake discs (9, 10 and 11) for warping or excessive wear. Remove brake piston springs (16) and discard, since these springs are no longer used.

To reassemble, lubricate piston and sealing ring assembly and install, taking care not to damage the rings. Complete reassembly by following procedure outlined in paragraph 204.

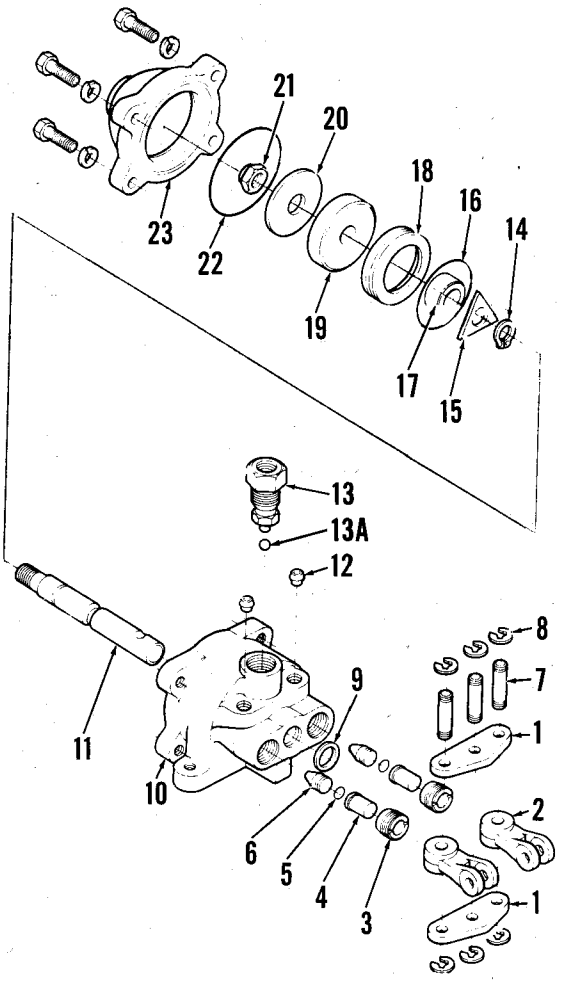


Fig. 185—Exploded view of brake valve used on Model TW-30.

1. Rocker arm
2. Control rod link
3. Valve retainer
4. Valve plunger
5. "O" ring
6. Valve needle
7. Retaining pin
8. Retaining ring
9. Seal
10. Housing
11. Valve spool
12. Seat
13. Check valve
13A. Ball
14. Snap ring
15. Spacer
16. "O" ring
17. Spacer sleeve
18. Actuating piston
19. Seal retainer
20. Washer
21. Lock nut
22. "O" ring
23. Valve housing cap

POWER TAKE-OFF

The independent type power take-off is driven by a hydraulically operated multiple disc clutch located in front end of rear axle center housing. On 8000, 8600, 8700, 9700, TW-10, TW-20 and some 9600 models, reduction gears located in rear compartment provide both 540 and 1000 rpm output shaft speeds. On other models, the pto is equipped with reduction gears for 1000 rpm operation only. The output shaft speed on dual speed models is changed by installing either the 540 rpm six-spline output shaft or 1000 rpm output shaft with 21 splines. On 1000 rpm only models a 21-spline 1000 rpm output shaft is used, but a 20 spline heavy-duty 1000 rpm shaft is available. On all models the output shaft supports the reduction gears and acts as a bearing surface.

On all models except TW-10, TW-20 and TW-30, fluid pressure to operate the pto clutch and also operate the differential lock clutch and Dual Power unit, on models so equipped, is provided by a gear type pump that is mounted on rear cover of the hydraulic system pump. Pressure in the pto clutch circuit is limited to 135-165 psi by the regulating valve in pto clutch valve body. Pressure to differential lock clutch is limited to 250-300 psi by the regulating valve sleeve on differential lock valve located in hydraulic system pump adapter plate. Operating pressure for Dual Power units is limited to 150-175 psi by Dual Power regulating valve located on wall of center housing. When both the differential lock and pto clutch are operated at the same time, system pressure is built up to 250-300 psi, but remains limited to 135-165 psi in pto clutch circuit. A relief valve within the pump body limits pump pressure to 450 psi in the event of malfunction of either the differential lock regulating valve or pto regulating valve.

Fluid pressure for operation of pto clutch and differential lock on Models TW-20, TW-20 and TW-30 is provided by the low pressure oil pump discussed in paragraph 174. With engine running at 2200 rpm, operating pressure should be 185-235 psi.

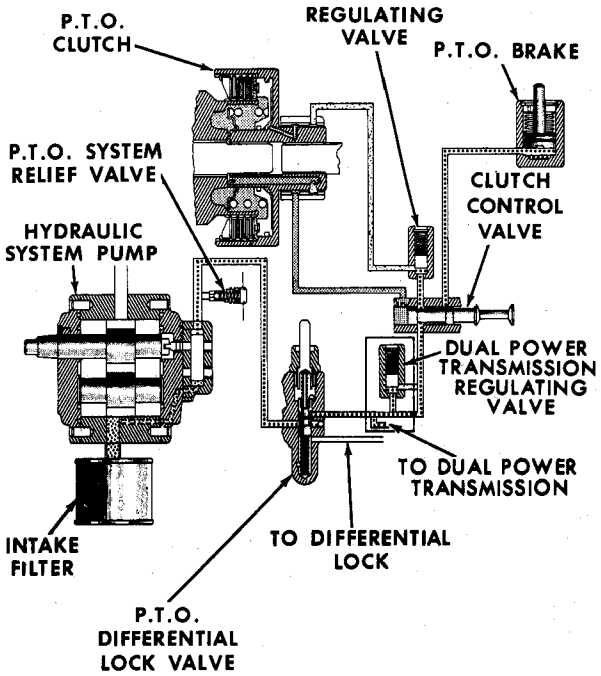


Fig. 186—Schematic diagram of the pto/differential lock hydraulic system. (All models except TW-10, TW-20 and TW-30). When differential lock valve is operated, line to pto clutch control valve is momentarily closed to prevent loss of pressure in clutch circuit, then valve reopens when pressure in differential lock circuit is built up. Pressure is directed to pto brake cylinder to hold clutch housing from turning when pto control valve is in disengaged position. Hydraulic pressure to Dual Power unit is controlled by Dual Power regulating valve. Hydraulic line is connected between lock valve on models not equipped with Dual Power.

When pto clutch valve is in "STOP" position, fluid pressure is directed to pto brake cylinder which applies a disc type brake on TW-10, TW-20 and TW-30 models or band type brake on all other models. The brake stops the pto clutch housing from turning due to fluid drag on the clutch discs. Brake is released by spring pressure whenever clutch is applied or engine is stopped.

CAUTION: As reduction gears are supported by the pto output shaft, do not operate tractor without either the 540 or 1000 rpm output shaft in place. Severe damage may be caused if driven gears are rotated under engine power if not supported by output shaft.

TROUBLESHOOTING

212. **OPERATIONAL CHECKS.** When troubleshooting pto malfunctions, refer to the following:

A. PTO CLUTCH WILL NOT ENGAGE. Trouble could be caused by:
1. Failure of hydraulic pump.
2. Control lever broken, disconnected or improperly adjusted.
3. Pto actuating arm in center housing disengaged from control valve spool.
4. Extremely cold oil in rear axle center housing.
5. Pto/differential lock relief valve ball or spring missing in hydraulic pump (all but TW models).

B. PTO STOPS UNDER LOAD. Trouble could be caused by:
1. Pto system pressure too low due to worn pump or leaking pump relief valve.
2. Pto clutch plates worn or damaged.

C. PTO WON'T STOP. Trouble could be caused by:
1. Extremely cold oil in rear axle center housing.
2. Pto control linkage disconnected or improperly adjusted.
3. Pto actuating arm in center housing disengaged from control valve spool.
4. Pto clutch plates warped or damaged.
5. Excessive wear of pto clutch brake.
6. Cut, broken or missing "O" ring on pto brake piston.

D. PTO SYSTEM PRESSURE TOO HIGH. Trouble could be caused by:
1. Extremely cold oil in rear axle center housing.
2. Low pressure hydraulic system control valve stuck closed or spring too stiff.

E. PTO SYSTEM PRESSURE TOO LOW, (WARNING LIGHT ILLUMINATES). Trouble could be caused by:
1. Low pressure hydraulic operating and or lube oil system pressure control valve spool(s) stuck open or spring(s) broken or weak.
2. Brake priority valve spool stuck closed or spring too stiff (Model TW-30 only).
3. Low pressure hydraulic system oil pump mounting bolts loose or rotors worn.
4. Low pressure hydraulic system oil pump or oil pick up tube seal damaged.
5. Hydraulic line leading to pto control valve leaking or damaged.
6. Cut or broken o-rings on pto clutch piston.
7. Pto regulating valve stuck open.
8. Worn or broken pto seal rings and/or pto support.
9. Leak in differential lock or Dual Power system.

213. **PTO/DIFFERENTIAL LOCK SYSTEM PRESSURE.** On all models except TW-10, TW-20 and TW-30, before checking pto/differential lock system pressure, operate tractor until oil in rear axle center housing is at normal operating temperature. Stop engine and connect a 0-500 psi hydraulic gage at upper ¼-inch pipe plug opening in pump adapter plate as shown in Fig. 188. On models equipped with Dual Power, connect gage to tee fitting in hydraulic pump cover for Dual Power line. Start engine and move control lever back and forth between "start" and "stop" positions several times to purge air from system. With engine running at 700 rpm, check pressure gage reading with clutch engaged and disengaged. Pressure readings should be within the range of 135-165 psi. System pressure of near 165 psi is desirable for positive clutch engagement. A variation of more than 3 psi will indicate internal leakage in pto clutch circuit. While observing pressure gage, depress differential lock pedal. Pressure should drop momentarily then return to same reading. If pressure reading is lower with differential lock engaged, there is an internal leak in the differential lock circuit. Differential lock circuit pressure can be checked by connecting a pressure gage to lower ¼-inch pipe plug opening as indicated in Fig. 188. With engine running at 700 rpm and differential lock engaged, pressure reading should be 250-300 psi.

To check fluid pressure for pto and differential lock on TW-10 and TW-20 models, first operate tractor until oil in rear axle housing is at normal temperature. Stop engine and connect a 0-500 psi hydraulic gage to low oil pressure system tee fitting (3–Fig. 189) on pump adapter plate. Pressure readings on models not equipped with Dual Power

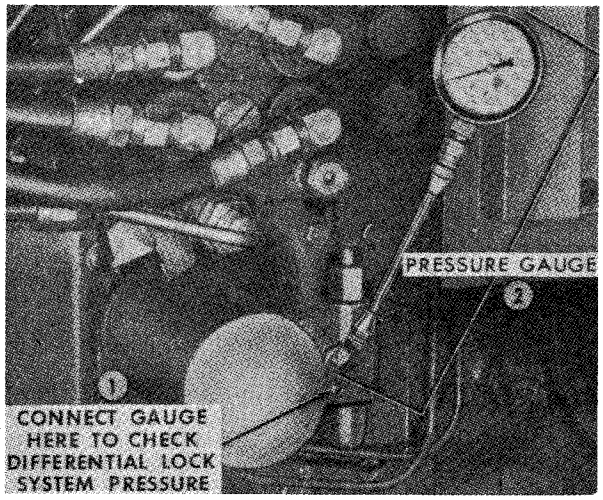


Fig. 188—Pressure gage installed to check pto clutch circuit pressure on all models except TW-10, TW-20 and TW-30. On Dual Power models, connect gage to Dual Power line tee in same location. Install gage in lower pipe plug hole as indicated to check differential lock system pressure. Refer to text for test procedure.

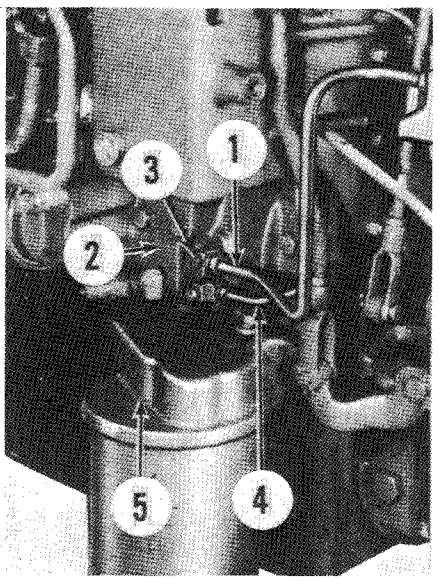


Fig. 189—To check pto and differential lock valve fluid pressure, connect a 0-500 psi gage to low oil system tee fitting (F) and refer to text. Model TW-30 is shown, however Models TW-10 and TW-20 are similar.

should be 185-220 psi with engine running at idle speed of 1000 rpm. On Dual Power models, pressure should be 185-220 psi at engine speed of 1000 rpm under each of the following conditions: Dual Power in underdrive, Dual Power in direct drive. With Dual Power in direct drive, engage the pto, with Dual Power in direct drive, engage the differential lock.

To check pto, differential lock, power brake and Dual Power system pressure on TW-30 models, first operate tractor until oil in rear axle housing is at normal operating temperature. Stop engine and connect a 0-500 psi hydraulic gage to low oil pressure system tee fitting (3–Fig. 189) on pump adapter plate. Pressure readings should be 185-235 psi under each of the following conditions with the engine idle speed set at 2200 rpm: with Dual Power in direct drive first apply left wheel brake then apply right wheel brake; apply both brakes at same time. With Dual Power in direct drive, engage pto then engage differential lock.

CONTROL LINKAGE ADJUSTMENT

215. To check adjustment of the pto clutch control cable on all models except TW-10, TW-20 and TW-30, refer to Fig. 190 and proceed as follows: Move pto control lever to full rearward "STOP" position; the actuating arm should snap to "OFF" position and the cable yoke pin be centered in slot of actuating arm. Then, move control lever fully forward to "START" position; the actuating arm should snap downward on 8700 and 9700 models or upward on all other models to "ON" position and the cable yoke pin should again be centered in slot in actuating lever. If the pin contacts end of slot in actuating lever in either of the two positions, or the actuating lever will not "snap" into either the "ON" or "OFF" position, readjust control linkage cable as follows:

Disconnect lower end of cable from actuating arm and loosen bottom clip. Move control lever to full rearward "STOP" position and snap actuating arm upward on 8700 and 9700 models or downward on all other models to "OFF" position, then reconnect cable with pin centered in slot of actuating arm and tighten bottom clip with cable in this position. Recheck adjustment as previously described and if correct adjustment is not yet obtained, proceed as follows:

Unbolt and remove console from tractor fender.

NOTE: It will be necessary to remove all control lever handles so that console can be lifted off control linkage.

Loosen top cable clip and position control lever to dimension shown in Fig. 190. Position top clip so that it is 1/16-inch from cable seal on 8700 and 9700 or butts against cable seal on other models, tighten clip and reinstall console. Readjust lower cable stop, if necessary, as previously described.

To check and adjust pto clutch control rod on TW-10, TW-20 and TW-30 models, refer to Fig. 191 and with pto lever (3) in off position, adjust turnbuckle (T) so pto handle is 3¼ inches from front of slot (1).

R&R AND OVERHAUL

216. **PTO/DIFFERENTIAL LOCK HYDRAULIC PUMP.** Fluid pressure for pto and differential lock on Models TW-10, TW-20 and TW-30 is provided by the low oil pressure system pump as noted in paragraph 174. Refer to paragraph 191 for pump removal.

Fluid pressure for pto and differential lock on all other models is provided by the hydraulic lift system pump. Refer to paragraphs 233 and 236 for pump removal and overhaul.

217. **PTO UPPER (CLUTCH OUTPUT) SHAFT AND REDUCTION GEARS.** To remove the pto clutch output shaft and drive gears, first remove hydraulic lift top link, where required, then refer to Fig. 192 and proceed as follows:

Unbolt the drive gear bearing retainer (top link bracket) (58) from rear axle center housing. Withdraw the retainer, along with drive gear (54), bearings (53 and 55) and shaft (33) as a unit. Remove the shaft from drive gear, taking care not to lose any shims (52) that may be located between gear and snap ring on rear end of shaft. Remove bearing retainer from rear bearing (55). Inspect gear teeth for chips and/or excessive wear.

