SHOP MANUAL

FORD

MODELS TW-5—TW-15—TW-25—TW-35

These Ford tractors are equipped with a six-cylinder diesel engine. An eight-speed gear type transmission and disc type clutch is standard on all models. A Dual Power planetary gear assembly which provides an underdrive ratio in all transmission speeds is standard on Model TW-35 and is available as an option on all other models.

Tractor identification numbers are located on a plate mounted on the frame behind the right-hand radiator side panel. For access to the identification plate, remove side panel on Models TW-5 and TW-15 or slide panel forward on Models TW-25 and TW-35. On tractors equipped with front wheel drive axle, a front axle identification plate is located on rear of front axle housing.

INDEX (By Starting Paragraph)

INDEX (CONT.)

DUAL DIMENSIONS

This service manual provides specifications in both the U.S. Customary and Metric (SI) system of measurements. The first specification is given in the measuring system used during manufacture, while the second specification (given in parenthesis) is the converted measurement. For instance, a specification of "0.011 inch (0.279 mm)" would indicate that the equipment was manufactured using the U.S. system of measurement and the metric equivalent of 0.011 inch is 0.279 mm.

CONDENSED SERVICE DATA

	TW-5	TW-15	TW-25	TW-35
GENERAL				
Engine	6 Cylinder, Direct Injection Diesel			
Make	Own			
Bore	4.4 in. (111.75 mm)			
Stroke	4.4 in. (111.75 mm)			
Displacement	401 cu. in. (6.6 L)			
Compression Ratio	16.3:1	15.6:1	15.6:1	15.6:1
Alternator Make	Motorola			
Starter Make	Own			
Battery	12-volt, Negative Ground			
Rating	128 Ampere Hours			
Forward Speeds	8			
With Dual Power	16			
Reverse Speeds	2			
With Dual Power	4			
TUNE-UP				
Firing Order	1-5-3-6-2-4			
Compression Pressure at Cranking Speed of 200 Rpm	300-400 psi (2069-2758 kPa)		275-375 psi (1896-2585 kPa)	
Valve Tappet Gap (Cold)—				
Intake	0.014-0.016 in. (0.36-0.41 mm)			
Exhaust	0.017-0.019 in. (0.43-0.48 mm)			
Injection Timing	25° BTDC			
Governed Engine Rpm—				
Low Idle	700-800		700-800	
Maximum (No-Load)	2525-2575		2425-2475	
Rated (Full Load)	2300		2200	
Rated Power at Pto	105.7 hp (78.8 kW)	121.4 hp (90.5 kW)	140.7 hp (104.9 kW)	170.3 hp (127.0 kW)
SIZES-CLEARANCES				
Crankshaft Journal Diameter	See Paragraph 66			
Crankpin Diameter	See Paragraph 64			

CONDENSED SERVICE DATA (CONT.)

	TW-5	TW-15	TW-25	TW-35
SIZES-CLEARANCES (CONT.)				
Camshaft Journal Diameter		2.3895-2.3905 in. (60.6933-60.7187 mm)		
Piston Pin Diameter	1.4997-1.500 in. (38.092-38.100 mm)		1.6246-1.6251 in. (41.267-41.277 mm)	
Valve Stem Diameter— Intake		0.3711-0.3718 in. (9.4259-9.4437 mm)		
Exhaust		0.3701-0.3708 in. (9.4005-9.4183 mm)		
Main Bearing Running Clearance		0.0022-0.0045 in. (0.056-0.114 mm)		
Rod Bearing Running Clearance— Copper-Lead Bearings		0.0017-0.0038 in. (0.043-0.096 mm)		
Aluminum Bearings		0.0021-0.0042 in. (0.053-0.106 mm)		
Camshaft Bearing Running Clearance		0.001-0.003 in. (0.025-0.076 mm)		
Crankshaft End Play		0.004-0.008 in. (0.102-0.203 mm)		
Camshaft End Play		0.001-0.007 in. (0.025-0.178 mm)		
Piston Skirt Clearance		See Paragraph 63		
CAPACITIES				
Cooling System— Less Heater	21 U.S. Qts. (20.0 L)	22 U.S. Qts. (21.0 L)	22 U.S. Qts. (21.0 L)	22.75 U.S. Qts. (21.5 L)
With Heater	22.75 U.S. Qts. (21.5 L)	23.25 U.S. Qts. (22.0 L)	23.25 U.S. Qts. (22.0 L)	24.25 U.S. Qts. (23.0 L)
Crankcase— With Filter Change		20 U.S. Qts. (19 L)		
Power Steering		4 U.S. Qts. (3.7 L)		
Transmission, Rear Axle and Hydraulic System		See Paragraph 191 or 226		
Front Wheel Drive Hub (Each)	1.6 U.S. Pts. (0.75 L)	1.6 U.S. Pts. (0.75 L)	3.8 U.S. Pts. (1.8 L)	3.8 U.S. Pts. (1.8 L)
Front Wheel Drive Differential Case	8 U.S. Qts. (7.5 L)	8 U.S. Qts. (7.5 L)	9.5 U.S. Qts. (9.0 L)	9.5 U.S. Qts. (9.0 L)
Fuel— Main Tank	33 U.S. Gals. (125 L)	33 U.S. Gals. (125 L)	75 U.S. Gals. (284 L)	75 U.S. Gals. (284 L)
Auxiliary Tank		24.5 U.S. Gals. (93 L)		

FRONT AXLE (TWO WHEEL DRIVE)

All Models So Equipped

An adjustable tread width front axle (Fig. 1) is standard on all models. On some tractors, the center member (12) is reversed to provide a shorter wheelbase.

1. R&R FRONT AXLE ASSEMBLY. To remove front axle, first remove front weights (all models) and carrier (TW-5 and TW-15). Raise front of tractor and support with safety stands. Remove front wheels. Disconnect hydraulic hoses from steering cylinder and plug all openings. Support axle assembly, then remove front pivot support bracket (10—Fig. 1). Withdraw axle assembly from front support housing.

To reinstall axle, reverse the removal procedure. Be sure that a thrust washer (11) is placed on each pivot pin. Tighten pivot support bracket cap screws to 200 ft.-lbs. (271 N·m) torque.

2. FRONT WHEEL SPINDLE. To remove spindle (1—Fig. 1), raise and support front of tractor. Remove wheel and tire. Remove nut retaining steering arm (8 or 13) to spindle. Note that threads of spindle are staked at the nut to prevent the nut from loosening and it may be difficult to remove. Remove steering arm and withdraw spindle from axle.

To remove front wheel hub (6—Fig. 2) and bearings, remove hub cap (1) and retaining nut (2). Withdraw hub, bearings, seal (9) and dirt shield (10) if necessary.

Clean all parts and inspect for wear or damage. To renew spindle bushings (4 and 6—Fig. 1), drive old bushings out of axle extension and install new bushings using a suitable piloted bushing driver. Bushings

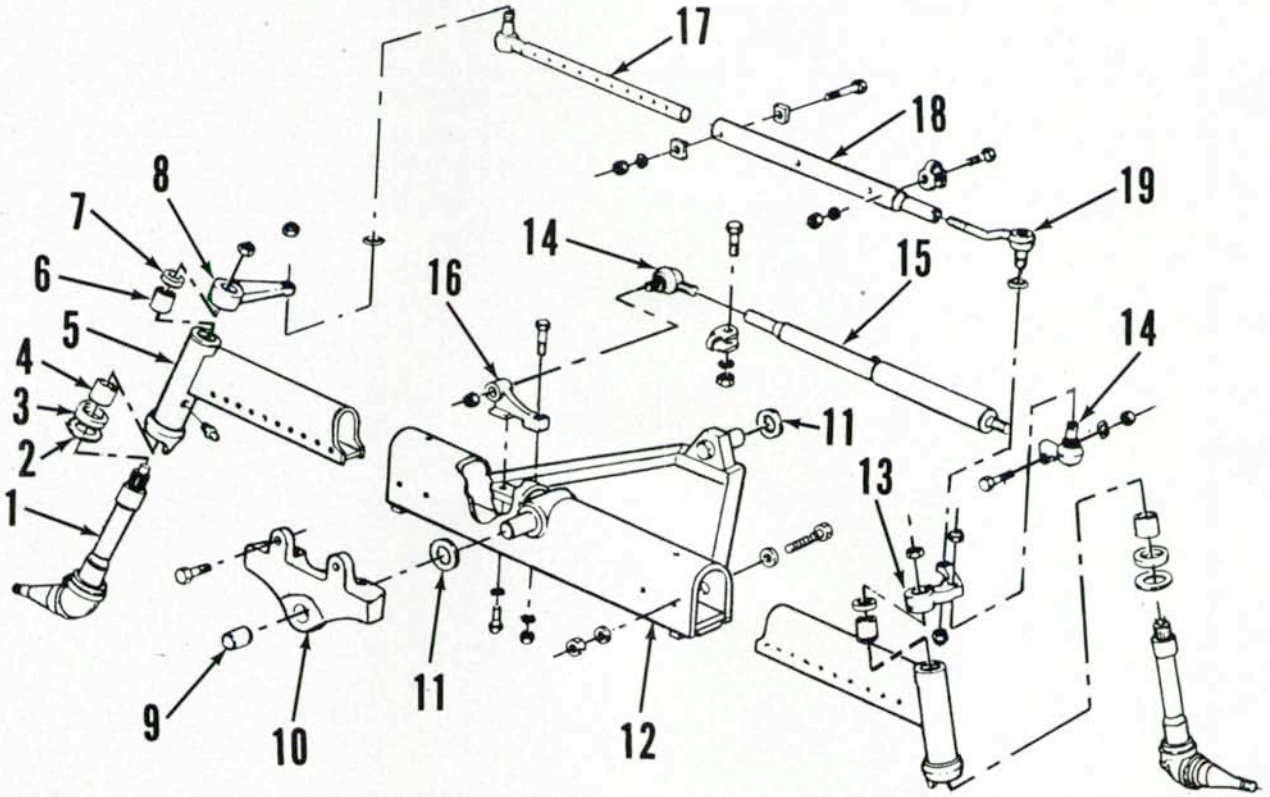


Fig. 1—Exploded view of adjustable front axle assembly. The center member (12) may be reversed to provide a shorter wheelbase on some models.

1. Spindle
2. Spacer
3. Thrust bearing
4. Bushing
5. Axle extension
6. Bushing
7. Seal
8. Steering arm
9. Bushing
10. Pivot support
11. Thrust washer
12. Axle center member
13. Steering arm
14. Ball joint ends
15. Steering cylinder
16. Cylinder anchor bracket
17. Tie rod
18. Tube
19. Tie rod end

are presized and should not require reaming if installed properly. Be sure grease holes are aligned.

Lubricate parts with grease during reassembly. Tighten steering arm retaining nut to 180 ft.-lbs. (244 N·m) torque. Pack wheel hub and bearings with grease and reinstall on spindle. Tighten castellated nut (2—Fig. 2) to 20-30 ft.-lbs. (27-41 N·m) torque and rotate wheel hub five revolutions. Further tighten castellated nut to a torque of 45-55 ft.-lbs. (61-75 N·m), then loosen nut ⅓ turn (two flats of nut). Install cotter pin, tightening nut to nearest castellation if necessary, to allow installation of pin.

3. TIE ROD AND TOE-IN. The tie rod ends are of the nonadjustable ball joint type. Renew tie rod ends that are excessively worn. Tighten tie rod end ball joint nut to 90 ft.-lbs. (122 N·m) torque.

The spindle steering arms and axle are marked (A—Fig. 3) during production to identify correct toe-in setting with steering in straight ahead position. If alignment marks are not visible or if parts are being renewed, check toe-in as follows: Position front wheels in straight ahead position, then measure distance between inner surface of front wheel rims at front and rear at wheel spindle height. Specified toe-in is 0 to ½ inch (0-13 mm) for standard front axle.

To adjust toe-in, remove clamp bolt from right end of tie rod and loosen clamp bolt on left end of tie rod. Rotate tie rod tube (18—Fig. 1) to obtain desired toe-in. Tighten left-hand clamp bolt to a torque of 70 ft.-lbs. (95 N·m) and right-hand bolt to 36 ft.-lbs. (49 N·m).

4. FRONT SUPPORT. To remove front axle support (1—Fig. 4), first disconnect battery cables. Remove front end weights, hood top panel and side panels and radiator grille. Disconnect wiring from front lights and horn. Drain engine coolant and remove radiator. On TW-25 and TW-35 models, drain fuel from main tank, then remove main fuel tank and the tank support assembly.

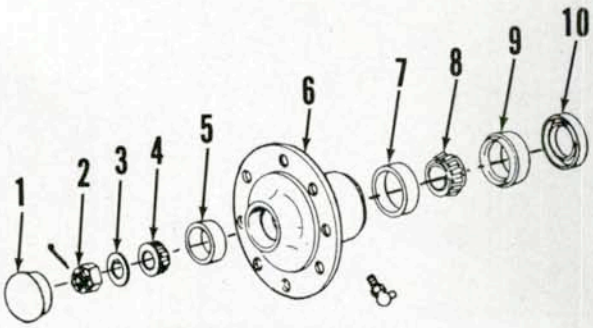


Fig. 2—Exploded view of front wheel hub assembly.

1. Hub cap
2. Nut
3. Washer
4. Bearing cone
5. Bearing cup
6. Wheel hub
7. Bearing cup
8. Bearing cone
9. Seal
10. Dirt shield

On all models, remove front axle assembly as outlined in paragraph one. Disconnect power steering hydraulic lines. Support front axle support with a suitable floor jack. Remove cap screws attaching support to frame side member, oil pan and engine, then withdraw the axle support assembly. Retain shims located between axle support and engine.

To reinstall axle support, reverse the removal procedure while noting the following special instructions: To determine correct thickness of shims (2—Fig. 4) to install between axle support (1) and oil pan (3), install axle support (without shims) and tighten engine and oil pan cap screws to 200 ft.-lbs. (270 N·m)

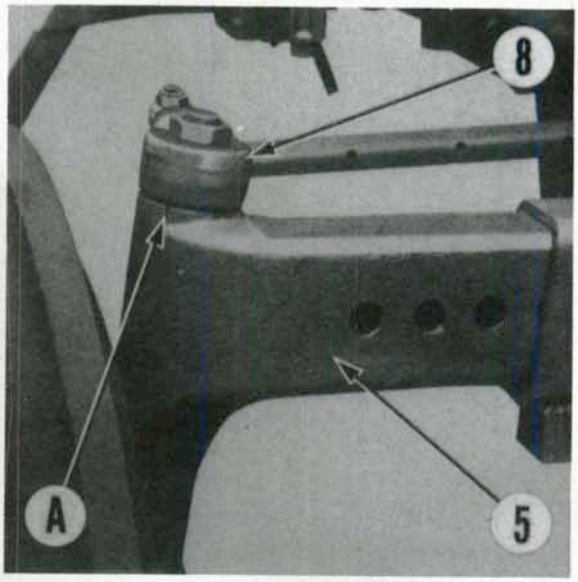


Fig. 3—Front axle (5) and steering arms (8) are marked (A) during production to indicate correct toe-in setting with front wheels in straight ahead position.

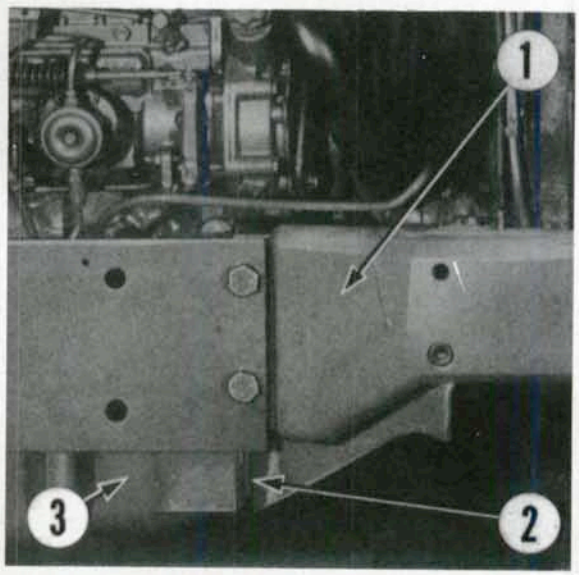


Fig. 4—Shims (2) are used to correctly align front axle support (1) with engine and oil pan (3).

torque. Use a feeler gage to measure gap between axle support and oil pan. Remove cap screws securing support to oil pan and install shims equal to measured gap. Reinstall oil pan cap screws and tighten engine and oil pan cap screws to 200 ft.-lbs. (270 N·m) torque.

FRONT WHEEL DRIVE

An optional front wheel drive axle is availble on all models. There are four different axles used. APL 345 type axle is used on early TW-5, TW-15 and TW-25 models and APL 3054 type axle is used on early TW-35 models. Late production TW-5 and TW-15 models use an APL 355 type axle, while late TW-25 and TW-35 models use an APL 365 type axle. The axle type number is stamped on an identification plate attached to the axle housing.

All Models So Equipped

5. LUBRICATION. It is recommended that the oil in front axle housing and planetary final drive housings be drained and refilled with new oil after every 1200 hours of operation. Oil level and drain plugs are located in front side of axle housing and in the end of each of the wheel hubs. Position front wheel hub so oil level line is horizontal when checking final drive housing oil level. Maintain oil level at bottom of check plug openings. Recommended oil is Ford M2C134-C.

The front wheel drive transfer case shares a common reservoir with the transmission and rear axle housing. It is recommended that transmission oil be changed after every 1200 hours of service. Recommended oil is Ford M2C134-C. Oil filler tube and oil level dipstick are located at rear of tractor.

6. R&R FRONT AXLE AND PIVOT SUPPORT. To remove front axle and pivot support as an assembly, first disconnect drive shaft. Remove front weights and remove weight carrier bracket (TW-5 and TW-15). Raise and support front of tractor, then remove front wheels. Place blocks between axle and pivot support to prevent tipping. Disconnect power steering lines from cylinder and plug the openings. Support the axle with a suitable hoist or jack. Remove cap screws attaching pivot support (1—Fig. 5, 6 or 7) to main support housing, then remove axle assembly from tractor.

Inspect pivot pins (8) and bushings for excessive wear or damage and renew as necessary.

To reinstall, reverse the removal procedure. Thrust washers (3) are available in various thicknesses to adjust axle end play, which should be 0.012-0.024 inch (0.30-0.60 mm) on all models. Tighten pivot support cap screws to 200 ft.-lbs. (271 N·m) torque and drive shaft flange bolts to 58 ft.-lbs. (78 N·m) torque.

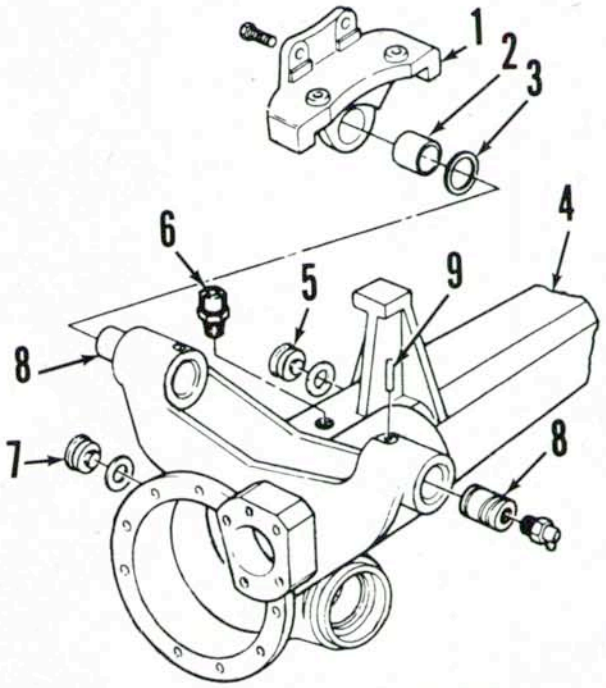


Fig. 5—Exploded view of front pivot support and front wheel drive axle housing typical of APL-345 and APL-355 axles used on TW-5, TW-15 and TW-25 tractors.

1. Support assy.
2. Bushing
3. Spacer washer
4. Axle housing
5. Oil level/filler plug
6. Breather
7. Oil drain plug
8. Pivot pins
9. Retaining pin

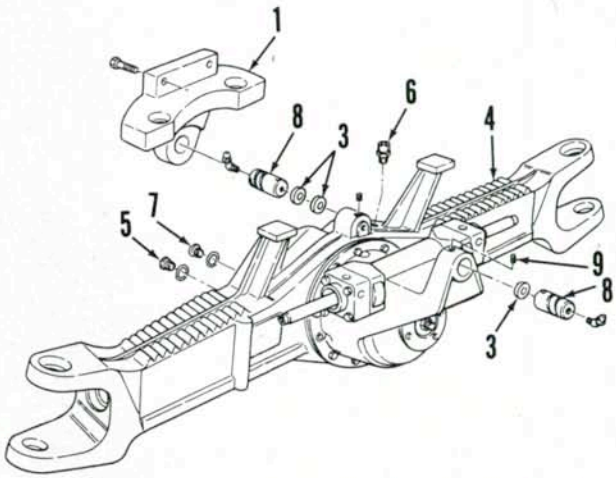


Fig. 6—Exploded view of APL-365 front wheel drive axle housing and pivot support typical of late production TW-25 and TW-35 tractors. Except for retaining set screw (9), refer to Fig. 5 for legend.

7. TOE-IN. Front wheel toe-in should be 0-1/4 inch (0-6 mm) on all models. To adjust toe-in, disconnect tie rod ball joint ends. Loosen clamp bolt, then turn tie rod end until desired toe-in is obtained when ball joints are reconnected. Be sure tie rods are adjusted equally.

APL-345 AND APL-355 TYPE AXLES

All Models So Equipped

8. WHEEL HUB AND PLANETARY CARRIER. To remove wheel hub and planetary assembly from either side, first raise and support front axle and remove wheel and tire. Remove drain plug (3—Fig. 10) and drain oil from hub. Remove the two socket-head retaining screws (1—Fig. 10), then insert pry bars into slots (2) in hub and pry planetary carrier (35) away from hub.

On APL-345 axles, remove cap screws (30—Fig. 8) attaching ring gear (29) to steering knuckle (17). Pull the ring gear off the knuckle locating dowels (18) using a suitable puller. Pull the hub (24) and bearings off steering knuckle.

NOTE: The center screw of puller must not apply force to end of sun gear shaft (36). Thread three long cap screws into ring gear bolt holes and locate a step plate on heads of cap screws to provide a base for puller screw.

On APL-355 axles, remove locking plate (30—Fig. 9) securing slotted nut (28). Remove the slotted nut using special hub nut socket (Nuday tool number 12235) or other suitable tool. Remove ring gear (29), hub (24) and bearings from steering knuckle (17).

On all models, remove bearings and oil seal from hub. Remove retaining rings (32—Fig. 8 or 9) and withdraw planetary gears (31) and bearings (33) from carrier. Remove thrust washer (40). The sun gear (36) is attached to axle shaft universal joint (11) by a retaining ring (16). To remove the retaining ring and sun gear, the steering knuckle (17) must first be removed as outlined in paragraph 9.

Inspect all parts for wear or damage and renew as necessary.

To reassemble, heat the inner and outer bearing cones (22 and 27—Fig. 8 or 9) to 212° F (100° C). Position inner bearing cone in hub, then install a new oil seal (21) to hold bearing in place. On APL-355 axle, install scraper "V" ring (20) onto the oil seal with the "V" side facing outward. On all axles, coat oil seal lip with grease and install hub assembly onto steering knuckle while bearing cone is still hot. Assemble the heated outer bearing cone onto the knuckle and hub.

On APL-345 axle, install ring gear onto spindle and tighten retaining cap screws evenly to 65 ft.-lbs. (90 N·m) torque.

On APL-355 axle, install ring gear and slotted nut onto steering knuckle and adjust bearing preload as follows: With hub nut finger tight (no preload on bearings), wrap a cord around hub stud nuts as shown in Fig. 11 and use a spring scale to measure rolling resistance of hub. Note spring scale reading while slowly rotating the hub, then tighten hub nut in small increments until hub rolling resistance increases 5-12 pounds (2.3-5.4 Kg) above spring scale reading obtained with zero bearing preload. Install locking plate (30—Fig. 9) into one of the slots in nut to lock it in place.

Install planetary gears with bearings in carrier and secure with retaining rings. Be sure gears are positioned so side with chamfered bore is facing carrier housing.

On all axles, the thrust washer (40—Fig. 8 or 9) located in center of planetary carrier controls axle shaft end play. The thrust washer is available in various thicknesses. To determine correct thickness of washer to provide specified axle shaft end play of 0.012-0.024 inch (0.30-0.60 mm), proceed as follows: Place original thrust washer in carrier, then use a straightedge and depth micrometer to measure distance (A—Fig. 12) from mounting surface of carrier to face of thrust washer. Push sun gear inward, then measure distance (B) from end of sun gear shaft to mounting surface of hub. Subtract dimension (B)

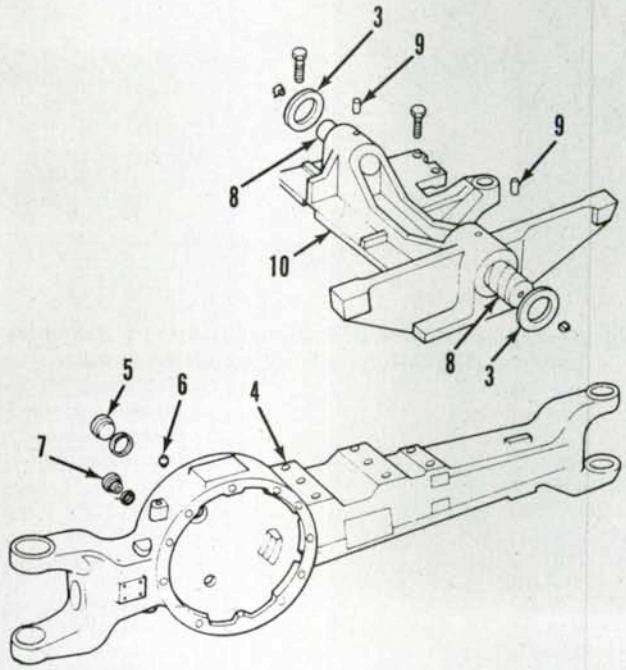


Fig. 7—Exploded view of APL-3054 front wheel drive axle housing and pivot support used on early TW-35 tractors.

3. Spacer washers
4. Axle housing
5. Oil level/filler plug
6. Breather
7. Oil drain plug
8. Pivot pins
9. Retaining pins
10. Pivot bracket

from dimension (A) to calculate shaft end play. If end play is not within specified range, install a thicker or thinner thrust washer as necessary to obtain correct end play.

Install planetary carrier and refill hub with Ford M2C104-A, M2C158-A, M2C105-A or M2C94-A oil.

9. STEERING KNUCKLE AND AXLE SHAFT. To remove steering knuckle (17—Fig. 8 or 9), first remove planetary carrier assembly as outlined in paragraph 8. Remove snap ring (39), retainer (38) and thrust washer (37) from sun gear. Disconnect steering tie rod ball joint. Support the steering knuckle, then remove upper and lower kingpins (12) and shims (upper kingpin only). Remove steering knuckle and hub assembly from axle housing.

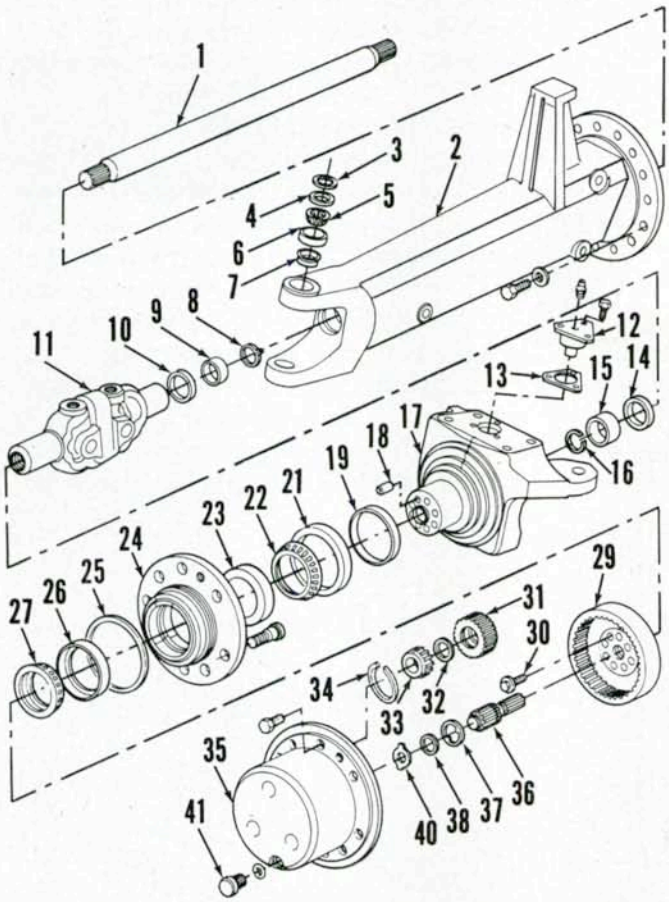


Fig. 8—Exploded view of hub and planetary assembly used on APL-345 type front wheel drive axle.

1. Axle shaft
2. Axle housing, L.H.
3. Seal
4. Retainer
5. Bearing cone
6. Bearing cup
7. Plug
8. Snap ring
9. Bushing
10. Oil seal
11. Universal joint
12. Kingpin
13. Shim
14. Seal
15. Bushing
16. Retaining ring
17. Steering knuckle
18. Locating pin
19. Dust shield
21. Oil seal
22. Bearing cone
23. Bearing cup
24. Hub
25. Seal
26. Bearing cup
27. Bearing cone
29. Ring gear
30. Cap screw
31. Planetary gear
32. Retaining ring
33. Bearing
34. Retaining ring
35. Planetary carrier
36. Sun gear
37. Thrust washer
38. Retainer
40. Thrust washer
41. Oil level/drain plug

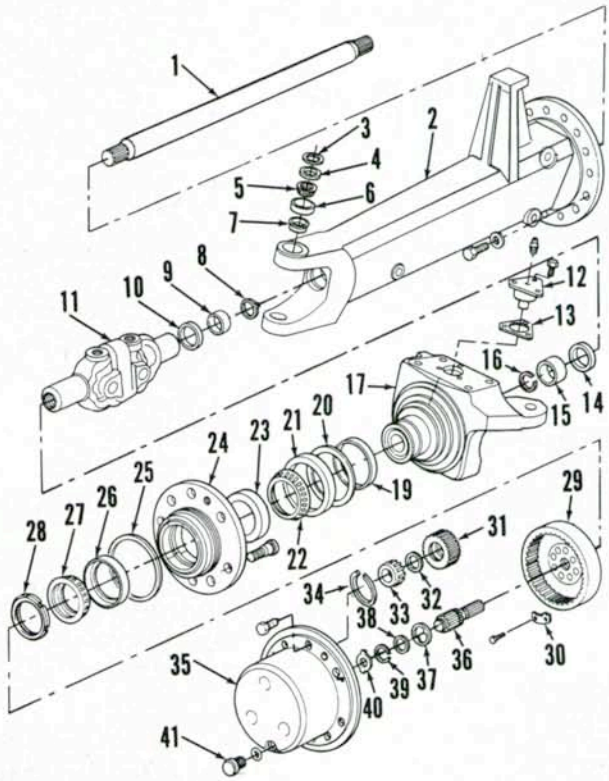


Fig. 9—Exploded view of hub and planetary assembly used on APL-355 type front wheel drive axle. Refer to Fig. 8 for legend except for the following:

20. Scraper "V" ring
28. Slotted nut
30. Lockplate
39. Retainer

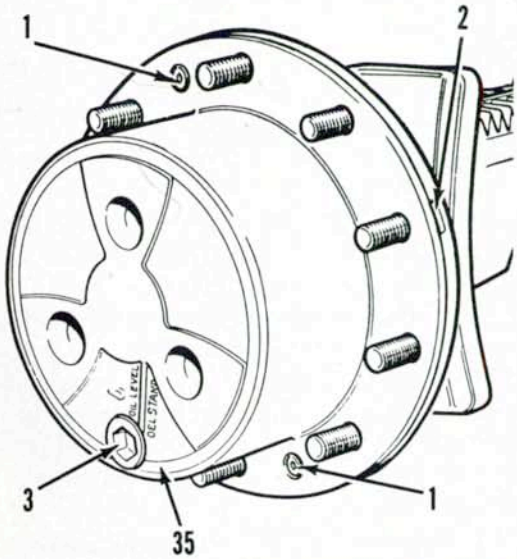


Fig. 10—To remove planetary carrier (35), remove two retaining screws (1) and insert pry bars in the two slots (2).

Sun gear (36), universal joint (11) and axle shaft (1) can be withdrawn from axle housing at this time. To separate axle shaft or sun gear from the universal joint, expand retaining ring (8 or 16) and pull shaft from universal joint.

To reinstall, slide axle shaft into axle housing being careful not to damage oil seal (10). Pack pivot bearings (5) with grease and assemble in axle housing. Position steering knuckle on axle housing, assemble shims (13) on upper kingpin, install kingpins and tighten retaining cap screws to 90 ft.-lbs. (120 N·m) torque.

NOTE: If steering knuckle, axle housing, kingpins or pivot bearings were renewed, the pivot bearing preload must be checked and adjusted as follows:

Install special torque wrench adapter (tool No. 0566), or similar tool, onto the upper kingpin so a torque wrench can be centered over kingpin as shown in Fig. 13. Check the torque required to swivel the steering knuckle, which should be 7-9 ft.-lbs. (10-12 N·m) for APL-345 axles or 11-13 ft.-lbs. (15-18 N·m) for APL-355 axles. Increasing thickness of shims (13—Fig. 8 or 9) will decrease turning torque, or decreasing thickness of shims will increase turning torque. Shims should be installed under the upper kingpin only.

Reinstall planetary carrier and refill hub with oil. Lubricate king pins and bearings with grease.

10. DIFFERENTIAL AND BEVEL GEARS. The differential and bevel drive gears can be removed without removing front axle assembly. Raise and support front of tractor. Drain oil from axle housing. Remove left front wheel. Disconnect steering tie rod end from steering knuckle. Disconnect hydraulic hose from steering cylinder end cap, remove retaining cap screws from end cap and slide end cap outward on piston rod to allow access to axle housing cap screws. Support left axle housing and planetary assembly, then unbolt and remove left axle housing from right housing. Remove the differential assembly from the axle housing.