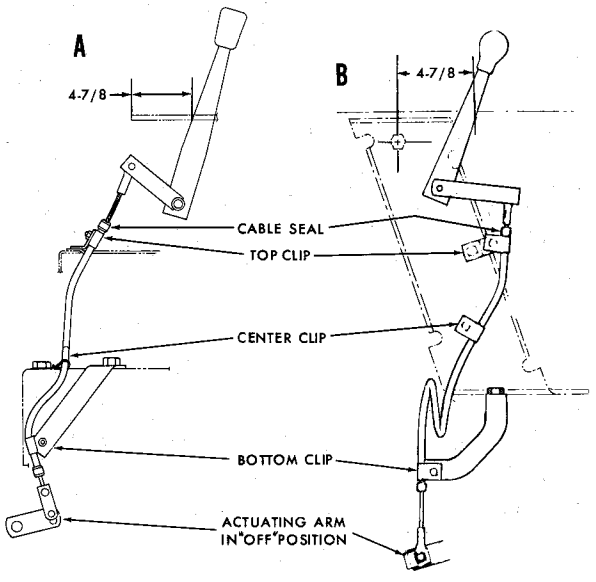


Fig. 190—View showing adjustment points for pto control linkage. Models 8700 and 9700 are shown in View "A" while 8000—9000—8600—9600 models are shown in View "B". Refer to text for procedure. See Fig. 191 for pto adjustment on Models TW-10, TW-20 and TW-30.

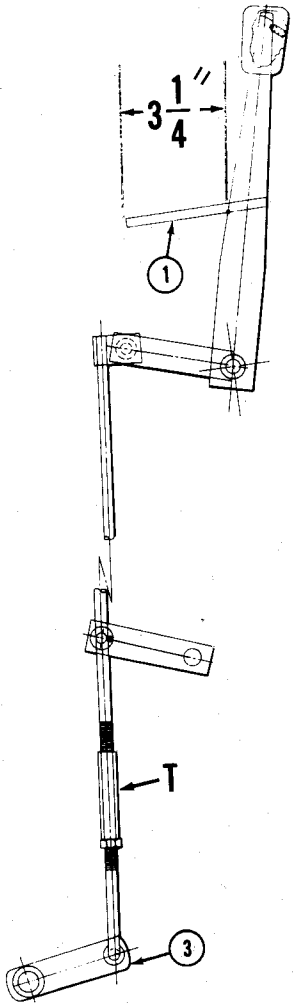


Fig. 191—Rotate turnbuckle (T) on Models TW-10, TW-20 and TW-30 to adjust pto control rod as outlined in text.

NOTE: Teeth on driven gears (61 and 62) may be inspected through drive gear opening in rear axle center housing; turn output shaft to rotate the gears.

Check bearings on drive gear and renew bearings if rough or worn; bearings may be removed using wedge type attachment with two-leg puller and step plate.

On dual speed models there are two driven reduction gears while there is only one driven reduction gear on 1000 rpm only models. To remove driven gear(s), first remove swinging drawbar and drain pto reduction gear housing (rear plug). Remove the cover from bottom of rear axle center housing. Remove pto output shaft after removing safety cap (72). Unbolt and remove output shaft bearing retainer (68), then support driven gear(s) (61 and 62) and remove bearing (64) and sleeve (63) assembly. The driven gear(s) can then be removed from bottom of rear axle center housing. Inspect needle bearing (59) in blind hole in rear axle center housing and remove if worn or damaged. Rear bearing (64) can be pressed from sleeve (63) after removing snap ring (65).

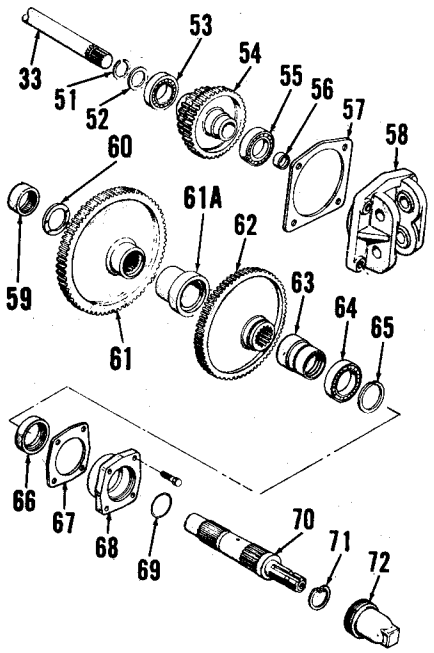


Fig. 192—Exploded view showing pto reduction gears, clutch output shaft and pto output shaft. Refer to Fig. 193 for view of both the 540 and 1000 rpm output shafts used on dual speed models. On 1000 rpm models only, drive gear (54) is a single gear and spacer (61A) is used in place of 540 rpm driven gear (61).

33. Clutch output shaft
51. Snap ring
52. Shims
53. Front bearing
54. Drive gear
55. Rear bearing
56. Gear bore plug
57. Gasket
58. Bearing retainer
59. Needle roller bearing
60. Thrust washer (3)
61. 540 rpm driven gear
61A. Spacer
62. 1000 rpm driven gear
63. Bearing sleeve
64. Ball bearing
65. Snap ring
66. Oil seal
67. Gasket
68. Bearing retainer
69. "O" ring
70. Output shaft
71. Snap ring
72. Safety cap

To reassemble, proceed as follows: Use 1-7/8-inch O.D. sleeve to drive output shaft front bearing (59) into housing, lubricate bearing and stick thrust washer (60) into place using heavy grease. Press rear bearing (64) onto sleeve (63) and secure with snap ring. On dual speed models, pilot the 1000 rpm driven gear (62) onto hub of the 540 rpm gear (61) with a thrust washer (60) between them and position the gears in housing. On 1000 rpm only models, install a thrust washer in spacer (61A) and install spacer and driven gear (62) in housing so that concave side of gear is next to spacer. Insert a thrust washer between sleeve (63) and gear(s) and install sleeve (63) and rear bearing (64). Install new oil seal (66) in retainer (68), lubricate seal and install retainer with new gasket. Install appropriate output shaft (Fig. 193) and secure with snap ring (71—Fig. 192).

Install bearings (53 and 55) on drive gear (54), making sure that sealed side of front bearing (53) faces forward (away from gear). Be sure that cup plug (56) in rear bore of gear is tight and does not have a vent hole; renew plug if loose or if it is early type having a vent hole. If original drive shaft (33) and drive gear (54) are being reinstalled, place shims (52) on rear end of shaft as removed on disassembly and insert shaft in gear. Position retainer on rear drive gear bearing with new gasket (57), then install assembly in rear axle center housing and tighten retaining cap screws to a torque of 68-92 ft.-lbs. Fill pto gear box through fill plug opening on left rear of differential housing with approximately 4 quarts for 8000, 9000, 8600, and 9600 models or 6½ quarts for 8700 and 9700 models. On Models TW-10, TW-20 and TW-30, replenish transmission oil as outlined in paragraph 176. Recommended lubricant for all models is Ford ESN-M2C53-A.

If shaft and/or drive gears have been renewed, drive shaft end play should be checked and correct shim (52) thickness installed on assembly as outlined in following paragraph 218.

218. **CLUTCH SHAFT END PLAY.** End play of shaft (33—Fig. 192, 197 or 198) should be 0.001-0.029 inch and is controlled by shims (52—Fig. 192) placed between rear snap ring (51) and shoulder on pto drive gear (54) hub. If the hydraulic lift cover is removed, end play can be checked by measuring gap between snap ring and gear hub with a feeler gage and, if not within limits of 0.001-0.029 inch, the assembly should be removed as outlined in paragraph 217 and the correct thickness of shims (52) installed to provide proper shaft end play. Make sure rear bearing retainer cap screws are tightened to a torque of 68-92 ft.-lbs. when making end play check.

If a new shaft (33) is being installed and the lift cover is not removed, check end play as follows: With the bearing retainer, drive gears and shaft removed as outlined in paragraph 217, install the assembly without a gasket and with total shim (52) thickness of approximately 0.100 inch. Install retainer cap screws and tighten snugly until snap ring on front end of shaft contacts pto clutch housing and there is no end play of shaft, clutch housing or hub, but do not force the retainer in with cap screws. Loosen and tighten alternate cap screws until gap is equal all around retainer, then measure resulting gap with feeler gage. Record the measurement and remove

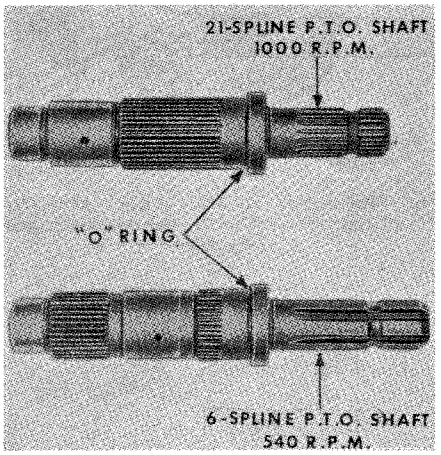


Fig. 193—Views showing 1000 rpm output shaft (top) and 540 rpm output shaft (bottom) used on dual speed models. Output shafts (1000 rpm) for single speed models are similar. Note location for sealing "O" ring (69—Fig. 192).

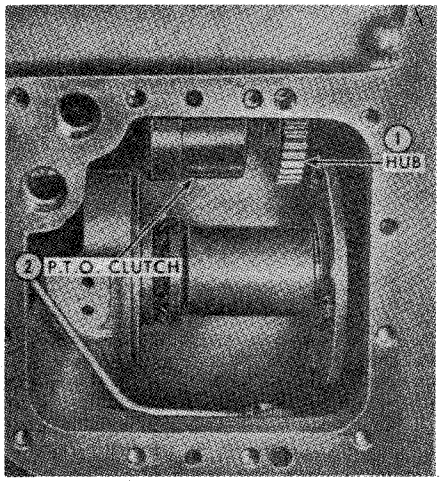


Fig. 194—View with hydraulic system pump removed showing pto clutch and drive hub. Clutch and hub can be removed out pump adapter plate opening after removing clutch output shaft reduction drive gears.

retainer, drive gear and shaft assembly. Withdraw shaft from drive gear and measure test shim pack thickness with micrometer. Subtract measured gap from test shim pack thickness; then, select shims of total thickness of 0.001 to 0.029 inch **less** than the resulting value of reassembly. For example, if test shim pack thickness was 0.098 inch and gap between retainer and housing was 0.043 inch, resulting value would be 0.055 inch. Desired shim pack thickness would be 0.001 to 0.029 inch less than this value (0.055) or 0.026 to 0.054 inch. Reinstall shaft gear and retainer assembly with new gasket and selected shim pack thickness as outlined in paragraph 217 and recheck end play.

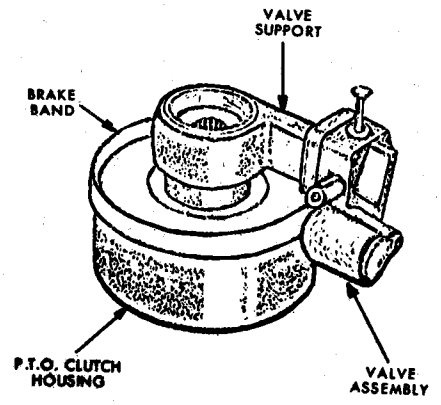


Fig. 195—After removing clutch assembly, lift off valve assembly with valve support and brake band.

219. **PTO OUTPUT SHAFT.** The power take-off output shaft (70—Fig. 192) can be withdrawn after removing cap (72) and retaining snap ring (71).

When installing output shaft, be sure the sealing "O" ring (69) is in proper groove as shown in Fig. 193 and that bearing surfaces of shaft are not scored or burred.

220. **R&R PTO CLUTCH AND VALVE ASSEMBLY (TW-10, TW-20 AND TW-30).** To remove pto clutch and valve assembly, separate tractor between transmission and rear axle center housing as outlined in paragraph 188. To renew pto clutch or valve assembly, proceed as follows:

NOTE: Removal of hydraulic lift cover is optional. Pto clutch and valve assembly can be removed and installed with lift cover in place, however, installation is difficult because control valve spool (81—Fig. 198) and fork cannot easily be seen for alignment.

Remove hydraulic lift cover, if desired, from center housing, then remove pto drive hub (34—Fig. 198) and thrust washer (35). Disconnect pto lube line (L—Fig. 198A) from fitting on inside left wall of center housing, then disconnect high pressure line (H). Remove shoulder bolt (B—Fig. 200), over center spring (S), locating pin (82) and stop pin (84) from pto control linkage. Turn control valve lever so shift fork will be released from control valve spool (81 – Fig. 198).

On TW-10 and TW-20 models, slide pto valve assembly forward and remove through center housing.

On TW-30 models, remove pto upper shaft and gears while supporting pto assembly, then slide pto assembly past hydraulic pump gear (G—Fig. 198A) and out center housing opening.

To reinstall pto clutch assembly, reverse removal procedure. Finger tighten locating pin (82 – Fig. 200), connect pto lube line (L – Fig. 198A) and high pressure line (H), then tighten locating pin (82 – Fig. 200) to a torque of 70-95 ft.-lbs. On TW-30 models, tighten pto upper shaft and gears bearing retainer to a torque of 68-92 ft.-lbs.

221. **R&R PTO CLUTCH AND VALVE ASSEMBLY. (All Other Models).** On 8000 models, it is possible to remove pto clutch and valve assembly

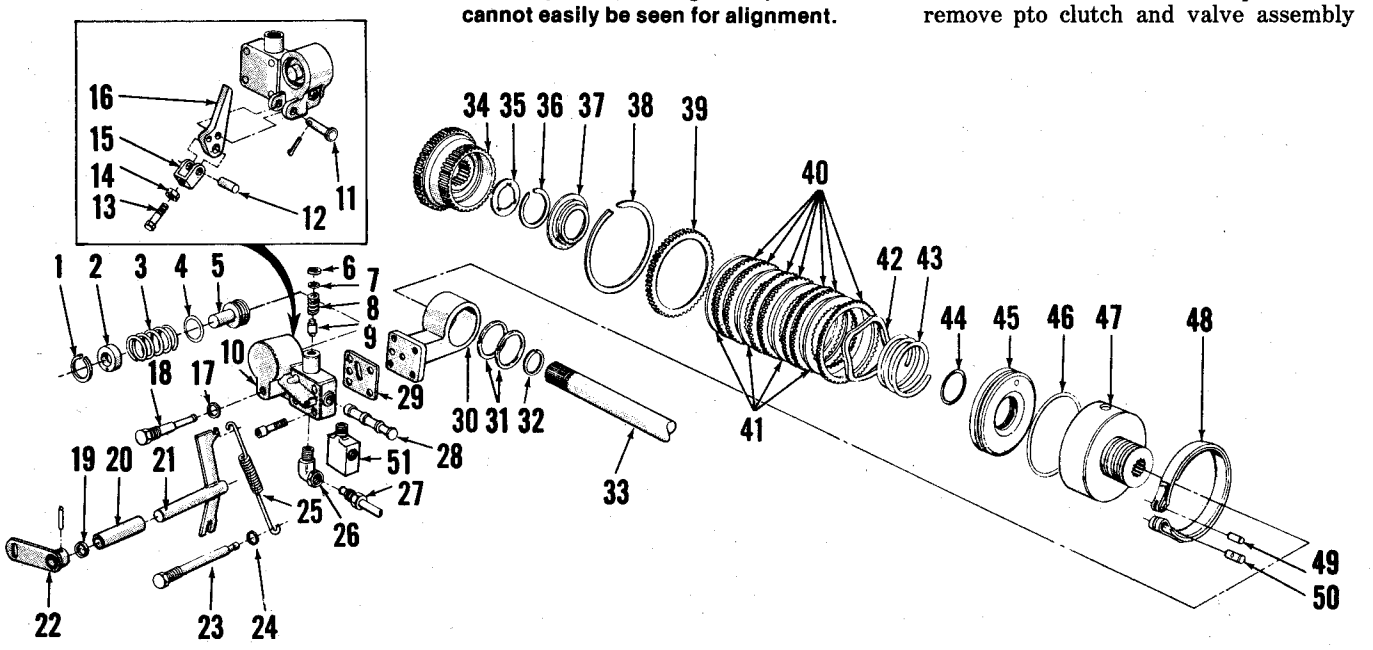


Fig. 197—Exploded view of clutch assembly, clutch brake mechanism, control valve assembly and actuating linkage on all models except TW-10, TW-20 and TW-30. Pin (18) is inserted through left side of rear axle center housing and pilots in hole in clutch valve housing (10) to keep the clutch assembly from rotating. Pin (23), also inserted from outer left side of center housing, acts as stop for control arm (21) and also as attaching point for the over-center spring (25). Inset shows view of valve housing from clutch side and the pto brake lever and related parts. On transmissions with Dual Power, regulator valve (51) is used in place of elbow (26). Refer to Fig. 198 for exploded view of pto assembly on Models TW-10, TW-20 and TW-30.

1. Snap ring
2. Piston guide
3. Piston return spring
4. "O" ring
5. Pto brake piston
6. Snap ring
7. Washer
8. Valve spring
9. Regulating valve
10. Valve housing
11. Lever pin
12. Clevis pin
13. Adjusting screw
14. Locknut
15. Clevis
16. Brake lever
17. "O" ring
18. Locating pin
19. "O" ring
20. Bushing
21. Actuating arm
22. Actuating lever
23. Stop pin
24. "O" ring
25. Over-center spring
26. Elbow fitting
27. Pressure line
28. Control valve spool
29. Gasket
30. Valve support
31. Sealing rings
32. Snap ring
33. Clutch output shaft
34. Clutch drive hub
35. Thrust washer
36. Snap ring
37. Spring retainer
38. Snap ring
39. Pressure plate
40. External spline discs
41. Internal spline discs
42. Feathering spring
43. Piston return spring
44. "O" ring, inner
45. Piston
46. "O" ring, outer
47. Clutch housing
48. Brake band
49. Band to arm pin
50. Band to clevis pin
51. Dual Power regulator valve

through opening in rear axle center housing after the hydraulic pump and adapter plate have been removed. On all other models, it is necessary to separate tractor to remove pto clutch and valve assembly due to interference with other parts. To remove pto clutch, proceed as follows:

On 8000 models, remove the adapter plate and hydraulic pump assembly from right side of rear axle center housing as outlined in paragraph 233. On all other models, separate tractor between transmission and rear axle center housing as outlined in paragraph 187 or 188. Remove pto upper (clutch output) shaft as indicated in paragraph 217. Remove hydraulic pump intake tube, filter screen and disconnect pto pressure line from inside of rear axle center housing. On models with Dual Power, remove Dual Power regulating valve from wall of center housing. On all except 8000 models, remove locating pin (18–Fig. 197), and remove pto clutch assembly.

On 8000 models, remove locating pin (18), slide clutch assembly rearward off input shaft and remove pto clutch assembly through pump adapter plate opening. Care should be taken not to lose thrust washer located between clutch and drive hub if they are separated during removal.

To reinstall pto clutch on 8000 models place clutch drive hub on transmission pto shaft and using heavy grease, stick thrust washer to clutch housing hub so that prongs on thrust washer enter holes in hub of housing (47—Fig. 197). Position clutch and valve assembly on rear of drive hub and rotate hub back and forth to align splines of hub with splines in pto clutch discs. With clutch fully forward, insert locating pin with new "O" ring in left side of rear axle center housing, making sure pin enters hole in pto valve housing, and tighten pin finger tight. Reconnect pto pressure line, reinstall pto upper shaft as in paragraph 217 and tighten locating pin to a torque of 70-95 ft.-lbs. Reinstall hydraulic pump as outlined in paragraph 234 or 235.

To reinstall pto clutch on all except 8000 models, install pto output shaft and drive gear as outlined in paragraph 217. Install thrust washer (35—Fig. 197) using heavy grease so that prongs of thrust washer enter holes in hub of housing (47). Install clutch assembly and control valve on pto output shaft and insert locating pin (18) finger tight to hold assembly in place. Connect control valve hydraulic line and install Dual Power regulating valve, on models so equipped, so that hydraulic connection is facing rearward. Connect Dual Power hydraulic line. Connect rear axle housing and transmission as outlined in paragraph 187 or 188. Tighten locating pin (18) to 70-95 ft.-lbs.

222. **OVERHAUL PTO CLUTCH AND VALVE ASSEMBLY (TW MODELS).** After removing pto clutch assembly as outlined in paragraph 220, refer to Fig. 198 and remove brake pad bolts, outer pad (55), spacers (50) and inner pad (54). Remove clutch pack from support and bearing assembly (30). Remove clutch rotor (52) then unbolt and remove valve assembly (80) from support and bearing assembly. Remove brake piston (57) with compressed air. Remove snap ring (38), pressure plate (39), clutch discs (40 & 41) and feathering spring (42) from housing (47). Using Ford tool No. 1312, compress piston return spring (43) as shown in Fig. 199 and remove snap ring (36). Use compressed air to unseat piston (45–Fig. 198). Inspect and renew any components that have excessive wear or damage.

Refer to Fig. 198 for view of control valve. Overhaul is evident after inspection of valve. If regulating valve (77—Fig. 198) is worn or damaged, it must be replaced as a complete unit.

NOTE: Lubricate all parts with hydraulic fluid/differential lubricant before reassembly.

Install a new "O" ring (58) on piston (57), then install feathering spring (42), clutch discs (40 & 41) and pressure plate (39) into housing (47). Reinstall snap ring (38) after compressing clutch spring as illustrated in Fig. 199.

Assemble brake rotor (52) on clutch housing (47), then attach clutch pack to support assembly (30). Install brake pads (53 & 55) and brake pad bolts. Tighten brake pad bolts to a torque of 27-37 ft.-lbs. Attach pto valve assembly (80) to support (30) and tighten bolts to a torque of 15-21 ft.-lbs.

223. **OVERHAUL PTO CLUTCH AND VALVE ASSEMBLY (All Other Models).** With pto clutch and valve assembly removed as outlined in paragraph 221, place unit on bench, front face down, and remove the brake band, valve support and valve assembly as a unit from the clutch housing as shown in Fig. 195. Withdraw control valve spool from valve body and remove the pin (11—Fig. 197) retaining band and lever (16) to valve body. Place valve body in a press and using suitable sleeve, compress guide (2) and spring (3) into valve body, then remove snap ring (1). Release spring pressure and remove the guide, spring and piston (5). Remove snap ring (6), flat washer (7), spring (8) and pto regulating valve (9) from bore in valve body.

Remove snap ring (38) from clutch housing (47), then remove the pressure plate (39), clutch discs (40 and 41) and feathering spring (42) from housing. Remove the cast iron sealing rings (31) from rear hub of housing. Refer to Fig. 199, place housing in a press and using

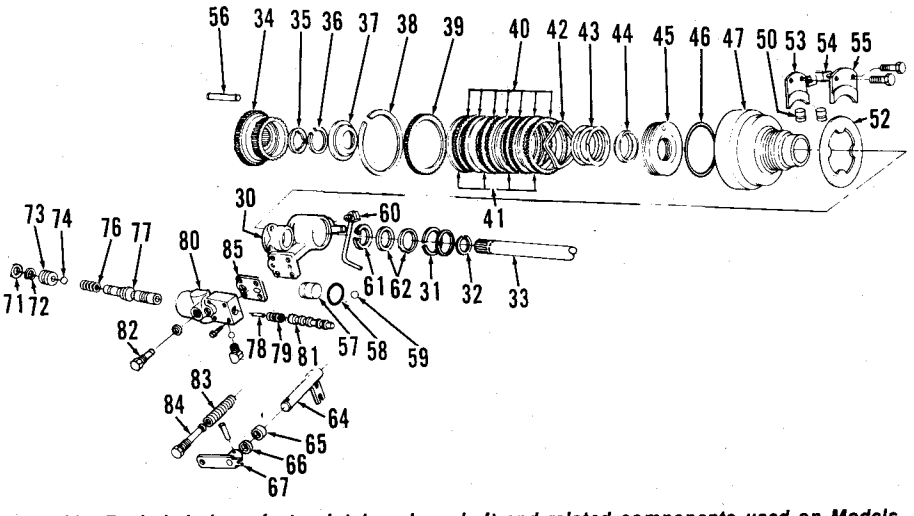


Fig. 198—Exploded view of pto clutch, valve, shaft and related components used on Models TW-10, TW-20 and TW-30. Refer to Fig. 200 for view of shift mechanism.

30. Support
31. Seal
32. Snap ring
33. Shaft
34. Hub
35. Thrust washer
36. Retaining ring
37. Spring retainer
38. Snap ring
39. Pressure plate
40. External spline discs
41. Internal spline discs
42. Feathering spring
43. Piston return spring
44. "O" ring, inner
45. Piston
46. "O" ring, outer
47. Clutch housing
50. Spacers
52. Brake rotor
53. Brake pad
54. Brake pad spring
55. Brake pad
56. Brake pin
57. Piston
58. Seal
59. Ball (5/16 in.)
60. Elbow
61. Snap ring
62. Support bearing
63. Ball
64. Shift fork
65. Bushing
66. Seal
67. Shift lever
71. Snap ring
72. "O" ring
73. Valve guide
74. Valve seal
76. Return spring
77. Pressure regulator valve
78. Push rod
79. Valve spring
80. Valve assembly
81. Control valve
82. Locating pin
83. Spring
84. Stop pin
85. Gasket

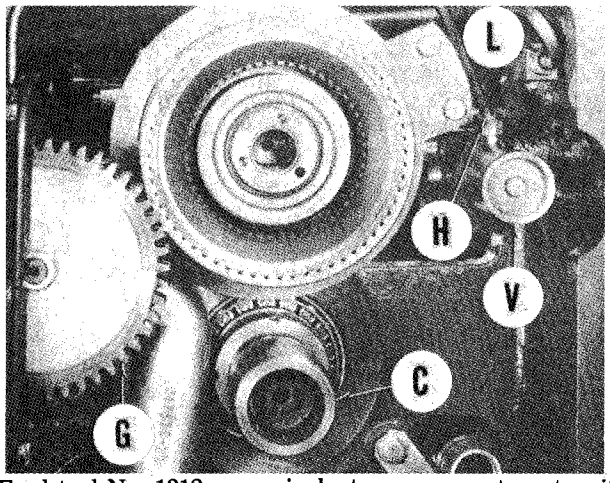


Fig. 198A—View of rear axle center housing on Models TW-10, TW-20 and TW-30. Refer to paragraph 220 for pto clutch removal.

C. Coupler
G. Hydraulic pump gear
H. High pressure line
L. Lube line
V. Pto valve

Ford tool No. 1312 or equivalent, compress the piston return springs (43—Fig. 197) and remove retaining snap ring (36). Gradually release spring pressure and remove the spring retainer (37) and spring (43). Use air pressure through clutch piston port located between the seal ring grooves on housing rear hub to remove piston (45) from housing.

Carefully clean and inspect all parts and remove the "O" rings (44 and 46) from clutch piston and the "O" ring (4) from brake piston. Renew all excessively worn, scored or otherwise damaged parts not suitable for further service. Lubricate all parts with hydraulic fluid/differential lubricant and using new "O" rings (4, 44 and 46) and cast iron rings (31), reassemble by reversing disassembly procedure. After placing the brake band, valve support and valve assembly back on the pto clutch housing, loosen locknut (14), tighten band adjusting screw (13) to a torque of 9-11 in.-lbs., back screw off 1½ turns, then tighten locknut.

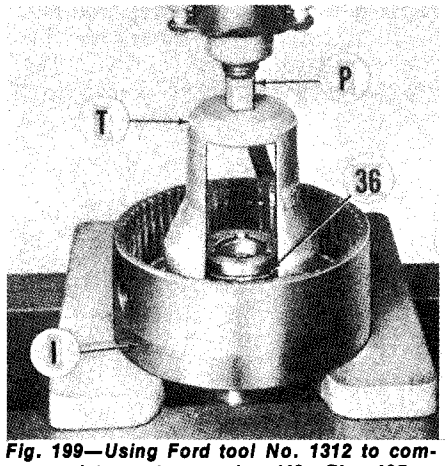


Fig. 199—Using Ford tool No. 1312 to compress piston return spring (43—Fig. 197 or 198), so snap ring (36) can be removed.

36. Retaining ring
I. Pto clutch housing
T. Tool No. 1312
P. Arbor press

HYDRAULIC LIFT SYSTEM

The hydraulic lift system incorporates automatic draft control, automatic position control and pump flow (rate of lift) control. Provision is also made for installation of optional remote cylinder control valves. Tractor is also available with a hydraulic system for remote cylinder operation only. Fluid for the system is common with differential and final drive lubricant. Refer to paragraph 197 for fluid type and quantity. Hydraulic power is supplied by a gear type pump that is mounted in right side of rear axle center housing. Pump is driven by gear machined on pto clutch input hub. The system is protected by a wire mesh screen filter on intake side of pump on all models except all 8700, 9700, TW-10, TW-20, TW-30 and late 8600 and 9600, which have a renewable intake filter. The pressure (outlet) side of system is protected by a renewable filter on pump adapter plate on all models.

HYDRAULIC FLUID

226. Fluid used in transmission and rear axle center housing and hydraulic system must be compatible with the wet type disc brakes and differential lock clutch. Refer to paragraph 176 for recommended fluid type and for transmission and rear axle capacity. Rear axle center housing should be drained and refilled with new lubricant after each 1200 hours of service or yearly, whichever occurs first. Before draining, be sure that 3-point lift arms are lowered and any remote cylinders are retracted. Maintain fluid level at oil level plug opening in left side of rear axle center housing at front side of left axle housing flange on 8000-9000 models. All other models have a dipstick located by the left side of the lift cover. Check fluid with the tractor level, with 3-point hitch lift arms in raised position and any remote cylinders extended.

HYDRAULIC SYSTEM FILTERS

227. The external throw-away type filter on pump adapter cover at right side of rear axle center housing should be renewed after each 300 hours of service. If tractor is equipped with external throwaway type intake filter, filter should be renewed after each 300 hours of service. External intake filter is located just below pump adapter plate on 8700, 9700, TW-10, TW-20 and TW-30 models or on left side of center housing on all other models.

On all models without external intake filter, the wire screen filter on pump intake tube should be cleaned each time the hydraulic system is being serviced and is accessible after removing hydraulic pump, lift cover or splitting tractor between transmission and rear axle center housing.

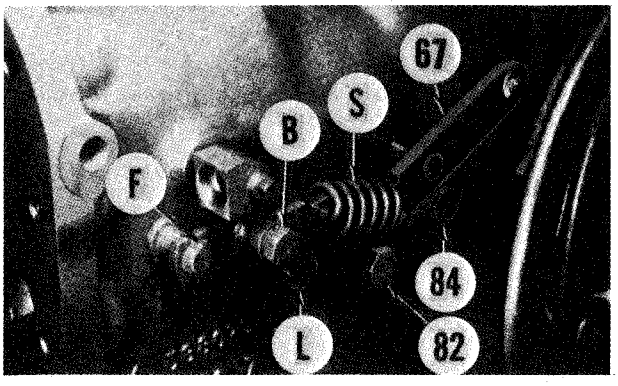


Fig. 200—View of shift mechanism for TW-10, TW-20 and TW-30 models.

B. Shoulder bolt
L. Locating bolt
S. Over center spring
67. Shift lever
82. Locating pin
84. Stop pin

TROUBLESHOOTING

228. When troubleshooting problems are encountered with the hydraulic lift system, refer to the following malfunctions and their possible causes:

A. FAILURE TO LIFT UNDER ALL CONDITIONS. Could be caused by:

1. Low oil level in rear axle center housing.
2. Flow control valve stuck in open position.
3. Faulty hydraulic pump.

4. Control linkage damaged or disconnected.
5. Leak in pump suction (intake) pipe.
6. Sticking exhaust control valve (34—Fig. 219).
7. Sticking or improperly installed exhaust pressure valve (36—Fig. 219).

B. FAILURE TO LIFT UNDER LOAD. Could be caused by:
1. Faulty hydraulic pump.
2. System pressure relief valve opening at too low a pressure or faulty relief valve.
3. Safety relief valve faulty.
4. Exhaust pressure valve (36—Fig. 219) sticking.
5. Clogged pump inlet screen.

C. OCCASIONALLY FAILS TO LIFT NOT DUE TO OVERLOADING. Could be caused by:
1. Flow control valve spool sticking occasionally.
2. Exhaust pressure valve (36—Fig. 219) sticking occasionally or valve installed backwards.
3. Lift control valve improperly adjusted.

D. EXCESSIVE LIFT CORRECTIONS (WILL NOT HOLD LOAD AFTER STOPPING ENGINE). Could be caused by:
1. Drop valve poppet or poppet ball leaking.
2. Lift piston seal leaking.
3. "O" ring seals between control valve body and lift cylinder leaking.
4. Safety valve leaking.