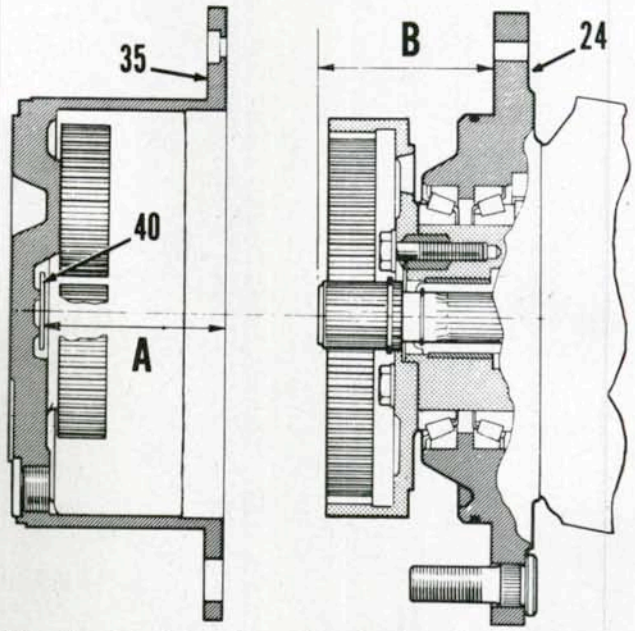


Fig. 12—To determine axle shaft end play, measure distance A and B and refer to text. Thrust washer (40) is available in various thicknesses to adjust end play.

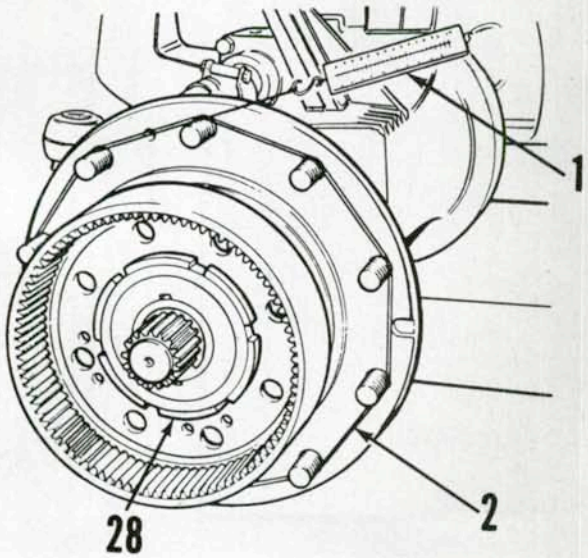


Fig. 11—On APL-355 axle, measure rolling resistance of hub bearings using a spring scale (1) and cord (2). Bearing preload is adjusted by turning slotted nut (28). Refer to text.

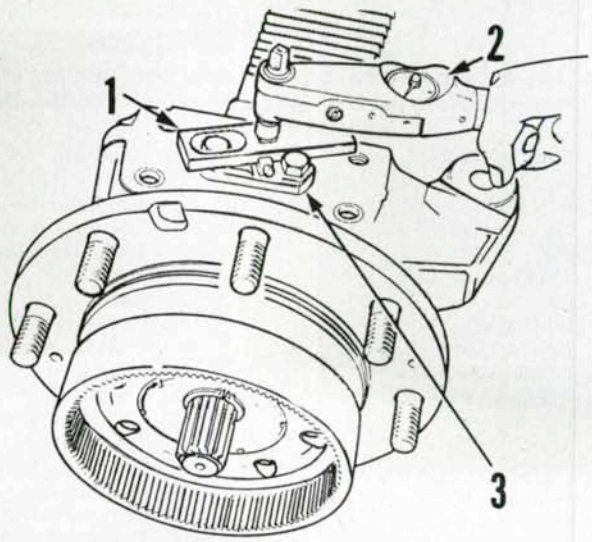


Fig. 13—Use a torque wrench (2) with an adapter tool (1) to measure pivot bearing turning torque. Shims are used under flange of upper kingpin (3) to adjust turning torque. Refer to text.

To remove bevel pinion gear assembly, disconnect drive shaft from pinion flange. Remove nut (19—Fig. 15) and withdraw drive flange (17) from pinion shaft. Drive the pinion (8) into axle housing until it is free from outer bearing. Remove bearing and oil seals from the axle housing.

To disassemble differential, remove cap screws (25) and separate the differential case halves. Remove pinion gears (32), side gears (29) and limited slip clutch plates (27) from the cases.

Inspect all parts for wear or damage and renew as necessary. The bevel pinion (8) and ring gear (37) must be renewed as a matched set. Note that identical serial numbers will be stamped on outer edge of ring gear and on end of pinion gear. The bearing preload spacer (12) must be renewed whenever bevel pinion is removed to ensure accurate adjustment of pinion bearing preload when reassembling. The differential pinion gears (32) and side gears (29) should also be renewed as a set if excessively worn or damaged.

If ring gear was removed from differential case, heat the gear to 212° F (100° C) prior to installation. Use guide pins in differential case to ensure that bolt holes in case and ring gear are aligned, then press ring gear on the case. Install roll pins (36).

Lubricate all parts with oil prior to reassembly. Assemble one set of clutch plates (27), thrust washer (28) and side gear (29) into ring gear case half (35), making sure that friction surface of thrust washer is against the machined surface of a clutch plate with external lugs. Install pinion gears (32), shafts (30) and thrust washers (33) into the case half. Position a dial indicator on differential case, then hold three of the pinion gears stationary while measuring backlash between fourth gear and the side gear. Specified backlash is 0.006-0.008 inch (0.15-0.20 mm) for APL-345 axles and 0.008-0.012 inch (0.20-0.30 mm) for APL-355 axles. To adjust backlash, install an appropriate thickness thrust washer (28) behind side gear. Repeat the above procedure to select proper thickness thrust

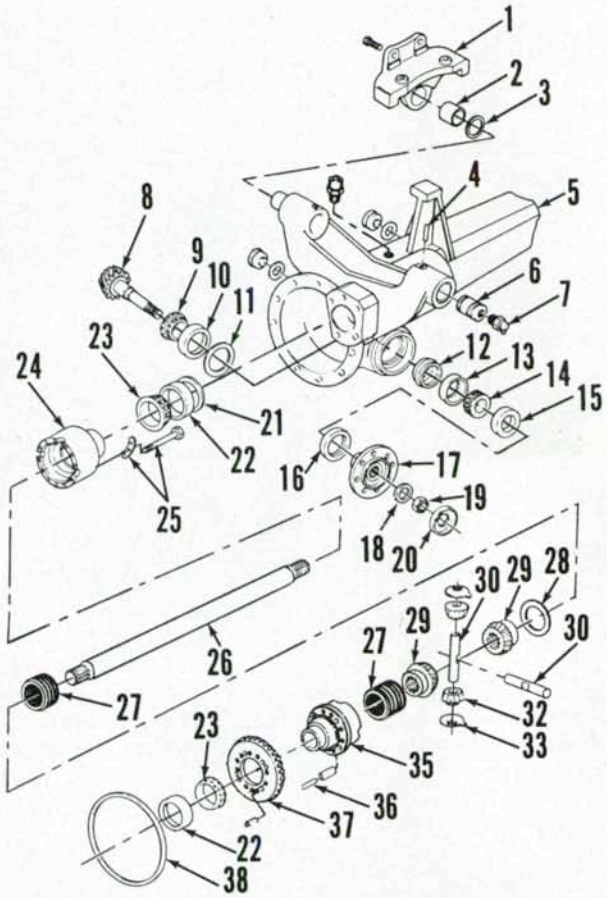


Fig. 15—Exploded view of differential components and right axle housing used on APL-355 axles. The APL-345 axle is similar.

1. Pivot support bracket
2. Bushing
3. Thrust washer
4. Pin
5. Axle housing, R.H.
6. Pivot pin
7. Grease fitting
8. Bevel pinion
9. Bearing cone
10. Bearing cup
11. Shim
12. Preload sleeve
13. Bearing cup
14. Bearing cone
15. Oil seal
16. Dust seal
17. Drive flange
18. Washer
19. Nut
20. Retainer
21. Shim
22. Bearing cup
23. Bearing cone
24. Differential case half
25. Cap screw & lockplate
26. Axle shaft
27. Limited slip clutch plates
28. Thrust washer
29. Side gears
30. Pinion shafts
32. Pinion gear
33. Thrust washer
35. Differential case half
36. Dowel pins
37. Bevel ring gear
38. Seal ring

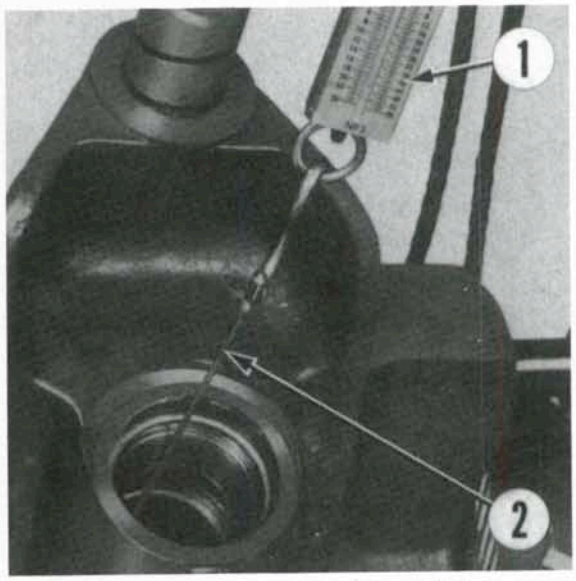


Fig. 16—Use a spring scale (1) and cord (2) to measure pull required to rotate differential assembly. Cord is wrapped around differential case and pulled through opening for pinion shaft. Refer to text.

washer for side gear and clutch pack in opposite differential case half.

Assemble the differential cases making sure that the part number stamped on each case is aligned. Tighten retaining bolts to 105 ft.-lbs. (145 N·m) torque. Install new bearing cones on differential cases if removed.

If differential cases, axle housing or differential carrier bearings are renewed, the differential bearing preload must be adjusted as outlined in paragraph 11 prior to installing bevel pinion shaft. If ring gear and pinion are renewed, the pinion engagement and bearing preload must be set as outlined in paragraphs 12 and 13 prior to final installation of differential and ring gear assembly. If original housings, bevel drive gears and bearings are being reused, the components can be installed using original shim packs.

11. DIFFERENTIAL BEARING PRELOAD. Differential carrier bearing preload must be adjusted with bevel pinion removed from carrier housing and with axle shafts removed from left and right axle housings. To adjust bearing preload, install original shim packs (21—Fig. 15) into axle housings, then press in bearing cups (22). Wrap a cord around differential case, then install differential assembly into right axle housing and pass end of cord out through pinion shaft bore. Assemble left axle housing onto right housing and tighten four equally spaced retaining cap screws to 220 ft.-lbs. (295 N·m) torque. Attach a suitable spring scale to cord and measure the pull required to steadily turn the differential assembly as shown in Fig. 16. The pull should be between 4-13 pounds (2-6 Kg). Increase shim thickness if pull is too low, or decrease shim thickness if pull is too high. After bearing preload is correctly set, remove the differential assembly.

12. BEVEL PINION ENGAGEMENT. If axle housing, bevel pinion or pinion bearings are being renewed, the pinion engagement position must be set as outlined below. The pinion engagement is adjusted by shims (11—Fig. 15) located behind pinion inner bearing cup (10).

On APL-345 axles, subtract the dimension etched on the end of pinion gear from the dimension marked on the center of axle housing. This is dimension "A." Place the inner bearing cone (9) into the cup (10). While holding the cup and cone tightly together, measure the overall thickness of the bearing assembly. This is dimension "B." Subtract dimension "B" from dimension "A." The difference between the two dimensions is the required shim pack thickness to be installed behind the inner bearing cup.

If a new bevel pinion is being installed in the original axle housing on models with APL-355 axle, adjust pinion engagement as follows: Compare the variance measurement (1—Fig. 17) scribed on the end of the old and new pinions. If the numbers are the same, no adjustment of the original shim pack is necessary. If the new pinion has a LARGER number than the old pinion, SUBTRACT shims from original shim pack equal to the difference between the two numbers. Note that the numbers represent millimeters. (Example: Number scribed on new pinion is +0.1 and number stamped on old pinion is -0.1, decrease shim thickness by 0.2 mm.) If number scribed on new pinion is SMALLER than the old pinion, ADD shims equal to the difference between the two numbers.

If pinion is being installed in a new axle housing on models with APL-355 axle, adjust pinion engagement as follows: Special adjustment tool set (Nuday tool No. 12237) is needed to perform this adjustment. Insert dummy pinion (part of special tool set) into axle housing and secure in place with washer and cap screw as shown in Fig. 18. Insert the mandrel (2) into differential bearing cup counterbore in axle housing. Use a feeler gage to measure clearance (C) between the mandrel and dummy pinion. Make the following calculations: Add the height of dummy pinion (dimension "A") which is etched on side of dummy pinion, plus dimension "B" which is 45 mm, plus clearance "C" measured with feeler gage. The result will be dimension "X."

Position pinion inner bearing cone (9—Fig. 15) into inner bearing cup. While holding the cup and cone tightly together, measure the thickness of the bearing assembly. This will be dimension "Y."

Subtract dimension "Y" from dimension "X." The result will be dimension "Z." From dimension "Z" subtract the dimension (in millimeters) etched next to the serial number on end of pinion. The difference obtained is the required thickness of shims (11—Fig. 15) to be installed behind the pinion inner bearing cup.

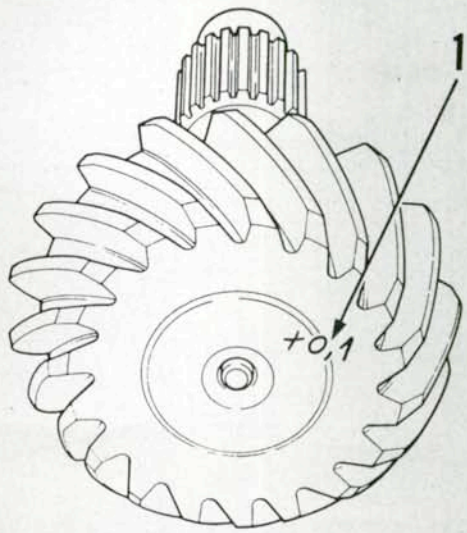


Fig. 17—Pinion engagement variance dimension (1) is scribed on end of bevel pinion.

13. PINION INSTALLATION AND BEARING ADJUSTMENT. Position correct thickness of shims (as determined in paragraph 12) into bore of axle housing, then install inner bearing cup (10—Fig. 15). Press rear bearing cone onto pinion (8), then insert pinion into housing bore. Position a new bearing preload sleeve (12) on pinion shaft. Install outer bearing cup (13), bearing cone (14), oil seal (15) and dust seal (16) into housing. Install flange (17), washer (18) and retaining nut (19) on the pinion, but do not tighten nut at this time. Using a suitable torque wrench, rotate pinion and measure rolling resistance of pinion bearings with zero preload. Secure pinion shaft and tighten pinion nut in small increments, stopping to check torque required to rotate pinion, until torque reading has increased 12-18 in.-lbs. (1-2 N·m) above initial zero preload reading.

After correct bearing preload is established, install retainer (20) to prevent retaining nut from loosening.

14. DIFFERENTIAL INSTALLATION AND BACKLASH ADJUSTMENT. Divide original shim pack, or shims as established in paragraph 11, equally and install shims (21—Fig. 15) and bearing cups (22) into axle housings. Install axle shafts in axle housings. Position differential assembly in right axle housing. Install left axle assembly and tighten retaining cap screws to 218 ft.-lbs. (295 N·m) torque.

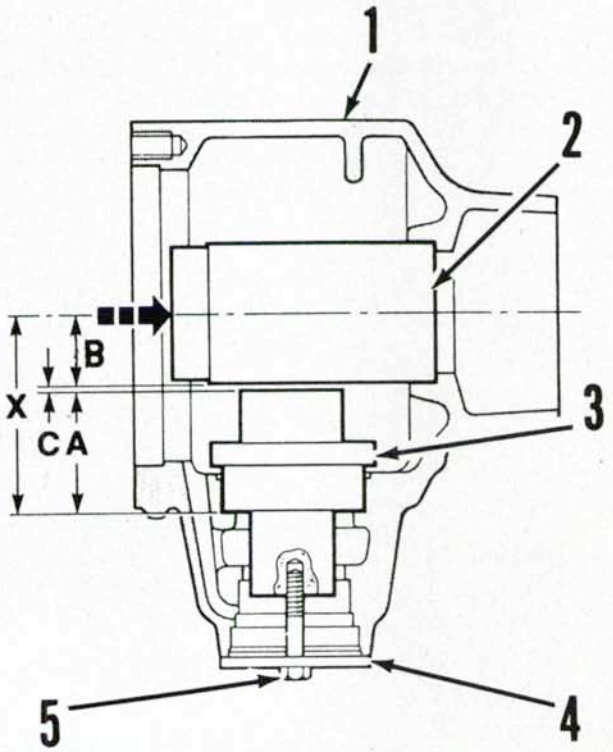


Fig. 18—On APL-355 axle, a special tool (No. 12237) is used during adjustment of pinion engagement setting. Refer to text.

Remove drain plug from axle housing. Position a dial indicator on housing with pointer through drain opening and against a tooth of ring gear as shown in Fig. 19. Hold the pinion flange and turn one axle shaft to rotate differential and ring gear forward and rearward while noting dial indicator reading. Backlash between pinion gear and ring gear should be 0.005-0.007 inch (0.13-0.18 mm) for APL-345 axle or 0.005-0.011 inch (0.13-0.28 mm) for APL-355 axle.

If backlash is excessive, transfer shims (21—Fig. 15) from right axle housing to left axle housing to move ring gear closer to pinion gear. If backlash is less than specified minimum value, move shims from left axle housing to right axle housing. Do not change the total shim pack thickness as bearing preload would be affected.

To check for proper bevel ring gear and pinion gear tooth contact pattern, apply Prussian Blue to gear teeth on ring gear. Turn the pinion to engage the coated teeth of ring gear. Compare the contact pattern on the teeth with examples shown in Fig. 20. If prop-

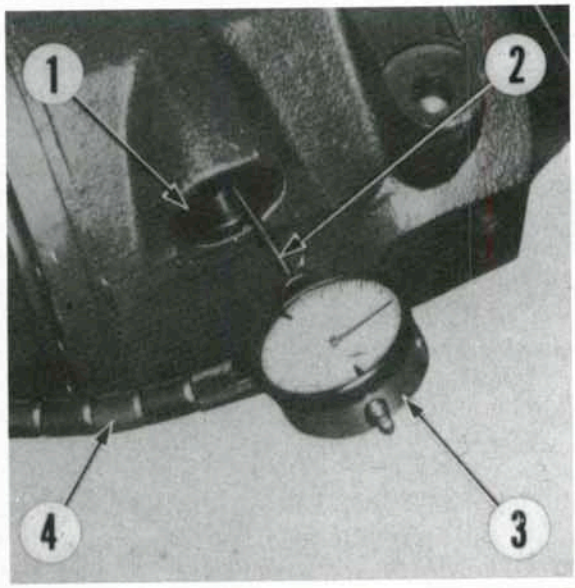


Fig. 19—To measure ring gear to pinion backlash on APL-345 and APL-355 axles, mount a dial indicator (3) on axle housing so the plunger (2) extends through oil drain hole (1) and contacts a tooth of ring gear.

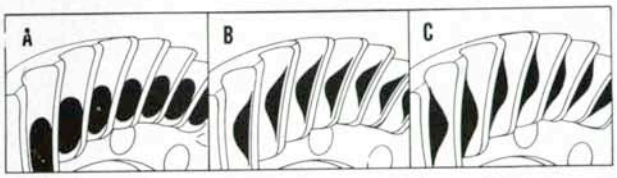


Fig. 20—Views of bevel ring gear tooth contact patterns

A. Proper tooth contact—drive side pattern
B. Contact too high—pinion gear requires thicker shim
C. Contact too low—pinion gear requires thinner shim

er tooth contact pattern is not obtained, pinion engagement shim pack (11—Fig. 15) is incorrect and adjustment procedure (paragraph 12) should be repeated.

APL-3054 TYPE AXLE

Model TW-35 So Equipped

15. R&R WHEEL HUB AND PLANETARY CARRIER. To remove wheel hub (25—Fig. 22) and planetary assembly, raise front of tractor and remove wheel and tire. Remove drain plug (6) and drain oil from hub. Scribe alignment marks on planetary carrier (12) and hub (25). Remove retaining bolts and withdraw carrier. Detach snap ring (15) and remove sun gear (16).

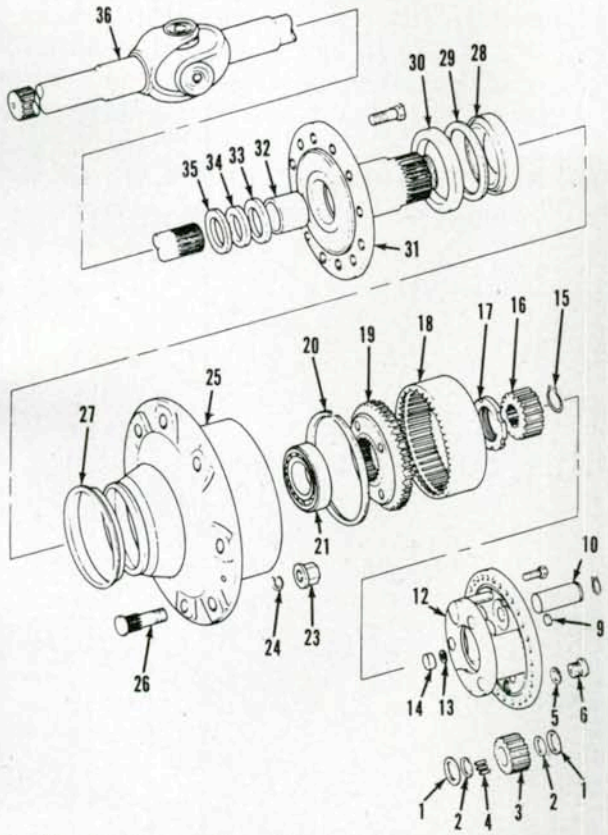


Fig. 22—Exploded view of hub and planetary final drive used in APL-3054 type front drive axle used on early TW-35 models.

1. Thrust washer
2. Spacer
3. Planetary pinion
4. Needle bearings
5. Seal
6. Oil level/drain plug
9. Seal plug
10. Pin
12. Planetary carrier
13. Shim
14. Thrust plug
15. Snap ring
16. Sun gear
17. Slotted nut
18. Ring gear
19. Ring gear carrier
20. Snap ring
21. Bearing
23. Wheel nut
24. Spring washer
25. Hub
26. Wheel stud
27. Dust shield
28. Bearing
29. Washer
30. Seal
31. Hub carrier
32. Bushing
33. Seal
34. Spacer
35. Retaining ring
36. Axle shaft

To reinstall carrier assembly, reverse the removal procedure making sure assembly marks on carrier and hub are aligned. Refill hub with Ford M2C134-C oil or equivalent. Capacity is approximately 3.2 U.S. pints (1.5 L).

16. OVERHAUL. With planetary carrier assembly removed as outlined in paragraph 15, remove pins (10—Fig. 22) and planet gears (3) with bearings from planetary carrier (12). Unscrew slotted nut (17) and remove ring gear (18) and carrier (19) from wheel hub (25). Pull hub and bearings off hub carrier (31). Remove oil seal (30), spacer (29) and bearing (28) from wheel hub. Remove bolts retaining hub carrier to steering knuckle and remove carrier. Axle shaft (36) can now be removed from housing.

Inspect all parts for excessive wear or damage and renew if necessary.

To reassemble, insert axle shaft into axle housing. Install hub carrier (31) and tighten retaining cap screws to a torque of 155 ft.-lbs. (210 N·m).

NOTE: The two shorter cap screws must be installed in two lowest holes to prevent interference between steering knuckle and axle yoke on full lock turn.

Assemble oil seal, spacer and bearings in wheel hub, then install hub onto hub carrier. Position ring gear and carrier in the hub, then install slotted nut finger tight onto carrier shaft. Complete assembly and adjust hub bearing preload and axle shaft end play as outlined in the following paragraph.

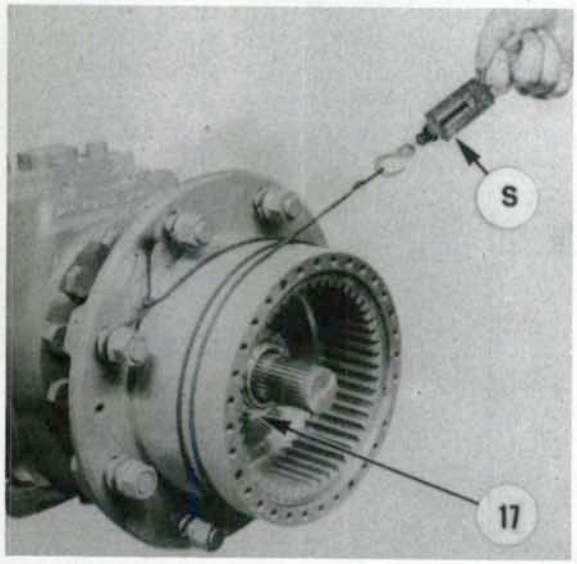


Fig. 23—To check wheel hub bearing preload, use a spring scale (S) and cord to measure pull required to rotate hub; turn slotted nut (17) to adjust preload. Refer to text.

17. ADJUSTMENT. Wheel hub bearing preload is adjusted by turning slotted nut (17—Fig. 22). Wrap a cord around wheel hub and use a scale as shown in Fig. 23 to measure pull required to rotate wheel hub. Tighten nut until pulling resistance is between 9-14 pounds (4-6 Kg) if new bearings were installed, or 4.5-7 pounds (2-3 Kg) if original bearings are used. Install lockplate and second slotted nut to serve as a locknut. Bend tabs of plate to engage both nuts.

To adjust axle shaft end play, remove dust plug (9—Fig. 22) from center of planetary carrier. Drive thrust plug (14) and shims (13) out of carrier, then reinstall thrust plug (without shims) and bottom the plug in bore of carrier. Push axle shaft fully inward into axle housing. Install planetary carrier onto hub and retain with two cap screws. Use a depth micrometer to measure distance from outer surface of planetary carrier to the plug (Fig. 24). Using a brass drift, drive the thrust plug against end of axle shaft. Measure the distance again from carrier surface to plug. The difference between the two measurements is the thickness of shims (13—Fig. 22) required to provide zero end play of axle shaft.

18. R&R AXLE SHAFTS. To remove axle shafts (36—Fig. 22), refer to paragraph 15 and remove planetary carrier, wheel hub and hub carrier. Axle shaft can now be removed from axle housing.

Inspect bushings (32—Fig. 22 and 19—Fig. 25) and seals (33—Fig. 22 and 18—Fig. 25) and renew if necessary.

To install axle shaft, reverse the removal procedure. Refer to paragraph 17 to adjust hub bearing preload and axle shaft end play.

19. STEERING KNUCKLE AND KINGPINS. Refer to Fig. 25 for an exploded view of steering knuckle assembly. The knuckle (20) can be removed from axle housing without disassembly of final drive components. Support planetary unit and knuckle, then remove upper and lower kingpin caps (12) and tie rod (1). If left knuckle is to be serviced, disconnect steering cylinder from steering arm. Remove shims (13), kingpins (14) and bearing cones, marking parts so they can be installed in original location if reused. Separate steering knuckle from axle housing.

Inspect all parts and renew if necessary. If renewal of steering knuckle is necessary, remove cap screws attaching hub carrier (31—Fig. 22) to knuckle and remove knuckle.

To reinstall steering knuckle, reverse the removal procedure while noting the following special instructions: Install kingpins with original shims. Tighten kingpin cap retaining screws to 100 ft.-lbs. (135 N·m) torque. Use an adapter plate to attach a torque wrench to the center of upper kingpin cap, and measure the torque required to turn the steering knuckle. If turning torque is not within specified range of 13.5-15.5 ft.-lbs. (18-21 N·m), add or remove shims (13) as required to obtain desired turning torque. Thickness of upper and lower shim packs should be equal.

20. R&R DIFFERENTIAL AND BEVEL GEARS. The differential and bevel drive gears can be removed

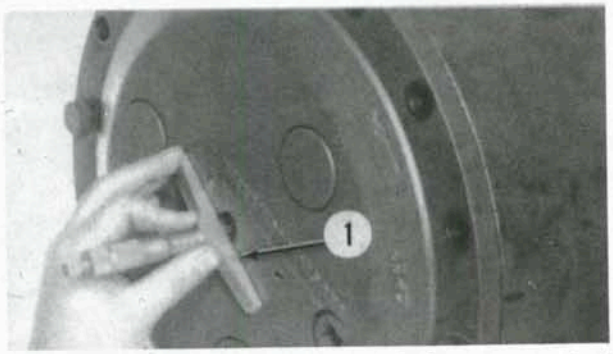


Fig. 24—To check axle shaft end play, use a depth micrometer (1) to measure distance from carrier surface to thrust plug. Refer to text for adjustment procedure.

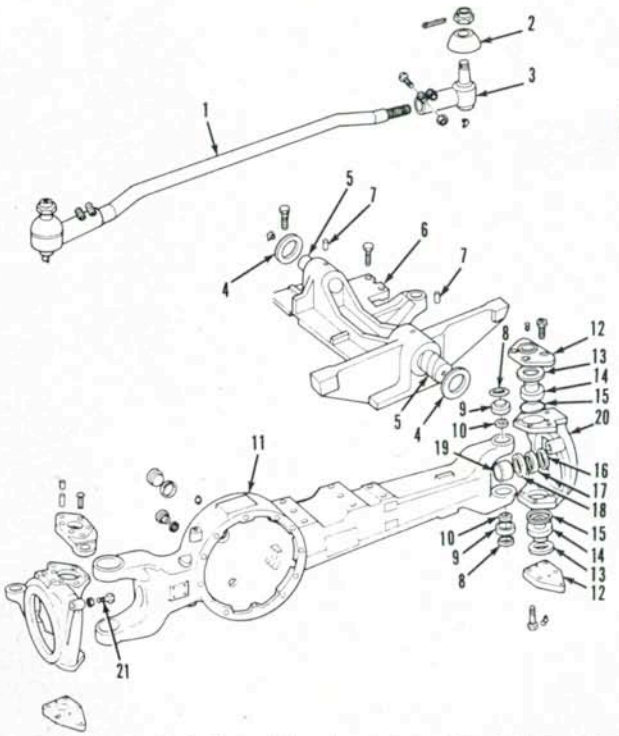


Fig. 25—Exploded view of front axle housing and steering knuckle used on APL-3054 type axle.

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

without removing front axle assembly from the tractor if desired. Raise and support front of tractor. Drain oil from axle housing. Disconnect drive shaft from pinion drive flange. Remove cap screws securing hub carriers (31—Fig. 22) to steering knuckles and remove planetary and hub assemblies. Withdraw axle shafts to disengage inner ends from differential side gears.

NOTE: Remove two differential housing mounting cap screws and replace with guide studs to support and align differential housing during removal and installation.

Unbolt and remove differential housing from axle housing, using a suitable floor jack or hoist to support the differential unit.

To reinstall differential housing, reverse the removal procedure. Tighten retaining cap screws to 60 ft.-lbs. (80 N·m) torque.

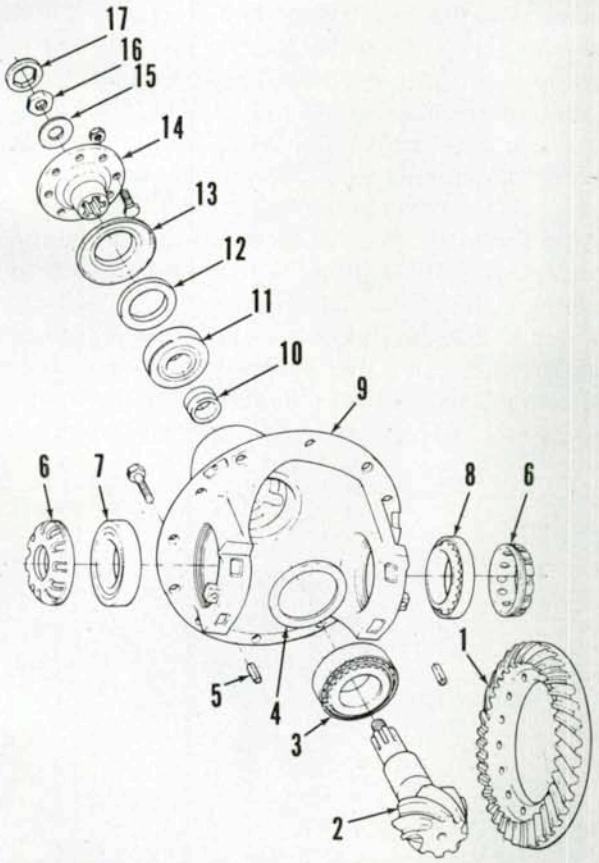


Fig. 26—Exploded view of bevel drive gear assembly for APL-3054 type front axle.

1. Ring gear
2. Pinion gear
3. Bearing
4. Shim
5. Roll pin
6. Adjusting nut
7. Bearing
8. Bearing
9. Differential housing
10. Sleeve
11. Bearing
12. Oil seal
13. Dust shield
14. Drive flange
15. Washer
16. Nut
17. Lockplate

21. OVERHAUL. Mount differential housing (9—Fig. 26) in a vise and loosen twelve cap screws that retain bevel ring gear (1) to differential case half (9—Fig. 27). Drive out roll pins (5—Fig. 26) that lock adjusting nuts (6), then unscrew and remove adjusting nuts and bearing cups (7 and 8). 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. 27) and remove both pinion shafts (3), pinion gears (2) and thrust washers (1). Remove two case halves (4 and 9) from differential housing separately. Separate bevel ring gear (1—Fig. 26) from differential case half. If necessary, remove bearing cones from differential case halves.

Remove retaining nut (16), washer (15) and drive flange (14) from bevel pinion gear (2), then drive or press bevel pinion gear from housing. Remove and discard collapsible sleeve (10). Remove oil seal (12) and bearing (11) from housing.

Clean and inspect all components and renew as necessary. Bevel ring and pinion gears are available

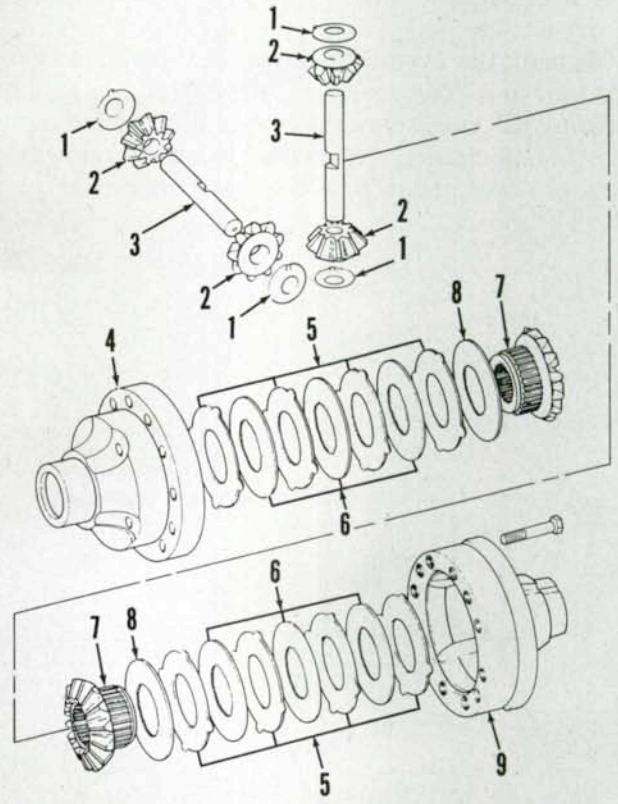


Fig. 27—Exploded view of limited slip differential assembly used in APL-3054 type axle.