E. LIFTS TOO SLOWLY. Could be caused by:
1. Flow control valve stuck in slow lift position.
2. Flow control valve scored or not properly fit in valve bore.
3. Faulty pump.

F. OVER CORRECTS IN DRAFT CONTROL. Could be caused by:
1. Flow control valve adjusting knob not properly set.
2. Lift control valve not properly adjusted.
3. Binding draft control linkage or lower lift hanger binding in bushings.
4. Flow control override linkage binding and not releasing variable flow valve from fast flow position.

G. SYSTEM DOES NOT RESPOND TO CHANGES IN DRAFT OF IMPLEMENT. Could be caused by:
1. Draft control linkage out of adjustment.

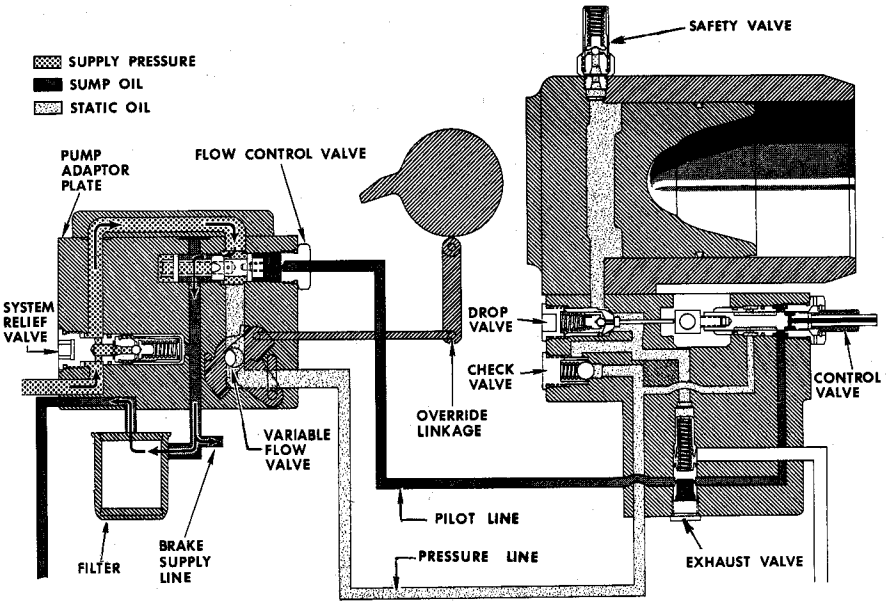


Fig. 203—Schematic diagram of hydraulic system with control valve in neutral position. Flow control valve returns oil to sump through filter and brake supply line and maintains static pressure in pressure line with the control valve in neutral or lowering position. When the control valve is placed in raising position, pressure is directed to pilot line, closing the flow control valve, thus directing fluid flow to pressure line and lift cylinder. When control valve is placed in lowering position, drop valve is forced open allowing fluid in cylinder to return to sump past the exhaust valve. Pressure in pilot line holds exhaust valve closed when line is pressurized with control valve in raising position. Variable flow valve restricts flow to lift cylinder pressure line, causing flow control valve to direct part of pump flow to sump depending upon position of variable flow valve. Thus, rate of lift can be varied by varying position of variable flow valve with control (F—Fig. 209) on console. When control valve lever is placed in full raise position, override linkage returns variable flow valve to full flow position.

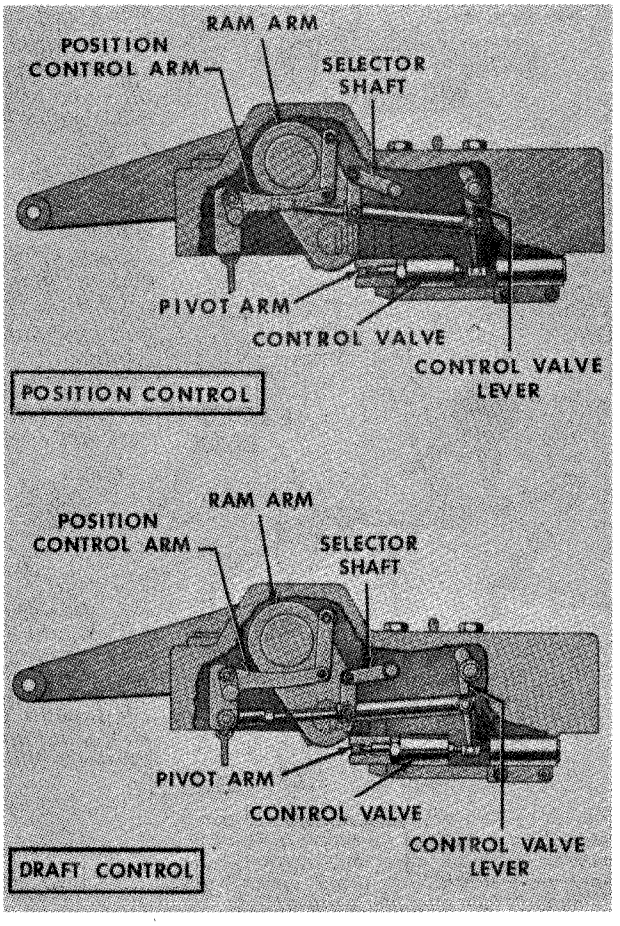


Fig. 204—Selector lever (S—Fig. 209) controls position of selector shaft which moves rear end of actuating rod attached to control valve lever to position control (top view) or draft control (bottom view) position in position control arm. Also, detent positions between full position control and full draft control provide varying degrees of draft control. Refer to exploded view of detent mechanism in Fig. 223.

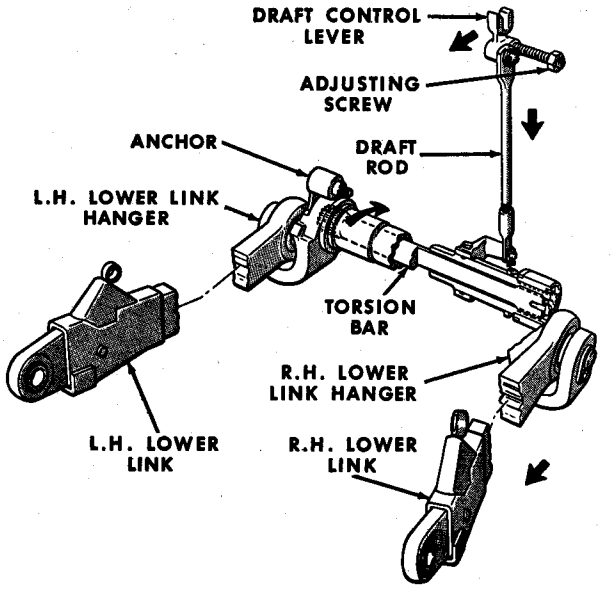


Fig. 205—Cut-away view showing draft control torsion bar and control linkage. Draft on lower links rotates lift link hangers against tension of torsion bar, thus rotating draft control lever. When selector lever (Fig. 204) is in draft control position, control valve position is controlled by draft on lower links.

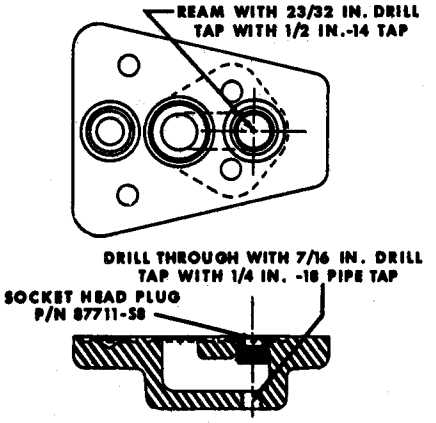


Fig. 206—On models not equipped with remote control valve, manifold plate must be modified as shown above to permit checking hydraulic system relief pressure. Refer also to Fig. 207.

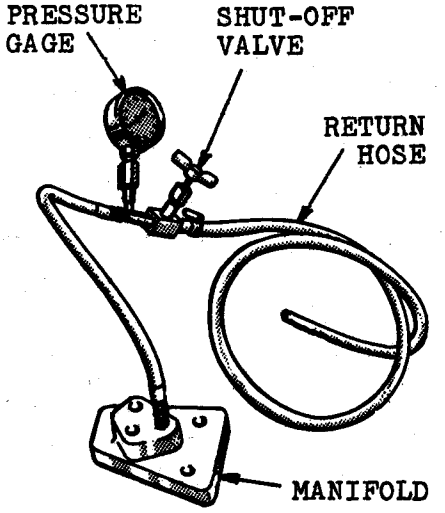


Fig. 207—With manifold on top of pump adapter plate modified as shown in Fig. 206, connect pressure gage and shut-off valve hose to manifold and insert return hose through filler plug opening in lift cover.

2. Linkage disconnected; roller disengaged from draft sensing yoke.
3. Lower link hanger stop not properly adjusted.
4. Reaction too slow due to flow control valve in slow flow position.

HYDRAULIC PRESSURE CHECK

229. Hydraulic system relief pressure should be 2500-2600 psi for TW-10, TW-20 and TW-30 models and 2450-2550 for all other models. Pressure can be adjusted by adding or removing shims (31—Fig. 216 or 3—Fig. 217), between relief valve body cap and relief valve spring.

Shims are available in thicknesses of 0.010 and 0.026 inch. Maximum allowable shim pack thickness is 0.080 inch. Adding one 0.010 inch thick shim will increase pressure approximately 42 psi on TW-10, TW-20 and TW-30 models and approximately 100 psi on all other models. If adding shims does not increase relief pressure or system pressure remains below desired pressure with maximum thickness (0.080 inch) shims installed, a worn or faulty pump should be suspected.

If equipped with remote control valves, connect pressure test gage at remote quick disconnect coupling. If not equipped with remote control valves, modify the manifold plate on top of pump adapter plate as shown in Fig. 206 and connect pressure test gage as shown in Fig. 207. Insert return hose in rear axle center housing filler plug opening, open the shut-off valve and start engine. With engine running at 700 rpm, close shut-off valve only long enough to observe pressure reading. After checking system pressure with modified manifold installed, either install new manifold or remove internal ½-inch pipe plug and close external opening with ¼-inch pipe plug.

ADJUSTMENTS

NOTE: The adjustments outlined in following paragraph 230 through 233 are those that can be made externally; internal adjustments are outlined in reassembly procedure in paragraphs outlining overhaul of the system components. Inability to make system function properly by external adjustment will indicate need of system overhaul and/or internal adjustment.

230. **LOWER LINK HANGER STOP.** Refer to Fig. 208; gap between left hand lower link hanger and eccentric stop should be 0.33-0.34 inch (⅓-inch). To adjust gap, loosen cap screw and turn eccentric, then retighten cap screw to a torque of 50-60 ft.-lbs.

231. **CONTROL LEVER LINKAGE ADJUSTMENT.** The lift control lever (L—Fig. 209) should move the control lever (6—Fig. 210) on lift cover through full range of travel without the lever (L—Fig. 209) contacting either end of slot in console. If the control lever can be moved against end of slot, adjust link (1—Fig. 210) as follows: Disconnect lower end of link (1) from lever (6) and

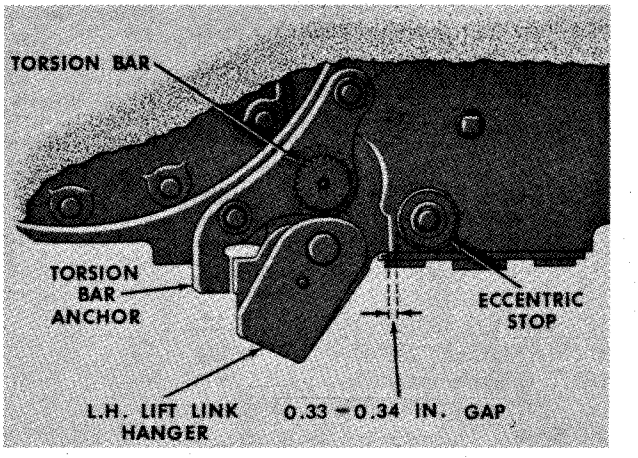


Fig. 208—Eccentric stop on left side of rear axle center housing is adjusted to provide a gap of 0.33-0.34 inch between stop and left hand lift link hanger. Hanger stop on torsion bar hanger is non-adjustable.

move end of lever down until it pushes override link (5) as far as it will go. Move lift control lever (L—Fig. 209) rearward so that it is 1/8 to ¼-inch from rear end of slot in console. Then, turn lower end of link (1—Fig. 210) to shorten or lengthen link as necessary so that it can be reconnected to lever (6) without moving either the control lever or lever (6).

After adjusting and reconnecting link (1), check to be sure that control lever can be moved through full range of travel without contacting either end of slot in console.

232. **POSITION CONTROL ADJUSTMENT.** Place selector lever (S—Fig. 209) in position control (fully rearward). With control lever adjusted as outlined in paragraph 231, start engine and move control lever (L) fully forward; the lift linkage should then move to fully lowered position. Slowly move control lever rearward; lift linkage should start to raise when lever is ½ to 1 inch away from front end of slot in console. If lift arms do not go to fully lowered position with control lever fully forward, or if lift arms do not start to raise until after lever is more than 1 inch away from front end of slot in console, adjust position control pivot as follows:

Position the control lever so that it is ½ to 1 inch from front end of slot in console. Refer to Fig. 211 and loosen locknut (N1) on position control adjusting pivot (P) while holding pivot with Allen wrench. Slowly turn position control pivot until lift arms just start to raise without moving control lever, then tighten locknut to a torque of 70-80 ft.-lbs. Recheck position control by moving control lever fully forward, allow lift arms to reach fully lowered position, then move lever slowly rearward until lift arms start to raise. Readjust position control pivot (P) if control lever position at time lift arms start to raise is not as stated.

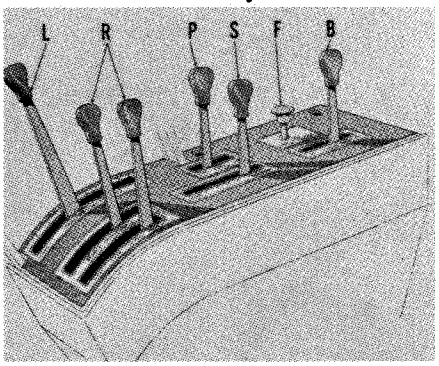


Fig. 209—View of control console on 8000, 8600, 9000 and 9600 models. Models 8700, 9700, TW-10, TW-20 and TW-30 are similar but positions of pto and selector control levers are reversed. Transmission brake lever (B) is not used on 8600, 8700, 9600, 9700, TW-10, TW-20 or TW-30.

B. Transmission brake lever
F. Flow control knob
L. Lift control knob
P. Pto control lever
R. Remote control levers
S. Selector (draft/position) control lever

232A. **DRAFT CONTROL ADJUSTMENT.** After adjusting control lever linkage as in paragraph 231 and position control pivot as in paragraph 232, check draft control adjustment as follows: Place selector lever (S—Fig. 209) in draft control position (fully forward). With engine running, move control lever (L) forward until lift arms are lowered, then slowly move lever towards rear of slot in console. When the rear side of lever is ½ to 1 inch away from rear end of slot, the lift arms should start to raise. If the lift arms do not start to raise with control lever in this position, refer to Fig. 211 and loosen locknut (N2) on draft control pivot (D) while holding pivot with Allen wrench. With the control lever ½ to 1 inch away from end of slot in console, slowly turn draft control pivot until lift arms just start to raise, then tighten locknut to a torque of 120-140 ft.-lbs. Recheck draft control adjustment and readjust pivot if necessary.

233. **R&R PUMP AND ADAPTER PLATE.** To remove hydraulic pump and adapter plate from right side of rear axle center housing, proceed as follows: Drain oil from rear axle center housing.

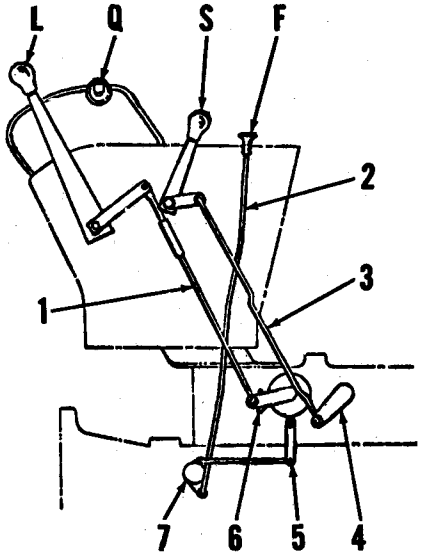


Fig. 210—View showing hydraulic lift lever to lift cover linkage. Lift control link (1) is adjustable. Quadrant stop (Q) is adjusted so that lever may be returned to desired setting after raising implement.