1. Thrust washers
2. Pinion gears
3. Shafts
4. Case half
5. Drive plates
6. Driven plates
7. Side gears
8. Pressure plates
9. Case half

only as a matched set. Identical serial numbers will be stamped on outer edge of bevel ring gear (1) and on end of bevel pinion gear (2).

22. REASSEMBLY AND ADJUSTMENT. 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 (4—Fig. 26) thickness.

NOTE: All measurements should be metric or conversion will be necessary. Multiply inches by 25.4 to convert to metric equivalent.

Refer to Fig. 28 and install dummy pinion (3), from special adjusting tool set No. 3131, into bore of differential housing. Install pinion setting mandrel (1) into differential bearing bores.

NOTE: Mandrel is smaller at one end, install small end of mandrel into bearing bore on bevel ring gear side.

Measure the gap (b—Fig. 28) between dummy pinion and mandrel with a feeler gage, then perform the following calculation. Add the height of dummy pinion (a) plus the measured gap (b) plus one-half the diameter of differential bores (c). The result is dimension (x).

Measure the overall thickness of the pinion bearing cup and cone assembly (3—Fig. 26), then add bearing thickness dimension to pinion setting number (in millimeters) etched next to serial number on face of bevel pinion gear. Subtract the result from previously determined dimension (x); the result is required thickness of pinion bearing shim (4—Fig. 26). Install correct thickness shim and the bearing cup into housing bore, and press bearing cone onto pinion shaft until seated against shoulder of gear.

To adjust pinion bearing preload, assemble bevel pinion (2—Fig. 26) with a new collapsible sleeve (10), bearings (3 and 11) and oil seal (12) into differential housing. Install dust shield (13), drive flange (14), washer (15) and nut (16). Tighten nut finger tight. Use a torque wrench to measure torque required to rotate pinion shaft with zero bearing preload. Then hold drive flange with a suitable tool and tighten retaining nut (16) in small increments until torque required to turn pinion shaft is 10-20 in.-lbs. (1-2 N·m) greater than initial zero preload torque reading. If desired torque reading is exceeded, bearing preload is excessive and a new collapsible sleeve (10) must be installed and bearing preload readjusted.

Bench assemble differential components (outside differential housing) as follows: Position bevel ring gear (1) onto differential case half (9—Fig. 27). Install pressure plates (8) on side gears (7) so polished side is toward gear, then assemble clutch disc plates (5 and 6) alternately on side gears. Refer to Fig. 27 for proper clutch pack assembly sequence. Install side gear and clutch components into differential case halves (4 and 9). Install bevel pinion gears (2), thrust washers (1) and shafts (3). Mate differential halves (4 and 9), install ring gear retaining screws and tighten to a torque of 155 ft.-lbs. (210 N·m).

Refer to Fig. 29 and check clutch pack free play as follows: Mount a dial indicator gage on differential case so gage plunger contacts outer clutch plate. Use two screwdrivers to move clutch plate assembly

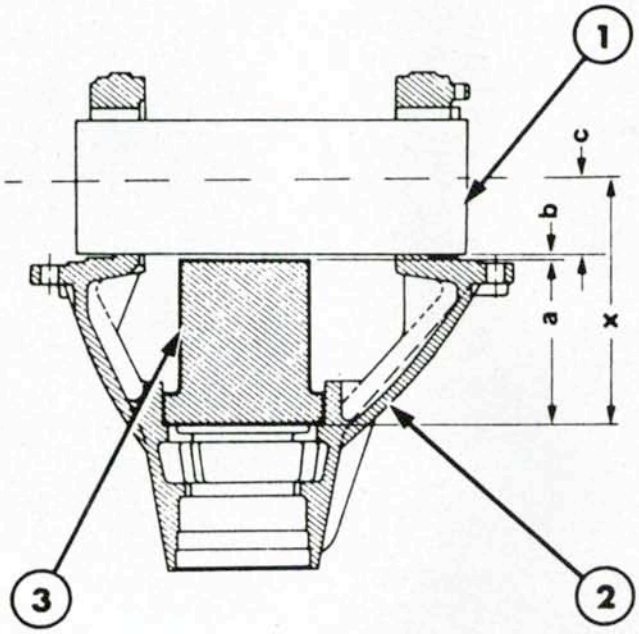


Fig. 28—Diagram of bevel pinion bearing shimming tools and measuring points. Refer to text.

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

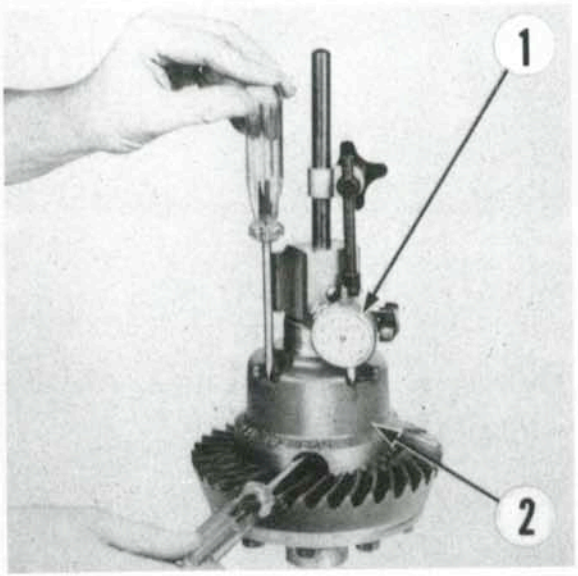


Fig. 29—Measure limited slip clutch pack free play by inserting dial gage (1) through case half (2) to contact clutch plate. Refer to text.

up and down and note movement of gage needle. Allowable free play is 0.004-0.008 inch (0.10-0.20 mm). Adjust free play by changing thickness of pressure plate (8—Fig. 27). Pressure plates are vailable in 2.8, 2.9 and 3.0 mm sizes. If after installation of thickest pressure plate free play remains excessive, a new set of clutch plates (5 and 6) must be installed. Repeat instructions for opposite differential case half.

Separate differential case halves for installation in differential housing (9—Fig. 26). Note that bearing (8) is wider than bearing (7) and that bearing (8) must be installed on ring gear case half (9—Fig. 27). While supporting differential housing with pinion gear in a horizontal position, install ring gear with differential case half 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. 30. Mate differential halves and install ring gear retaining screws, but do not tighten at this time. Install bearing cups (7 and 8—Fig. 26) and adjusting nuts (6). Hand tighten the adjusting nuts to eliminate any bearing free play, then tighten bevel ring gear cap screws to a torque of 155 ft.-lbs. (210 N·m).

Backlash between bevel ring gear and pinion gear should be 0.008-0.011 inch (0.20-0.28 mm) and is measured using a dial gage with gage plunger located perpendicular to a tooth of ring gear. Turn adjusting nuts (6—Fig. 26) to move ring gear toward pinion to reduce backlash, or away from pinion to increase backlash.

To set differential carrier bearing preload, mount a dial indicator so gage plunger contacts back (flat) side of bevel ring gear (1). While prying differential side to side, turn adjusting nut (6) on side opposite ring gear until no movement of differential assembly is noted on dial gage, then tighten adjusting nut an additional 1-1/2 to 2-1/2 slots to obtain recommended preload on bearings.

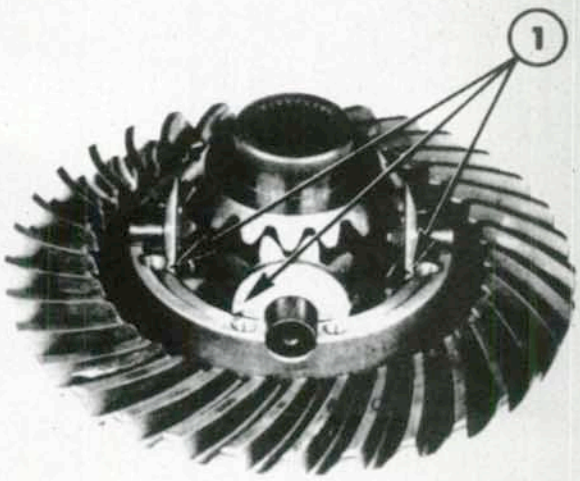


Fig. 30—Projections (1) on thrust washers must mate with differential case half as shown.

Recheck bevel ring gear to pinion gear backlash as previously described. Repeat adjustment steps as necessary to obtain proper bearing preload and gear backlash. When adjustment is completed, drive locking roll pins (5) into slot in adjusting nuts to secure the nuts.

Refer to Fig. 31 for proper bevel ring and pinion gear tooth contact pattern. If pinion shimming procedure was not performed properly, ideal tooth pattern will not be obtained and shimming procedure will have to be repeated.

APL-365 TYPE AXLE

Models TW-25 And TW-35 So Equipped

23. WHEEL HUB AND PLANETARY CARRIER. To remove wheel hub and planetary assembly from either side, first raise and support front axle and remove wheel and tire. Remove drain plug from planetary carrier (1—Fig. 32) and drain oil. Remove the two socket-head retaining screws (2), then insert pry bars into slots in hub and pry planetary carrier from hub. Remove snap rings (6) and withdraw planetary gears (4), bearings (5) and thrust washers (3) from carrier.

Remove locking plate (13), then remove slotted nut (12) using special socket (tool No. 12236) or other suitable tool. Remove ring gear (14) from hub support. Remove hub (18) using a suitable puller or by striking rear of hub with a soft hammer. Remove bearings (16) and oil seal (19).

The sun gear (11) is attached to axle universal joint (28) by a retaining ring (27). To remove sun gear, the steering knuckle (22) must first be removed as outlined in paragraph 24.

To reassemble, heat the hub bearings (16) to 212° F (100° C). Install inner bearing cone onto steering knuckle hub support. Install a new oil seal into hub, then position scraper "V" ring (20) onto oil seal with "V" side facing outward. Lubricate seal lip with

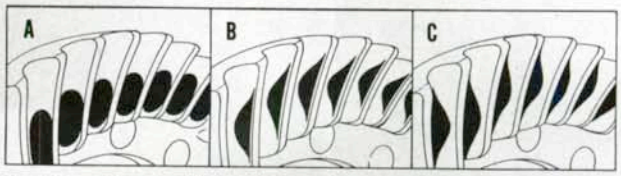


Fig. 31—Views of bevel ring gear tooth contact patterns.

A. Proper tooth contact—drive side pattern
B. Contact too high—pinion gear requires thicker shim
C. Contact too low—pinion gear requires thinner shim

grease, then position hub on hub support. Install outer bearing cone on hub support. Install ring gear on hub support and retain with slotted nut. Tighten the nut until all free play is removed from bearings.

Adjust hub bearing preload as follows: Wrap a cord around hub as shown in Fig. 33 and use a spring scale to measure rolling resistance of hub bearings and oil seal. Then, tighten the slotted nut (12) in small increments until pull required to rotate hub is 8-15 pounds (3.6-6.8 Kg) greater than initial (no preload) spring scale reading. Install lockplate (13—Fig. 32) to secure slotted nut.

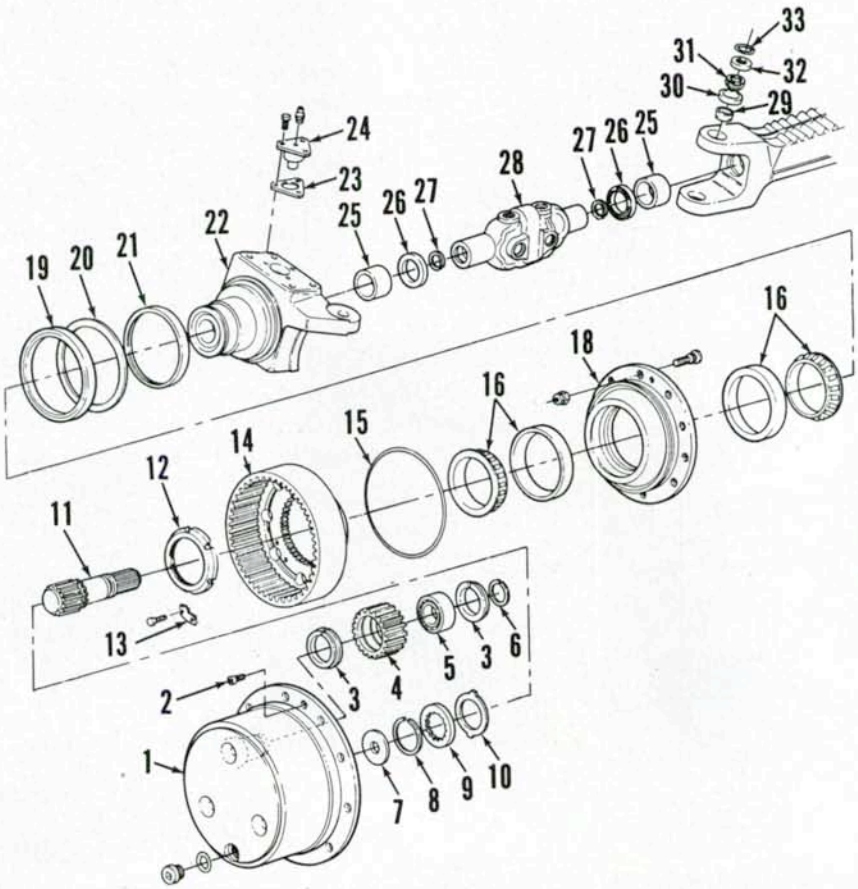
The thrust washer (10—Fig. 32) located in center of planetary carrier controls axle shaft end play. To determine correct thickness of washer to provide specified axle shaft end play of 0.012-0.024 inch (0.30-0.60 mm), proceed as follows: Place original thrust washer in carrier, then use a straightedge and depth micrometer to measure distance (A—Fig. 34) from mounting surface of carrier to face of thrust washer. Push sun gear and axle shaft fully inward, then measure distance (B) from end of sun gear to mounting surface of hub. Subtract dimension (B) from dimension (A) to calculate axle shaft end play. If end play is not within specified range, install a thicker or thinner thrust washer as necessary to obtain correct end play.

Assemble thrust washers (3—Fig. 32), planet gears (4) and bearings (5) in carrier. Be sure gears are positioned so side with chamfered inner bore is facing carrier housing. Install planetary carrier and refill hub with Ford M2C134-C or equivalent oil.

24. STEERING KNUCKLE, KINGPINS AND AXLE SHAFT. To remove steering knuckle (22—Fig. 32), first remove planetary carrier (1) as outlined in paragraph 23. Note that it is not necessary to remove planetary ring gear (14) and wheel hub (18) unless renewal of steering knuckle is required. Remove snap ring (8), splined washer (9) and thrust washer (10) from sun gear. Disconnect steering rod ball joint end from steering knuckle. Support steering knuckle and hub, remove upper and lower kingpins (24), bearing cones (31) and shims (23), then slide steering knuckle from axle housing.

Sun gear, universal joint and axle shaft can now be withdrawn from axle housing. To separate axle shaft or sun gear from universal joint, expand retaining ring (27) and pull shaft from universal joint.

To reassemble, slide axle shaft into axle housing being careful not to damage oil seal (26). Position steering knuckle on axle housing, assemble shims (23) on upper kingpin, install kingpins and tighten retaining cap screws to 90 ft.-lbs. (120 N·m) torque.



1. Planetary carrier
2. Retaining screws
3. Thrust rings
4. Planet gear
5. Bearing
6. Retaining ring
7. Thrust washer
8. Snap ring
9. Splined washer
10. Thrust washer
11. Sun gear
12. Slotted nut
13. Lockplate
14. Ring gear
15. "O" ring
16. Bearings
18. Hub
19. Oil seal
20. Scraper "V" ring
21. Sleeve
22. Steering knuckle
23. Shim
24. Kingpin
25. Bushing
26. Oil seal
27. Retaining ring
28. Universal joint
29. Plug
30. Bearing cup
31. Bearing cone
32. Cover
33. "O" ring

Fig. 32—Exploded view of hub and planetary final drive assembly used on APL-365 type front drive axle.

NOTE: If steering knuckle, axle housing, kingpins or pivot bearings were renewed, the pivot bearing preload must be checked and adjusted as follows:

Install special torque wrench adapter tool (No. 0566), or similar tool, onto upper kingpin so a torque wrench can be attached over center of kingpin as shown in Fig. 35. Measure the torque required to swivel the steering knuckle, which should be 13-15 ft.-lbs. (18-20 N·m). Increasing thickness of shims (23—Fig. 32) will decrease turning torque, or decreasing thickness of shims will increase turning torque. Shims should be installed under the upper kingpin only.

Reinstall planetary carrier and refill hub with recommended oil. Lubricate kingpins and bearings with grease.

25. DIFFERENTIAL AND BEVEL GEARS. To remove differential assembly, first remove front axle assembly from tractor as outlined in paragraph 6. Drain the oil from axle housing. Remove steering knuckles and axle shafts as outlined in paragraph 24. Support the differential carrier housing, remove carrier retaining cap screws and withdraw carrier, differential and bevel drive gears from axle housing.

To disassemble, drive out roll pins (2—Fig. 36) retaining the adjusting nuts (1) and remove the adjusting nuts and bearing cups (3 and 18). Use a suitable puller to remove bearing cones (4 and 17) from differential case halves.

NOTE: Scribe a mark on carrier housing identifying position of ring gear (7) in the carrier to ensure correct reassembly.

Remove locking plates (5) and retaining cap screws from ring gear. Separate the differential case halves, withdraw the pinion gears (13), thrust washers (14) and shafts (12), then remove case halves from carrier housing.

Remove retaining nut (32) and the drive flange (30) from bevel pinion shaft (20). Drive the bevel pinion assembly out of carrier housing. Remove oil seal (28) and rear bearing from housing bore.

Inspect all parts for excessive wear or damage and renew as necessary. The bevel pinion and ring gear must be renewed as a matched set. The pinion bearing preload spacer (25) must be renewed whenever

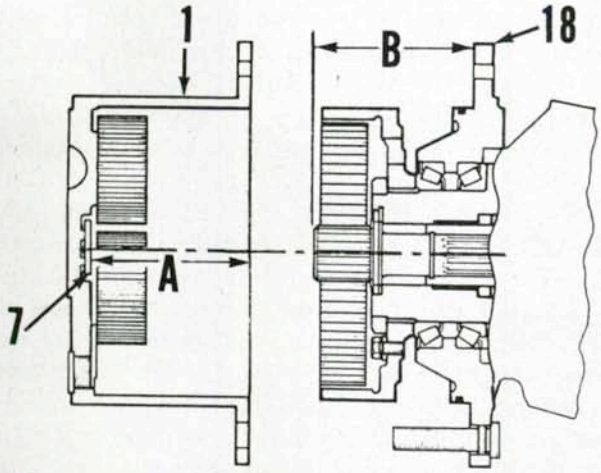


Fig. 34—Thrust washer (7) controls axle shaft end play. To adjust, measure dimensions "A" and "B" and refer to text.

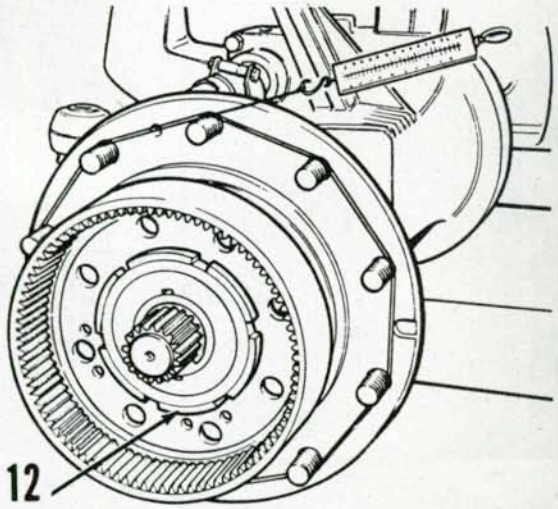


Fig. 33—To adjust wheel hub bearing preload, use a spring scale and cord as shown to measure rolling resistance of hub. Refer to text and tighten slotted nut (12) as necessary.

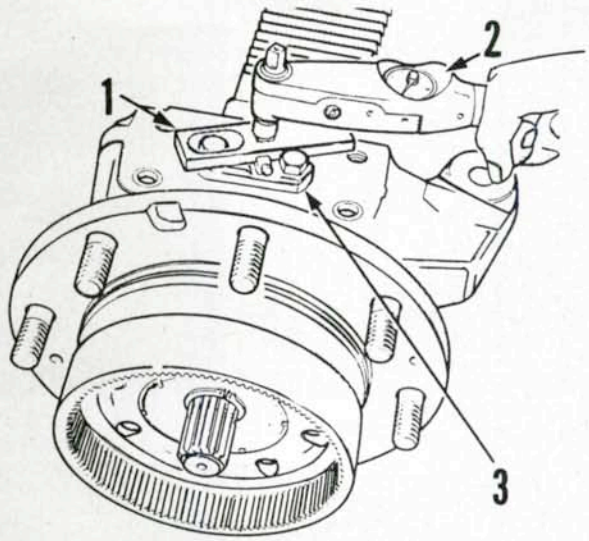


Fig. 35—Use adapter (1) and a torque wrench (2) to measure torque required to swivel steering knuckle. Refer to text for adjustment of kingpin bearing preload.

bevel pinion is removed. The differential pinion gears (13) and side gears (15) must be renewed as a set if excessively worn or damaged.

Lubricate all parts with oil prior to reassembly.

26. BEVEL PINION ENGAGEMENT. If bevel ring gear and pinion are being renewed, the pinion engagement position must be set as outlined below. The pinion engagement is adjusted by shims (23—Fig. 36) located behind pinion inner bearing cup (22).

Compare the variation measurement (in millimeters) scribed on the end of the old and new pinions (Fig. 37). If the measurements are the same, the original shim pack should be used. If the new pinion has a LARGER number than the old pinion, SUBTRACT shims from original shim pack equal to the difference between the two numbers. (Example: Number scribed on new pinion is 0 and number scribed on old pinion is -0.2, decrease shim thickness by 0.2 mm). If number scribed on new pinion is SMALLER than number on old pinion, ADD shims equal to the difference between the two numbers.

27. BEVEL PINION INSTALLATION AND BEARING ADJUSTMENT. Install inner bearing cup (22—Fig. 36) with selected shim pack (23) and outer bearing cup (26) into carrier housing. Insert bevel pinion with a new preload sleeve (25) into housing bore. Install outer bearing cone, oil seal, drive flange, washer and retaining nut. Tighten the nut just enough to remove end play from pinion shaft bearings. Using a suitable torque wrench, measure rolling resistance of pinion shaft with zero preload on bearings. Then tighten pinion nut in small increments while checking torque required to rotate pinion at each tightening stage. Pinion bearing preload is correct when rolling torque reading is 10-18 in.-lbs. (1-2 N·m) greater than initial (zero preload) reading. After correct bearing preload is obtained, install retainer (33) to prevent pinion nut from loosening.

28. DIFFERENTIAL REASSEMBLY AND ADJUSTMENTS. If ring gear was removed from differential case, install two suitable guide studs in differential case to align bolt holes. Heat ring gear to 212° F (100° C), then press the gear onto differential case half. Install roll pins (6—Fig. 36) making sure slots in each set of pins are positioned 180 degrees apart.

Assemble one set of limited slip clutch plates (9 and 10), spacer (11) and side gear (15) into one of the differential case halves. Be sure friction surface of spacer is against machined surface of clutch plate with external lugs (9). Install pinion gears (13), thrust washers (14) and shafts (12) into the case half, then use a dial indicator to measure backlash between pinion gears and side gear as shown in Fig. 38. Specified backlash is 0.008-0.012 inch (0.20-0.30 mm). To adjust backlash, install an appropriate thickness spacer (11—Fig. 36) behind side gear. Repeat the above procedure to select proper thickness spacer for opposite differential case half.

Place ring gear and differential case halves with side gears and clutch plates into carrier housing. Be sure ring gear is positioned on left side of bevel pinion when viewed from rear of axle. Assemble pinion

1. Adjusting nut
2. Roll pin
3. Bearing cup
4. Bearing cone
5. Lockplates
6. Roll pins
7. Ring gear
8. Case half
9. Drive plates
10. Driven plates
11. Spacer
12. Shaft
13. Pinion gear
14. Thrust washer
15. Side gear
16. Case half
17. Bearing cone
18. Bearing cup
20. Bevel pinion gear
21. Bearing cone
22. Bearing cup
23. Shim
24. Differential carrier housing
25. Sleeve
26. Bearing cup
27. Bearing cone
28. Oil seal
29. Dust cover
30. Drive flange
31. Washer
32. Nut
33. Retainer

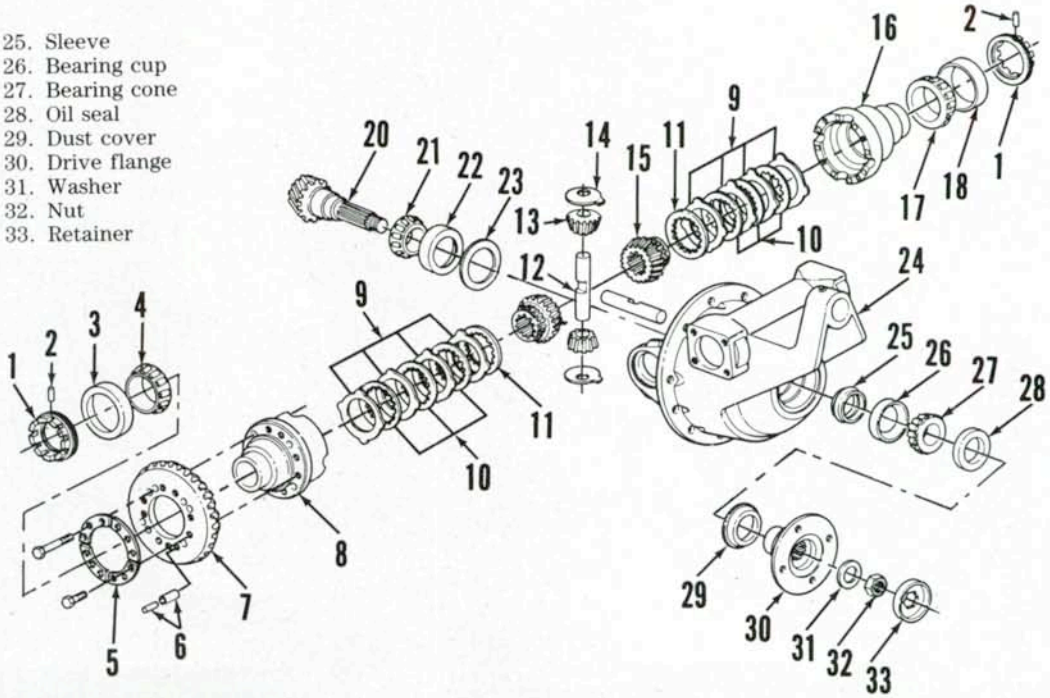


Fig. 36—Exploded view of differential assembly and bevel pinion gears used on APL-365 type front axle.

gears, thrust washers and shafts in case halves. Align part number stamped across the case halves and tighten retaining cap screws to 107 ft.-lbs. (145 N·m) torque. Install new locking plates (5) over the cap screw heads.

Heat differential bearing cones (4 and 17) to 212° F (100° C), then install bearings onto differential case. Install bearing cups and loosely install adjusting nuts (1).

Use a dial indicator to measure backlash between ring gear and pinion as shown in Fig. 38A. Turn adjusting nuts as necessary to obtain specified backlash of 0.007-0.010 inch (0.18-0.25 mm). When desired backlash is obtained install roll pin (2—Fig. 36) into slot of adjusting nut on ring gear side to secure the adjustment.

To adjust differential carrier bearing preload, first loosen adjusting nut on side opposite the ring gear to make certain there is no preload on the bearings. Measure the distance between two diagonally opposite machined lugs on differential carrier as shown in Fig. 39. Then, tighten adjusting nut on side oppo-

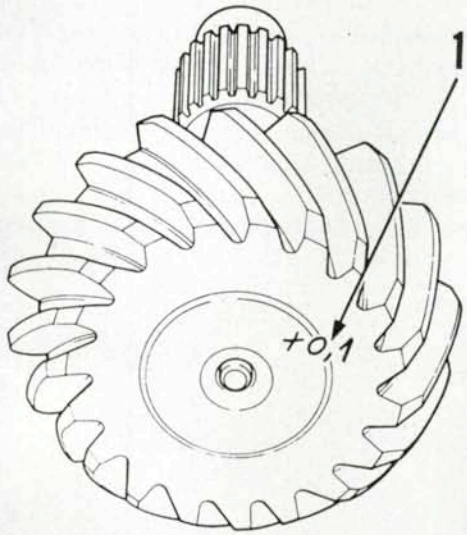


Fig. 37—When renewing bevel ring gear and pinion, compare variance measurement (1) scribed on end of new and old pinion and refer to text for pinion engagement adjustment procedure.

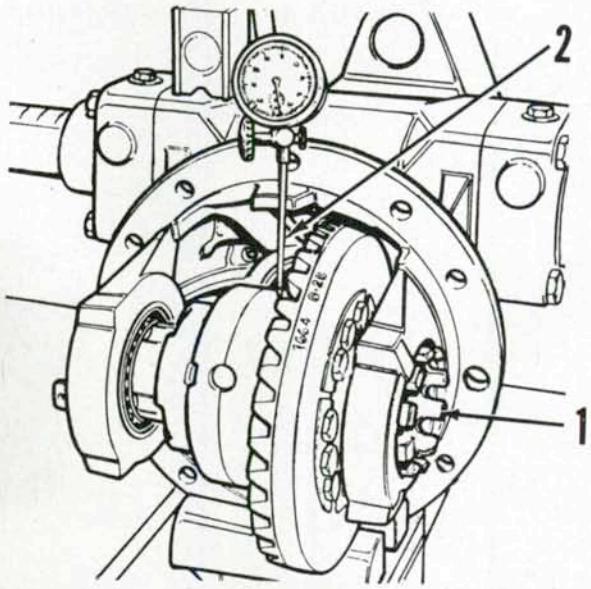


Fig. 38A—Use a dial indicator (2) to measure backlash between ring gear and pinion. Turn adjusting nut (1) to adjust backlash.

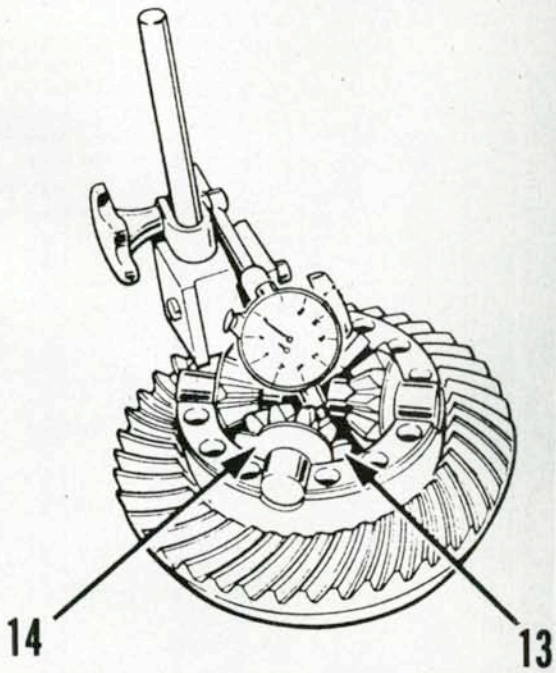


Fig. 38—Use a dial indicator to measure backlash between differential bevel gears (13) and side gear.

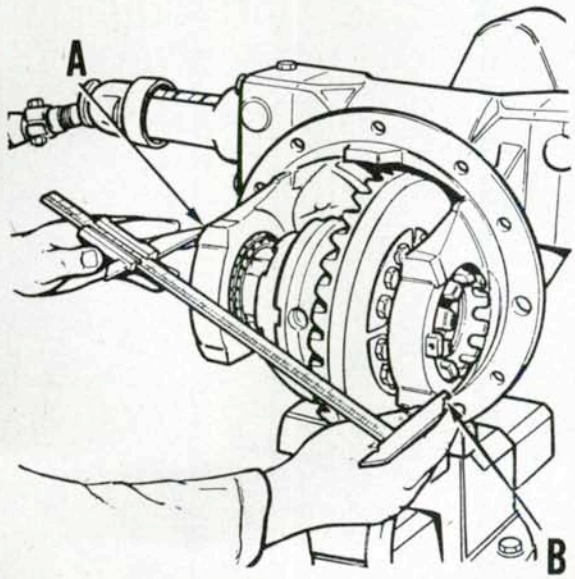


Fig. 39—When setting differential carrier bearing preload, measure distance across two diagonally opposite machined lugs (A and B) on differential carrier. Refer to text.

site ring gear until distance across the two lugs increases by 0.008 inch (0.20 mm). This provides proper preload on carrier bearings. Install locking roll pin into slot of adjusting nut to secure adjustment.

To check for proper ring gear and pinion gear tooth contact pattern, apply Prussian Blue to several gear teeth on ring gear. Rotate bevel pinion to engage coated teeth of ring gear, then compare the contact pattern with examples shown in Fig. 40. If proper tooth contact pattern is not obtained, pinion engagement shim pack (23—Fig. 36) is incorrect and adjustment procedure should be repeated.

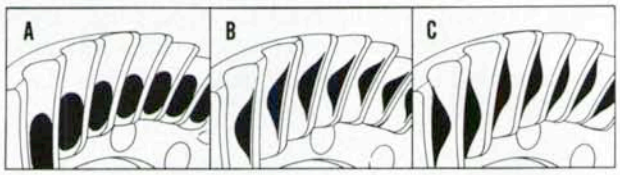


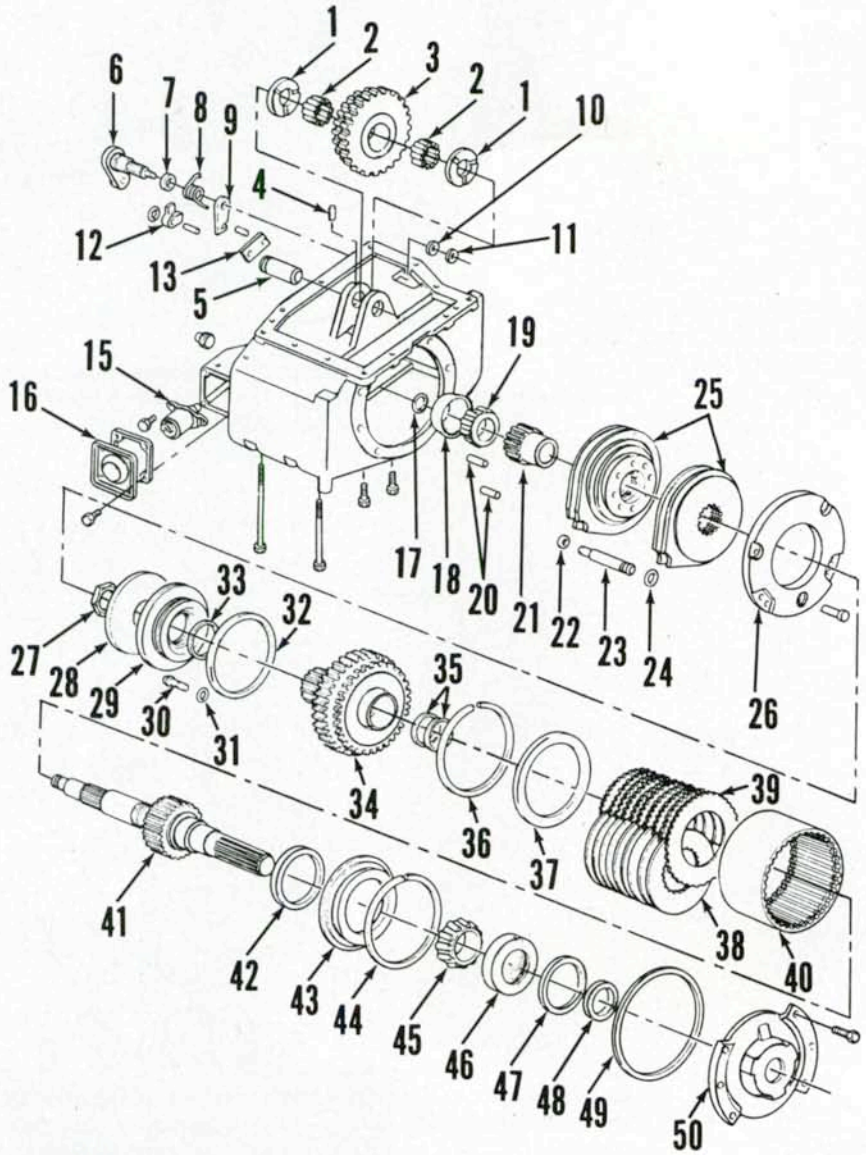
Fig. 40—Views of bevel ring gear tooth contact patterns.

A. Desired tooth contact—drive side pattern
B. Contact too high—pinion gear requires thicker shim
C. Contact too low—pinion gear requires thinner shim

TRANSFER CASE

Models With APL-345, APL-355 And APL-365 Type Axles

30. The transfer case is mounted on the bottom of rear transmission housing. A drive gear is mounted on the rear axle differential pinion shaft and meshes with an idler gear in the transfer case to transmit power to the multiplate clutch assembly. The clutch assembly is spring applied to engage clutch when there is no hydraulic pressure to the clutch operating piston. When hydraulic pressure is directed to the



1. Thrust washer
2. Bearing
3. Idler gear
4. Roll pin
5. Idler shaft
6. Brake lever shaft
7. Seal
8. Spring
9. Lever
10. Shim
11. Retaining ring
12. Stop
13. Link
15. Solenoid valve
16. Cover
17. Oil seal
18. Bearing cup
19. Bearing cone
20. Dowel pins
21. Splined spacer
22. Retainer
23. Anchor pin
24. Seal
25. Brake assy.
26. Retaining plate
27. Nut
28. Spring plate
29. Piston
30. Plunger
31. "O" ring
32. Outer seal
33. Inner seal
34. Actuating housing
35. Seal rings
36. Retaining ring
37. Pressure plate
38. Drive plates
39. Driven plates
40. Clutch housing
41. Output shaft
42. Spacer
43. Return plate
44. Retaining ring
45. Bearing cone
46. Bearing cup
47. Shim
48. Oil seal
49. Seal
50. End cover

Fig. 41—Exploded view of transfer case used on all front wheel drive models except early TW-35.

operating piston, the clutch plates are released which disengages drive to front axle. The oil supply to the operating piston is controlled by a solenoid operated valve located in the transfer case.

31. REMOVAL. To remove transfer case, first drain oil from transfer case and transmission housing. Disconnect wire from control valve solenoid. Disconnect oil supply tube from transfer case. Remove drive shaft cover. Support transfer case with a suitable floor jack. Remove mounting cap screws, then lower transfer case and move rearward to disconnect output shaft from drive shaft.

32. OVERHAUL. To disassemble transfer case, drive roll pin (4—Fig. 41) into center of idler gear shaft (5). Push out the shaft and remove idler gear (3) with thrust washers (1) and bearings (2). Unbolt and remove end cover (50), then lift output shaft (41) with clutch assembly from transfer case. Unbolt and remove solenoid valve assembly (15).

To remove transmission parking brake, remove socket-head screws attaching brake retaining plate (26) to transfer case. Use a suitable puller and slide hammer to remove the retaining plate from locating dowels in transfer case. Remove retaining ring (11) and shim washer (10) from brake lever shaft (6), then withdraw brake lever, spring (8) and link (9). Remove brake discs and actuator assembly (25).

Secure clutch assembly in a vise, then remove nut (27) and spring plate (28) from output shaft (41). Remove retaining ring (44) from front of clutch housing (40), then withdraw return plate (43), clutch plates (38 and 39) and pressure plate (37). Support the clutch housing in a press as shown in Fig. 42, then press output shaft out of rear bearing cone (19). Withdraw shaft from splined spacer (21) and clutch housing. Remove piston (29—Fig. 41) from actuating housing (34) by pushing against piston plungers (30).

The actuating housing (34) is retained to clutch housing (40) by a retaining ring (36). The housings should be separated only if renewal is necessary. To compress retaining ring, drive seven suitable size wedges into spline grooves at the access spaces (S—Fig. 43) located around inside diameter of clutch housing. Pull actuating housing and retaining ring out of clutch housing.

Inspect all parts for excessive wear or damage and renew if necessary. Clutch plates (38 and 39—Fig. 41) must be renewed as a set. The bushings in clutch actuating housing (34) are not available separately for service. The transmission brake discs must be renewed as a set if worn or damaged. Renew all seal rings.

Make certain that oil passages in output shaft and clutch piston housing are open. Inspect mesh filters (A—Fig. 44) on solenoid control valve for contamination. Clean the filters with solvent, if necessary, but do not use compressed air to blow dry the filters. Do not immerse the solenoid body in the solvent.

To reassemble, install clutch piston and plungers into actuating housing. Slide output shaft into clutch housing, then assemble pressure plate, clutch plates and return plate into clutch housing and secure with retaining ring. Install splined spacer on rear of output shaft, then press bearing cone onto the shaft. In-

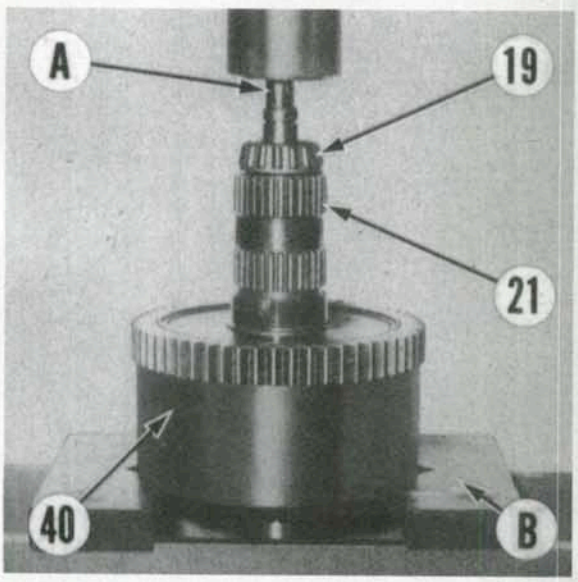


Fig. 42—Support clutch housing (40) and press output shaft out of rear bearing cone (19) to separate shaft from splined spacer (21) and clutch housing.

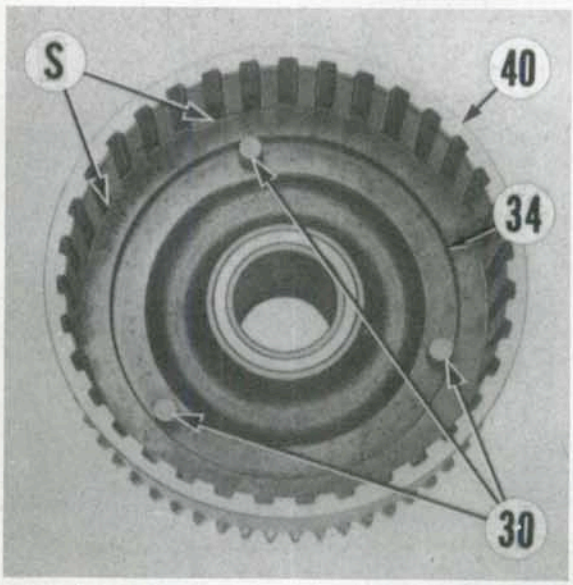


Fig. 43—To separate actuating housing (34) from clutch housing (40), drive wedges into spline grooves at the access spaces (S) located around inside diameter of clutch housing to compress retaining ring.

stall spring plate and nut. Use a straightedge to align splines of spacer and actuating housing as shown in Fig. 45 while tightening the nut.

Support output shaft and clutch assembly in a press as shown in Fig. 46. Using a sleeve (2) that will fit over the clutch return plate (43), compress the clutch plates against the piston actuating housing while measuring the movement of the return plate with a dial indicator as shown in Fig. 46. Return plate movement (clutch plate clearance) should be within specified range of 0.047-0.071 inch (1.2-1.8 mm). To adjust clearance, tighten or loosen retaining nut (27—Fig. 41) as necessary. Stake the nut to the shaft after correct clearance is obtained.

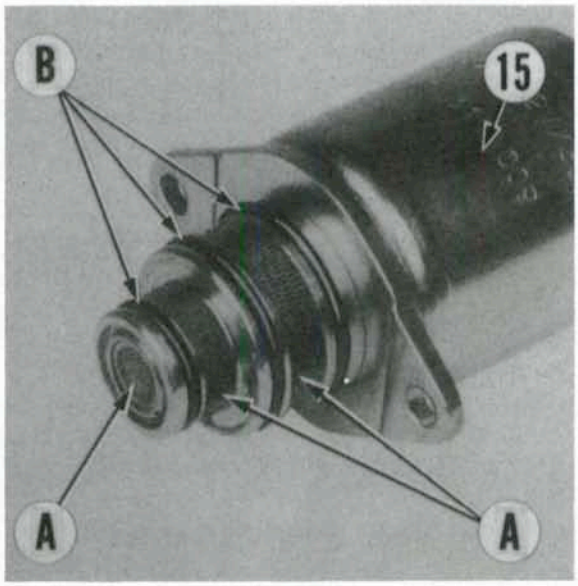


Fig. 44—View of solenoid control valve (15) showing mesh filters (A) and "O" ring seals (B).

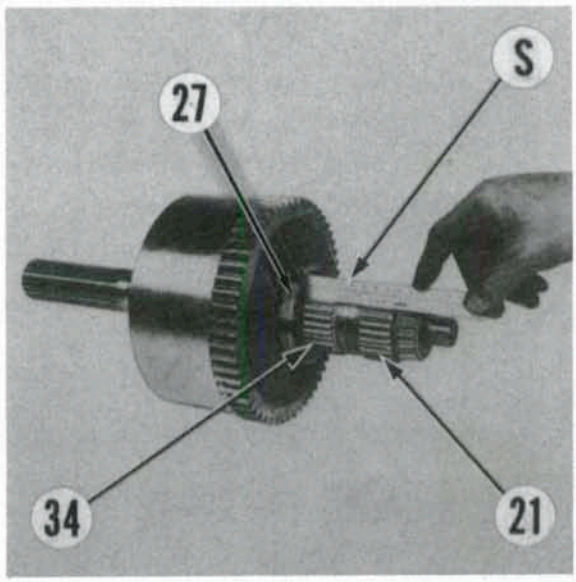


Fig. 45—When assembling clutch unit, use a straightedge (S) to align splines on spacer (21) and clutch actuating housing (34) as nut (27) is tightened.

Assemble transmission brake plates and actuator in transfer case. Use aligning tool (No. 0562) or other suitable tool to align brake plate splines. Install brake actuating linkage so splined brake lever (6—Fig. 41) is located at approximately 8 o'clock position. Select shim washer (10—Fig. 41) to provide zero end play when retaining ring (11) is installed. Install brake retaining plate (26) and tighten socket-head screws to 90 ft.-lbs. (120 N·m) torque. Secure the brake lever in "applied" position to hold brake plates in place, then remove alignment tool.

Install output shaft and clutch assembly into transfer case. Install end cover (50) with original shim (47) and tighten retaining cap screws to 90 ft.-lbs. (120 N·m) torque. Check output shaft end play, which should be 0.001-0.003 inch (0.025-0.075 mm). If necessary, install different thickness shim (47) to obtain specified end play.

Complete reassembly by installing idler gear assembly and solenoid control valve.

33. INSTALLATION. To install transfer case assembly, reverse the removal procedure. Tighten mounting cap screws to 55 ft.-lbs. (75 N·m) torque.

Adjust transmission brake control linkage as follows: Place hand control lever in "OFF" position. Move brake control lever (6—Fig. 47) fully upward to apply brake. Adjust cable adjuster nut (1) until clevis (3) can be attached to brake lever, then turn cable adjuster downward five revolutions to lower the lever and provide specified brake disc clearance in disengaged position. Tighten jam nuts (2).

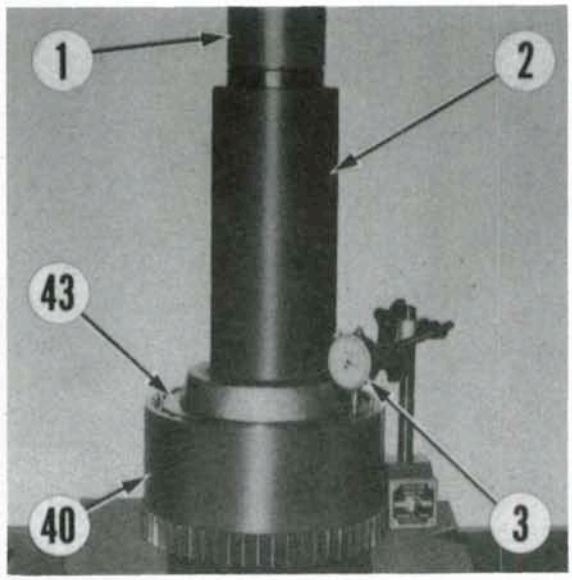


Fig. 46—Use a dial indicator to measure clutch plate clearance. Refer to text for adjustment procedure.

1. Press
2. Sleeve
3. Dial indicator
40. Clutch housing
43. Return plate

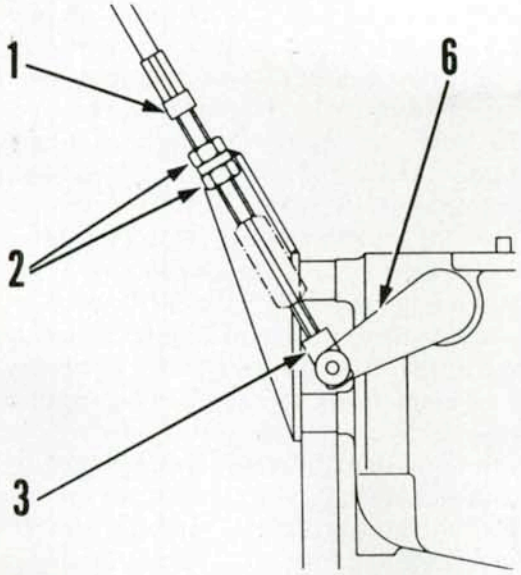


Fig. 47—Refer to text for transmission brake control linkage adjustment.

1. Cable adjusting nut
2. Jam nuts
3. Clevis
6. Transfer case brake lever

TRANSFER CASE

Model TW-35 With APL-3054 Type Front Axle

34. OPERATION. The transfer case is mounted on the transmission handbrake housing as shown in Fig. 50. The transfer case output shaft is supported at the rear by a needle roller bearing (2) located within the hollow shaft of the transmission handbrake, while the front is supported by a tapered roller bearing (11). The transfer case 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 (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 case. In this position, clutch plates (3 and 4) are engaged as pressure of Belleville washers (15) against pressure plate (21) forces clutch plates together. With clutch plates engaged, plate carrier (22) and output shaft (10) rotate and transfer power to front wheel drive.

35. R&R TRANSMISSION HANDBRAKE AND TRANSFER CASE. Jack up left side of tractor to divert transmission oil away from transmission handbrake housing. Remove left rear wheel and drain oil from transfer case. Remove locknuts securing drive shaft rear flange to transfer case 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 case assembly, remove hex head bolts that secure assembly to rear axle center housing. Remove complete unit. To reinstall, reverse removal procedure.

1. Handbrake housing
2. Roller bearing
3. Driven plates
4. Drive plates
5. Clutch drum
6. Retainer ring
7. Split ring
8. Transfer case 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. Clutch oil pressure port & roll pin
20. Thrust ring
21. Pressure plate
22. Plate carrier

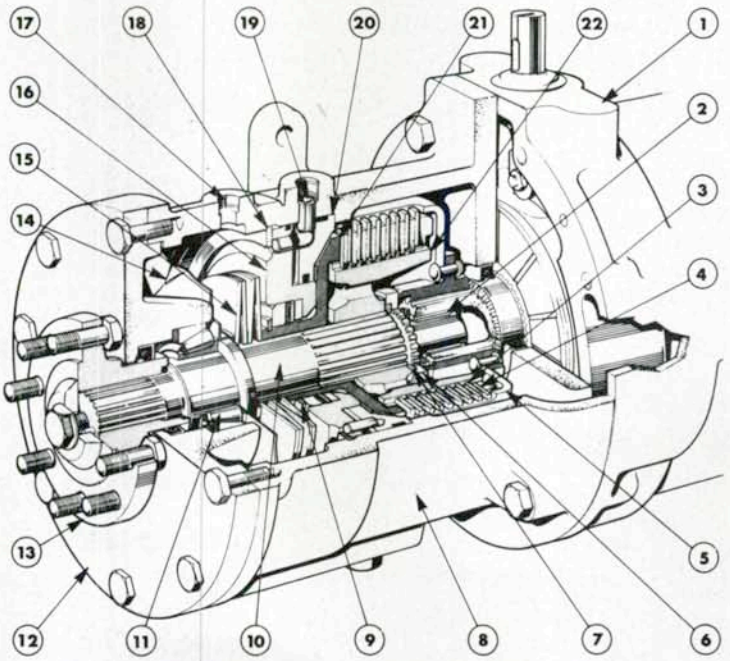


Fig. 50—Sectional view of transfer case assembly used on early TW-35 models with APL-3054 front drive axle. Refer to Fig. 51 for exploded view.

36. OVERHAUL. Disconnect clutch oil feed and return lines from transfer case housing ports (17 and 19—Fig. 50). 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 case from handbrake assembly. Using special tool Ford No. 0567 or equivalent, remove hex bolt, lockplate disc and pin (25—Fig. 51) from end of output shaft, then remove flange (13). Mark housing and cover for proper alignment during reassembly. Remove cover bolts and transfer case cover (12). It may be necessary to use a hammer and brass drift to aid in removal. Remove clutch and output shaft assembly snap ring (18). Drive roll pin (19) into transfer case 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 case 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 horseshoe shaped tool, 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 of transfer case. Remove roller bearing, if necessary, from front of transfer case handbrake shaft.

Inspect transfer case components and renew as necessary. Front wheel drive control valve must be renewed as a unit assembly if defective.

To reassemble, 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 plate (21) and assemble shim (33), thrust bearing (32) and small thrust washer (31) on pressure plate. 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 (15) 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. 52) is facing up and measure gap between pressure plate (21) and underside of output shaft collar (C) using a 0.787 inch (20 mm) 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 between shaft collar and pressure plate. Result is required thickness of shim (30—Fig. 51). 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

2. Bearing
3. Driven plate
4. Drive plate
5. Clutch drum
6. Retainer ring
7. Split rings
8. Housing
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 plate
22. Plate carrier
23. Cap screw
24. Lockplate
25. Split pin
26. Disc
27. Oil seal
28. Shim
29. "O" ring
30. Shim
31. Thrust washer
32. Bearing
33. Shim
34. Seal ring
35. Detent spring
36. Seal ring
37. Dowel pins
38. Seal ring
39. Pressure plate
40. Gasket
41. Thrust washers
42. Bearing
43. Oil seal
45. Drive shaft

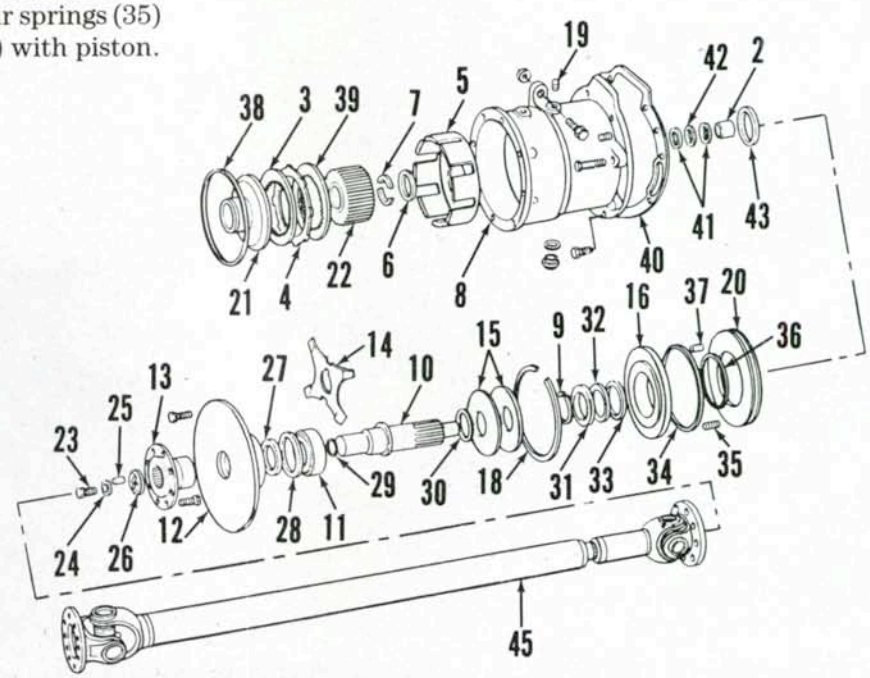


Fig. 51—Exploded view of transfer case assembly used on early TW-35 tractors with front drive axle.

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.

Coat transfer case housing bores (where piston and thrust ring are located) with petroleum jelly, then 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. 50), then drive roll pin into feed hole 0.006 inch (0.15 mm) from outer edge of hole. Roll pin must engage thrust ring recess to prevent turning. Secure clutch piston with snap ring (18—Fig. 51). Coat outer edge of oil seal (43) with a suitable sealant and press into transfer case cover (12) with sealing lip toward 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. (43 N·m). Mount transfer case assembly on blocks face down. Measure distance from rear face of case to output shaft shoulder as shown in Fig. 53. Distance should be between 2.216-2.232 inches (56.29-56.69 mm). Install correct thickness of shim (28—Fig. 51) 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 90 ft.-lbs. (120 N·m).

To determine proper end clearance between transfer case output shaft and drive shaft in brake housing, place a straightedge of known height across face of brake housing as shown in Fig. 54. Measure distance from straightedge to end of brake drive shaft, then calculate distance shaft extends beyond face of

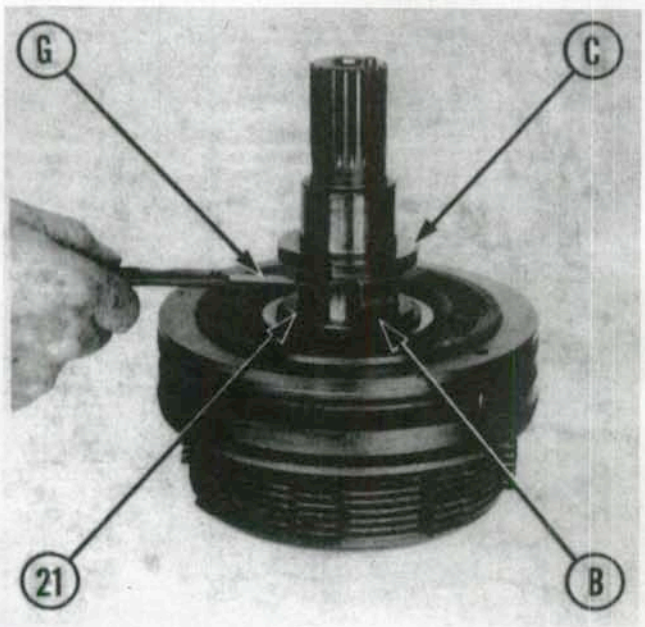


Fig. 52—View showing transfer case clutch shimming measurement. Refer to text.

B. Gage block
C. Output shaft collar
G. Feeler gage
21. Pressure plate

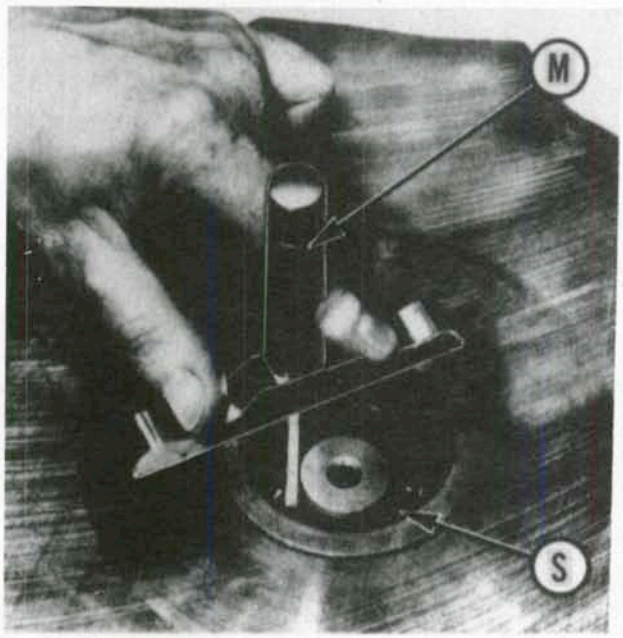


Fig. 53—View showing measurement from rear face of housing to shoulder of output shaft (S) to determine shim thickness for correct output shaft end play.

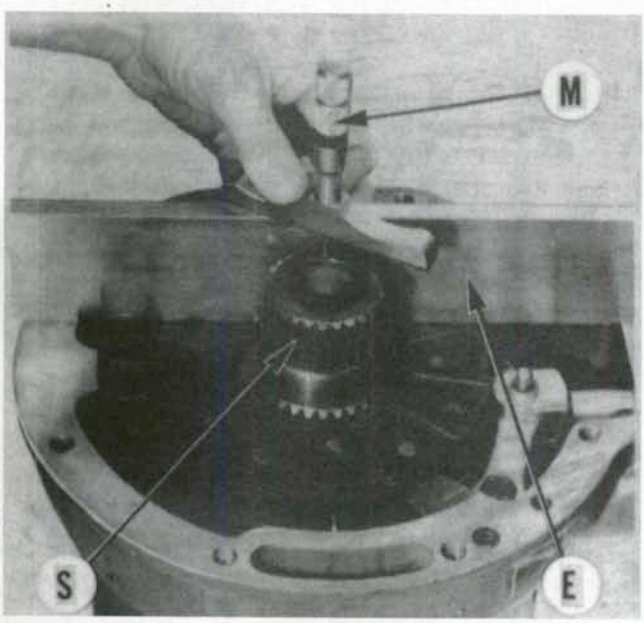


Fig. 54—Use a depth gage (M) and straightedge (E) to determine distance brake shaft (S) projects beyond face of brake housing. Refer to text for brake shaft to output shaft end clearance setting.

brake housing. Subtract the previously measured distance from face of transfer case to shoulder of output shaft (Fig. 53) from brake shaft dimension. The result is the total thickness of thrust needle bearing (42—Fig. 51) and two washers (41) needed to obtain desired end clearance. Thrust washers are available in the following thicknesses: 2.38 mm, 2.5 mm, 2.8 mm, 3.0 mm and 3.15 mm.

Coat thrust needle bearing and thrust washers with petroleum jelly and install on rear end of transfer case output shaft. Polished face of thrust washers must face the needle bearing.

Install a new needle bearing in bore of brake driven shaft if necessary. Apply suitable sealer to housing mounting gasket (40), then install transfer case assembly and control valve plate onto brake housing. Tighten housing retaining cap screws to a torque of 40 ft.-lbs. (54 N·m). Tighten control valve retaining plate bolts to a torque of 18 ft.-lbs. (24 N·m). Connect oil lines and install transfer case drain plug.

HYDROSTATIC POWER STEERING

FLUID AND FILTER

All Models

37. The integral power steering pump and reservoir are mounted on left-hand side of engine. It is recommended that power steering fluid and filter be renewed after every 600 hours of service as follows: Disconnect return line hose (R—Fig. 56) from reservoir. Remove retaining bolt (1), then withdraw reservoir (2) while catching the oil in a suitable container. Renew filter (3—Fig. 58) and O ring (4). Reinstall reservoir and fill with new oil to a level ¾ inch (19 mm) below bottom of filler opening.

Recommended power steering fluid is Ford M2C134-C. Capacity is approximately 4 U.S. quarts (3.7 L).

The power steering system is self-bleeding. After filling reservoir, start engine and cycle steering from lock to lock several times. Check fluid level and add oil as required to maintain oil level ¾ inch (19 mm) below bottom of filler opening.

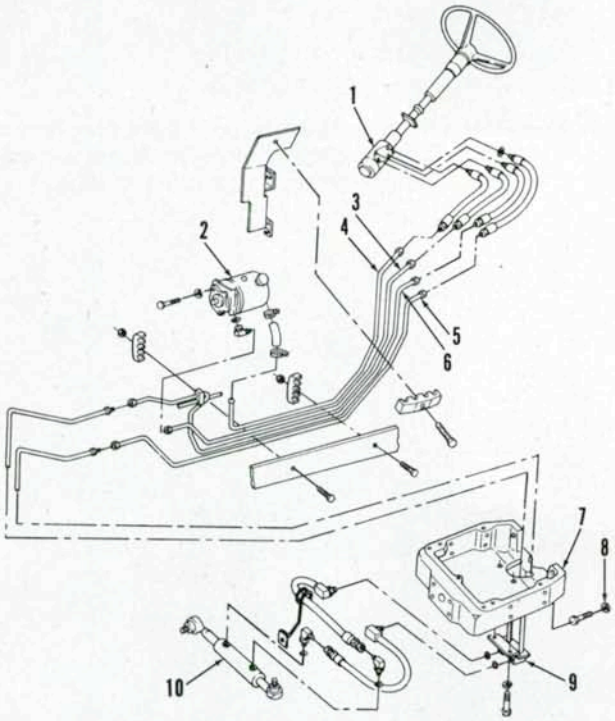


Fig. 55—Hydrostatic power steering system with an integral hydraulic pump and reservoir is used on all models. On tractors with front drive axle (except early TW-35), steering cylinder is integral with front axle housing.

1. Steering motor
2. Hydraulic pump & reservoir assy.
3. Pressure tube
4. Return tube
5. Right turn tube
6. Left turn tube
7. Axle support
8. Shims
9. Tube assy.
10. Steering cylinder

SYSTEM PRESSURE TEST

All Models

38. The power steering pump incorporates a pressure relief valve (32—Fig. 58) which is located in the pump body (13) within the reservoir housing. Relief valve opening pressure should be 1550-1650 psi

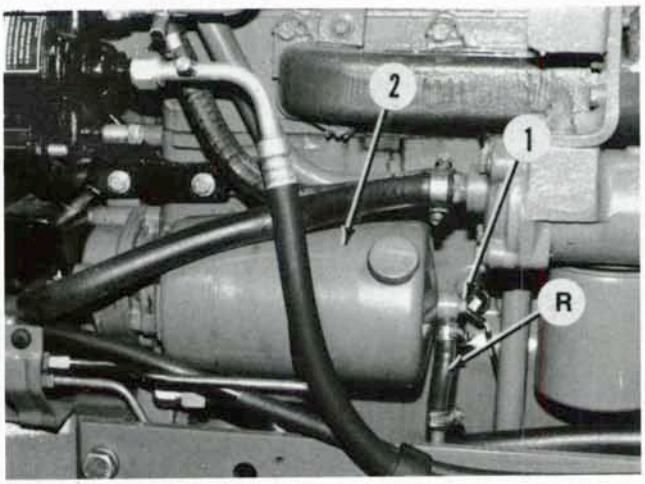


Fig. 56—Power steering pump and reservoir assembly is located on left side of engine.

R. Return line
1. Retaining bolt
2. Reservoir housing

(10690-11375 kPa) on Models TW-5, TW-15 and TW-25; 1950-2100 psi (13445-14480 kPa) on Model TW-35.

To check system relief pressure, install a 0-3000 psi (0-20000 kPa) pressure gage in pump to motor high pressure tube (4—Fig. 57) using a tee fitting (5). Start the engine, turn steering wheel to hold front wheels against the stop and note pressure gage reading.

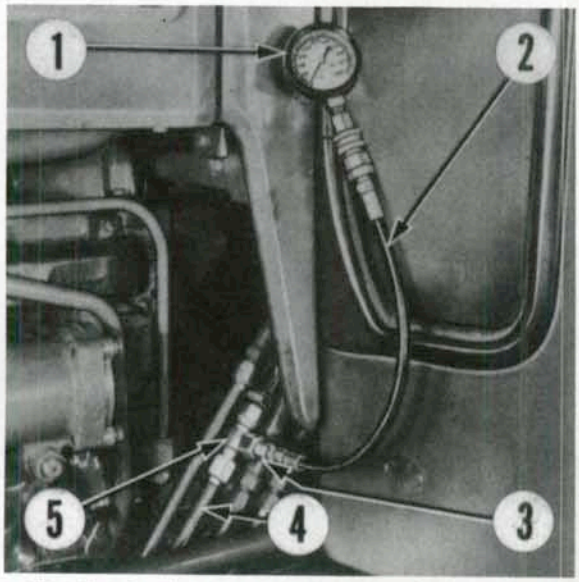


Fig. 57—To check power steering relief valve pressure, install a 0-3000 psi (0-20000 kPa) pressure gage in pump to steering motor pressure line using a tee fitting.

1. Pressure gage
2. Hose
3. Reducer
4. Pressure line
5. Tee fitting

If pressure is not within specified range, the pump must be removed from the engine as outlined in paragraph 40 to adjust relief valve. Remove the reservoir and filter. Remove plug (24—Fig. 58) from pump body and add or remove shims (25) to obtain specified relief pressure. Changing shim thickness 0.007 inch (0.17 mm) will change relief pressure setting about 70-80 psi (483-550 kPa).

Reinstall pump and retest relief valve pressure. If pressure cannot be correctly adjusted, remove pump and overhaul as outlined in paragraph 40.