F. Flow control knob
L. Lift control lever
Q. Quadrant stop
S. Selector lever
1. Control lever link
2. Flow control link
3. Selector link
4. Selector shaft arm
5. Override linkage
6. Lift control arm
7. Variable flow valve arm

Remove access panel from right fender on early models and thoroughly clean adapter plate and surrounding area. Disconnect control rod or cable from flow control valve arm at adapter and pull up out of way.

If equipped with remote control valves, remove remote control valve access panel then back out manifold and remote control valve attaching bolts until they are free of pump adapter plate. Raise remote control valve stack slightly to disengage from pump adapter plate. Wire valve stack to adjacent tractor components as required to hold in place above pump cover. Remove inlet manifold (26—Fig. 212).

Refer to Fig. 212. Remove the hydraulic pressure tube and the pilot pressure tube connecting adapter plate to lift cover. Disconnect the flow control override spring and link from flow control valve inner arm. Remove cotter pin connecting differential lock pedal to valve and pull pedal up out of way.

On TW-10 and TW-20 models, disconnect pto/differential lock valve pressure line from pump adapter plate and at tee fitting on top right of transmission. It may be necessary to remove transmission access panel on cab floor. On TW-30 models, disconnect pto and differential lock pressure line from pump adapter plate and valve assembly. Disconnect pto pressure line at rgulating valve.

On early models which use hydraulic oil instead of brake fluid in brakes, disconnect brake fluid lines from adapter plate and push lines downward out of way. If necessary to renew hydraulic system filter, unscrew and discard filter at this time. Remove cap screws around outside edge of adapter plate and pry plate and pump assembly from rear axle center housing.

234. If the pump intake tube and internal intake filter have not been removed, carefully reinstall pump and

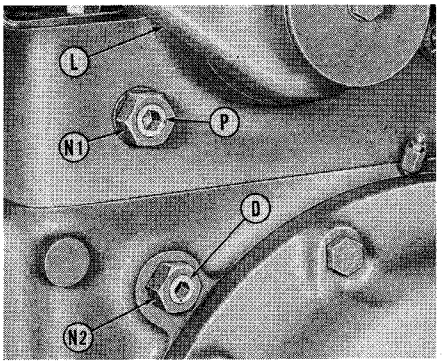


Fig. 211—View showing location of position control eccentric pin (P) and draft control eccentric pin (D) at right rear corner of lift cover and rear axle center housing. Lift shaft arm is (L).

adapter plate (use new gasket between plate and center housing) by reversing removal procedure and observing the following: Take care to be sure that pump opening fits over the intake pipe and install, but do not tighten, adapter plate retaining cap screws. Reconnect brake lines (if so equipped) and reinstall hydraulic pressure tube and pilot pressure tube. Tighten pilot pressure tube fittings to a torque of 20-25 ft.-lbs. Tighten pressure line to lift cover hollow bolt to a torque of 20-25 ft.-lbs. and tighten pressure tube to adapter plate nut to a torque of 50-55 ft.-lbs. Then, tighten adapter plate cap screws to a torque of 30-40 ft.-lbs. Reinstall the remote control valves (if so equipped) using new "O" rings between the valves, adapter plate and manifold and tighten retaining cap screws to a torque of 20-25 ft.-lbs. Reconnect all linkage and reinstall access plate in right fender. Install new external oil filter.

235. If the pump intake pipe and intake filter were removed, or pipe shifted in retainer bracket, reinstall pump and adapter plate separately as follows: Be sure pipe bracket cap screws are tight and separate pump from adapter plate. Position the pump on intake pipe and stick pump to adapter plate "O" rings in counterbores with heavy grease. Install adapter plate with new gasket, taking care not to dislodge the "O" rings, and install adapter plate to pump cap screws. Loosely install the adapter plate cap screws, then tighten pump retaining cap screws to a torque of 20-25 ft.-lbs. Complete remainder of reinstallation procedure as outlined in paragraph 234.

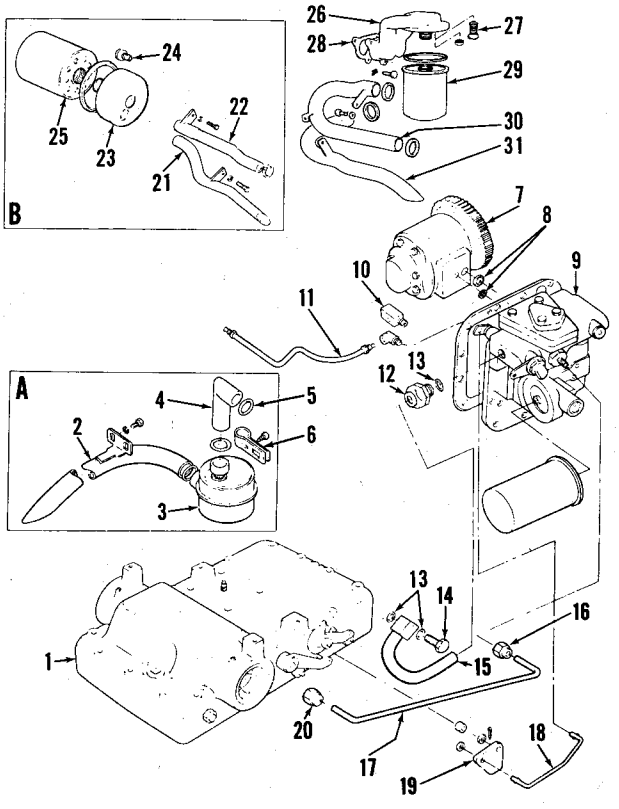
236. **OVERHAUL PUMP.** With pump and adapter plate removed as outlined in paragraph 233, remove pump retaining cap screws and separate pump from adapter plate. Refer to following sections.

237. TW-10 AND TW-20. Refer to Fig. 213 and remove cotter pin and nut securing pump drive gear then remove drive gear using suitable puller. Remove woodruff key from shaft. Remove 16 bolts and lock washers securing front and rear cover to body. Remove rear cover by lightly tapping pump shaft with a rubber mallet. After rear cover is removed, lightly tap gear shafts with mallet to remove front cover. Keep components in order as removed. Remove pressure loading rings (5) and seal rings (4) from front and rear covers (7 and 12).

Carefully clean and inspect all parts. Minor burrs and score marks can be removed using "O" grade emery paper and kerosene. Check gear track wear in pump body. Maximum permissible gear track wear is 0.0025 inch. Maximum runout across gear face to tooth edge is 0.001 inch and width of gears must be within 0.002 inch of each other. Gear journals must be within 0.0005 inch of each other. If wear or scoring is extensive, it is usually more economical to renew pump rather than attempt repairs.

Using new parts as necessary, reassemble pump using new seal and sealing rings by reversing disassembly procedure and observing the following:

Lightly lubricate each component with a high temperature grease to protect pump from heat damage during initial start up. Place front and rear bearings (11) over drive/driven gears (10) making sure recess in each bearing is against gear faces and that relief grooves will be on pump outlet side. Install gears and bearings in pump body (3). Pack shaft seal cavity with high temperature grease. Install front cover (7), then tighten front cover bolts to a torque of 65-70 ft.-lbs. Install woodruff key, drive gear and retaining nut. Tighten retaining nut to a torque of 40-55 ft.-lbs. Install pump as outlined in paragraph 235.



1. Lift cover
2. Pump suction line
3. Intake filter (internal)
4. Intake elbow
5. Seal
6. Intake support clamp

Fig. 212—View showing connections between lift cover and pump adapter plate. Pump (7) mounts on adapter plate (9). Flare nut (20) connects pilot line to pilot pressure sleeve (18—Fig. 221) and hollow bolt (14) connects system pressure tube (15) to pressure sleeve (10—Fig. 221). Components (26 through 31) are used on Models 8700, 9700, TW-10, TW-20 and TW-30; items in insets (A or B) are used on other models.

7. Pump assembly
8. Seal rings
9. Pump adapter plate
10. Dual Power valve
11. Pressure line
12. Pressure line fitting
13. "O" rings
14. Hollow bolt
15. Pressure line
16. Pilot line fitting
17. Pilot line
18. Override link
19. Override arm
20. Pilot line fitting
21. Pickup tube
22. Pump inlet
23. Manifold
24. Valve
25. External inlet filter
26. Manifold
27. Valve
28. Gasket
29. External inlet filter
30. Pump inlet
31. Pickup tube

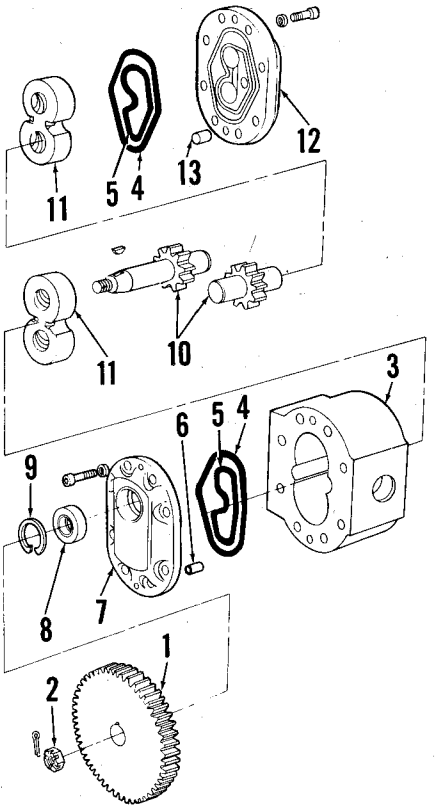


Fig. 213—Exploded view of hydraulic pump assembly used on TW-10 and TW-20 models.

1. Pump drive gear
2. Slotted nut
3. Pump body
4. Outer seal
5. Pressure seal
6. Hollow dowel
7. Front cover
8. Seal
9. Snap ring
10. Gear set
11. Bearing assembly
12. Rear cover
13. Solid dowel

238. TW-30. Refer to Fig. 214 and remove cotter pin and nut securing pump drive gear; remove drive gear (5) using a suitable puller. Remove woodruff key from shaft. Remove five bolt and lock washers holding pump together while noting location of shorter bolt. Remove rear cover (11) by lightly tapping pump shaft with a rubber mallet. After removing rear cover, lightly tap gear shafts with mallet to remove front cover (4). Keep components in order as removed. Minor burrs and score marks can be removed using "O" grade emery paper and kerosene. Check gear track wear in pump body. If excessively worn, replace complete pump. Maximum allowable runout across gear face-to-tooth edge should not exceed 0.00035 inch. Face width of paired gears must be within 0.0005 inch of each other and journal size on each side of individual gear must be within 0.0005 inch of each other. Inspect remaining components and renew as necessary. Lightly lubricate components with high temperature grease to protect pump from heat damage during initial start up.

Install a black pressure pre-load seal (6) in front and rear covers (4 and 11). Install a blue pressure load seal (7) on top of black pressure pre-load seals. Install ring seal (10) in front and rear covers (4 and 11). Install wear plates (8) in covers with bronze side facing out. Note that diamond shaped holes in wear plates are placed over larger holes in front and rear covers. Wear plates fit inside diameters of ring seals (10). Install drive/driven gear (2) in front cover (4) then install pump body (9) over gears making sure dowels enter dowel holes in cover. Install five bolts and washers then tighten to a torque of 35 ft.-lbs. Install woodruff key and pump drive gear. Install retaining nut and tighten to a torque of 40-55 ft.-lbs.; install new cotter key. Install pump as outlined in paragraph 235.

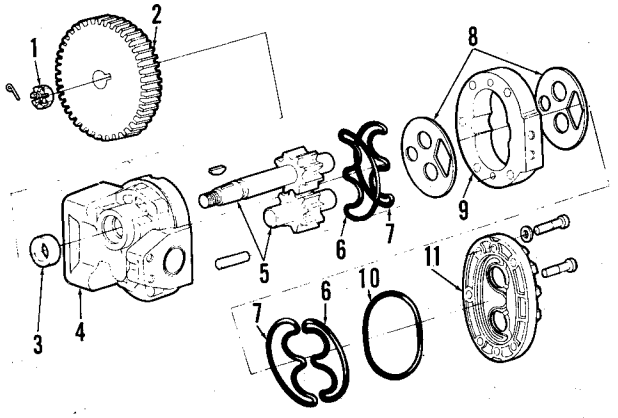


Fig. 214—Exploded view of hydraulic pump used on Model TW-30.

1. Slotted nut
2. Drive/driven gear
3. Shaft seal
4. Front cover
5. Gear set
6. Preload seal (black)
7. Pressure load seal (blue)
8. Wear plate
9. Pump body
10. Ring seal
11. Rear cover

238A. ALL OTHER MODELS. Refer to exploded view of pump assembly in Fig. 215 and proceed as follows:

Straighten tab washer (2), remove nut (1) and washer, pull gear (3) from pump shaft and remove Woodruff key (13). Remove pto pump body (33) from pump rear cover (23) and remove bearing (29) and gears (30 and 31). Unbolt and remove rear cover (23) and remove drive coupling (16). Unbolt and remove front cover (8) and push the bearings (12 and 17) with gears (14 and 15) from pump body (11) as a unit. Remove snap ring (4) and seal (5) from front cover; discard the seal, sealing rings and "O" rings. Remove pto pump pressure relief valve plug (18), washer (19), spring (20) and ball (21).

Separate the bearings and pump gears, keeping the parts in relative position. Carefully clean and inspect all parts. Minor burrs and score marks can

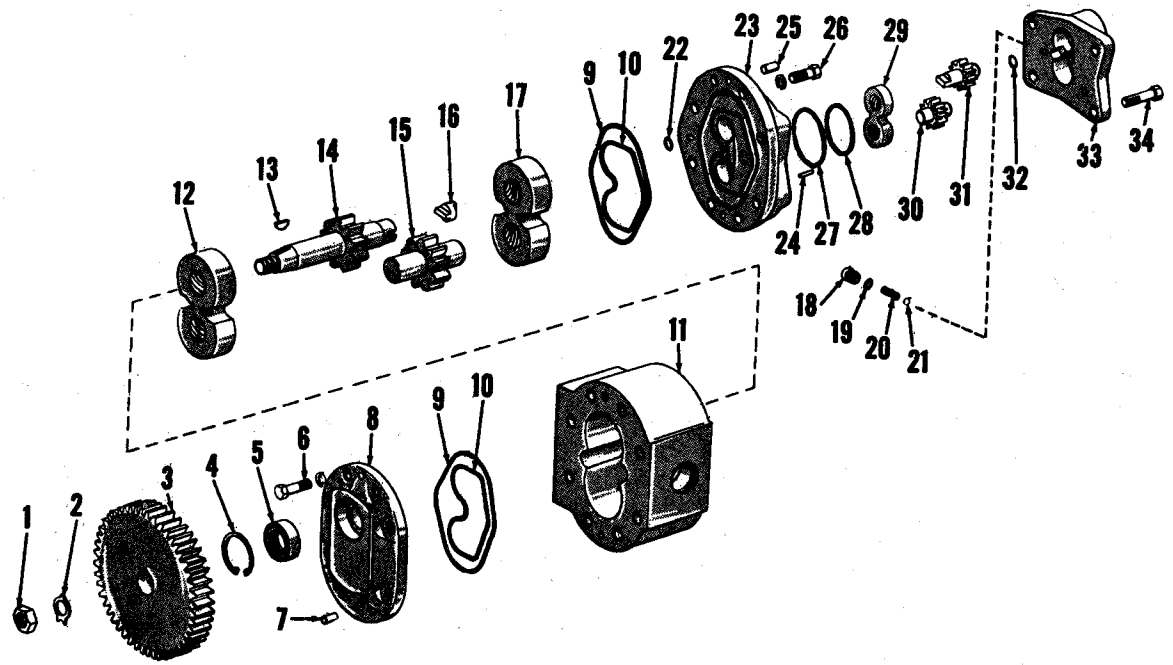


Fig. 215—Exploded view of hydraulic pump assembly for all models except TW-10, TW-20 and TW-30. Pto pump gear (31) is driven by hydraulic system pump gear (14) via coupling (16). Only one bearing (29) is used on pto pump section; body (33) serves as rear bearing.