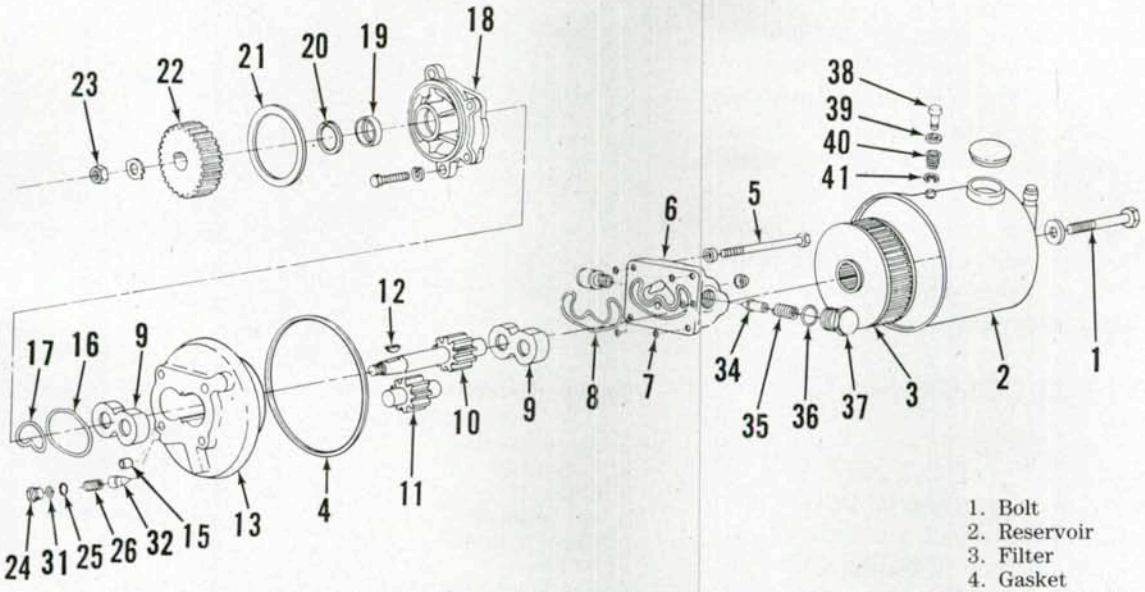
TROUBLE-SHOOTING

All Models

39. Refer to the following for checking possible causes of steering system malfunction:

1. HARD STEERING. Could be caused by:
   a. Misadjusted or faulty pump relief valve.
   b. Worn or damaged pump.
   c. Worn or damaged motor.
   d. Steering column components binding.
   e. Front axle binding.

2. NO STEERING OR SLOW STEERING RESPONSE. Could be caused by:
   a. Low oil level in reservoir.
   b. Incorrect grade of oil being used.
   c. Damaged pump or motor.



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

Fig. 58—Exploded view of power steering pump and reservoir assembly used on all models.

3. EXCESSIVE WHEEL DRIFT. Could be caused by:
   a. Oil leakage past steering motor valve spool.
   b. Oil leakage past steering cylinder piston seal.

4. ERRATIC STEERING. Could be caused by:
   a. Rotor vanes in motor damaged or sticking.
   b. Air in system.

STEERING PUMP

All Models

40. R&R AND OVERHAUL. To remove steering pump and reservoir, disconnect steering pressure line and return line from pump and reservoir. Remove two cap screws attaching pump to engine front cover, then withdraw pump and reservoir assembly.

To disassemble, remove bolt retaining reservoir (2—Fig. 58) and withdraw reservoir and filter element (3). Remove drive gear retainer nut (23), then pull drive gear (22) off pump shaft and remove Woodruff key. Scribe alignment marks on flange housing (18), pump body (13) and end cover (6). Remove through-bolts (5), then separate pump components. Keep parts in their relative position during disassembly as an aid to proper reassembly. If necessary, remove power steering relief valve (32) and flow control valve (34).

Inspect all parts for wear, scoring or other damage and renew as necessary. Pump gears (10 and 11) and pump body (13) are not serviced separately. If gear wear track is deeper than 0.0025 inch (0.064 mm) on inlet side of pump body, renew the pump assembly. Renew all "O" rings and seals.

To reassemble, reverse the disassembly procedure. Tighten relief valve and flow control valve plugs to 35 ft.-lbs. (47 N·m) torque. Tighten pump through-bolts evenly to 26 ft.-lbs. (35 N·m) torque. Tighten pump drive gear retaining nut to 35 ft.-lbs. (47 N·m) torque.

Reinstall pump and refill reservoir with Ford M2C134-C fluid. Start the engine and turn steering wheel to bleed air from system while adding oil to reservoir to maintain correct level.

STEERING COLUMN

All Models

41. To remove steering column assembly, first disconnect battery cables. Disconnect tachometer cable from injection pump. Remove steering wheel using a suitable puller. Remove throttle hand control lever. Remove instrument panel retaining screws, raise the instrument panel and disconnect tachometer cable from rear of panel. Identify location of wires in instrument panel wiring harness, then disconnect wires and remove instrument panel. Remove instrument panel cowling. Loosen clamp bolt attaching steering shaft to steering motor flexible coupling. Remove bolts attaching steering column to upper support bracket, then withdraw steering column assembly.

Refer to appropriate Fig. 60 or Fig. 61 for exploded view of steering column assembly. Disassemble, inspect and renew parts as necessary.

To reinstall, reverse the removal procedure. Tighten steering column mounting bracket bolts to 23 ft.-lbs. (31 N·m) torque and tighten steering wheel retaining nut to 28 ft.-lbs. (38 N·m) torque.

STEERING MOTOR

All Models

42. REMOVE AND REINSTALL. To remove steering motor, first disconnect battery cables. Remove

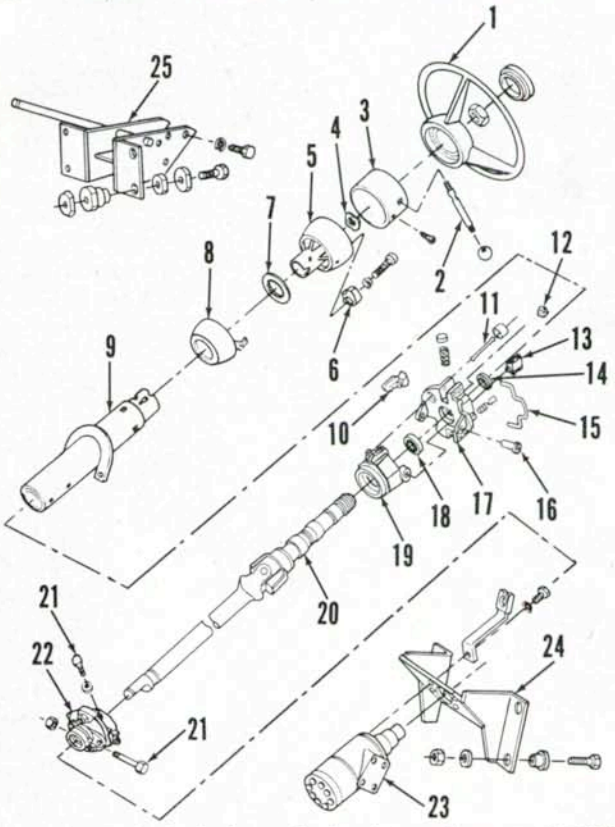


Fig. 60—Exploded view of steering column assembly used on early models.

1. Steering wheel
2. Lock lever
3. Cover
4. Spring washer
5. Upper extension
6. Retainer
7. Thrust washer
8. Lower extension
9. Column tube
10. Lock pawl
11. Rod
12. Retainer
13. Actuator
14. Bearing
15. Release lever
16. Pin
17. Upper flange
18. Bearing
19. Lower flange
20. Steering shaft
21. Clamp bolts
22. Flexible coupling
23. Steering motor
24. Motor support bracket
25. Column support bracket

side panels from left side of tractor. On Model TW-35, remove auxiliary hydraulic pump if so equipped. On all models, mark the hydraulic hoses to ensure correct reassembly, then disconnect hoses from steering motor. Plug all openings to prevent entry of dirt. Loosen the clamp bolt that attaches flexible coupling flange to steering motor shaft. Remove mounting cap screws from steering column lower bracket, then withdraw bracket and steering motor as a unit.

To reinstall motor, reverse the removal procedure. Start engine and turn steering wheel from lock to lock several times to purge air from system.

43. OVERHAUL. Thoroughly clean exterior of motor prior to disassembly. Install a hydraulic fitting into one of the four ports in motor housing, then clamp the fitting in a vise so input shaft (23—Fig. 64) is pointing downward.

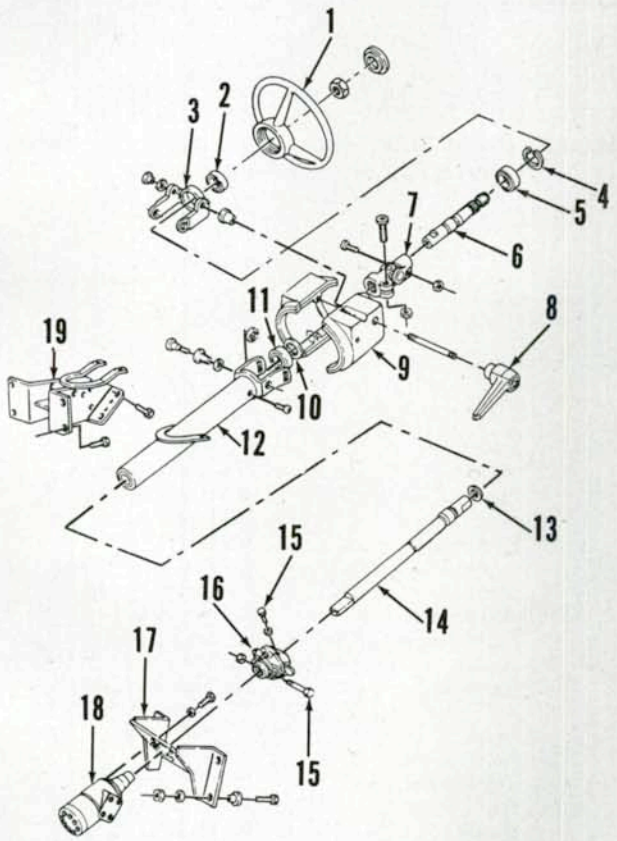


Fig. 61—Exploded view of steering column assembly used on late production tractors.

1. Steering wheel
2. Bearing
3. Yoke
4. Snap ring
5. Bearing
6. Upper shaft
7. Coupling
8. Lock lever
9. Cover assy.
10. Retaining ring
11. Bearing
12. Column tube
13. Retaining ring
14. Lower shaft
15. Clamp bolts
16. Flexible coupling
17. Motor support bracket
18. Steering motor
19. Column support bracket

Remove cap screws from end cover (1), then carefully remove end cover, seal retainer (4) and seal (3).

NOTE: Lapped surfaces of end cover (1), commutator set (5 and 6), manifold (7), stator-rotor set (8), spacer (10) and housing (11) must be protected from scratches, burrs or other damage as sealing of these parts depends on their finish and flatness.

Remove commutator set (5 and 6) and manifold (7). Lift off the spacer (10), drive link (9) and stator-rotor set (8) as an assembly. Handle stator-rotor carefully to prevent vanes and springs from falling out.

Reposition housing in vise so input shaft is pointing upward. Scribe an alignment mark on flange of upper cover (33) and housing (11) for aid in reassembly. Remove upper cover mounting screws, then grasp input shaft and withdraw input shaft, upper cover and valve spool assembly. Slide upper cover from input shaft and remove spacer (25). Remove shims (31) from upper cover or from face of thrust washer (29). Remove dust seal (37), retaining ring (36), stepped washer (35) and seal ring (34).

Remove retaining ring (30), thrust washers (29 and 27), thrust bearing (28) and spring washer (26) from input shaft. Drive pin (24) from input shaft, then withdraw torsion bar (15) and spacer (21). Place end of valve spool (14) on a flat surface and rotate input shaft until drive ring (22) falls free, then rotate input shaft clockwise until actuator ball (17) is disengaged from helical groove in input shaft. Withdraw input shaft from valve spool. Do not remove actuator ball spring (16) unless renewal is necessary.

Inspect all parts for excessive wear, scoring or other damage and renew if necessary. If valve spool or housing must be replaced, renew the complete steering motor. The commutator (5) and commutator ring (6) must be renewed as a matched set. The difference in thickness of commutator and commutator ring must not exceed 0.0015 inch (0.038 mm). The difference in thickness between rotor and stator (8) must not exceed 0.002 inch (0.05 mm). Be sure metering element vanes (2—Fig. 65) move freely in slots of rotor without binding. Check rotor to stator clearance with a feeler gage as shown in Fig. 65. Metering element must be renewed as an assembly if clearance exceeds 0.006 inch (0.15 mm).

Before reassembling, wash all parts in clean solvent and air dry. All parts, unless otherwise indicated, are to be assembled dry.

Install plug (13—Fig. 64) with new O ring (12) and recirculating ball (18) and plug (20) in housing if removed. Assemble small thrust washer, thrust bearing, large thrust washer and snap ring on input shaft. If actuator ball retaining spring (16) was removed, install a new spring in spool. Place actuator ball (17) in its seat inside valve spool, then insert input shaft into spool and engage helix and actuator ball with

a counterclockwise motion. Using the midsection of torsion bar (15) as a gage, rotate input shaft until torsion bar just fits between end of valve spool and thrust washer as shown in Fig. 66. This positions actuating ball in neutral position on input shaft helix. Hold valve spool in a vertical position, then insert drive ring (22—Fig. 64) into valve spool until drive ring is fully engaged on input shaft spline.

Remove torsion bar gage. Install spacer (21) over torsion bar, then insert the assembly into valve spool. Align holes in torsion bar and input shaft, then press pin (24) into input shaft and torsion bar until end of pin is about 1/32 inch (0.8 mm) below outer diameter of shaft. Place spacer (25) over the valve spool, then slide spool assembly into valve body (11). Assemble original shims (31) on thrust washer (29). Lubricate new seal ring (32) with grease and install in upper cover (33). Install upper cover, aligning match marks on cover flange and housing, and install retaining screws finger tight. Install a hose clamp around cover flange and housing (as shown in Fig. 67) to align the outer diameters, then tighten mounting screws evenly to a torque of 20 ft.-lbs. (27 N·m).

NOTE: If either the input shaft or upper cover has been renewed, the following procedure for shimming end cover must be used.

With upper cover installed (with original shims) as outlined above, position housing in a vise so input shaft points downward. Pull downward on input shaft to remove free play and hold shaft to prevent

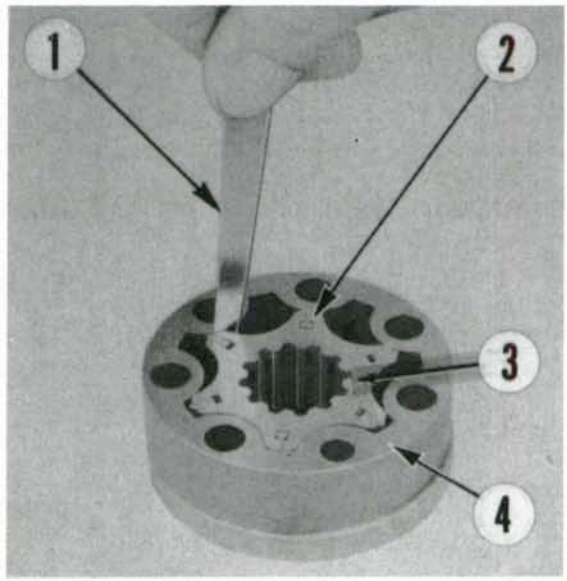
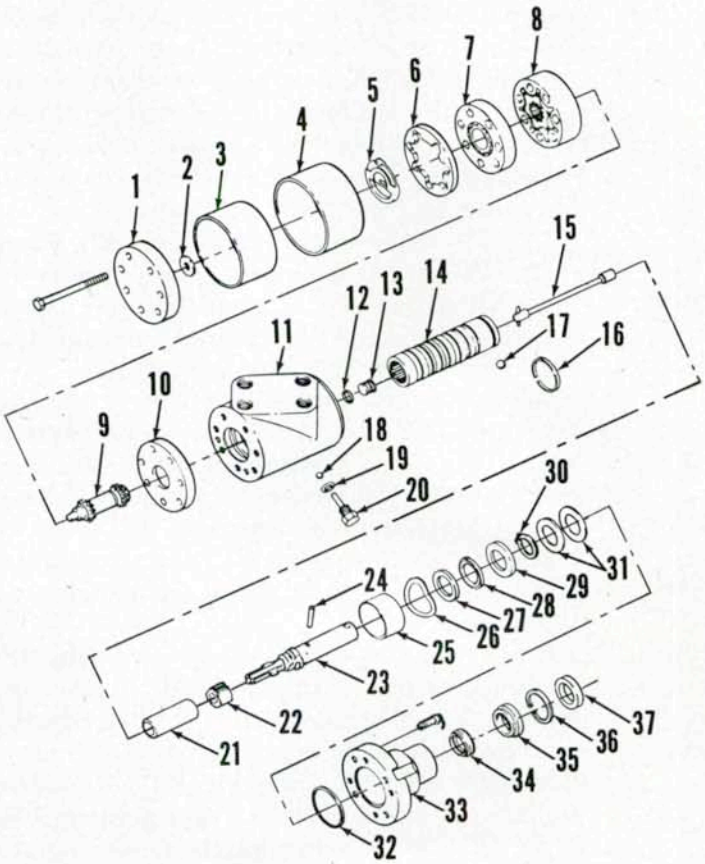


Fig. 65—Use a feeler gage (1) to measure clearance between tips of rotor (3) and stator (4).



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

Fig. 64—Exploded view of power steering motor assembly used on all models.

it from turning. Insert drive link (9—Fig. 68) into splines in spool and rotate drive link until spool (14) is flush with end of housing. Withdraw drive link, align drive link slot with torsion bar pin, then insert drive link fully into valve spool. Note that it may be necessary to turn valve spool slightly to achieve engagement of torsion bar pin in drive link slot. Check the position of valve spool relative to face of housing as shown in Fig. 68. The spool must be flush to no more than 0.0025 inch (0.064 mm) above face of housing. If necessary, add or remove shims (31—Fig. 64) to obtain specified spool position.

With drive link installed, place spacer plate (10—Fig. 64) onto housing with plain side up. Install stator-rotor set (8) over drive link splines and align cap screw holes. Be sure that vanes (V—Fig. 69) and vane springs (S) are properly installed (arched back of springs must contact vanes). Install manifold (7—Fig.

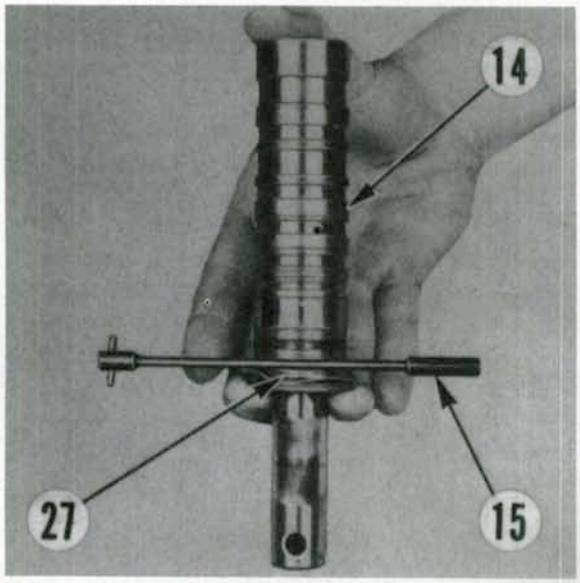


Fig. 66—Use torsion bar (15) as a gage between thrust washer (27) and end of spool (14) to establish neutral position.

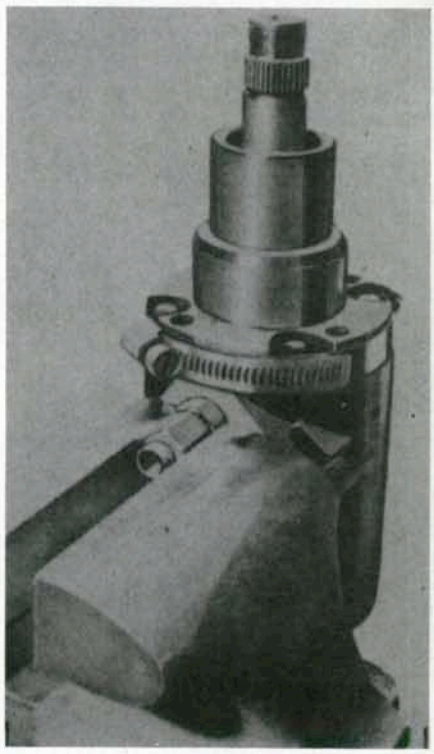


Fig. 67—A large hose clamp may be used as shown to align upper cover to valve body before tightening retaining screws.

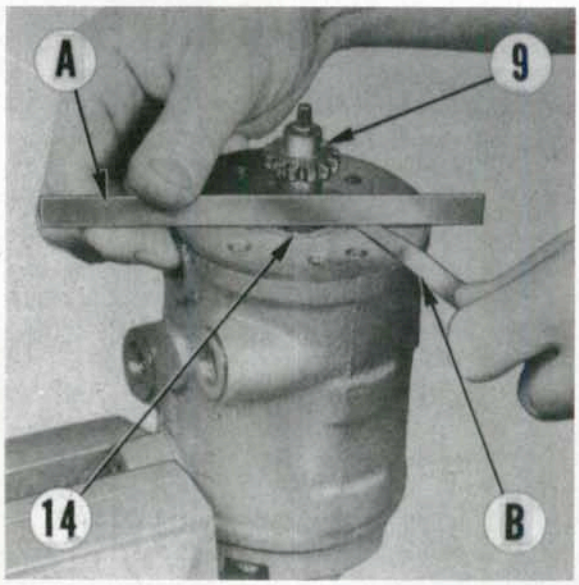


Fig. 68—End of valve spool must be flush to no more than 0.0025 inch (0.064 mm) above face of valve body. Refer to text for shimming procedure.

A. Straightedge
B. Feeler gage
9. Drive link
14. Valve spool

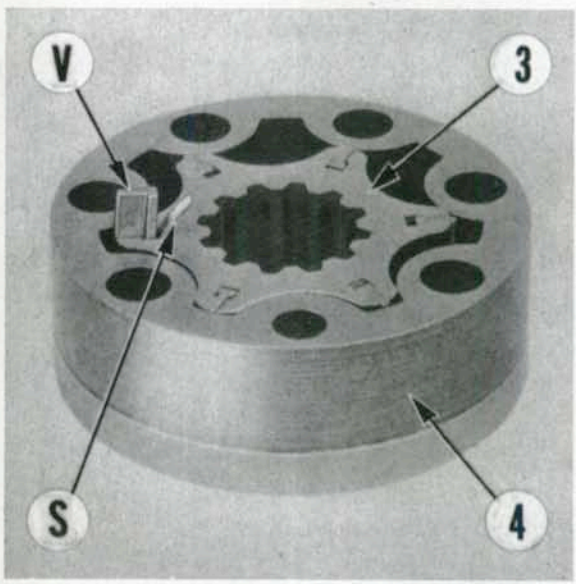


Fig. 69—Arched back of springs (S) must contact rotor vanes (V).

70) with circular slotted side up. Install commutator ring (6) making sure that side of ring with slot (S) faces down. Place commutator (5—Fig. 71) into commutator ring with counterbore side up. Be sure that nose on drive link (9) engages slotted hole in commutator. Install seal (3—Fig. 64) and retainer (4). Use a small amount of grease to stick washer (2) in position on end cover (1), then install end cover making sure that pin in end cover engages center hole in commutator. Install cap screws and tighten to an initial torque of 3 ft.-lbs. (4 N·m) following the sequence shown in Fig. 72. Make certain that input shaft turns freely, then tighten cap screws to a final torque of 20 ft.-lbs. (27 N·m) in sequence shown in Fig. 72. Note that input shaft must rotate when a torque of no more than 100 in.-lbs. (11 N·m) is applied to the shaft.

Reposition unit in the vise so input shaft is up. Install a seal protector sleeve over shaft splines or cover end of shaft with tape. Lubricate seal (34—Fig. 64), then carefully slide seal over shaft and into cover bore with lip facing inward. Install stepped spacer (35) with flat side outward. Install retaining ring (36) with rounded edge inward. Install dust seal (37) in cover bore.

Pour clean hydraulic oil into inlet port and rotate input shaft until oil appears at outlet port. Plug all ports to prevent entry of dirt until installation.

STEERING CYLINDER

All Models With External Cylinder

44. R&R AND OVERHAUL. To remove cylinder, disconnect hydraulic lines and plug all openings. Disconnect ball joint end from steering arm. Remove bolts attaching cylinder anchor bracket to axle, then withdraw cylinder assembly.

Refer to appropriate Fig. 75 or 76 and disassemble cylinder as follows: Loosen clamp bolts, then remove the ball joint ends (1). Unscrew the tube (13) from cylinder (3). Withdraw piston and rod (6) from cylinder.

Inspect parts for wear, scoring or other damage and renew as necessary. Renew all seals, back-up rings and seal rings.

To reassemble, reverse the disassembly procedure. Lubricate all seals with power steering oil during assembly. As an aid to assembly, warm the piston seal ring in warm steering oil prior to installation, then use a hose clamp to seat seal into piston groove af-

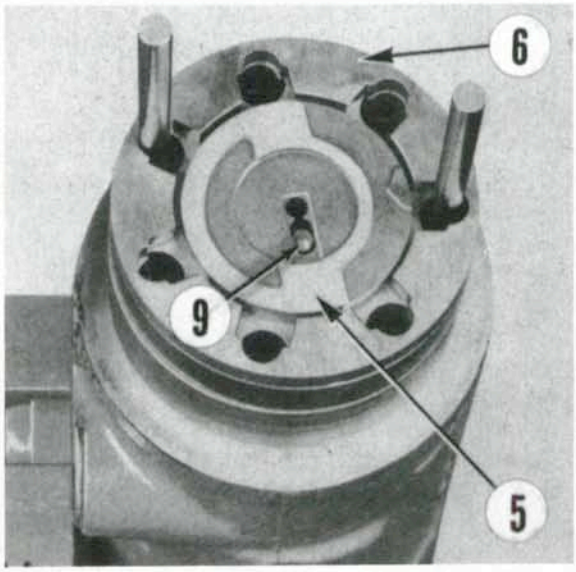


Fig. 71—Be sure that nose of drive link (9) engages slotted hole in commutator (5).

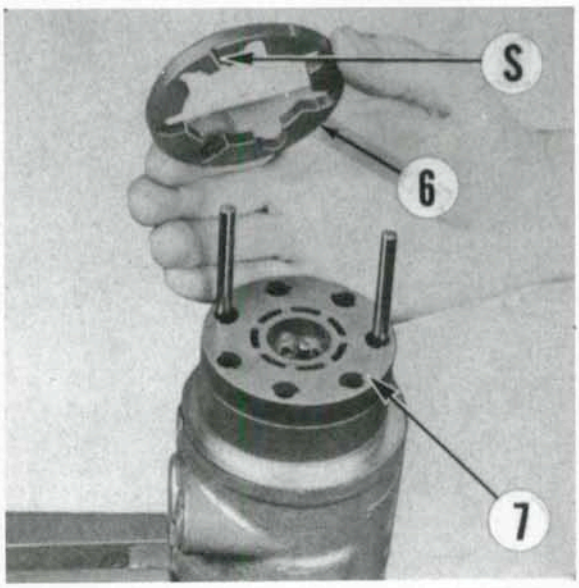


Fig. 70—Install commutator ring (6) with slot (S) facing the manifold (7).

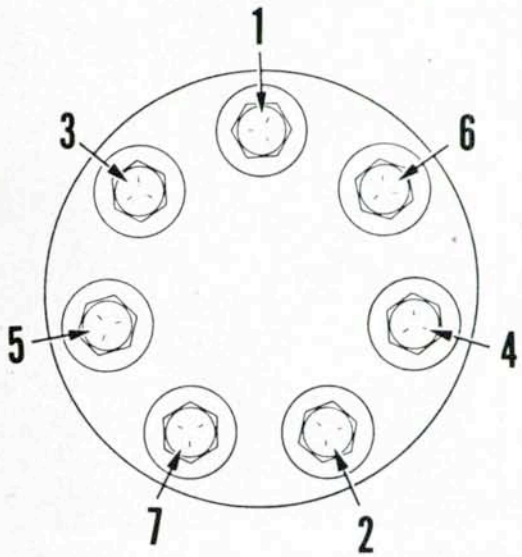


Fig. 72—Tighten steering motor end cover retaining cap screws in the sequence shown.

ter installation. Tighten gland and tube (13) to 200 ft.-lbs. (270 N·m) torque.

To install cylinder, first attach cylinder end anchor to axle. Rotate left-hand spindle arm to full left turn so spindle stop contacts stop on axle housing. Collapse the cylinder until piston bottoms in cylinder tube, then attach cylinder rod ball joint end to steering arm.

NOTE: The cylinder rod must be extended a minimum of 1/8 inch (3 mm) to a maximum of ¾ inch (19 mm) from fully collapsed position when attached to steering arm. Adjust ball joint ends as necessary up to a maximum exposed thread of ¾ inch (19 mm) on rod end and ¼ inch (6.4 mm) on cylinder anchor end.

Tighten ball joint end nuts to a torque of 178 ft.-lbs. (241 N·m). Tighten ball joint clamp bolts to a torque of 48 ft.-lbs. (65 N·m) on cylinder anchor end and 20 ft.-lbs. (27 N·m) on steering arm end. Check front wheel toe-in and adjust tie rod, if necessary, to provide 0 to ½ inch (0-13 mm) toe-in for standard front axle, or 0 to ¼ inch (0-6 mm) toe-in for front wheel drive axle. Start engine and turn front wheels from lock-to-lock several times to purge air from system. Make certain spindle stops contact axle housing stops on full left and right turns.

All Models With Integral Cylinder

45. OVERHAUL. The steering cylinder is integral with the front axle housing on tractors equipped with APL-345, APL-355 and APL-365 front drive axles. Refer to appropriate Fig. 77 or 78 for an exploded view of cylinder assembly.

To disassemble, disconnect ball joint ends (1 and 22) from steering arms. Remove the steering stops (2), then bend or cut the locking tabs on flange of ball joint ends away from flats on ends of cylinder rod. Heat ends of cylinder rod to loosen thread locking compound, then unscrew ball joint ends from cylinder rod. Unbolt and remove end cap (6) from left side of cylinder. Withdraw cylinder rod and piston assembly from cylinder.

Remove steering hose and fitting from right end of cylinder. On APL-345 and APL-355 axle, the cylinder sleeve (18—Fig. 77) and gland (20) can be pushed out left-hand end of cylinder. On APL-365 axle, remove right end cap (23—Fig. 78) and withdraw sleeve (18) from cylinder.

Inspect cylinder sleeve, rod and piston for wear or scoring and renew if necessary. The piston is retained on cylinder rod by retaining rings. Renew all seal rings and seals.

Lubricate all parts with power steering oil during assembly. If cylinder sleeve, end cap(s) or gland (APL-345 and APL-355 axles) have been renewed it will be necessary to establish correct thickness of shim

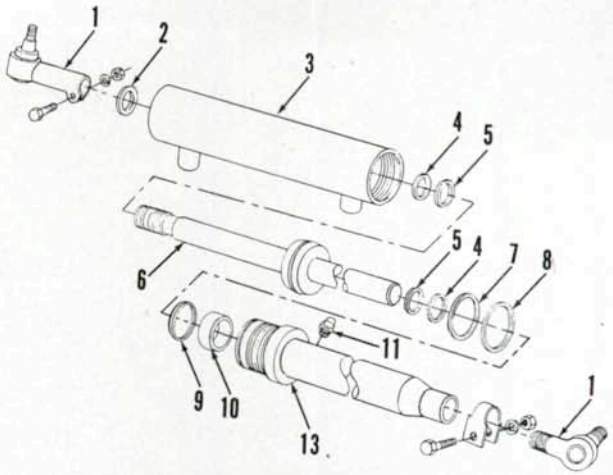


Fig. 75—Exploded view of power steering cylinder used on early production models with external cylinder.

1. Ball joint ends
2. Wiper seal
3. Cylinder tube
4. Back-up ring
5. Seal ring
6. Piston & rod assy.
7. "O" ring
8. Seal ring
9. Seal ring
10. Bushing
11. Vent plug
13. Tube & gland assy.

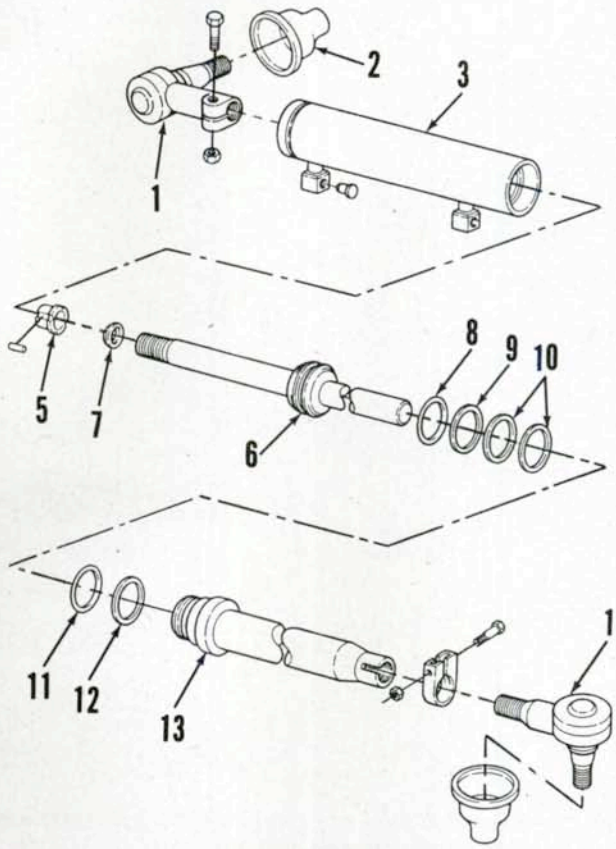
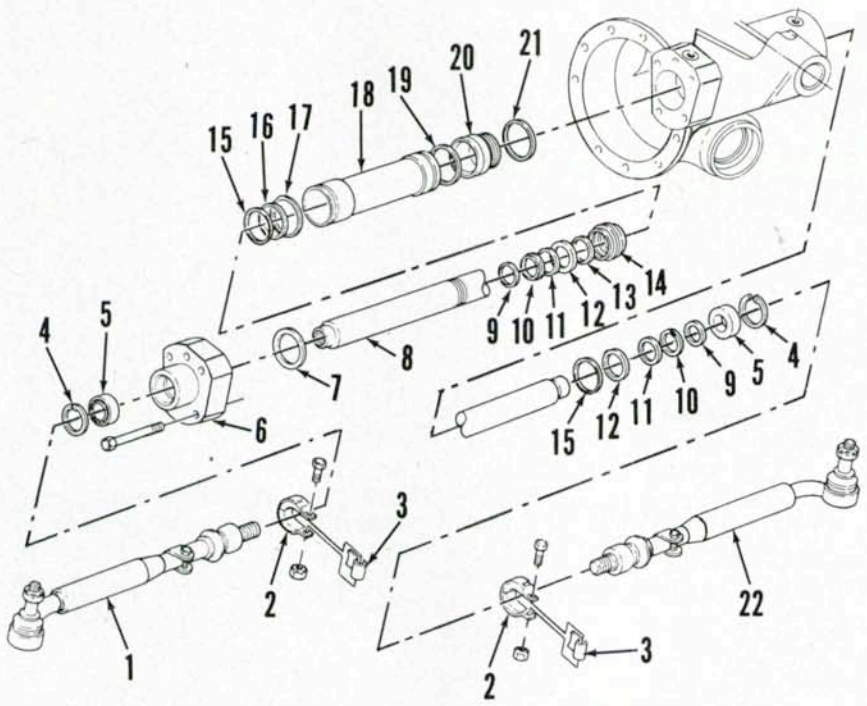


Fig. 76—Exploded view of power steering cylinder used on late production (1987 and after) two wheel drive tractors.