1. Nut
2. Locking washer
3. Drive gear
4. Snap ring
5. Oil seal
6. Cap screws
7. Dowel pins
8. Front cover
9. Outer sealing ring
10. Inner sealing ring
11. Pump body
12. Front bearing
13. Woodruff key
14. Driven gear
15. Idler gear
16. Drive coupling
17. Rear bearing
18. Plug
19. Washer
20. Relief valve spring
21. Pto relief valve ball
22. "O" ring
23. Rear cover
24. Dowel pin
25. Dowel pin
26. Cap screws
27. Outer sealing ring
28. Inner sealing ring
29. Front pto pump bearing
30. Pto pump idler gear
31. Pto pump driven gear
32. "O" ring
33. Pto pump body
34. Cap screws

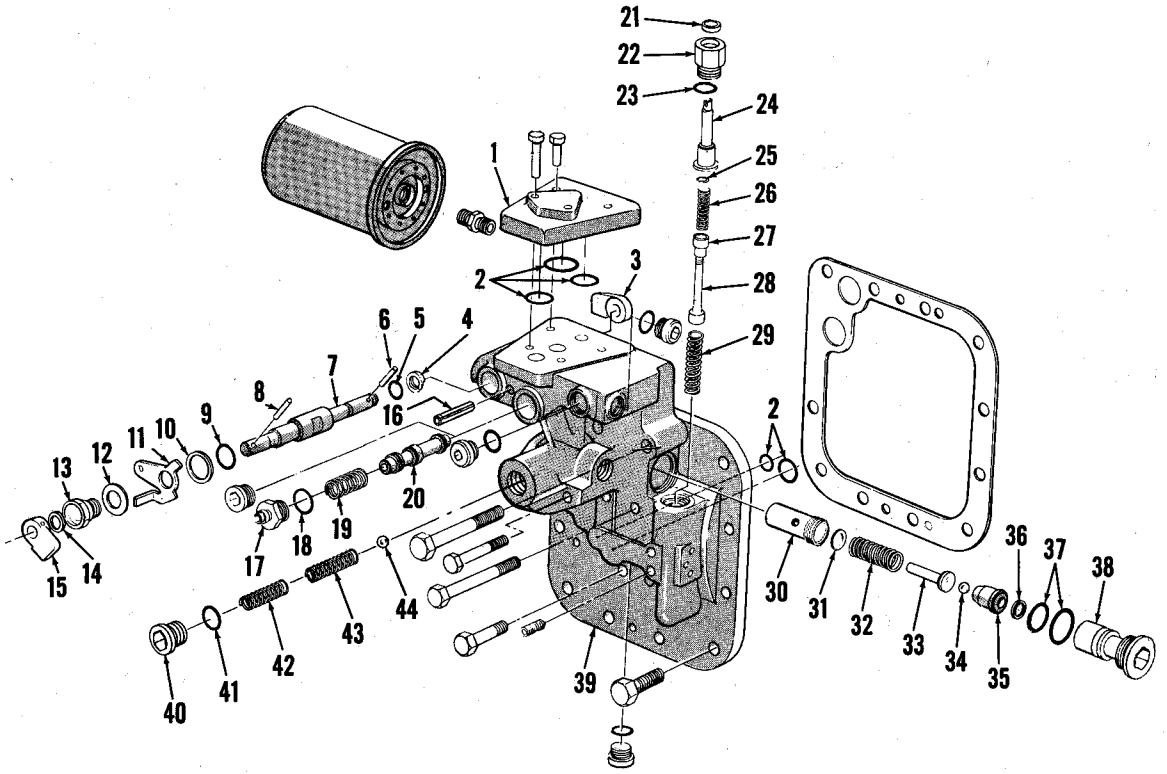


Fig. 216—Exploded view of pump adapter plate and valve assembly. On models equipped with remote control valves, valve units are mounted between adapter plate and manifold (1). Adapter plate (39) is serviced as complete plate and valve assembly only; all other parts are available separately. Flow control valve spool (20) is select fit to bore size in adapter plate. See Fig. 217 for exploded view of pressure relief system used on Models TW-10, TW-20 and TW-30.

1. Manifold
2. "O" rings
3. Variable flow valve arm
4. Back-up washer
5. "O" ring
6. Roll pin
7. Variable flow valve
8. Roll pin
9. "O" ring
10. Friction washer
11. Valve lever
12. Spring washer
13. Gland
14. Shims (as required)
15. Valve arm
16. Roll pin
17. Connector
18. "O" ring
19. Flow control valve spring
20. Flow control valve
21. Seal ring
22. Guide
23. "O" ring
24. Valve rod
25. Snap ring
26. Spring
27. Pressure regulating valve (pto)
28. Differential lock valve
29. Spring
30. Valve cap
31. Shims
32. Relief valve spring
33. Spring guide
34. Relief valve ball
35. Valve seat
36. Seal ring
37. "O" rings
38. Relief valve body
39. Pump adapter plate
40. Retainer
41. "O" ring
42. Spring
43. Ball guide
44. Check ball

be removed using "O" grade emery paper and kerosene. Check gear wear track in pump body, especially at intake side of pump. Maximum permissible gear track wear is 0.0025 inch. Maximum runout across gear face to tooth edge is 0.001 inch and width of gears must be within 0.002 inch of each other. Gear journals must be within 0.001 inch of each other on either side of each gear. If wear or scoring is extensive, it is usually more economical to renew the pump than attempt repairs.

Using new parts as necessary, reassemble pump using new seal and sealing rings by reversing disassembly procedure and observing the following: Install new seal in front cover with lip of seal towards inside of pump. Assemble the pump gears and bearings with relief groove side of bearings towards gears and with "V" notched side of bearings to intake side of pump. Tighten cover and pto pump body retaining cap screws to a torque of 45-50 ft.-lbs. and the gear retaining nut to a torque of 35-40 ft.-lbs. Bend tab of retaining washer against flats on nut. If pump intake pipe and filter were not moved from original position, assemble pump to adapter plate using new "O" rings and tighten cap screws to a torque of 20-25 ft.-lbs.

239. **PUMP ADAPTER PLATE OVERALL.** Refer to exploded view of the pump adapter plate and hydraulic valves in Fig. 216 or 217 and to appropriate following paragraph:

240. DIFFERENTIAL LOCK VALVE. To remove differential lock valve assembly from pump adapter plate, unscrew the valve rod guide (22–Fig. 216). Remove valve rod (24) and guide, then lift out the valve spool (28), regulating valve (27) and spring (26) assembly and withdraw valve return spring (29). Remove snap ring (25) from upper end of valve (28) to remove spring and regulating valve. Remove rod (24) from guide and remove the seal and "O" ring (21 and 23). Carefully clean and inspect all parts including valve bore in pump adapter plate. Renew any worn or damaged parts and reassemble as follows:

Install new seal (21) in guide and place new "O" ring on guide. Lubricate guide and rod (24) and insert rod through guide. Install regulating valve (27), small end first, on valve spool (28), then install spring (26) and snap ring (25). Insert spring (29) in valve bore, then install valve assembly and the actuating rod and guide assembly. Tighten guide securely.

241. PRESSURE RELIEF VALVE **TW-10, TW-20 And TW-30.** To remove hydraulic system relief valve on TW-10, TW-20 and TW-30 models, first remove differential lock valve as outlined in paragraph 240. The relief valve can then be unscrewed and removed from pump adapter plate.

To disassemble relief valve, refer to Fig. 217 and remove snap ring (1) and cap (2); take care not to lose any shims

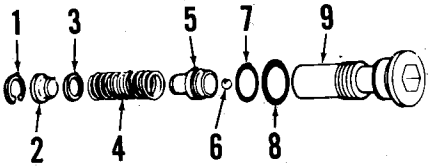


Fig. 217—Exploded view of hydraulic pressure relief valve used on TW-10, TW-20 and TW-30 models.

1. Snap ring
2. Valve cap
3. Shim
4. Valve spring
5. Ball retainer
6. Ball
7. "O" ring
8. "O" ring
9. Relief valve body

(3) or valve ball (6). Carefully clean and inspect all parts. If valve body (9) is damaged beyond further use, a new relief valve assembly will have to be installed. Compare relief valve spring (4) with new spring. If any parts are replaced, system relief pressure should be checked and adjusted as outlined in paragraph 229.

Assemble valve using new "O" rings (7 and 8) and same shims (3) as removed unless necessary to adjust relief pressure. Lubricate "O" rings then reinstall valve in pump adapter plate. Tighten valve securely.

242. **All Other Models.** To remove the hydraulic system pressure relief valve assembly first remove the differential lock valve as outlined in paragraph 240. The relief valve can then be unscrewed and removed from pump adapter plate.

To disassemble relief valve, unscrew cap (30—Fig. 216) from valve body (38); take care not to lose any shims (31) or the valve ball (34). Carefully clean and inspect all parts. If the cap or valve body are damaged beyond further use, a new relief valve assembly must be installed; all other parts are serviced separately. Compare relief valve spring with new spring. If any parts are renewed, system relief pressure should be checked and adjusted as outlined in paragraph 229.

Assemble valve using new seal ring (36) and same shims (31) as removed unless necessary to adjust relief pressure. With valve assembled, install new "O" rings (37) on valve body, lubricate the "O" rings and reinstall valve in pump adapter plate. Tighten valve securely.

243. FLOW CONTROL VALVE. The flow control valve (20—Fig. 216) can be removed from bore in pump adapter plate after removing connector fitting (17) and spring (19). If valve is stuck in bore, it may be removed by threading a puller screw into internal threads in outer end of valve spool.

The flow control valve is a selective fit in bore in pump adapter plate and should have a clearance of 0.0005-0.0011 inch in bore. The valves and pump adapter plate are color coded for size identification; refer to the following chart:

VALVE BORE IDENTIFICATION

Color Code	Valve Bore I.D. [in.]
Blue/white	0.9376-0.9379
White	0.9379-0.9382
Blue	0.9382-0.9385
Yellow	0.9385-0.9388
Green	0.9388-0.9391

VALVE SPOOL IDENTIFICATION

Color Code	Valve Spool O.D. [in.]
Blue/white	0.9368-0.9371
White	0.9371-0.9374
Blue	0.9374-0.9377
Yellow	0.9377-0.9380
Green	0.9380-0.9383

Lubricate valve spool and insert in bore with hollow end first (tapped end out), then install spring and connector fitting with new "O" ring (18). Tighten connector fitting securely.

244. VARIABLE FLOW VALVE. To remove variable flow valve (7—Fig. 216), proceed as follows: Drive the roll pins (6 and 8) from each end of valve and remove the arms (3 and 15). Remove shims (14) if so equipped. Unscrew gland (13) and remove friction washer (10), lever (11) and spring washer (12); discard "O" ring (9). Push valve out towards outside of adapter plate and remove the two "O" rings (5) and back-up rings (4) from valve. Clean and inspect all parts and renew any excessively worn or damaged parts. Reassemble using new "O" rings and back-up rings as follows:

Install a new "O" ring (5) on each end of valve, then install back-up ring at outside of each "O" ring. Lubricate valve and bore and install valve with flow control notch up and long end of valve towards inside of adapter plate. Place the spring washer (12), lever (11) and friction washer (10) on gland and install new "O" ring (9) on gland shoulder. Install the gland over valve shaft and into adapter plate; tighten gland securely. Reinstall shims (14), if so equipped, unless arm (15), gland (13) and/or valve (7) have been renewed. If a new arm, gland and/or valve have been installed, install arm (15) without shims and check end play of valve. If end play is more than 0.012 inch, remove arm and install shims as necessary. Shims are available in thicknesses of 0.012 and 0.024 inch. Be sure valve does not bind after reinstalling arm.

LIFT COVER, CYLINDER AND CONTROL VALVE

245. **R&R LIFT COVER, CYLINDER AND VALVE ASSEMBLY.** Because of construction differences, refer to the appropriate following paragraphs for removal notes. Paragraphs 246 and following describe procedure for 8000, 8600, 9000 and 9600 models; paragraphs following 247 describe removal for 8700, 9700, TW-10, TW-20 and TW-30 models.

246. Proceed as follows to remove the lift cover (with cylinder and valve attached) from 8000, 8600, 9000 and 9600 models: Remove battery cover and disconnect battery ground cable. Unbolt and remove seat assembly from operator's platform. Unbolt and remove both fenders. Loosen set screws in console control lever handle and remove the handles. Unbolt console and lift off from over the control levers. Shut off fuel supply valve, disconnect fuel line at valve and disconnect fuel gage sender wire at tank. Drain fuel tank to lighten as necessary, then unbolt and lift tank from mounting plate. Unbolt and remove fuel tank mounting plate and cover plate from top of lift cover. Unbolt remote control hose bracket from rear end of lift cover and allow remote hoses to hang over right axle housing. Disconnect control linkage from remote control valves, lift cover and flow control valve. Remove the hydraulic system pressure tube and the pilot pressure tube connecting lift cover to hydraulic pump adapter plate. Disconnect pto control cable at lower end and unbolt control cable bracket. Unbolt control lever support and lift off the support and control levers with linkage and pto cable attached. Disconnect rear (trailer) light socket and disconnect lift rods from cross-shaft lift arms. Bolt lifting fixture or plate to the lift cover, then unbolt lift cover from rear axle center housing. Using a hoist, raise the lift cover, cylinder and valve assembly from rear axle center housing. Set assembly on work bench with front end down and support unit to keep it from tipping while performing service work on the cylinder, control valve and/or linkage.

To reinstall lift cover assembly, place new gasket on the lift cover, then with hoist attached so that lift cover is level, lower the unit onto rear axle center housing so that roller on draft control linkage enters draft control lever yoke and dowels in lift cover enter mating holes in rear axle center housing. Reinstall remote control hose bracket, control lever support with levers and linkage and the pto cable bracket. Install remaining lift cover retaining cap screws and tighten all cap screws to a torque of 95-130 ft.-lbs. If lift cylinder was removed from cover, tighten the four lift cylinder attaching cap screws to a torque of 200-240 ft.-lbs. at this time. Complete balance of reassembly by reversing removal procedure and observing the following: Tighten pilot pressure tube nuts to a torque of 20-25 ft.-lbs. Tighten the hollow bolt retaining system pressure line to lift cover to a torque of 20-25 ft.-lbs. and the nut at pump adapter plate end of pressure line to a torque of 50-55 ft.-lbs.

247. To remove the lift cover from 8700, 9700, TW-10, TW-20 and TW-30 models, first remove the cab or platform as follows: Remove screws retaining gearshift boot, raise boot, loosen gearshift lever clamps and detach gear-

shift levers. On models equipped with Dual Power, control pedal assembly and linkage should be removed to prevent damage. Disconnect and cap brake lines. Disconnect engine clutch linkage. Disconnect wires, hoses, tubing or linkage which will interfere with cab or platform removal. On cab equipped models, remove scuff plates in door openings, remove access plates and unscrew front cab mounting bolts being careful not to lose shims. Remove bolts securing front of platform on models so equipped. Unscrew bolts securing rear of cab or platform to rear axle housing and using a suitable hoist lift cab or platform away from tractor.

Disconnect tubes from remote valves and remove quick coupler bracket and tubes from lift cover. Remove pto control rod, lever and bracket assembly from lift cover on TW-10, TW-20 and TW-30 models. Detach lift rods from lift arms. Disconnect pressure line (15—Fig. 212), pilot pressure line (17) and override link (18). Bolt lifting fixture or plate to the lift cover, then unbolt lift cover, cylinder and valve assembly from rear axle center housing. Set assembly on work bench with front end down and support unit to prevent tipping while performing service work.

To reinstall lift cover assembly, place a new gasket on lift cover then with hoist attached so that lift cover is level, lower the unit onto rear axle center housing so that roller on draft control linkage enters draft control lever yoke and dowels in lift cover enter mating holes in rear axle center housing. Tighten lift cover retaining bolts to a torque of 95-130 ft.-lbs. on 8700-9700 models and to 140-170 ft.-lbs. on TW-10, TW-20 and TW-30 models. Complete remainder of reassembly by reversing disassembly procedure. If lift cylinder was removed from cover, tighten lift cylinder attaching cap screws to a torque of 200-240 ft.-lbs. on 8700-9700 models and to 250-310 ft.-lbs. on TW-10, TW-20 and TW-30 models. Tighten pilot pressure tube nuts to a torque of 20-25 ft.-lbs. Tighten hollow bolt retaining system pressure line to lift cover to a torque of 20-25 ft.-lbs. and the nut at pump adapter plate end of pressure line to a torque of 50-55 ft.-lbs. Tighten platform retaining bolts to a torque of 100-120 ft.-lbs. or cab retaining bolts to a torque of 200-240 ft.-lbs.