1. Ball joint ends
2. Dust cover
3. Cylinder tube
5. Bushing
6. Piston & rod assy.
7. Wiper seal
8. "O" ring
9. Seal ring
10. Wear rings
11. "O" ring
12. Back-up ring
13. Tube & gland assy.



1. Tie rod, L.H.
2. Steering stop
3. Tube
4. Snap ring
5. Seal
6. End cap
7. Shim
8. Cylinder rod
9. Ring
10. Washer
11. Retainer
12. Spacer
13. Seal
14. Piston
15. Piston rings
16. Seal ring
17. Seal ring
18. Cylinder sleeve
19. "O" ring
20. Gland
21. Gland seal
22. Tie rod, R.H.

Fig. 77—Exploded view of power steering cylinder typical of APL-345 and APL-355 type front drive axles.

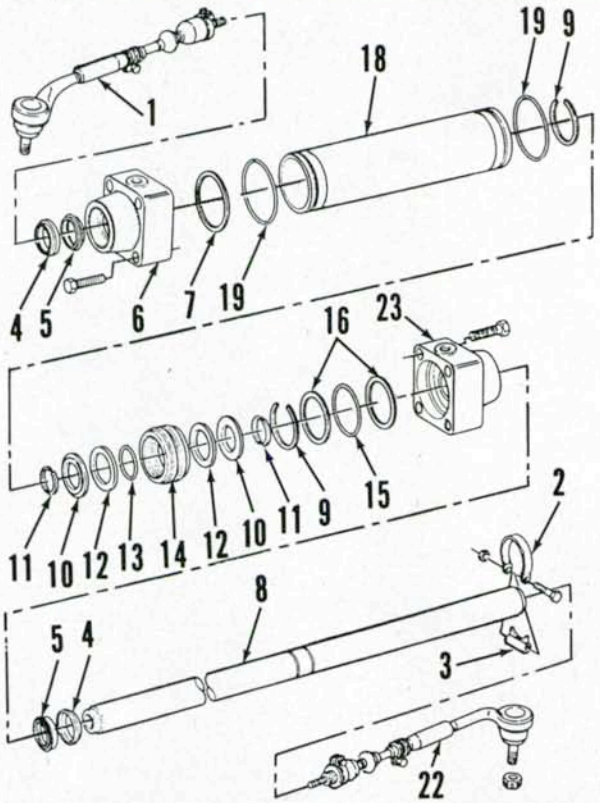


Fig. 78—Exploded view of power steering cylinder used on tractors equipped with APL-365 front drive axle.

1. Tie rod, L.H.
2. Steering stop
3. Tube
4. Retainer
5. Seal
6. End cover, L.H.
7. Shim
8. Cylinder rod
9. Retainer
10. Washer
11. Split ring
12. Spacer
13. "O" ring
14. Piston
15. Seal
16. Piston rings
18. Cylinder sleeve
19. "O" ring
22. Tie rod, R.H.
23. End cover, R.H.

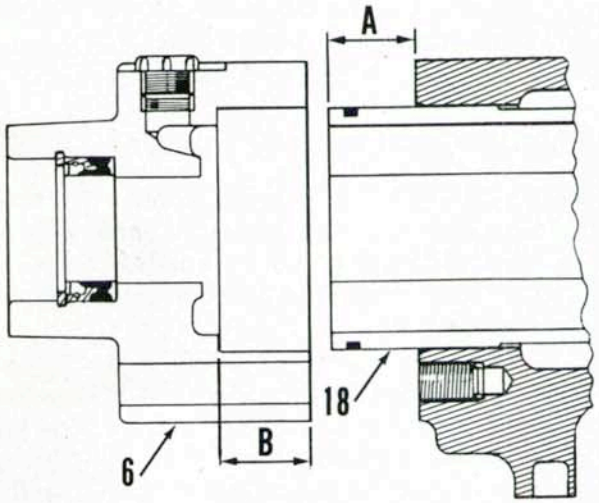


Fig. 79—Measure dimensions (A and B) to determine required thickness of steering cylinder tube shim.

(7—Fig. 77 or 78) to be installed between sleeve and left end cap. Install cylinder gland (if used) and sleeve into axle housing. On APL-365 axle, install right end cap (23—Fig. 78). On all axles, be sure sleeve is pushed fully into housing, then measure protrusion (A—Fig. 79) of sleeve from face of housing. Measure depth (B) of end cap counterbore. Subtract dimension (A) from dimension (B); the result is thickness of shim required to secure sleeve in axle housing.

Assemble cylinder in reverse order of disassembly. Apply Loctite 242 to threads of cylinder rod before installing ball joint ends. Check front wheel toe-in and adjust if necessary to provide 0 to ¼ inch (0-6 mm) toe-in. Start engine and cycle steering from stop to stop several times to purge air from system.

ENGINE AND COMPONENTS

R&R ENGINE

All Models

46. To remove engine, proceed as follows: Disconnect the battery cables. Remove air precleaner, muffler, hood side panels, radiator grille and side panels and hood top panel. Drain engine coolant and disconnect radiator hoses. Disconnect engine oil cooler and hydraulic oil cooler hoses and power steering lines. Discharge air conditioning system (if equipped) and disconnect hoses at the condenser. Disconnect heater hoses at the engine. Disconnect hoses to engine coolant filter. Remove air cleaner and intercooler (TW-35). Remove main fuel tank and auxiliary fuel tank and step. Remove auxiliary hydraulic pump if so equipped.

Disconnect electrical wiring from engine and front end. Disconnect wires from starting motor, then remove starting motor. Disconnect throttle cable, fuel shut-off cable and tachometer cable from fuel injection pump.

On TW-5 and TW-15 tractors, remove front end weights. On TW-25 and TW-35 tractors, remove front end weights and front frame rail. On tractors equipped with front wheel drive, disconnect drive shaft. On all models, install wooden wedges between front axle and axle support to prevent tipping. Support tractor under front of transmission using suitable splitting stand. Support front axle and radiator assembly using an overhead hoist or other suitable method. Remove right and left frame rails. Remove cap screws attaching front axle support to engine and oil pan, then carefully roll front end assembly away from engine.

Support the engine with a suitable lifting bracket and hoist. Remove cap screws attaching engine to transmission housing, then separate engine from transmission.

To reinstall engine, reverse the removel procedure while noting the following special instructions: Tighten the 5/8 inch bolts attaching engine to transmission to 115 ft.-lbs. (155 N·m) torque and ¾ inch bolts to 200 ft.-lbs. (270 N·m) torque. Be sure that shims are installed between axle support and engine oil pan. Tighten axle support cap screws to 200 ft.-lbs. (270 N·m) torque. Tighten side frame attaching cap screws and front frame rail (TW-25 and TW-35) cap screws to 200 ft.-lbs. (270 N·m) torque.

ENGINE COMPRESSION PRESSURE

All Models

47. Engine compression pressure should be checked at cranking speed of 200 rpm with engine at normal operating temperature. Compression pressure should be 300-400 psi (2070-2760 kPa) on TW-5 tractors; 275-375 psi (1895-2585 kPa) on TW-15, TW-25 and TW-35 models. Maximum allowable variation between cylinders is 20 psi (140 kPa) on all models.

CYLINDER HEAD

All Models

48. To remove the cylinder head, first drain cooling system. Remove precleaner, muffler, side panels, grille and hood panel. On Models TW-5 and TW-15, remove main fuel tank. On Model TW-15, remove the turbocharger assembly. On Model TW-25, remove the air cleaner and turbocharger. On Model TW-35, remove air cleaner, intercooler assembly and turbocharger.

On all models, remove thermostart unit, fuel injector lines, injector nozzles and fuel filters. Plug all openings in fuel system to prevent entry of dirt. Remove intake and exhaust manifolds. Disconnect upper radiator hose, heater hose and temperature sender unit. Remove fan and alternator bracket, thermostat housing and support bracket assembly. Remove rocker arm cover, rocker arm shaft assembly and push rods. Be sure to arrange push rods in order of removal so they can be reinstalled in their original locations. Loosen and remove cylinder head bolts evenly, starting at each end and working to center of head. Remove cylinder head and gasket from cylinder block.

Remove all carbon deposits from cylinder head before removing the valves. Inspect cylinder head for cracks, burrs or other damage. Use a feeler gage and straightedge to check flatness of cylinder head. Maximum allowable warpage is 0.003 inch (0.076 mm) in any 6 inches (150 mm), or 0.006 inch (0.15 mm) overall. Cylinder head surface may be machined if excessively warped or rough; however, cylinder head must be renewed if depth from valve seat inserts to face of cylinder head is less than 0.117 inch (2.97 mm) after machining.

NOTE: After resurfacing cylinder head, install the head (without gasket), rocker shaft supports and all head bolts. Tighten head bolts finger tight, then use a feeler gage to check for clearance under head of each bolt. If clearance exceeds 0.010 inch (0.25 mm) for any bolt, use a ½ inch x 13 UNC-2A tap to increase thread depth in block.

Reinstall cylinder head using a new head gasket. Lubricate threads of head bolts with engine oil, then tighten bolts in two steps following tightening sequence shown in Fig. 85. Tighten bolts to initial torque of 140 ft.-lbs. (190 N·m), then to a final torque of 160 ft.-lbs. (217 N·m).

Complete installation by reversing the removal procedure while noting the following special instructions: Install injectors using new seal gaskets and tighten retaining nuts to 12 ft.-lbs. (16 N·m) torque. Tighten rocker cover bolts to 12 ft.-lbs. (16 N·m) torque, intake manifold cap screws to 25 ft.-lbs. (34 N·m) torque, exhaust manifold cap screws to 28 ft.-lbs. (37 N·m) torque and turbocharger stud nuts to 33 ft.-lbs. (44 N·m) torque. Adjust valve clearance as outlined in paragraph 51. Prime turbocharger (if so equipped) with oil as outlined in paragraph 105. Bleed air from fuel system as outlined in paragraph 88.

VALVES, SEATS, GUIDES AND SPRINGS

All Models

49. Exhaust valves (18—Fig. 86) are equipped with positive type rotators (16) and use an "O" ring type seal (17) between valve stem and rotator body. Intake valves (12) are fitted with umbrella type oil seals (10). Both the exhaust and intake valves seat on renewable valve seat inserts which are a shrink to fit in cylinder head. Valve guides are integral with cylinder head.

On TW-5 models, valve seat angle is 45 degrees and valve face angle is 44-1/2 degrees for intake and exhaust. Recommended valve seat width is 3/32 inch (2.38 mm). Minimum allowable valve margin width is 1/32 inch (0.8 mm). Valve face-to-seat contact point should be 1/16 inch (1.6 mm) below upper edge of valve face. If necessary, lower the valve seat using a 30 degree grinding stone or raise the seat using a 60 degree grinding stone.

On TW-15, TW-25 and TW-35 models, exhaust valve seat angle is 45 degrees and valve face angle is 44-1/2 degrees. Intake valve seat angle is 30 degrees and valve face angle is 29-1/2 degrees. Recommended valve seat width is 3/32 inch (2.38 mm). Minimum allowable valve margin width is 1/32 inch (0.8 mm) for intake valves and 1/16 inch (1.6 mm) for exhaust valves. Valve face-to-seat contact point should be 1/16 inch (1.6 mm) below upper edge of valve face. The exhaust valve seat can be lowered using a 30 degree stone or raised using a 60 degree stone. Intake valve seat can be lowered using 15 degree grinding stone or raised using a 45 degree stone.

Renew valve seat inserts that are cracked, loose or excessively worn. Oversize inserts are available; refer to Fig. 88 for overize cylinder head counterbore machining dimensions. New seat inserts must be chilled in dry ice prior to installation.

Check valve stems and guides for wear using a suitable telescoping gage and micrometer. Standard valve stem diameter is 0.3711-0.3718 inch (9.4259-9.4437 mm) for intake valve and 0.3701-0.3708 inch (9.4005-9.4183 mm) for exhaust valve. Desired valve

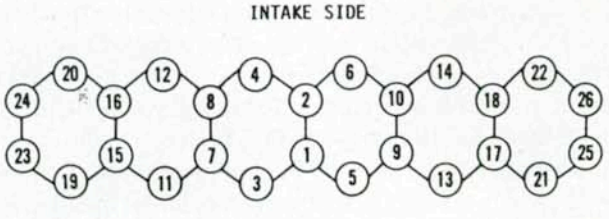


Fig. 85—Tighten cylinder head retaining bolts in sequence shown.

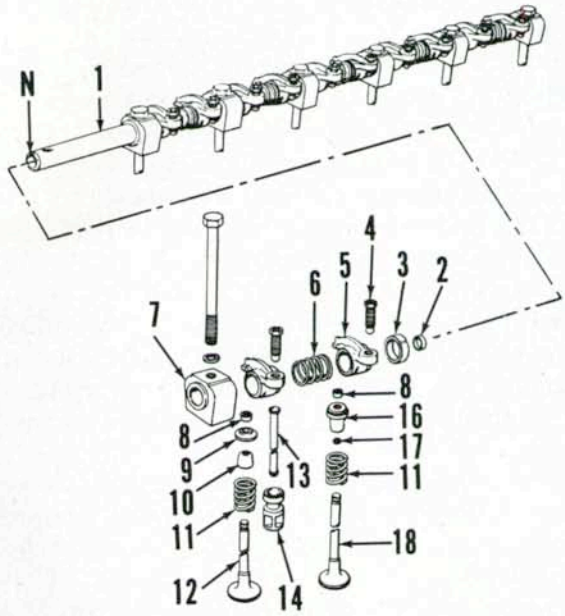


Fig. 86—Exploded view showing rocker arms and valves. Install rocker shaft with notch (N) facing up and toward front of engine.

1. Rocker shaft
2. Plug
3. Spacer
4. Adjusting screw
5. Rocker arm
6. Spring
7. Rocker shaft support
8. Retainer locks
9. Spring retainer
10. Stem seal
11. Spring
12. Intake valve
13. Push rod
14. Cam follower
16. Valve rotator
17. Seal
18. Exhaust valve

stem-to-guide clearance is 0.0010-0.0024 inch (0.0254-0.0609 mm) for intake and 0.0020-0.0037 inch (0.051-0.094 mm) for exhaust. If clearance exceeds 0.0045 inch (0.114 mm) for intake and 0.0055 inch (0.140 mm) for exhaust, guides should be reamed for installation of valves with oversize stems. Valves are available with 0.003 inch (0.076 mm), 0.015 inch (0.38 mm) and 0.030 inch (0.76 mm) oversize stems. Be sure to reface valve seat after reaming valve guide.

NOTE: Some production cylinder heads may have one or more 0.003 inch (0.076 mm) or 0.015 inch (0.38 mm) oversize valve guide and valve installed. Heads so equipped are stamped 03 or 15 or Y003 OS or Y015 OS on exhaust side of head opposite the oversize guide.

Intake and exhaust valve springs are interchangeable. Valve spring free length should be 2.15 inches (54.6 mm). Springs should exert a force of 60-70 pounds (267-311 N) when compressed to a length of 1.74 inches (44.2 mm), and a force of 125-140 pounds (556-623 N) when compressed to a length of 1.32 inches (33.5 mm).

Valve springs should be checked for squareness by setting spring on a flat surface and checking with a square. Renew spring if out of square more than 1/16 inch (1.6 mm). Renew any spring showing signs of rust or pitting.

When reinstalling valves, all components should be assembled in their original locations if being reused. Valve stem seals (10 and 17—Fig. 86) and retainer locks (8) should be renewed when reassembling.

ROCKER ARMS

All Models

50. To disassemble rocker arms, withdraw cylinder head bolts from rocker shaft supports (7—Fig. 86) and slide components off the shaft. Rocker arms (5) are interchangeable, but they should be reinstalled in original locations if reused.

Rocker shaft diameter should be 1.000-1.001 inch (25.400-25.425 mm), and inside diameter of rocker arms should be 1.003-1.004 inch (25.476-25.501 mm). Renew shaft and/or rocker arm if clearance is excessive or if valve contact pad is grooved or excessively worn. Torque required to turn valve adjusting screws (4) should be approximately 18 ft.-lbs. (24 N·m); renew screw and/or rocker arm if torque required to turn screw is less than 9 ft.-lbs. (12 N·m).

When reassembling, be sure notch (N—Fig. 86) in end of rocker shaft is up and toward front of engine. This will correctly locate shaft oil holes. Turn rocker arm adjusting screws out two turns before installing assembly on cylinder head. Tighten cylinder head bolts as outlined in paragraph 48. Adjust valve clearance as outlined in paragraph 51.

VALVE CLEARANCE ADJUSTMENT

All Models

51. Valve clearance should be adjusted after every 600 hours of operation, and whenever rocker arms or cylinder head have been removed. Clearance should be 0.014-0.016 inch (0.36-0.40 mm) for intake valves and 0.017-0.019 inch (0.43-0.48 mm) for exhaust valves with engine cold. To adjust valve clearance, rotate crankshaft to position No. 1 piston at top dead center of compression stroke (rocker arms for No. 1 cylinder should be loose). Adjust the six valves indicated on chart shown in Fig. 89.

NOTE: Torque required to turn the self-locking adjusting screws in rocker arms should be approximately 18 ft.-lbs. (24 N·m). If torque is less than 9 ft.-lbs. (12 N·m), renew adjusting screw and/or rocker arm.

Turn crankshaft one complete revolution to position No. 6 piston at top dead center on compression stroke, then adjust remaining six valves indicated on chart (Fig. 89).

TIMING GEAR COVER

All Models

52. To remove timing gear cover, first separate front end assembly from engine as follows: Disconnect the battery. Remove air precleaner, muffler,

Insert Oversize	Counterbore Diameter in Cylinder Head	
	Exhaust Valve Seat	Intake Valve Seat
0.010 in. (0.25mm)	1.607-1.608 in. (40.82-40.84mm)	1.907-1.908 in. (43.44-43.46mm)
0.020 in. (0.50mm)	1.617-1.618 in. (41.07-41.10mm)	1.917-1.918 in. (43.69-43.72mm)
0.030 in. (0.76mm)	1.627-1.628 in. (41.33-41.36mm)	1.927-1.928 in. (43.95-43.97mm)

Fig. 88—Table listing cylinder head counterbore machining dimensions for installation of oversize valve seat inserts.

hood side panels, radiator grille and side panels and hood top panel. Drain cooling system and disconnect radiator hoses. Disconnect hoses from engine oil cooler, hydraulic oil cooler and power steering cylinder. Discharge air conditioner (if so equipped) and disconnect hoses at the condenser. Drain the fuel, then remove main fuel tank. On TW-5 and TW-15 models, remove front end weights. On TW-25 and TW-35 models, remove front frame rail and weights.

Support tractor under front of transmission housing using suitable splitting stand. Support front axle and radiator using an overhead hoist or other suitable method. Insert wooden wedges between front axle and axle support to prevent tipping. If equipped with front wheel drive axle, disconnect drive shaft. Remove cap screws attaching axle support to frame rails, engine and oil pan. Carefully move front end assembly away from the engine.

Drain engine oil and remove the oil pan. Remove drive belts and engine cooling fan. Remove cap screw and washer from end of crankshaft, then remove crankshaft pulley using a suitable puller. Unbolt and remove timing gear cover (5—Fig. 91) from engine.

With timing gear cover removed, the crankshaft front oil seal and dust seal can be renewed. Use a suitable seal installer to drive new seal into front cover until it is fully seated in cover bore. Be sure lip of seal faces inward. Inspect crankshaft spacer for wear at seal contact surface and renew if grooved or scratched.

To reinstall timing gear cover, reverse the removal procedure while noting the following special instructions: Be sure oil slinger is installed onto crankshaft with dished face outward. Tighten front cover retaining cap screws evenly to 16 ft.-lbs (22 N·m) torque. Tighten crankshaft pulley retaining cap screw to a torque of 145 ft.-lbs. (196 N·m). Install oil pan following procedure outlined in paragraph 69. Be sure shims are installed between axle support and oil pan. Tighten axle support mounting cap screws to 200 ft.-lbs. (270 N·m) torque.

TIMING GEARS

All Models

53. The timing gear train consists of the crankshaft gear, camshaft gear, injection pump drive gear and a camshaft drive gear (idler gear). See Fig. 92.

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

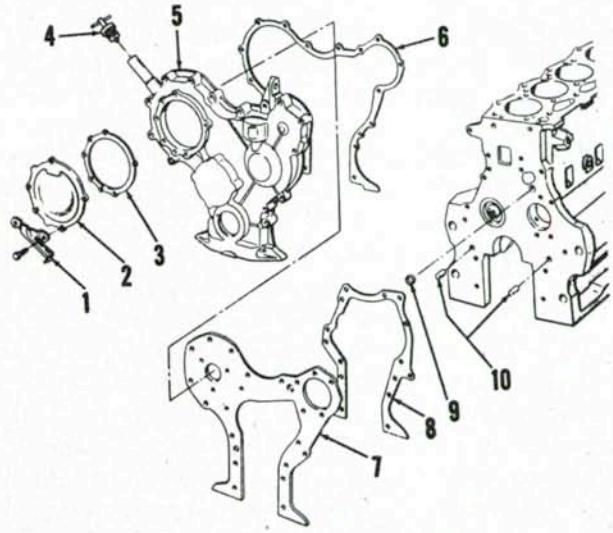


Fig. 91—Exploded view showing timing gear cover and related parts.

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

WITH	ADJUST VALVES											
No. 1 Piston at T.D.C. (Compression)	1	2	3			6	7			10		
No. 6 Piston at T.D.C. (Compression)				4	5			8	9		11	12

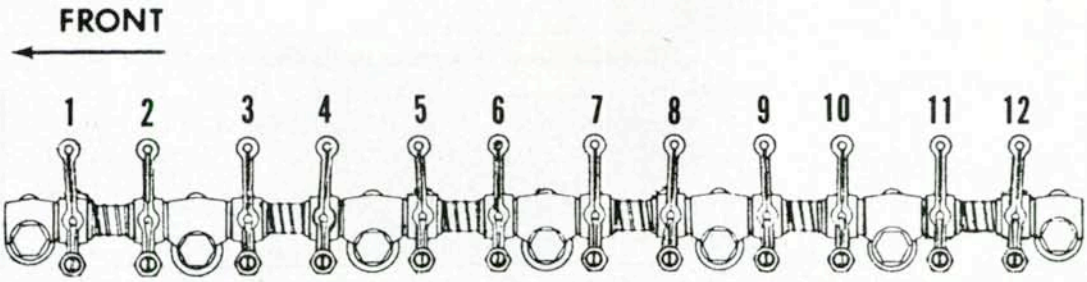


Fig. 89—Chart shows valve clearance adjusting sequence.

Timing gear backlash between crankshaft gear and camshaft drive gear, or between camshaft drive gear and camshaft gear should be 0.001-0.009 inch (0.025-0.23 mm). Backlash between camshaft drive gear and fuel injection pump drive gear should be 0.001-0.012 inch (0.025-0.30 mm). If backlash is not within recommended limits, renew the camshaft drive gear, gear shaft and/or any other gear concerned.

54. IDLER GEAR AND SHAFT. To remove idler gear (2—Fig. 92), remove retaining cap screw and withdraw gear and adapter shaft (2—Fig. 93) from front of cylinder block.

Inspect gear, bushing and shaft for excessive wear or other damage and renew if necessary. Inside diameter of bushing should be 2.0005-2.0015 inches (50.813-50.838 mm). The bushing and gear are available only as an assembly. Idler gear end play is controlled by the flange on adapter shaft and should be within range of 0.001-0.011 inch (0.025-0.28 mm).

To reinstall idler gear, mesh the gear with crankshaft gear, camshaft gear and injection pump gear while aligning the three sets of timing marks as shown in Fig. 92. Install adapter shaft and tighten retaining cap screw to a torque of 100 ft.-lbs. (136 N·m).

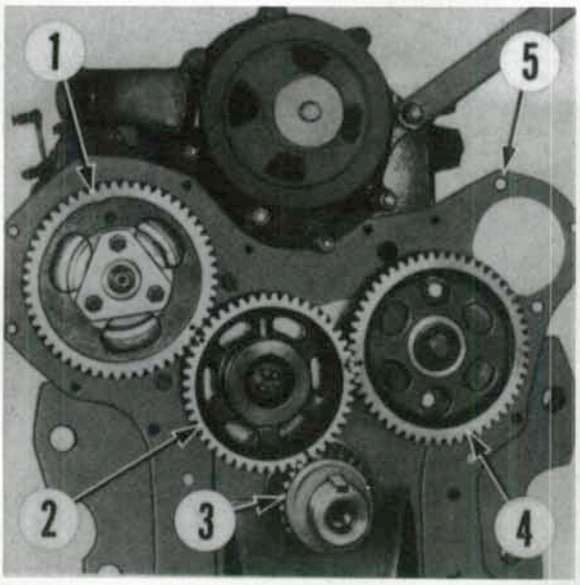


Fig. 92—Timing gears are properly timed when timing marks are aligned as shown on crankshaft gear, idler gear, camshaft gear and injection pump gear.

1. Injection pump gear
2. Idler gear
3. Crankshaft gear
4. Camshaft gear
5. Front cover plate

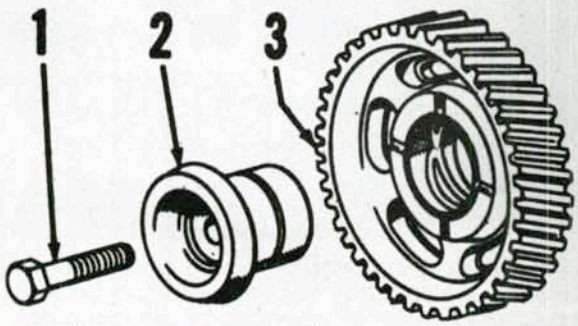


Fig. 93—View of idler gear (3) and adapter shaft (2). Bushing in gear is not available separately.

55. CAMSHAFT GEAR. To remove camshaft gear (4—Fig. 94), remove retaining cap screw (1) and pull gear from shaft. The gear should be a hand push fit on camshaft.

With gear removed, inspect gear, Woodruff key (8), thrust plate (5) and spacer (6) for wear or damage and renew as necessary. Camshaft end play is controlled by the thrust plate and should be within specified range of 0.001-0.007 inch (0.025-0.18 mm).

When reinstalling gear, be sure to align all timing marks as shown in Fig. 92. Tighten retaining cap screw to a torque of 42 ft.-lbs. (57 N·m).

56. INJECTION PUMP GEAR. To remove injection pump drive gear (1—Fig. 92), remove the three cap screws from gear retaining plate and withdraw the gear.

When reinstalling pump drive gear, align all timing marks as shown in Fig. 92. Turn injection pump camshaft clockwise, if necessary, until timing mark

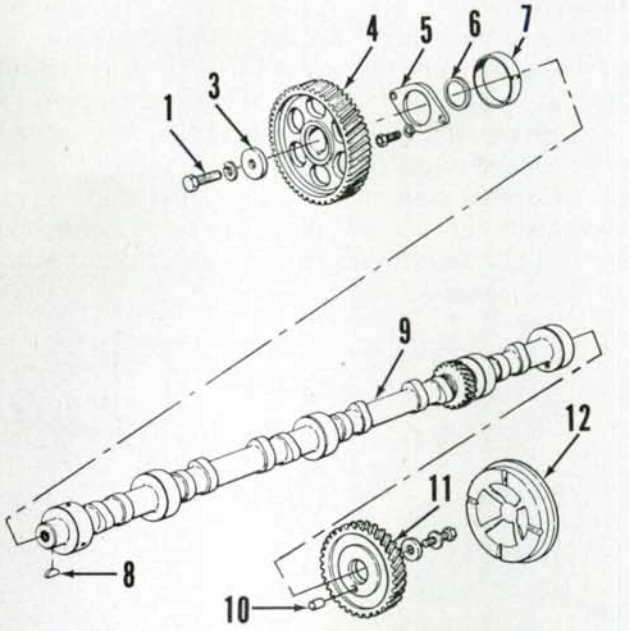


Fig. 94—View showing assembly of camshaft gear to camshaft. The thrust plate (5) controls camshaft end play.

1. Cap screw
3. Washer
4. Camshaft gear
5. Thrust plate
6. Spacer
7. Camshaft bearing
8. Woodruff key
9. Camshaft
10. Dowel pin
11. Hydraulic pump drive gear
12. Rear cover

on pump drive adapter hub is slightly past timing mark on pump housing and the three retaining cap screws can be installed through the retainer plate and drive gear into pump drive adapter. Tighten retaining cap screws to a torque of 30 ft.-lbs. (41 N·m). Check and adjust injection pump timing as outlined in paragraph 74.

57. CRANKSHAFT GEAR. The crankshaft gear (3—Fig. 95) is a press fit on crankshaft and should not be removed unless excessively worn or damaged. To remove gear, use removal tool (Nuday tool No. 2314) or other suitable puller to pull gear from crankshaft.

To reinstall gear, use installing tool (Nuday No. 2134) and insert (Nuday No. 1237) or other suitable tool to press gear onto crankshaft. Be sure timing mark on gear faces outward.

CAMSHAFT AND BEARINGS

All Models

58. To service camshaft, camshaft bearings and/or tappets, the engine must be removed from tractor as outlined in paragraph 46. Remove cylinder head, timing gear cover, engine clutch, flywheel and rear plate. Pry rear cover (12—Fig. 94) from rear of cylinder block. Remove cap screw attaching auxiliary hydraulic pump drive gear (11) to rear of camshaft. Remove engine oil pan if tappets and/or camshaft bearings are to be removed.

Prior to removing camshaft, check camshaft end play. Specified end play is 0.001-0.007 inch (0.025-0.18 mm). If end play is excessive, renew thrust plate (5) when reassembling. Turn engine upside down so tappets fall away from camshaft lobes, or use suitable tools through push rod bores to lift and hold tappets away from camshaft. Remove cap screws attaching thrust plate to cylinder block, then carefully withdraw camshaft.

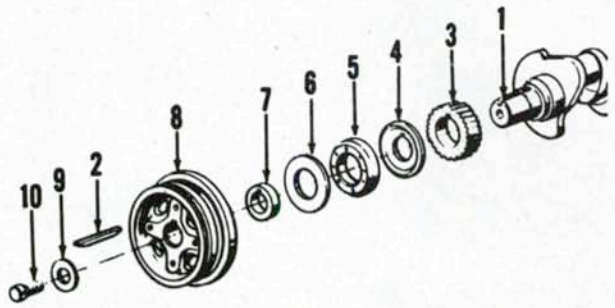


Fig. 95—View showing crankshaft gear, front oil seal and crankshaft pulley. Dust seal (6) and oil seal (5) are pressed into timing gear cover and ride on spacer (7).

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

Tappets can now be removed through bottom of cylinder block. Identify tappets in order of removal so they can be reinstalled in their original bore if reused.

Inspect camshaft and tappets for excessive wear, pitting or scoring and renew if necessary. Always renew the tappets if camshaft is renewed. Check camshaft, bearings and tappets against the following values:

Bearing Journal	2.3895-2.3905 in. (60.6933-60.7187 mm)
Desired Journal to Bearing Clearance	0.001-0.003 in. (0.025-0.076 mm)
Camshaft End Play	0.001-0.007 in. (0.025-0.18 mm)
Tappet Diameter	0.9889-0.9894 in. (25.118-25.130 mm)
Bore Diameter	0.990-0.991 in. (25.146-25.171 mm)
Desired Tappet to Bore Clearance	0.0006-0.0021 in. (0.015-0.053)

Use suitable bushing driver (such as Nuday tool No. 1255 and No. 1442) to remove and install camshaft bearings. Be sure oil holes (3—Fig. 97) in the bearings are aligned with oil passages in cylinder block. New bearings are presized and should not require reaming if carefully installed.

Lubricate camshaft, tappets and bearings during installation. Be sure gear timing marks are all aligned as shown in Fig. 92. Tighten camshaft gear retaining cap screw to a torque of 42 ft.-lbs. (57 N·m). Complete installation by reversing removal procedure.

CONNECTING ROD AND PISTON UNIT

All Models

59. Connecting rod and piston units are removed from above after removing the cylinder head, oil pan

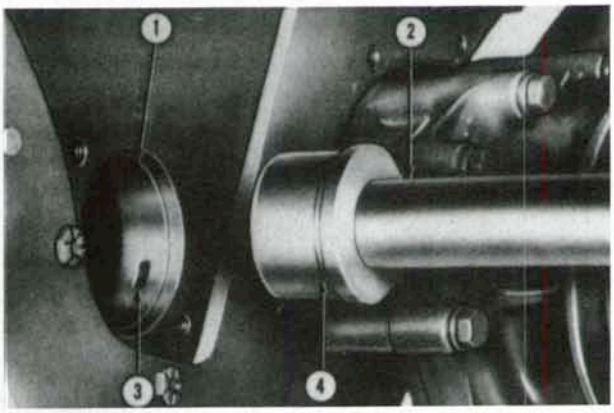


Fig. 97—View showing special tool for camshaft bearing installation. Be sure that bearings are installed with oil holes aligned with oil passages in cylinder block.

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

and oil pump. Be sure to remove top ridge from cylinder bores before attempting to push the pistons out of cylinders.

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 toward the front end of engine. Assemble connecting rod to piston so cylinder number on rod will face right side of engine (away from camshaft). Refer to Fig. 98. When installing connecting rod cap, be sure that cylinder identification number on rod and cap are toward same side of engine. Install new connecting rod nuts and tighten to a torque of 62 ft.-lbs. (84 N·m).

PISTON PINS

All Models

60. The floating type piston pin is retained in piston bosses by a snap ring at each end. Piston pin is available in standard size only. Pin diameter should be 1.4997-1.5000 inches (38.092-38.100 mm) on TW-5 models and 1.6246-1.6251 inches (41.267-41.277 mm) on TW-15, TW-25 and TW-35 models. On all models, piston pin should have a clearance of 0.0003-0.0005 inch (0.0076-0.0127 mm) in piston bosses.

Heating piston in warm water or oil prior to reassembly will make installation of piston pin easier. Piston pin retaining rings should be renewed whenever they have been removed. Be sure sharp edge side of retaining rings face away from piston pin.

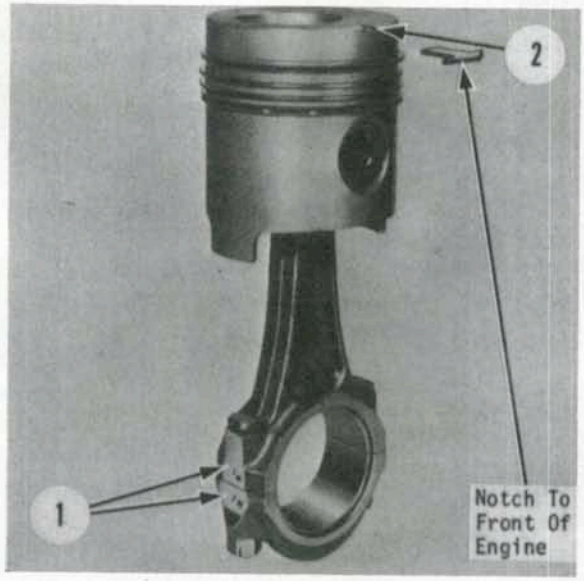


Fig. 98—View showing proper assembly of piston to connection rod. Be sure that connecting rod and cap numbers (1) match and are in register and that notch (2) in piston crown is toward front of engine.

PISTONS AND RINGS

All Models

61. Pistons are fitted with three compression rings and one oil control ring. The top compression ring is a keystone type while remainder of compression rings are rectangular, straight faced type.

Pistons should be checked for wear and damage at the ring grooves, piston skirt and piston pin bosses. A special keystone gage should be used to check top ring groove for excessive wear. All other ring grooves can be checked by inserting a new ring in piston groove and measuring side clearance between ring and groove with a feeler gage. Refer to the following specifications and renew piston if ring grooves are excessively worn.

Ring Side Clearance in Groove—	
Top compression	Keystone
Second and third compression	0.004-0.0055 in. (0.10-0.14 mm)
Oil Control	0.0025-0.004 in. (0.06-0.10 mm)
Ring End Gap—	
Top compression	0.012-0.038 in. (0.31-0.96 mm)
Second and third compression	0.010-0.035 in. (0.25-0.89 mm)
Oil control	0.013-0.033 in. (0.33-0.84 mm)

Prior to installing new rings, each ring should be checked for proper end gap in the cylinder that it is to be installed. Be sure ring is pushed squarely into cylinder bore, then measure end gap using a feeler gage as shown in Fig. 99. Refer to specifications

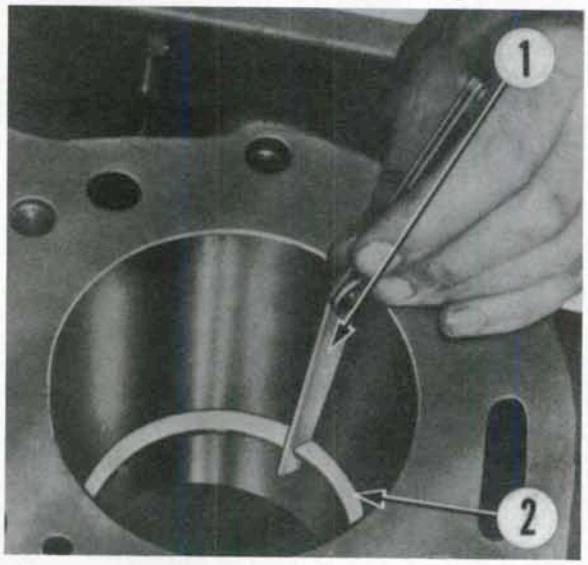


Fig. 99—Piston ring end gap of each ring (2), fitted in the cylinder in which it will be installed, should be checked with a feeler gage (1) as shown.

above. Insufficient ring end gap may cause scoring or ring breakage. Excessive end gap may result in compression leakage past the rings.

NOTE: Service replacement ring sets are slightly different than rings used in production. Observe the following differences when installing new ring sets.

On production piston ring set, top compression ring is bright chrome finish, keystone type ring. Second compression ring is bright chrome finish with step on inside diameter facing up. Third compression ring is dull black finish with step on inside diameter facing up. Oil control ring with slotted expander is installed either way up.

On service piston ring set (Fig. 100), top compression ring is bright chrome finish, keystone type ring and may be installed either way up. Second compression ring is bright chrome finish, rectangular ring with step on inside diameter facing up. Third compression ring is dull black finish, rectangular ring with step on outside diameter facing down and a nonslotted expander behind the ring. Oil control ring may be installed either way up.

Space the ring end gaps on piston as follows: Position gap of oil control coil expander in line with identification mark on top of piston (Fig. 98). Position gap of oil control ring 90 degrees from coil expander gap. Position gap of lower compression ring 180 degrees from oil control ring gap. Position gaps of second and top compression rings at 120 degree intervals from gap of lower compression ring.

Piston ring sets are available in standard size and 0.020 inch (0.50 mm), 0.030 inch (0.76 mm) and 0.040 inch (1.0 mm) oversizes. The standard size ring set is used with standard size pistons and also with 0.004 inch (0.10 mm) oversize pistons.

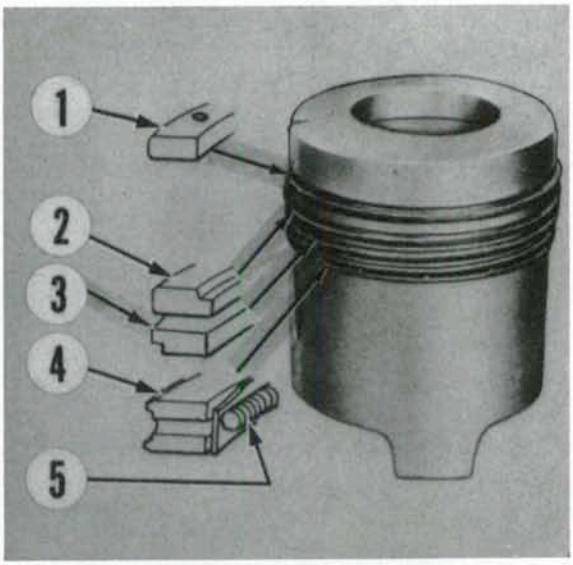


Fig. 100—View showing correct installation of service type piston ring set. Refer to text.

1. Keystone ring
2. Second compression ring
3. Third compression ring
4. Oil control ring
5. Coil expander

CYLINDERS

All Models

62. Cylinder bores in engine block are unsleeved. Standard cylinder bore diameter is 4.401-4.403 inches (111.78-111.84 mm). If cylinder bores are excessively worn or damaged, they can be rebored for installation of oversize pistons. Cylinders should be rebored if cylinder taper or out-of-round exceeds 0.005 inch (0.13 mm). All cylinders must be rebored to the same oversize. Pistons are available in oversizes of 0.020 inch (0.25 mm), 0.030 inch (0.76 mm) and 0.040 inch (1.0 mm). Pistons 0.004 inch (0.10 mm) oversize are also available for installation in standard size cylinders which can be refinished by honing rather than reboring oversize. Refer to paragraph 63 for fitting pistons to cylinder bores.

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 lubricate with oil to prevent rusting.

A cylinder sleeve is available for service installation in cases where bore porosity cannot be corrected by reboring. Cylinder must be bored to provide 0.000-0.002 inch (0.00-0.05 mm) interference fit for sleeve in bore. A counterbore must be machined for lip of sleeve so top of sleeve is flush with block surface. Sleeve should be chilled in dry ice prior to installation. Use suitable tools to press or pull sleeve into cylinder bore. Do not drive sleeve into bore as sleeve lip may crack. Standard or 0.004 inch (0.10 mm) oversize piston must be used in sleeve. The sleeve cannot be rebored oversize.

63. FITTING PISTONS. Recommended method for determining finished bore size for fitting pistons is as follows: Using a micrometer, measure piston diameter at centerline of and at right angle to piston pin bore (Fig. 101). Note that this dimension is not the point of largest diameter of the piston, but it is the point from which piston-to-bore clearance is calculated. Using an inside micrometer, measure cylinder bore diamter at right angle to crankshaft centerline. Subtract the piston measurement from the cylinder bore measurement; the result is piston-to-bore clearance.

Specified clearance is 0.008-0.009 inch (0.20-0.23 mm) for pistons No. 1 through No. 5. The No. 6 (rear) piston should be fitted with 0.002 inch (0.05 mm)

more clearance than the others, or 0.010-0.011 inch (0.25-0.28 mm). If clearance exceeds specified limit, rebore cylinders to next oversize. If clearance is less than specified, hone cylinder with a rigid hone until desired clearance is obtained.

CONNECTING RODS AND BEARINGS

All Models

64. Connecting rods are fitted with a press-fit bushing at piston pin end and slip-in precision type bearing inserts at crankpin end. The crankpin bearing inserts may be of two different materials, copper-lead or alluminum-tin alloy. The bearing inserts will have an identification marking as follows:

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

NOTE: The engine may be assembled with bearing inserts of different material, but inserts of the same material must be installed on the same journal.

The standard size bearing inserts of each material are available in two different thickness and are color coded to indicate thickness as follows:

Copper-Lead Insert Wall Thickness—
Red ..... 0.0943-0.0948 in. (2.395-2.408 mm)
Blue ..... 0.0947-0.0952 in. (2.405-2.418 mm)

Aluminum-Tin Insert Wall Thickness—
Red ..... 0.0941-0.094 in. (2.390-2.403 mm)
Blue ..... 0.0945-0.950 in. (2.400-2.413 mm)

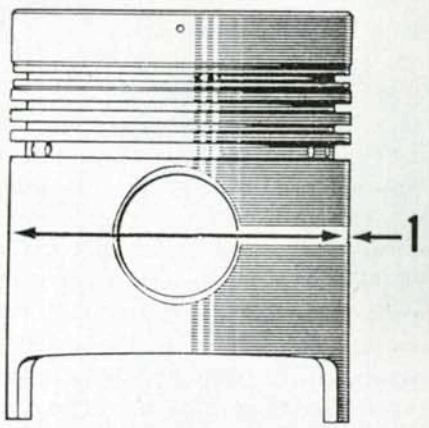


Fig. 101—When fitting pistons to cylinders, measure diameter (1) of piston at centerline of and at right angle to piston pin bore.

In production, crankshaft crankpin journals are color coded to indicate journal diameter as follows:

Crankpin Journal Diameter (Standard)—
Red ..... 2.7500-2.7504 in. (69.85-69.86 mm)
Blue ..... 2.7495-2.7500 in. (69.84-69.85 mm)

Crankpin Journal to Bearing Liner Clearance—
Copper-lead bearings ..... 0.0017-0.0038 in. (0.043-0.096 mm)
Aluminum-tin bearings ..... 0.0021-0.0042 in. (0.053-0.106 mm)

If crankpin bearing clearance exceeds the specified limit when using red inserts, it is permissible to install blue inserts to reduce the clearance. If the blue inserts do not provide the desired clearance, it will be necessary to regrind crankpin journals for installation of 0.002, 0.010, 0.020, 0.030 or 0.040 inch (0.05, 0.25, 0.50, 0.75 or 1.0 mm) undersize bearings.

NOTE: Some crankshafts used in TW-5 tractors have rod bearing journals and/or main journals ground 0.010 inch (0.25 mm) undersize during production. Engines with undersize crankshafts will be identified with one of the following codes stamped on right front of block near the engine code.
M—Undersize main bearing journals
P—Undersize rod bearing journals
MP—Undersize main and rod bearing journals

Inspect piston pin bushings for wear or damage. Inside diameter of bushing should be 1.5003-1.5006 inches (38.108-38.115 mm) for TW-5 models and 1.6253-1.6256 inches (41.283-41.290 mm) for TW-15, TW-25 and TW-35 models. Specified piston pin-to-bushing clearance is 0.0003-0.0005 inch (0.0076-0.0127 mm) for all models.

If renewal of piston pin bushing is necessary, use a suitable piloted bushing driver to press old bushing out and new bushing in. The bushing should not protrude from either side of connecting rod. The oil hole(s) in bushing must be drilled as follows: On all models, drill a 3/64 inch (1.2 mm) diameter hole in top of bushing using the hole in top of connecting rod as a guide as shown in Fig. 102. On TW-15, TW-25 and TW-35 models, use a long 5/32 inch (4 mm) drill as shown in Fig. 103 to drill from crankshaft end of rod through bottom of bushing.

Final size the piston pin bushings using a spiral expansion reamer to obtain specified pin-to-bushing clearance.

Check connecting rod alignment using a suitable alignment gage. Renew connecting rod if it is twisted more than 0.012 inch (0.30 mm) or bent more than 0.004 inch (0.10 mm).

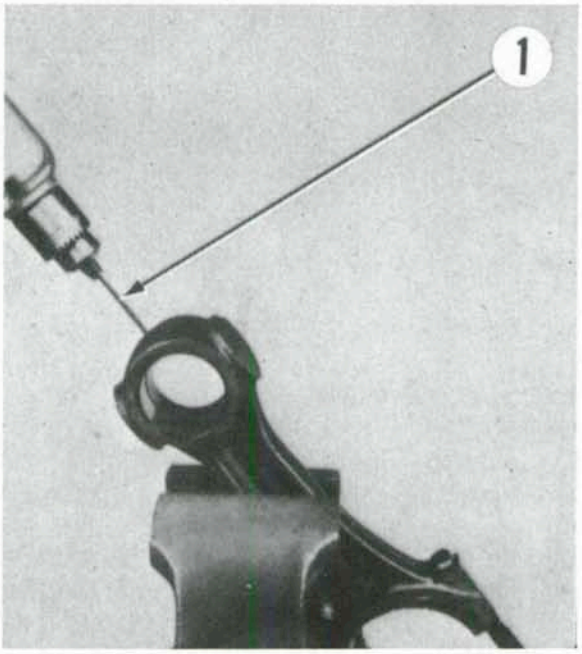


Fig. 102—On all models, oil hole in top of piston pin bushing must be drilled after bushing is installed, but before reaming bushing to final size. Diameter of hole must be 3/64 inch (1.2 mm).

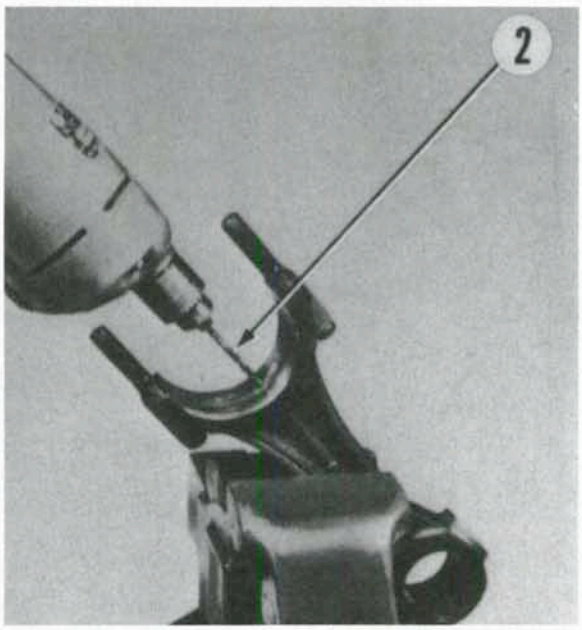


Fig. 103—On TW-15, TW-25 and TW-35 models, a 5/32 inch (4 mm) diameter hole must be drilled in bottom of bushing, drilling from crankshaft end of rod as shown.

CRANKSHAFT AND MAIN BEARINGS

All Models

66. The crankshaft is supported in seven precision insert type main bearings. Crankshaft end thrust is contolled by the flanged bearing insert located on second main journal from the front. Before removing main bearing caps, make certain that they have an identification number so they can be reinstalled in original location.

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

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

NOTE: The engine may be assembled with bearing inserts of different material, but inserts of the same material must be installed on the same journal.

The standard size bearing inserts of each material are available in two different thicknesses and are color coded to indicate thickness as follows:

Red ..... 0.1245-0.1250 in. (3.162-3.175 mm)
Blue ..... 0.1249-0.1254 in. (3.172-3.185 mm)

In production, main bearing journals are color coded to indicate journal diameter as follows:

Red ..... 3.3718-3.3723 in. (85.644-85.656 mm)
Blue ..... 3.3713-3.3718 in. (85.631-85.644 mm)

NOTE: Some crankshafts used in TW-5 tractors have crankpin journals and/or main journals ground 0.010 inch (0.25 mm) undersize during production. Engines with undersize crankshafts will be identified with one of the following codes stamped on right front of block near the engine code.
M—Undersize main journals
P—Undersize crankpin journals
MP—Undersize main and crankpin journals

Crankshaft journals should be reground for installation of undersize bearings if the following specified limits are exceeded.

Main Journal Wear Limit ..... 0.005 in. (0.13 mm)
Main Journal Taper (Max.) .....0.0002 in. (0.005 mm)
Main Journal Out-of-Round (Max.) ..... 0.0002 in. (0.005 mm)

When renewing main bearings, install bearing inserts color coded to match color code of journals. Then, use Plastigage to check for specified clearance of 0.0022-0.0045 inch (0.056-0.114 mm). If main bearing clearance exceeds the specified limit when using red bearing inserts, it is permissible to install blue inserts to reduce the clearance. If blue inserts do not provide the desired clearance, it will be necessary to refinish main journals for installation of 0.002, 0.010, 0.020, 0.030 or 0.040 inch (0.05, 0.25, 0.50, 0.75 or 1.0 mm) undersize bearings.

To install main bearings, proceed as follows: Be sure bearing bores and bearing inserts are clean. Lubricate bearings, then install in block and bearing caps. Install all main bearing caps except the rear cap and tighten retaining bolts finger tight. Pry crankshaft forward against flange of thrust bearing and pry thrust bearing cap rearward to align thrust surfaces of bearing, then tighten main bearing cap bolts to 120 ft.-lbs. (162 N·m) torque. Use a dial indicator to check for specified end play of 0.004-0.008 inch (0.10-0.20 mm). If end play is excessive, renew thrust bearing and/or crankshaft. If end play is less than specified, check for burrs or dirt on thrust surfaces.

Refer to paragraph 67 for installation of rear main bearing cap and oil seal. Oil pan retaining bolts should be tightened after engine is installed in tractor; refer to paragraph 69.

CRANKSHAFT OIL SEALS

All Models

67. Crankshaft front oil seal is located in the timing gear cover. Renewal of seal requires removal of timing gear cover as outlined in paragraph 52.

To renew crankshaft rear oil seal, engine must be removed from tractor and the clutch, flywheel, engine rear plate, oil pan and rear main bearing cap removed.

Clean mating surfaces of block and rear main bearing cap, then apply a light coat of sealing compound to both surfaces (3—Fig. 104). Install new side seals (1) in rear main bearing cap and assemble cap to block so side seals protrude slightly beyond oil pan mounting surface of block. Tighten main bearing cap bolts to 120 ft.-lbs. (162 N·m) torque, then trim side seals to allow end of seals to project 0.016 inch (0.40 mm) above bearing cap and block surfaces.

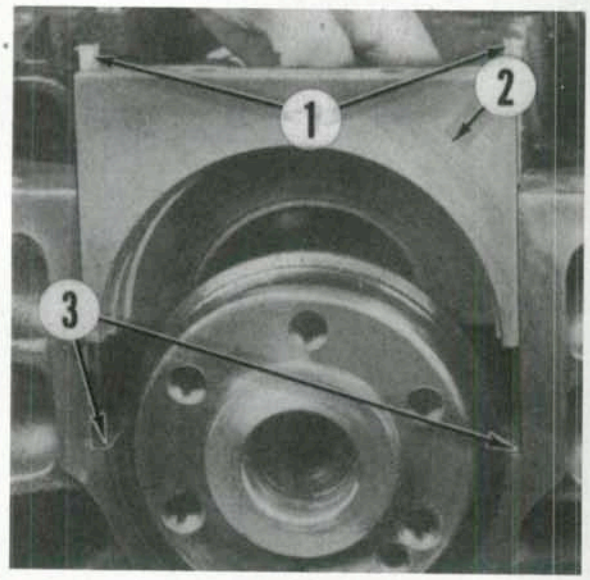


Fig. 104—When installing rear main bearing cap (2), side seals (1) should protrude slightly above face of cap as shown. Apply light coat of sealing compound to block and cap mating surfaces (3).

Apply a light coat of high temperature grease to seal lip and crankshaft flange, then install seal using special installing tool (No. 1301), or other suitable installing tool. If seal contact surface on crankshaft is smooth, install seal flush with rear face of block. If crankshaft surface is worn, install seal 1/16 inch (1.5 mm) below face of cylinder block so seal lip contacts unworn surface of crankshaft flange. Apply penetrating oil to side seals to cause them to swell.

Mount a dial indicator on end of crankshaft and check runout of seal (Fig. 105). Maximum allowable runout is 0.015 inch (0.38 mm).

FLYWHEEL

All Models

68. The flywheel can be removed after splitting the tractor between engine and transmission as outlined in paragraph 130. Unbolt and remove clutch assembly and flywheel.

Inspect flywheel and starter ring gear for wear, cracks or other damage and renew if necessary. The ring gear can be cut off or heated and driven off flywheel if renewal is necessary. Heat new ring gear to 400° F (205° C) prior to installation. Do not overheat gear. Heat sensing crayons which melt at 400° F (205° C) and 450° F (232° C) can be used to mark ring at several points around gear to avoid overheating. Tap gear flat against shoulder of flywheel, then quench with water to cool gear rapidly.

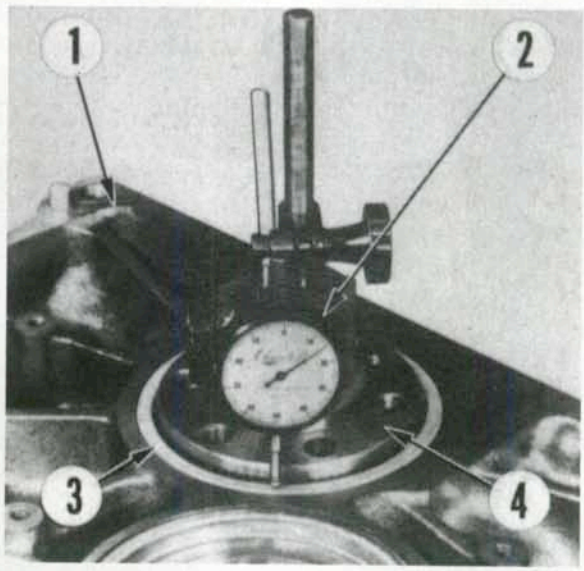


Fig. 105—After renewing crankshaft rear oil seal, use a dial indicator to check runout of seal as shown.

1. Cylinder block
2. Dial indicator
3. Oil seal
4. Crankshaft

The flywheel mounting bolt holes are unevenly spaced so flywheel can be mounted in only one position. Apply Loctite 271 to threads of mounting bolts, then tighten bolts evenly to a torque of 160 ft.-lbs. (217 N·m). Use a dial indicator to check runout of flywheel face at outer edge of friction surface. If runout exceeds 0.0055 inch (0.14 mm), remove flywheel and check mounting surfaces for burrs or dirt and correct as necessary.

OIL PAN

All Models

69. To remove oil pan with engine installed in tractor, proceed as follows: One at a time, replace existing cylinder block-to-axle front support bolts with bolts 8 inches (200 mm) long. This will allow support to be moved forward slightly to provide access to the front oil pan mounting bolts. Remove hood side panels, hood top panel and radiator grille panels. On TW-5 and TW-15 tractors, remove bolts attaching main fuel tank supports to radiator frame. On all models, disconnect hoses as necessary between front end and engine to allow front end assembly to be moved forward approximately 1-1/2 inches (38 mm). Remove bolts attaching side frame rails to front support, then move front support forward until there is sufficient clearance to remove front oil pan mounting bolts.

Drain the engine oil and remove dipstick. Support oil pan with a suitable floor jack. Remove oil pan mounting bolts and lower oil pan from engine.

If a new oil pan is being installed, refer to paragraph 4 for shimming front support to oil pan. To reinstall oil pan, proceed as follows:

Be sure all gasket surfaces are clean. Apply a thin film of sealer to gasket, oil pan and timing gear cover. Lift oil pan into position and install mounting bolts finger tight. Tighten the rear mounting bolts first to 32 ft.-lbs. (43 N·m) torque, then tighten remaining bolts from the middle outward to a torque of 32 ft.-lbs. (43 N·m). Tighten front support bolts to a torque of 200 ft.-lbs. (270 N·m).

OIL PUMP AND RELIEF VALVE

All Models

70. To remove oil pump, first remove oil pan as outlined in paragraph 69. Unbolt and remove oil pump (3—Fig. 107) from bottom of cylinder block.

Check end play of idler gear (4—Fig. 107) bearing. If end play exceeds 0.008 inch (0.20 mm), idler gear and bearing assembly should be renewed.

Unbolt and remove cover plate (8—Fig. 108) and tubes (12 and 13). Remove drive gear (3) and Woodruff key from pump shaft, then withdraw pump rotor assembly (6). Remove relief valve (9).

Inspect all parts for wear or scoring and renew as necessary. Measure clearance between inner and outer rotors and face of pump housing using a straightedge as shown in Fig. 109. Specified end clearance is 0.0010-0.0035 inch (0.025-0.089 mm). Use a feeler gage to measure clearance between outer rotor and pump housing as shown in Fig. 110. Specified clear-

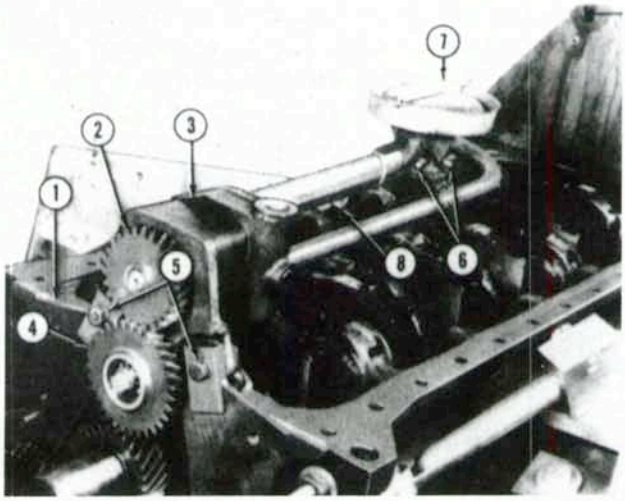


Fig. 107—View of engine oil pump with oil pan removed.

1. Pump support plate
2. Pump drive gear
3. Oil pump housing
4. Idler gear
5. Pump mounting bolts
6. Cap screws
7. Inlet tube & screen
8. Cap screw

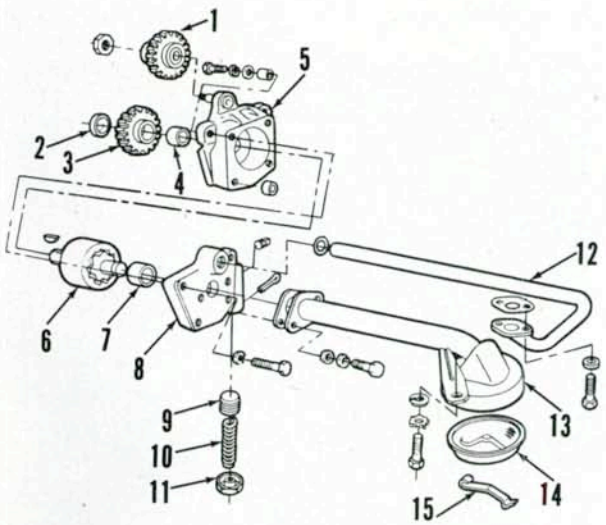


Fig. 108—Exploded view of oil pump assembly.

1. Idler gear
2. Plug
3. Drive gear
4. Bushing
5. Pump housing
6. Rotor & shaft assy.
7. Bushing
8. Cover plate
9. Relief valve
10. Spring
11. Plug
12. Outlet tube
13. Inlet tube
14. Screen
15. Retainer spring

ance is 0.006-0.011 inch (0.15-0.28 mm). Check clearance between inner and outer rotors as shown in Fig. 111. Specified clearance is 0.001-0.006 inch (0.03-0.15 mm). Renew rotor assembly and pump housing as necessary if clearances are not within specifications. Relief valve spring tension should be 20 pounds (89 N) when compressed to 1.91 inches (48.5 mm).

Assemble pump and prime with oil by filling pump inlet with oil while rotating pump drive gear. Install pump assembly and tighten pump mounting bolts to a torque of 25 ft.-lbs. (34 N·m). Install oil pan as outlined in paragraph 69.

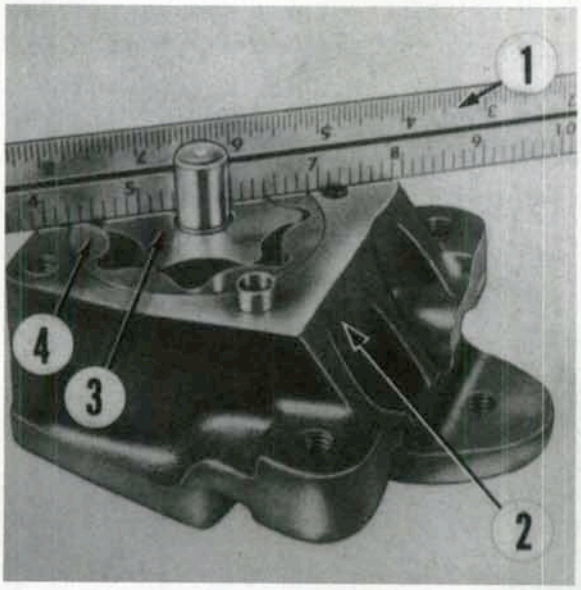


Fig. 109—To check rotor end clearance, place a straightedge across pump housing and measure gap between straightedge and rotor.

1. Straightedge
2. Pump housing
3. Inner rotor
4. Outer rotor

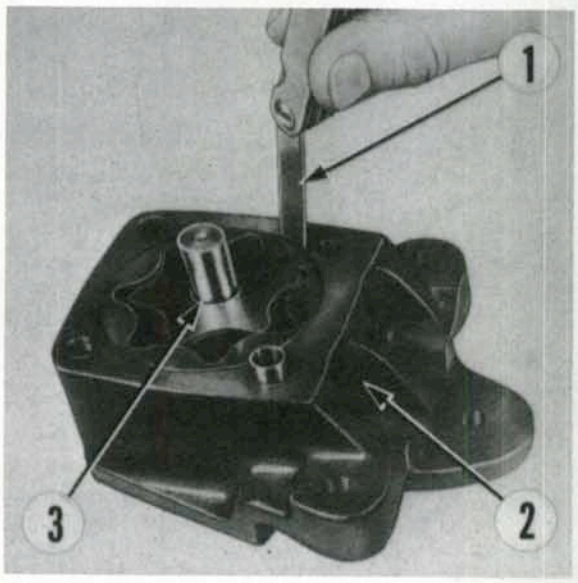


Fig. 110—Use a feeler gage (1) to measure clearance between pump housing (2) and rotor assembly (3).

Normal oil pump pressure is 40-65 psi (275-450 kPa) at 2200 engine rpm. Relief valve opening pressure should be 60-80 psi (415-550 kPa).

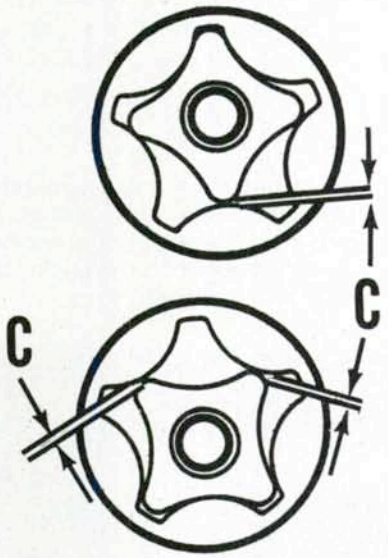


Fig. 111— Measure inner to outer rotor clearance (C) as shown; renew rotors if clearance exceeds 0.006 inch (0.15 mm).

DIESEL FUEL SYSTEM

The diesel fuel system consists of three basic components: the fuel filter, injection pump and injection nozzles. When servicing any unit associated with the fuel system, the maintenance of absolute cleanliness is of utmost importance.

FILTER AND BLEEDING

All Models

71. All 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 element every 600 hours of operation. Close fuel shut-off valve at tank before removing filter.

To bleed air from system, loosen bleed screw (1--Fig. 113) on filter housing. Actuate hand priming lever on fuel lift pump (3) until air free fuel flows from bleed screw, then tighten bleed screw. Loosen bleed screw (2) on injection pump and actuate priming lever. Close bleed screw when air-free fuel flows from injection pump. Loosen injector line fittings at the injectors. With stop control in "run" position and throttle lever in full speed position, crank engine until fuel is discharged at the injector line connectors. Tighten fuel line fittings and start engine.

FUEL LIFT PUMP

All Models

72. PRESSURE CHECK. To check lift pump pressure, disconnect pressure line at top side of fuel lift pump and install a pressure gage as shown in Fig. 114. Actuate lift pump priming lever and observe pressure gage reading.

NOTE: If no resistance is felt when operating the priming lever, the injection pump camshaft may be holding lift pump rocker lever in neutral position. Rotate engine crankshaft about one revolution to reposition injection pump camshaft.

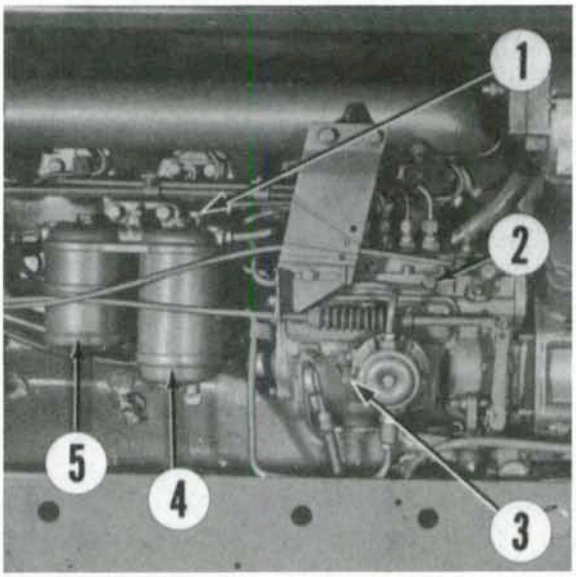


Fig. 113—View of injection pump, fuel filter and sediment separator showing location of air bleed screws (1 and 2).

1. Bleed screw
2. Bleed screw
3. Priming lever
4. Fuel filter
5. Sediment separator

Specified lift pump pressure is 2-5 psi (14-34 kPa). Pressure should hold steady (without operating priming lever) for a minimum of five minutes.

73. R&R AND OVERHAUL. The diaphragm type fuel lift pump is mounted on outside of fuel injection pump and is driven by a cam on injection pump camshaft. Component parts of pump are available for service.

To remove pump, first shut off fuel. Disconnect fuel inlet and outlet lines from the pump. Remove two stud nuts and withdraw pump assembly.