250. **OVERHAUL CONTROL VALVE.** With the lift cover removed as outlined in paragraph 246 or 247, remove the control valve assembly as follows: Remove the pilot pressure tube connecting sleeve (18—Fig. 221) and pressure sleeve (10). Remove the four cap screws (33) retaining lift cylinder to cover and remove the cylinder and control valve as an assembly. Unbolt control valve block from the lift cylinder. To disassemble control valve unit, refer to exploded view in Fig. 219 and proceed as follows:

Unscrew plug (17) and remove poppet spring (19), ball seat (20), ball (21), drop valve poppet (22) and poppet actuator (23). Unscrew plug (31) and remove spring type valve ball guide (29), check valve spring (28) and check valve ball (27). Unscrew control valve bushing (43) and remove bushing along with control valve (44), valve keeper (40), spring (45) and spring seat (46). Withdraw valve and keeper from bushing. Remove snap ring (47), spring seat and spring from bushing. Unscrew plug (39) and remove exhaust valve pressure spring (37), exhaust pressure valve (36), exhaust valve control spring (35) and exhaust control valve (34). Carefully clean and inspect all parts and renew any that are scored, excessively worn or damaged. If valve body (24) is worn or damaged beyond further use, a complete new valve assembly must be installed; all other parts are available separately. If necessary to renew control valve, insert a 1/8-inch diameter rod through hole in valve (44) and unscrew keeper (40). If keeper threads into new valve freely, either renew keeper or treat threads with Grade A "Loctite" on reassembly.

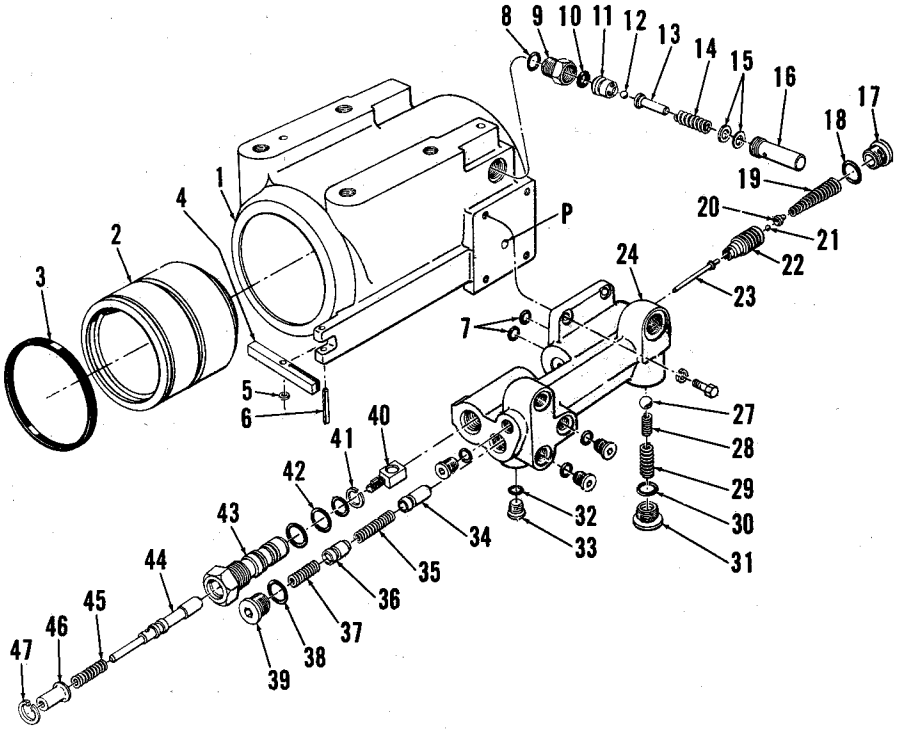


Fig. 219—Exploded view showing hydraulic lift cylinder and control valve assemblies. Cylinder and control valve are removed as a unit, then control valve body can be unbolted from cylinder. When in fully raised position, piston (2) skirt contacts pivot arm (4) moving control valve (44) to neutral position. Safety valve (items 8 through 16) limits pressure in lift cylinder to 2650-2750 psi, thus preventing damage due to shock loads.

P. Pressure port
1. Lift cylinder
2. Piston
3. Piston ring
4. Shut-off pivot arm
5. Washer
6. Roll pin
7. "O" rings
8. "O" ring
9. Safety valve body
10. Seal ring
11. Valve seat
12. Valve ball
13. Spring guide
14. Safety valve spring
15. Shims
16. Valve cap
17. Plug
18. "O" ring
19. Drop poppet spring
20. Spring & ball seat
21. Drop poppet ball
22. Drop poppet valve
23. Actuator rod
24. Control valve body
27. Check valve ball
28. Check valve spring
29. Spring type guide
30. "O" ring
31. Plug
32. "O" rings
33. Passage plugs
34. Exhaust control valve
35. Exhaust valve spring
36. Exhaust pressure valve
37. Exhaust pressure spring
38. "O" ring
39. Plug
40. Control valve keeper
41. Back-up ring
42. "O" rings
43. Control valve bushing
44. Control valve spool
45. Control valve spring
46. Spring seat
47. Snap ring

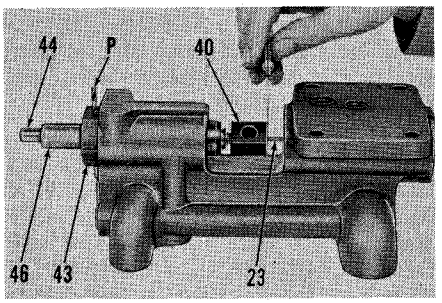


Fig. 220—Checking adjustment of valve keeper (40). Position control valve spool (44) so that a 1/8-inch diameter pin or drill bit (P) can be inserted through spool and bushing (43), then measure gap between keeper and actuator rod (23) for drop poppet. Control valve spring seat is (46).

Reassemble valve unit by reversing disassembly procedure and using all new "O" rings. Tightening torques are as follows: (All values are in ft.-lbs.)

Control valve bushing.....120-150
Drop poppet plug 80-100
Exhaust valve plug 60-70
Check ball plug 80-100

After reassembly, adjust control valve keeper as follows: Insert a 1/8-inch diameter pin or drill bit through hole in control valve bushing and valve as shown in Fig. 220. Then measure gap between keeper (40) and drop poppet actuator (23) with feeler gage. Turn keeper into or out of control valve to obtain a gap of 0.012-0.016 inch between keeper and actuator. When proper gap is obtained, remove pin or drill bit.

Assemble valve block to cylinder using new "O" rings and tighten cap screws to a torque of 20-25 ft.-lbs.

251. **OVERHAUL SAFETY VALVE.** With lift cylinder removed as outlined in paragraph 246 or 247, unscrew the safety valve body (9—Fig. 219) from cylinder and remove valve assembly from lift cylinder. With appropriate adapters, connect valve assembly to pressure test pump. Valve should pop open at 2650-2750 psi, and should not leak at below pop-off pressure. If valve leaks or pop-off pressure is not correct, disassemble valve by unscrewing cap (16) from body. Inspect valve ball and seat and compare free length of spring with that of new spring. Assemble valve using new seal (10) and other parts as necessary and recheck for leakage and pop-off pressure. Vary shims (15) as required to obtain 2650-2750 psi pop-off pressure. Shims are available in thicknesses of 0.010-0.014 and 0.022-0.026 inch. Reinstall valve assembly using new "O" ring and tighten securely.

252. **LIFT CYLINDER AND PISTON.** With lift cylinder removed as outlined in paragraph 246 or 247, remove the control valve assembly (see paragraph 250) and the control valve arm pivot roll pin (6—Fig. 219), arm (4) and washer (5). Using low air pressure applied at fluid passage (P) in cylinder, force piston from cylinder.

CAUTION: A sudden blast of air pressure will eject the piston at a dangerous speed.

Remove piston ring (3) and inspect piston and cylinder bore for scoring. Renew cylinder and/or piston if not suitable for further service. Install new piston ring, lubricate piston, seal and cylinder with hydraulic fluid and install piston, closed end first, into cylinder.

253. **LIFT COVER, LIFT SHAFT AND RELATED LINKAGE.** With lift cover removed as outlined in paragraph 246 or 247 and with cylinder and control valve removed from cover, refer to exploded views in Figs. 221 and 222, then proceed as follows:

254. CONTROL LINKAGE. Remove snap ring (31—Fig. 221) from eccentric pin (29), snap ring (4) from control lever shaft (5) and clevis pin (68—Fig. 222) from selector shaft (24), then remove the spring loaded actuator rod with control lever (65), position control arm (30) and draft/position control guide (51) assembly from lift cover. If necessary to disassemble spring loaded actuator rod, loosen locknut (N) and unscrew hex rod (58) from yoke (57). Remove internal snap ring (59) from sleeve (63) and withdraw hex rod with spring (61) and bushings (60). Remove snap ring (62) from rod and remove the spring and bushings. To disassemble draft/position guide assembly, refer to Fig. 223 and drive out retaining pins (49) to remove draft roller (53) and pin (54) and the position control lever pin (52). Remove pins (50) to remove detent spring mounting pins (45), spring (46) and spacer (47). Drive out pin (55) and remove yoke pin (56) and yoke (57) from guide (51).

To remove control lever shaft (5—Fig. 221), remove nut (14), lever (13), Woodruff key (12) and friction disc (11), then withdraw shaft from inside of cover and remove the two flat washers (6) and spring (7) from shaft.

To remove selector lever shaft (24), remove snap ring (17), lever (16) and Woodruff key (25), then withdraw shaft from inside cover.

The position control eccentric pin (29) can be removed after removing nut (27) and lockwasher (28) from outer end of pin and driving the retaining pin (32) from cover.

Reassemble linkage and reinstall in cover by reversing disassembly procedure and using Figs. 221, 222 and 223 as a guide. Length (L—Fig. 224) of the spring loaded actuator rod must be adjusted to 13-49/64 to 13-51/64 inches from center to center of pin holes as shown in Fig. 224. To adjust length, loosen locknut (N) and turn hex rod (58) in or out of yoke (57), then tighten locknut.

255. LIFT SHAFT, LIFT CYLINDER ARM AND BEARINGS. With

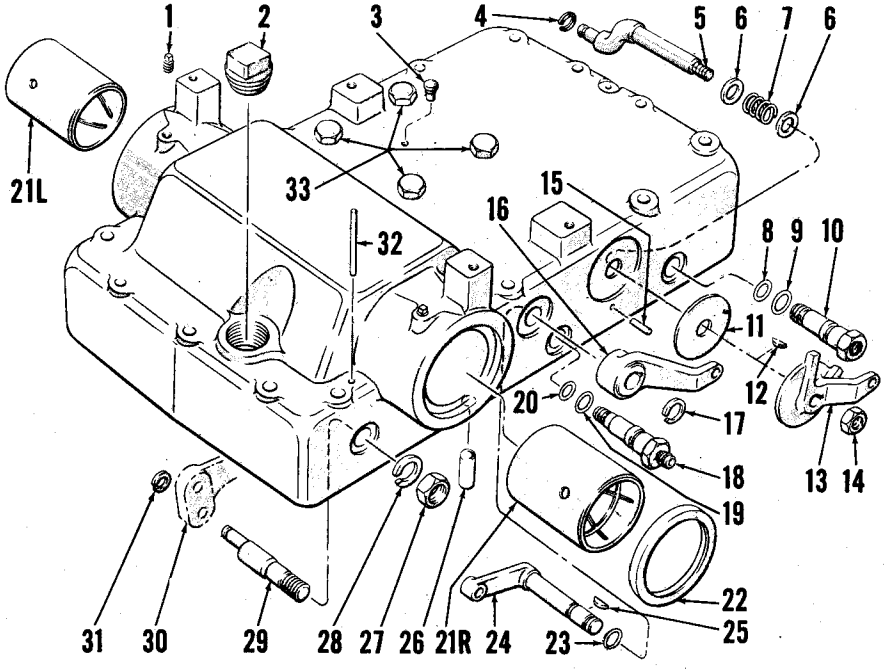


Fig. 221—Exploded view of hydraulic lift cover. Pressure sleeve (10) and pilot sleeve (18) thread into control valve body (24—Fig. 219). Control lever friction disc (11) keeps lever in desired position; spring (7) is adjusted by tightening nut (14). Cap screws (33) retain lift cylinder to cover.

1. Pipe plugs
2. Filler plug
3. Breather
4. Snap ring
5. Control lever shaft
6. Washers
7. Friction disc spring
8. "O" ring
9. "O" ring
10. Pressure sleeve
11. Friction disc
12. Woodruff key
13. Control lever
14. Friction adjusting nut
15. Override lever pin
16. Selector lever
17. Snap ring
18. Pilot sleeve
19. "O" ring
20. "O" ring
21. Lift shaft bushings (L, left; R, right)
22. Lift shaft seal (right)
23. "O" ring
24. Selector shaft & arm
25. Woodruff key
26. Dowel pins
27. Locknut
28. Lockwasher
29. Position control eccentric
30. Position control arm
31. Snap ring
32. Retaining pin
33. Cap screws

control linkage removed as outlined in paragraph 254, remove cap screws (40—Fig. 222) from each end of lift shaft (36) and remove the lift arms (39). Inside diameter of left bushing (21L—Fig. 221) is larger than inside diameter of right bushing; therefore, shaft must be removed out left side of cover. Disengage snap rings (37—Fig. 222) at each side of lift cylinder arm (38) and bump shaft to left side of cover until the lift cylinder arm and snap rings can be removed from shaft, then withdraw shaft from cover.

The bushings (21L and 21R—Fig. 221) and shaft seals (22) can be removed from cover after removing lift shaft. Install new bushings with suitable driver, then install new seals with lips of seals inward.

NOTE: It is not necessary to remove lift shaft to renew seals; remove seals by drilling small hole in seal case, thread a metal screw welded to adapter in hole and pull seal with slide hammer.

When reinstalling lift shaft, note that index marks on shaft must be aligned with index mark on lift cylinder arm and index mark on each lift arm. Lift arms are interchangeable from right to left. Tighten cap screw (40—Fig. 222) in each end of lift shaft to a torque of 65-85 ft.-lbs.

256. LIFT COVER. To renew lift cover, remove the linkage and lift shaft from old cover as outlined in paragraph 254 and 255, then install the linkage and lift shaft in new cover. New cover is fitted with lift shaft bushings, right seal and dowel pins (26—Fig. 221).

LOWER LINK HANGERS TORSION BAR AND DRAFT CONTROL LINKAGE

257. **TORSION BAR.** To remove torsion bar (12—Fig. 225), proceed as follows: Remove cap screw (15) and lockwasher from right end of torsion bar. Unbolt left lower link pin and remove pin and lift link. Unbolt and remove torsion bar anchor (11), then withdraw bar from lift link hanger (3). If bar is broken or seized, remove snap ring (14) and flat washer (13) from right end of lift hanger (3), then use suitable drift to drive bar out to left side.

Install torsion bar by reversing removal procedure. Tighten anchor retaining cap screws to a torque of 50-60 ft.-lbs. and cap screw (15) in right end of bar to a torque of 20-25 ft.-lbs.

258. **LOWER LINK HANGERS.** To remove right lower link hanger (9—Fig. 225), remove right link pin and link from hanger, then remove retaining snap ring (10) and remove right hanger from right end of left hanger (3).

To remove left lower link hanger, first remove lift cover as outlined in paragraph 246 or 247 and remove torsion bar as in paragraph 257, then proceed as follows: Remove snap ring (10) and pull right hanger off right end of left hanger. Loosen locknut (N) and remove set screw (S) from draft control arm (7). Pull left lower link hanger out far enough to remove draft control arm and Woodruff key (4), then remove hanger from rear

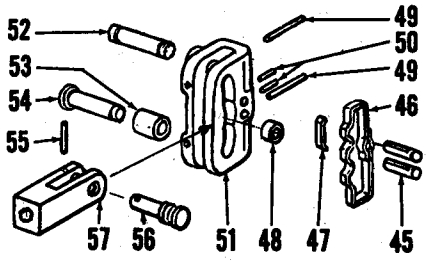


Fig. 223—Exploded view of draft/position control guide and detent mechanism. Head of pin (56) detents in notches formed in spring (46). Spring is mounted in split pins (45) which are retained in guide (51) by roll pins (50). Roller (53) engages yoke on draft control lever (18—Fig. 226).

45. Split pins
46. Detent spring
47. Spring spacer
48. Roller for pin (56)
49. Roll pins
50. Roll pins
51. Guide
52. Position control pin
53. Roller
54. Draft control pin
55. Roll pin
56. Yoke pin
57. Actuator rod yoke

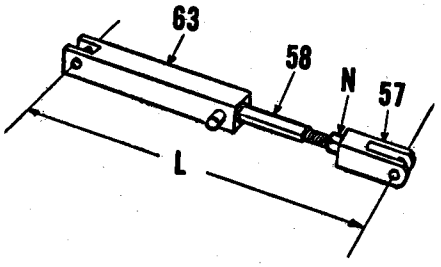


Fig. 224—Length (L) of assembled actuator rod must be adjusted to 13-49/64 to 13-51/64 inches. To adjust, loosen locknut (N) and turn hex rod (58) in yoke (57). Hollow actuator sleeve is (63).

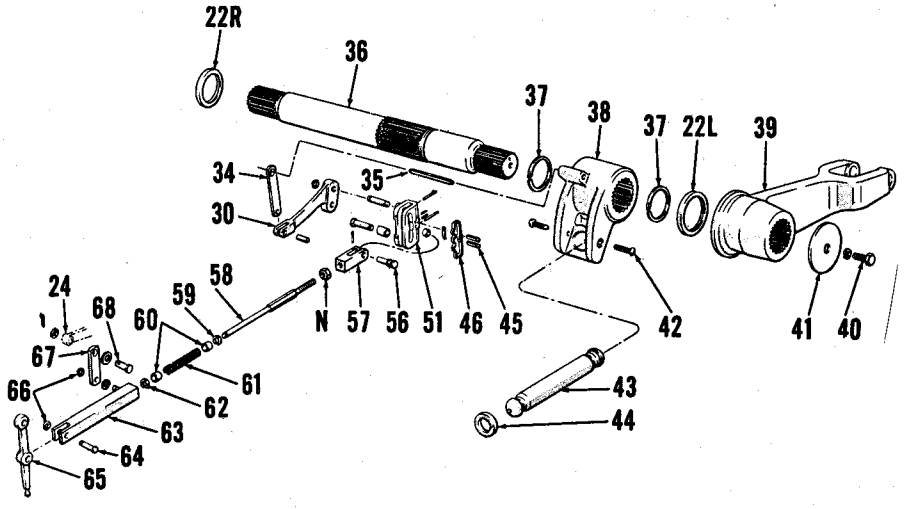


Fig. 222—Exploded view showing lift shaft and control linkage as removed from lift cover. Refer also to Fig. 223 for exploded view of selector detent mechanism and to Fig. 224 for adjustment of control valve actuator link. Bumper ring (44) on piston rod (43) prevents rod from striking cylinder if lift arms are raised with piston in forward (lowered) position.

N. Locknut
22. Lift shaft seals (L, left; R, right)
24. Selector shaft arm
30. Position control arm
34. Position control link
35. Spring pin
36. Lift shaft
37. Snap rings
38. Lift cylinder arm
39. Lift arms
40. Cap screws
41. Retaining washers
42. Round head groove pins
43. Lift piston rod
44. Bumper ring
45. Detent spring pins
46. Detent spring
51. Guide
56. Pin
57. Yoke
58. Hex rod
59. Internal snap ring
60. Bushings
61. Spring
62. External snap ring
63. Actuator sleeve
64. Pin
65. Control valve lever
66. Snap rings
67. Selector arm link
68. Clevis pin

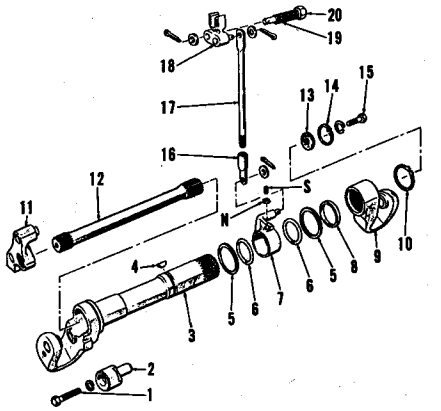


Fig. 225—Exploded view showing torsion bar, lower link hangers and draft control linkage. Refer to Fig. 226 for adjustment of draft control link (16 and 17), and to Fig. 208 for adjustment of hanger stop (2).

1. Cap screw
2. Hanger stop eccentric
3. Left lower link hanger
4. Woodruff key
5. Washers
6. "O" rings
7. Draft control arm
8. Spacer
9. Right lower link hanger
10. Snap ring
11. Torsion bar anchor
12. Torsion bar
13. Flat washer
14. Snap ring
15. Cap screw
16. Link end
17. Draft control link
18. Draft control lever
19. Eccentric pin
20. Locknut

axle center housing. Reverse removal procedure to install hanger.

259. **DRAFT CONTROL LINKAGE.** To service draft control linkage shown in Fig. 225, lift cover and cylinder assembly must first be removed as outlined in paragraph 246 or 247. The eccentric pin (19), lever assembly (18) and link (16 and 17) can then be removed. To remove draft control arm (7), follow procedure outlined in paragraph 258 for removal of left lower link hanger (3).

When draft control linkage is reassembled and prior to reinstalling lift cover, the link (16 and 17) must be adjusted for proper length as follows: Turn eccentric pin (19) so that eccentric is in "up" position. Measure distance (D—Fig. 226) between center of dowel pin hole (H) in rear axle center housing to center of yoke in lever (18). If distance (D) does not measure 5-5/8 inches, back out eccentric pin until lever can be removed from pin and turn link rod (17) into link end (16) if measurement is less than 5-5/8 inches, or out of link end if measurement exceeds 5-5/8 inches.

REMOTE CONTROL VALVES

Remote control valves for operation of remote cylinders may be installed between manifold (1—Fig. 227) and top face of hydraulic system pump adapter plate. The valve spools have detents for lift, lowering and float positions. When in either lift or lowering detent position, a pop-off valve releases the spool detent before pressure in remote cylinder reaches hydraulic system relief pressure. The valve must be moved manually from float detent position. Flow of early remote valves was determined by system volume. Later model valves have a flow control valve knob which may be used to vary the volume of flow to a remote cylinder.

260. **CHECK AND ADJUST REMOTE CONTROL VALVE DETENT PRESSURE. Early type without flow control valve.** With pressure gage installed at quick coupler remote cylinder connection, start engine and adjust engine speed to 700 rpm, then pressurize remote line in which gage is installed by moving control lever to raising or lowering position. Lever should return to neutral position as gage pressure reaches 2000-2300 psi. Check remaining valve (if equipped with two valves) by moving gage to proper hose quick coupler connection.

If control lever will not return to neutral within specified pressure reading, adjust detent pop-off pressure as follows: Using a short screwdriver, pry rubber plugs (1—Fig. 228) from valve end caps (3) and turn screws (12) in to increase, or out to decrease pressure.

261. **CHECK AND ADJUST REMOTE CONTROL VALVE DETENT PRESSURE. Late type with flow control valve.** With pressure gage installed at quick coupler remote cylinder connection, start engine and adjust engine speed to 1000 rpm on 8700 and 9700, 1500 rpm on TW-10, TW-20 and TW-30, or 700 rpm on all other models. Pressurize remote line in which gage is installed by moving control lever to raising or lowering position. Lever should return to neutral position as gage pressure reaches 2000-2300 psi on 8000, 9000, 8600 and 9600 models and 1900-2200 psi on all other models. If equipped with more than one remote valve, move gage to proper hose quick coupler connection and repeat test.

If control lever will not return to neutral within specified pressure reading, adjust detent pop-off pressure as follows: Remove end cap (27—Fig. 229). Unscrew detent guide (20) from valve spool (31) and remove detent assembly (15 through 26) as a unit. Using an Allen wrench, adjust screw (28) in to increase pop-off pressure. Reassemble detent unit into valve and retest.

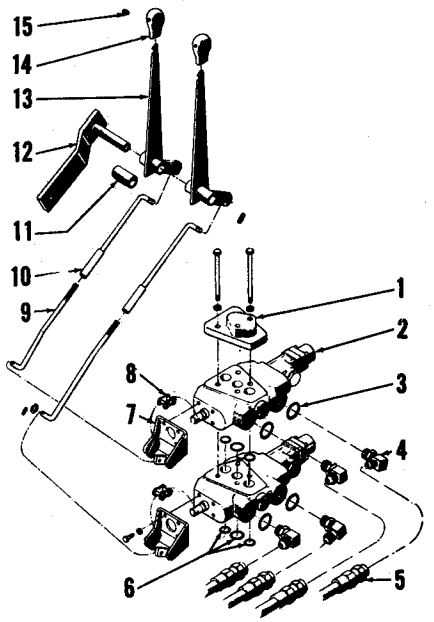


Fig. 227—Remote control valves (2) are mounted between manifold (1) and pump adapter plate top surface. Lever position is adjusted by shortening or lengthening links (9 and 10) to align levers with detent positions of valve. Early valve without adjustable flow control is shown.

1. Manifold
2. Remote control valves
3. "O" rings
4. Remote hose fittings
5. Remote hose
6. "O" rings
7. Bellcrank brackets
8. Connecting links
9. Lower control rod
10. Upper control rod
11. Spacer (single valve)
12. Lever bracket
13. Control levers
14. Lever knobs
15. Set screws

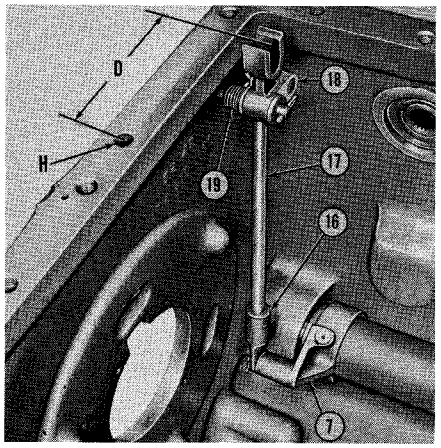


Fig. 226—With eccentric pin (19) in "up" position, adjust link (17) by turning link into or out of link end (16) so that distance (D) between center of dowel hole (H) in rear axle center housing to center of draft control lever yoke is 5-5/8 inches. Control arm is (7).

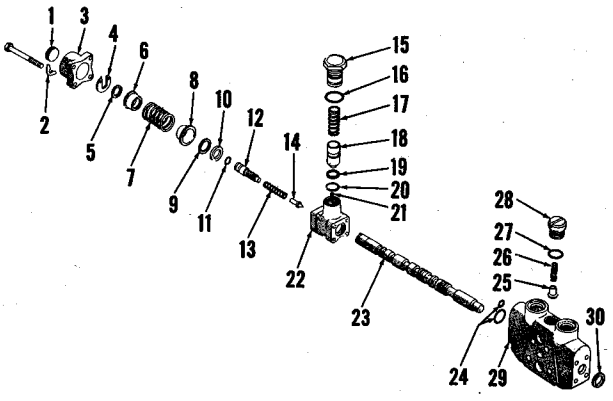


Fig. 228—Exploded view of remote control valve without adjustable flow control valve. Detent pop-off adjusting screw (12) threads into end of valve spool (23). When valve (14) pops-off, pressure lifts detent plunger (18) allowing valve to return to neutral position.

1. Rubber plug
2. Cap screw locks
3. End cap
4. Spool stop
5. Snap ring
6. Stop collar
7. Centering spring
8. Stop collar
9. Teflon back-up ring
10. Quad seal ring
11. "O" ring
12. Adjusting screw
13. Spring
14. Poppet valve
15. Plug
16. "O" ring
17. Detent spring
18. Detent plunger
19. "O" ring
20. Back-up ring
21. Detent ball
22. Detent housing
23. Valve spool
24. "O" rings
25. Check valve poppet
26. Spring
27. "O" ring
28. Plug
29. Valve body
30. Quad seal ring

262. **ADJUST REMOTE CONTROL VALVE LEVER LINKAGE.** The links (9 and 10—Fig. 227) may be shortened or lengthened as necessary to align lever with markings on console when remote control valve is in raise, lower or float detent position. Disconnect lower rod (9) from bellcrank on remote valve bracket (7) and turn rod into or out of upper rod (10) as necessary for proper lever alignment.

263. **R&R REMOTE CONTROL VALVES.** To remove the remote control valve, first remove access panel from right fender, then proceed as follows: Disconnect the remote hoses (5—Fig. 227) from valve fittings (4) and remove the fittings if desired. Plug all openings and disconnect control lever rods (9) from bellcranks on brackets (7). Back out the cap screws retaining manifold (1) and valves (2) to pump adapter plate and slide the valves and manifold unit outward. Separate the manifold and remote valves and cover openings in pump adapter plate.

Reinstall valves by reversing removal procedure and using all new "O" rings. Tighten the cap screws retaining manifold and valves to pump adapter plate to a torque of 20-25 ft.-lbs. Tighten the fitting jam nuts to a torque of 45-55 ft.-lbs.

264. **OVERHAUL REMOTE VALVE UNIT.** Remove linkage bracket (7—Fig. 227) then refer to Fig. 228 or Fig. 229 for guide to disassembly. Count turns required to remove adjusting screw (12—Fig. 228 or 28—Fig. 229), so setting may be duplicated during assembly.

CAB

265. **REMOVE AND REINSTALL.** To remove and reinstall cab on all models so equipped, remove hood, grill panels, grill, precleaner, muffler and hood. On TW-30 models also remove cowl panel next to cab, air intake and turbo grill. Disconnect following components on all models: negative battery cable, a-c receiver/dehydrator, if so equipped, pto cable at axle housing, hydraulic lift control rod, system selector rod, remote control rods, flow control rod and remote cylinder flow control cables. Unhook differential lock link pedal linkage. Unplug main electrical harness and windshield washer harness. Note that washer wire is grey with yellow stripe on tractors with C prefixed serial numbers while tractors with A or B numbers have a green wire with black stripe.

Disconnect brake lines at master cylinder, throttle cable, tachometer cable and fuel shut off cable at fuel injection pump. Let cables hang from front of cab. Close heater valves and remove hoses. Mark and remove power steering hoses, brake lines and clutch linkage. Remove roof retaining bolts and attach Ford spreader bar tool No. 2420 or similar lifting device to cab. Remove gear shift levers, Dual Power foot pedal and control rod. Remove scuff plates then lift floor mat and remove mounting bolt access plates and front mounting bolts.

NOTE: Front mounts may have shims between cab rails and insulators. Identify shims for proper reinstallation.

Remove any remaining components that will interfere with cab removal then remove rear mount bolts and raise cab using suitable hoist making sure cab doesn't bind.

To install cab reverse removal procedure. Torque front mounting bolts to 180-220 ft.-lbs. then tighten rear bolts to a torque of 200-240 ft.-lbs.

NOTE: Shims are placed on top of front mount insulators. Reconnect and adjust linkages and hoses as necessary. Purge air from power steering system.

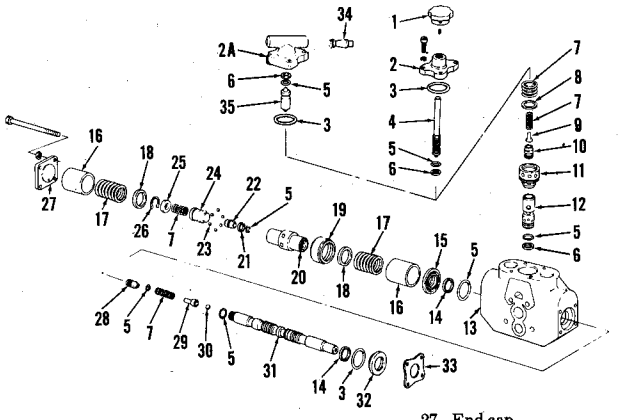


Fig. 229—Exploded view of late remote control valve with adjustable flow control valve. Detent pop-off adjusting screw (28) threads into valve spool (31). Components (2A, 34 and 35) are used on 8700, 9700, TW-10, TW-20 and TW-30 models.

1. Knob
2. & 2A. Flow control cap
3. Seal
4. Adjuster valve
5. "O" ring
6. Back-up washer
7. Spring
8. Washer
9. Relief poppet
10. Flow valve piston
11. Flow valve sleeve
12. Flow valve guide
13. Valve body
14. Quad seal ring
15. Plate
16. Sleeve
17. Centering spring
18. Stop
19. Detent ring
20. Detent guide
21. Detent seal
22. Piston end
23. Detent ball (7)
24. Detent piston
25. Spacer
26. Snap ring
27. End cap
28. Detent adjusting screw
29. Valve seat
30. Adjusting valve seat
31. Valve spool
32. Valve plate
33. Retainer
34. Adjuster
35. Poppet

NOTES