To disassemble, remove cover plate (1—Fig. 115) and pulsator diaphragm (2). Scribe alignment marks on pump housing halves (3 and 11) and diaphragm

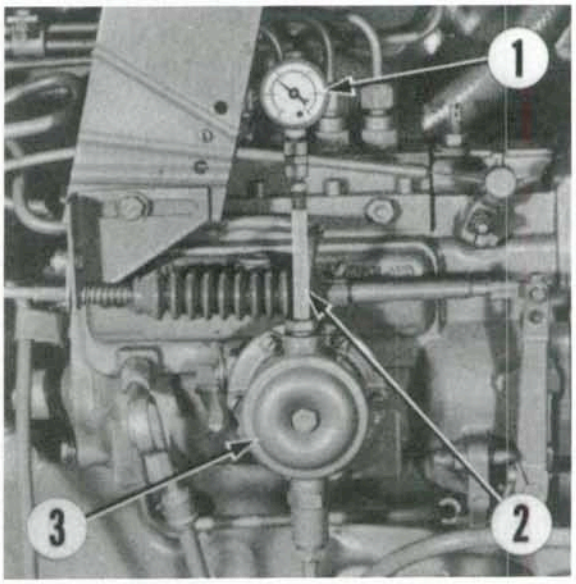
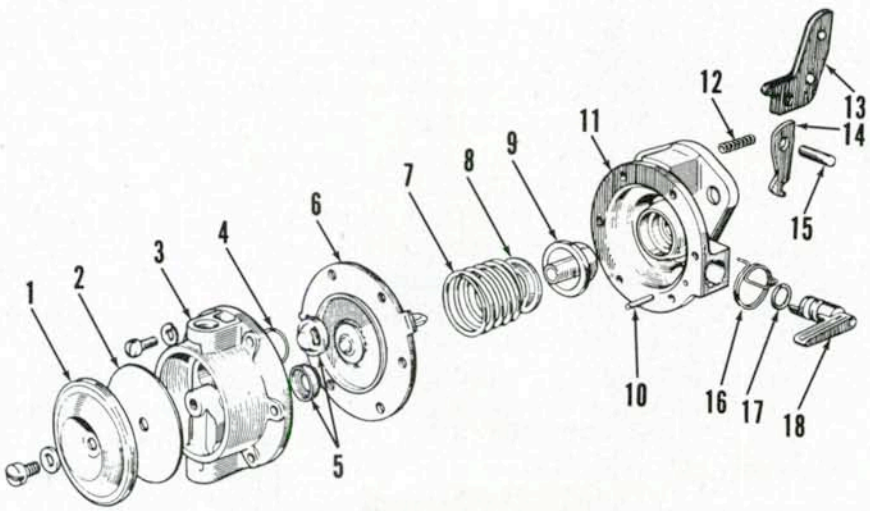


Fig. 114—To check fuel lift pump pressure, install a pressure gage (1) in outlet port of lift pump (3) and operate priming lever.



1. Cover plate
2. Pulsator diaphragm
3. Outer housing
4. Gasket
5. Check valves
6. Pump diaphragm
7. Spring
8. Retainer
9. Seal
10. Pin
11. Inner housing
12. Spring
13. Rocker arm
14. Diaphragm lever
15. Pivot pin
16. Spring
17. Seal
18. Priming lever

Fig. 115—Exploded view of fuel lift pump.

(6) to aid alignment when reassembling. Remove retaining screws and separate pump housing halves. Push inward on diaphragm and disengage pull rod, then lift out diaphragm. Drive out retaining pin (10) and withdraw priming lever (18), seal (17) and spring (16). Remove pivot pin (15) and withdraw rocker arm (13) and lever (14).

The inlet and outlet valves (5) are staked into the outer housing (3). When renewing valves, insert into housing as shown and stake in position. After installing rocker arm pivot pin (15), securely stake pin in place in three places. Install priming lever with a new seal (17). Retaining pin (10) must be installed with outer end below flush with machined surface of inner housing. Make certain scribe marks on pump housing halves are aligned when reassembling housing.

Reinstall pump, then bleed air from system as outlined in paragraph 71.

FUEL INJECTION PUMP

All Models

74. PUMP TIMING. To check and adjust pump to engine static timing, proceed as follows: Remove cover plate from front of timing gear cover, and remove flywheel timing hole cover plate from right side of engine rear cover plate. Turn crankshaft in normal direction of rotation until No. 1 piston is on compression stroke and 25 degree BTDC flywheel timing mark on flywheel is aligned with arrow at edge of timing hole (Fig. 116). At this point, timing marks on pump drive gear adapter hub and pump housing must be aligned as shown in Fig. 117. If timing marks are not aligned, loosen the three cap screws that retain drive gear to pump drive hub. Rotate the pump shaft and hub until timing marks are aligned, then tighten cap screws.

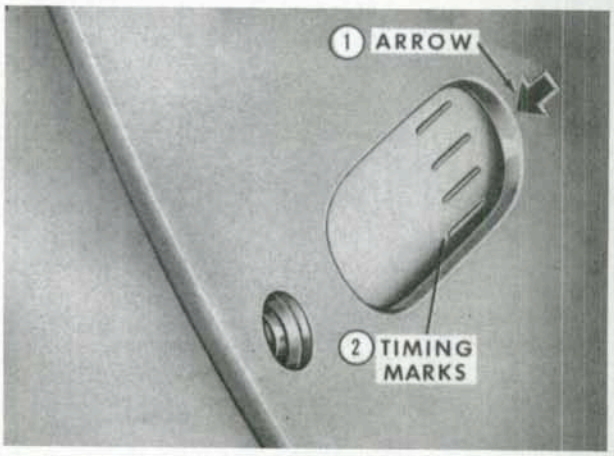


Fig. 116—View with cover plate removed showing timing pointer on engine rear plate and timing marks on flywheel.

75. R&R FUEL INJECTION PUMP. Thoroughly clean the pump, fuel lines and area around pump. Proceed as outlined in paragraph 74 to position flywheel and pump timing marks in alignment. Shut off the fuel. Disconnect and remove all fuel lines from the injection pump and cap all openings. Remove pump lubrication tube (7—Fig. 118). Disconnect fuel shut-off cable (3), throttle control linkage (5) and tachometer drive cable (8). Remove the three cap

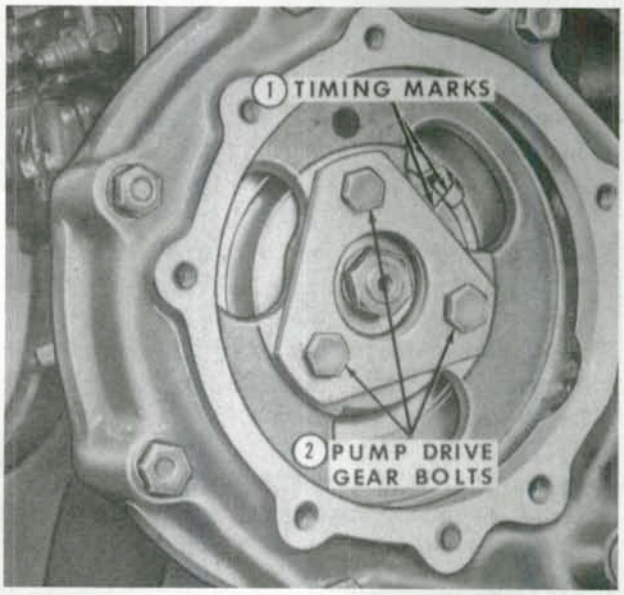


Fig. 117—Remove pump drive gear cover from front of timing gear cover to view injection pump timing marks.

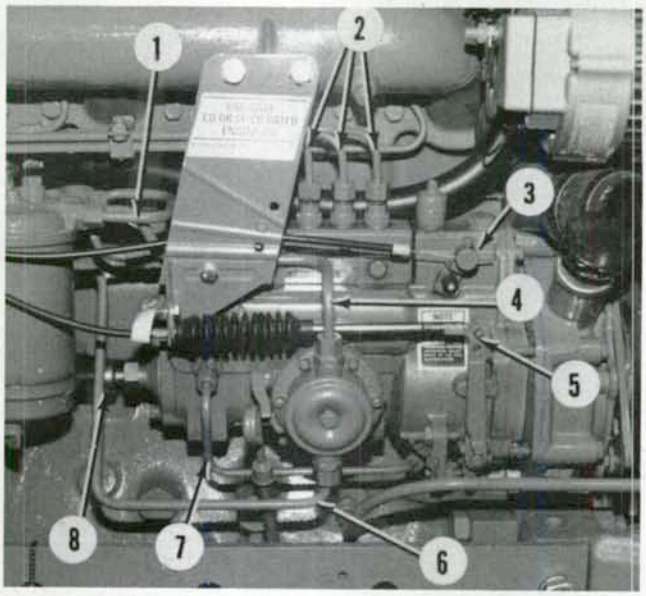


Fig. 118—View of fuel injection pump installed on the engine.

1. Fuel inlet tube
2. Injector tubes
3. Fuel shut-off
4. Lift pump outlet tube
5. Throttle control linkage
6. Lift pump inlet tube
7. Pump lubrication tube
8. Tachometer drive cable

screws attaching pump drive gear to adapter hub. Remove pump mounting cap screws, then withdraw pump from engine front plate.

NOTE: The pump drive gear will remain in the engine timing gear cover and cannot become out-of-time. However, the crankshaft should not be turned with injection pump removed.

To reinstall fuel injection pump, reverse the removal procedure. Time the pump as outlined in paragraph 74. Tighten injection pump mounting cap screws to a torque of 38 ft.-lbs. (52 N·m), pump drive gear cap screws to 30 ft.-lbs. (41 N·m) and injector line fittings to 26 ft.-lbs. (35 N·m). Bleed air from fuel system as outlined in paragraph 71.

ENGINE SPEED ADJUSTMENT

All Models

76. Engine speed adjustments should be made with engine at normal operating temperature. Low idle speed is 700-800 rpm for all models. High idle no-load speed is 2525-2575 rpm for TW-5 models and 2425-2475 rpm for all other models.

To adjust engine speed, disconnect throttle linkage at the injection pump. Adjust low idle stop screw (1—Fig. 119) and high idle stop screw (2) as necessary to obtain specified speeds. Set hand throttle lever and injection pump throttle lever (3) in maximum high idle speed position, then adjust throttle control cable (4), if necessary, so cable can be reconnected to injection pump lever. Recheck low idle and high idle speed settings for both hand throttle and foot throttle operation.

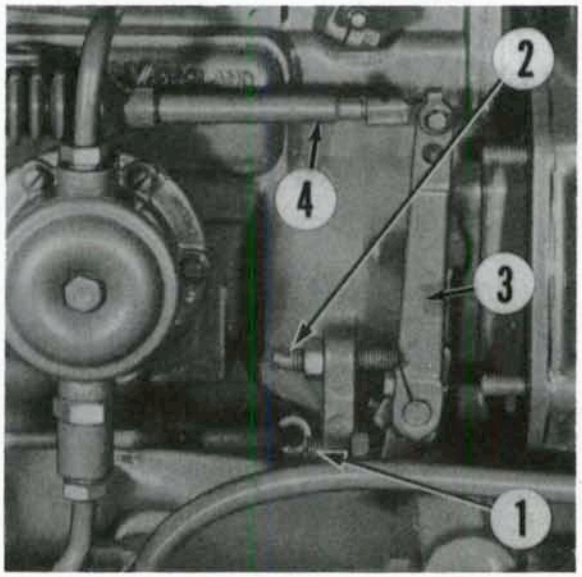


Fig. 119—View of throttle linkage showing low idle and high idle speed adjusting screws.

1. Low idle speed adjusting screw
2. Maximum no-load speed adjusting screw
3. Throttle lever
4. Throttle control cable

INJECTION NOZZLES

All Models

77. LOCATING A FAULTY NOZZLE. If engine does not run properly and a faulty injection nozzle is suspected, locate the faulty nozzle as follows: With engine running, loosen the high pressure fuel line fitting on each nozzle holder in turn, thereby allowing fuel to escape at the union rather than enter the cylinder. The faulty nozzle is the one that least affects running of the engine when its fuel line is loosened.

78. NOZZLE TESTING. A complete job of testing and adjusting fuel injection nozzles requires the use of a special nozzle tester. The nozzle should be tested for opening pressure, spray pattern, seat leakage and leak back.

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

Connect injector nozzle to tester and operate tester lever to purge air from injector and to be sure nozzle is not plugged. If tester lever is hard to operate or if fuel does not spray from all four nozzle spray holes, service nozzle as outlined in paragraph 84.

79. OPENING PRESSURE. With valve to tester gage open, slowly operate tester lever and note gage pressure at which nozzle spray occurs. Nozzle opening pressure should be 2825-2875 psi (19480-19825 kPa) on TW-5 models and 3225-3275 psi (22235-22580 kPa) for TW-15, TW-25 and TW-35 models.

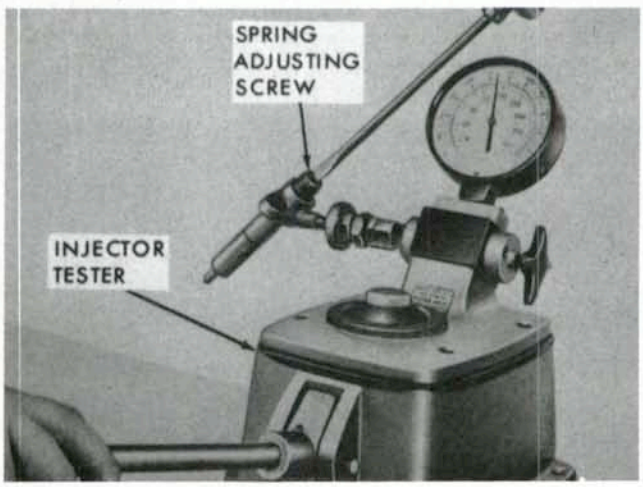


Fig. 121—Use a nozzle tester to set opening pressure; refer to paragraph 79 for specifications.

If opening pressure is not within specified range, remove nozzle cap nut and turn adjusting screw as required to obtain specified opening pressure. See Fig. 122. If opening pressure cannot be properly adjusted, overhaul nozzle as outlined in paragraph 84.

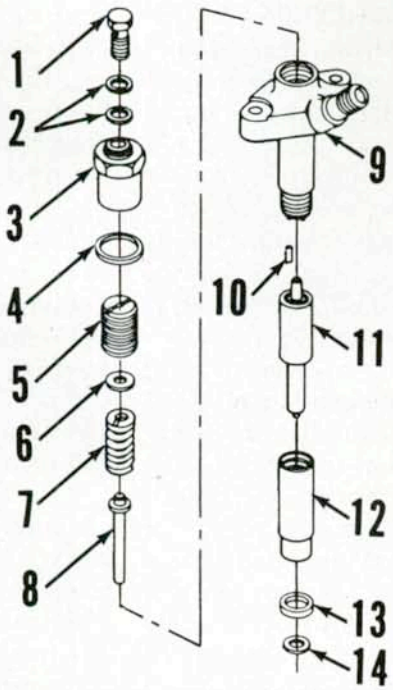
80. SPRAY PATTERN. Operate the tester lever rapidly and observe spray pattern. All four sprays must be similar, well atomized and form a cone shaped overall spray pattern. If spray pattern does not meet these conditions, overhaul nozzle as outlined in paragraph 84.

81. SEAT LEAKAGE. Wipe nozzle tip dry, then slowly operate tester lever to maintain gage pressure at 150 psi (1035 kPa) below opening pressure of injector. Hold this pressure for six seconds, then check nozzle tip for leakage. Visible wetting of nozzle tip is permissible. If a drop of fuel forms at tip, nozzle should be overhauled or renewed.

82. LEAK BACK. Operate tester lever to bring gage pressure to approximately 2300 psi (15860 kPa), then release lever and note time required for gage pressure to drop from 2200 psi (15170 kPa) to 1500 psi (10340 kPa). If time required is less than 5 seconds, nozzle valve is worn or there is leakage between nozzle and holder mating surfaces. Refer to paragraph 84 for overhaul information.

83. REMOVE AND REINSTALL INJECTORS. Before removing injector, clean all dirt from lines, injectors and cylinder head around injectors. Disconnect fuel leak-off lines and high pressure line. Cap all openings. Remove injector retaining cap screws, then withdraw injector from cylinder head.

Before reinstalling injector, be sure the bore in cylinder head is clean and free of carbon deposits. Install a new copper seal washer in cylinder head and install a new dust seal around injector body. Install injector and tighten retaining cap screws evenly to a torque of 22 ft.-lbs. (30 N·m). Reconnect fuel lines.



1. Leak-off bolt
2. Washers
3. Cap nut
4. Seal washer
5. Adjusting screw
6. Washer
7. Spring
8. Spindle
9. Nozzle holder
10. Dowel
11. Nozzle valve assy.
12. Nozzle nut
13. Seal
14. Seal washer

Fig. 122—Exploded view of fuel injector assembly.

84. OVERHAUL INJECTORS. Secure the injector nozzle in a holding fixture, then remove cap nut (3—Fig. 122) and adjusting screw (5). Withdraw washer (6), spring (7) and spindle (8). Remove nozzle retaining nut (12) using nozzle nut socket (tool No. 8126) or equivalent, and remove nozzle valve (11) from holder (9).

Place all components in clean fuel oil as they are disassembled. Nozzle and needle valve (11) are a lapped fit and must never be interchanged.

Clean injector assembly using tools from injector cleaning kit (tool No. 1720) as follows: Soften hard carbon deposits by soaking in a suitable carbon solvent, then use a brass wire brush to remove carbon from exterior surfaces. Rinse parts in clean fuel oil immediately after cleaning to prevent corrosion of polished surfaces. Clean the pressure chamber of nozzle using pressure chamber drill as shown in Fig. 123. Clean nozzle spray holes using a 0.012 inch (0.30 mm) diameter cleaning wire held in a pin vise as shown in Fig. 124. To prevent breakage of cleaning wire, the wire should protrude from pin vise only far enough to pass through the spray holes. Clean the nozzle valve seat using the valve seat scraper tool. When nozzle cleaning is completed, back flush nozzle using a reverse flushing adapter on the injector tester to flush carbon particles from nozzle.

Rinse all parts in clean fuel oil and assemble while wet. Position nozzle valve on nozzle holder making sure that dowel pins are correctly located in nozzle

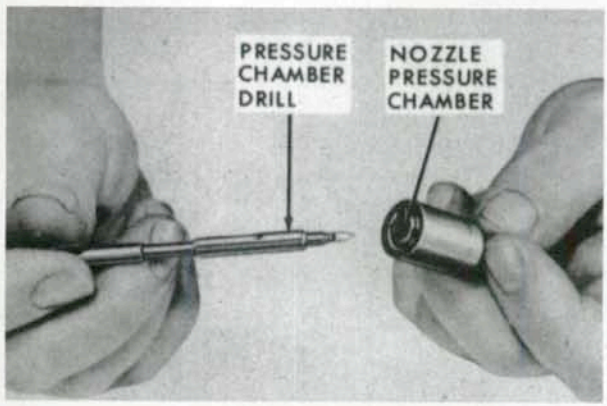


Fig. 123—Clean nozzle tip cavity with pressure chamber drill.

as shown in Fig. 125. Tighten nozzle retaining nut to a torque of 70 ft.-lbs. (95 N·m). Install spindle, spring, washer and adjusting screw. Connect injector to tester and adjust opening pressure as outlined in paragraph 79. Install cap nut, then retest the injector as outlined in paragraphs 79 through 82. Renew nozzle valve if injector fails any of the tests.

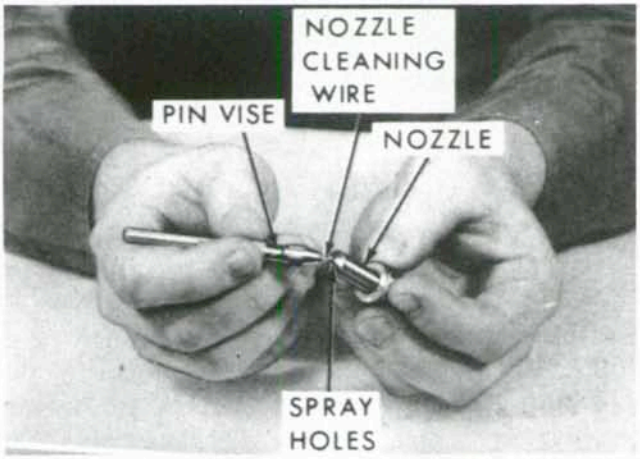


Fig. 124—Use a cleaning wire held in a pin vise to clean nozzle spray holes.

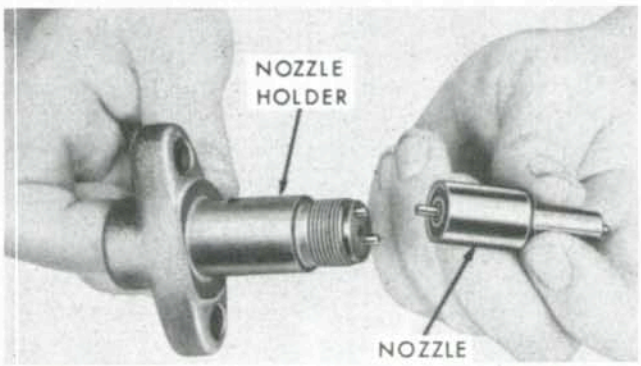


Fig. 125—Be sure polished mating surface of nozzle valve and holder are clean and free of nicks or scratches.

TURBOCHARGER

Models TW-15, TW-25 and TW-35 are equipped with an AiResearch turbocharger. Lubrication and cooling of turbocharger is provided by the engine oil. After engine is operated under load, turbocharger should be allowed to cool by idling engine at about 1000 rpm for 2 to 5 minutes before engine is shut off.

Most turbocharger failures are caused by one of the following basic reasons: Lack of lubrication, contamination of lubricant, excessive operating temperature or ingestion of dirt or other foreign objects. The cause of turbocharger failure must be corrected before installing a new turbocharger, or premature failure of new turbocharger will result.

All Models So Equipped

85. REMOVE AND REINSTALL. To remove turbocharger, remove hood side panels, grille panels, intercooler grilles (TW-35), muffler, precleaner and hood top panel. On TW-35 models, remove intercooler assembly. On all models, remove exhaust pipe, air intake tube and air outlet tube from turbocharger. Disconnect oil supply and return tubes. Unbolt and remove turbocharger from exhaust manifold.

Prior to installation, pour clean engine oil into center housing oil inlet and rotate turbine shaft to lubricate the bearings. Install turbocharger using a new mounting gasket and tighten retaining nuts to a torque of 33 ft.-lbs. (45 N·m). Reconnect air inlet and outlet tubes, exhaust pipe and oil supply pipe, but do not connect oil return tube at this time.

Prime the turbocharger with oil as follows: With engine stop control handle pulled out, crank the engine until oil from engine lubrication system flows out turbocharger oil return passage. Connect oil return tube, then start engine and run at low speed while checking for leaks.

NOTE: After turbocharger unit reaches operating temperature, the rotating assembly should coast freely to a stop after engine is stopped. If rotating assembly comes to a sudden stop, the cause should be corrected before continuing to operate tractor.

86. BEARING CLEARANCE CHECK. It is recommended that the following bearing clearance measurements be performed prior to disassembly of turbocharger as an aid to determining condition of internal components. If clearances are not within specified range, the turbocharger should be overhauled.

Mount a dial indicator to center housing so indicator plunger extends through oil inlet port and contacts turbine wheel shaft as shown in Fig. 128. Apply pressure to both the turbine wheel and compressor wheel to move shaft toward and away from dial indicator plunger and note indicator reading. If shaft-to-bearing radial clearance is less than 0.003 inch (0.076 mm) or greater than 0.006 inch (0.15 mm), overhaul the turbocharger.

Mount the dial indicator on turbocharger so indicator plunger contacts end of compressor wheel as shown in Fig. 129. Move turbine wheel and compressor wheel back and forth and note dial indicator reading. If shaft end play is less than 0.001 inch (0.025 mm) or greater than 0.004 inch (0.102 mm), overhaul the turbocharger.

87. OVERHAUL. Prior to disassembling turbocharger, clean the exterior and mark compressor housing (22—Fig. 130), center housing (15) and turbine housing (1) to ensure correct alignment when reassembling.

Remove retaining bolts (4 and 19) and clamps (2 and 21), then carefully separate compressor housing and turbine housing from center housing. Clamp a suitable socket or wrench in a vise and engage serrated end of turbine wheel (5) in the socket or wrench, or

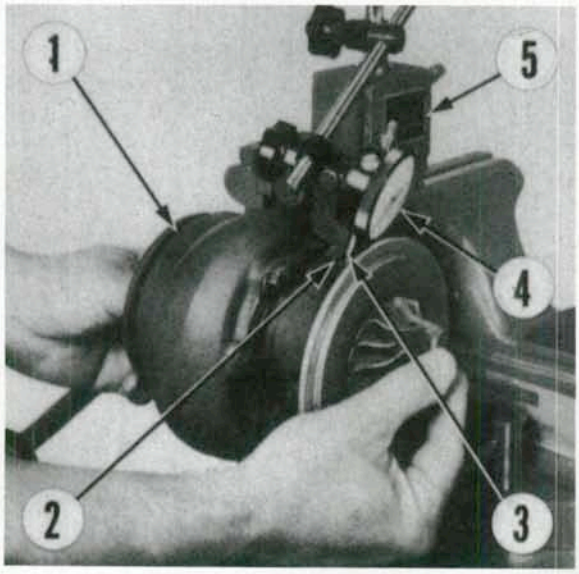


Fig. 128—Position dial indicator plunger (3) through oil port (2) to contact turbine wheel shaft to check shaft-to-bearing radial clearance. Refer to text for specifications.

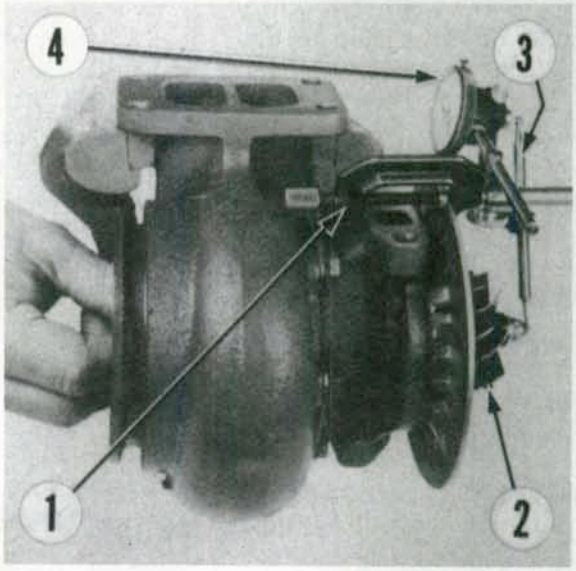


Fig. 129—Position dial indicator plunger (3) against end of compressor wheel (2) to check shaft-to-thrust bearing axial clearance. Refer to text for specifications.

1. Turbine housing
2. Clamp
3. Lockplate
4. Cap screw
5. Turbine wheel & shaft
6. Seal ring
7. Shroud
8. Snap ring
9. Bearing
10. Thrust collar
11. Seal ring
12. Rubber seal ring
13. Thrust bearing
14. Spring pin
15. Center housing
16. Back plate
17. Compressor impeller
18. Locknut
19. Cap screw
20. Lockplate
21. Clamp
22. Compressor housing
23. Lockplate
24. Cap screw

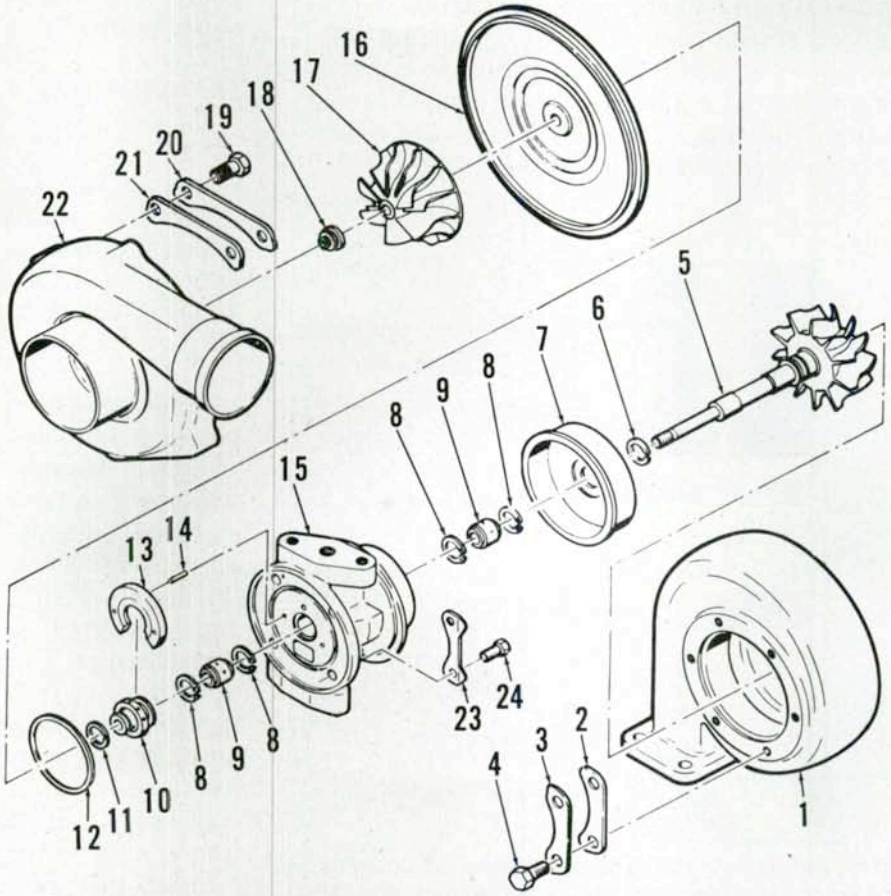


Fig. 130—Exploded view of AiResearch turbocharger used on TW-15, TW-25 and TW-35 models.

use a suitable turbine wheel holding fixture to prevent turbine wheel shaft from turning. Support the rotating assembly in a vertical position, then use a double universal socket wrench or a "T" handle to remove compressor wheel retaining nut (18). Use care to avoid placing bending load on turbine wheel shaft. Remove the compressor wheel (17), then withdraw turbine wheel assembly (5) and shroud (7) from center housing. Unbolt and remove back plate assembly (16). Remove thrust collar (10) and thrust bearing (13). Remove outer retaining rings (8) and withdraw bearings (9) from center housing. It is not necessary to remove inner retaining rings (8) unless they are damaged or unseated from grooves in housing.

Clean all parts in a noncaustic cleaning solution. When deposits have softened, use a soft bristle brush and a plastic or wooden scraper to remove deposits. Use compressed air to blow out oil passages and internal cavities in center housing. Make certain oil passage orifice (1—Fig. 131) in turbine end oil cavity is not obstructed. Use a wire to clean the orifice. Diameter of orifice is 0.053-0.060 inch (1.35-1.52 mm).

If turbocharger is damaged due to lack of lubrication which results in bearing seizure or if impellers are damaged due to contact with foreign objects or housing walls, renewal of center housing and rotating parts will probably be required. Always renew rubber seal ring (12—Fig. 130), metal seal rings (6 and 11), bearings (9), retaining rings (8) if removed, lockplates (2, 20 and 23) and cap screws (4, 19 and 24).

Inspect bore in center section and bore in back plate for step wear in metal seal ring contact area. Check thrust bearing for scoring or excessive wear. Thrust bearing surface must be flat within 0.0003 inch (0.008 mm). Shoulders of ring groove in thrust collar must not have step wear. Check for loose or damaged thrust spring in back plate; the spring is not serviced separately. The back plate-to-center housing mounting surface must be flat within 0.0005 inch (0.013 mm). Compressor impeller and turbine wheel must be free of deposits and must not be bent, cracked, eroded or show signs of rubbing on housings. Do not attempt to straighten bent blades. Turbine wheel shaft must not show signs of scoring or overheating. Renew parts that do not meet the following specifications.

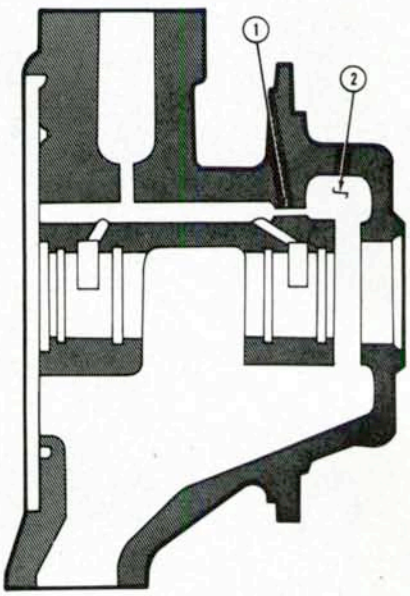


Fig. 131—Sectional view of turbocharger center housing showing lubrication passages and oil passage orifice (1) in turbine end oil cavity (2).

Center Housing Bearing Bore—	
Maximum ID	0.623 in. (15.82 mm)
Turbine Wheel Shaft—	
Minimum Journal OD	0.3994 in. (10.145 mm)
Seal Ring Hub OD—	
Standard	0.682-0.683 in. (17.32-17.35 mm)
Minimum	0.681 in. (17.30 mm)
Seal Ring Groove Width—	
Standard	0.0645-0.0685 in. (1.683-1.740 mm)
Maximum	0.0735 in. (1.867 mm)
Back Plate Bore for Seal Ring—	
Maximum ID	0.501 in. (12.73 mm)
Thrust Bearing	
Thickness	0.1716-0.1720 in. (4.359-4.369 mm)
Clearance Between Thrust Bearing and Thrust Collar	0.001-0.004 in. (0.03-0.10 mm)
Thrust Collar Seal Ring Groove—	
Maximum Width	0.066 in. (1.68 mm)

To reassemble, install new retaining rings (8) and bearings (9) in center housing being careful not to scratch housing bore. Lubricate bearings with oil. Install metal seal ring (6) in turbine shaft groove, lubricate shaft with oil, then assemble shroud (7) and center housing over the shaft. Install new metal seal ring (11) on thrust collar (10), then assemble thrust collar and bearing (13) over shaft with seal ring end of collar facing away from center housing and grooved side of bearing facing toward center housing. Be sure thrust bearing seats on pins in center housing. Install a new rubber seal ring (12) on center housing, then install back plate (16) over turbine shaft and thrust collar seal ring. Tighten retaining cap screws to a torque of 75-90 in.-lbs. (8.5-10 N·m).

Install compressor impeller onto turbine shaft. Lightly oil threads of locknut. Tighten the nut to a

torque of 18-20 in.-lbs. (2.0-2.2 N·m), then use a double universal joint socket wrench or a "T" handle to tighten nut an additional ¼ turn. This will provide correct assembly torque for the locknut.

Check shaft end play and radial clearance as outlined in paragraph 86. If clearances are not within specifications, locate problem and correct before proceeding with assembly.

Install turbine housing and compressor housing aligning match marks made prior to disassembly. Tighten turbine housing cap screws to a torque of 140-170 in.-lbs. (15.8-19.2 N·m) and compressor housing cap screws to a torque of 100-130 in.-lbs. (11.3-14.7 N·m). Bend tabs of lockplates to secure cap screws.

Reinstall turbocharger and prime with oil before starting engine as outlined in paragraph 85.

INTERCOOLER

Model TW-35 is equipped with an intercooler which cools the compressed air from the turbocharger before it enters the engine. The main parts of the intercooler are an exhaust aspirated air precleaner, a tip turbine fan and a heat exchanger. Approximately 10 percent of the high pressure air from the turbocharger is used to drive the tip turbine fan. The flow of cool air from the tip turbine fan is directed through the intercooler heat exchanger to cool the remaining 90 percent of the intake air from the turbocharger.

Model TW-35

88. TIP TURBINE FAN. Remove hood side panels and intercooler grille panels for access to tip turbine fan. Disconnect exhaust aspirator hose and turbocharger hose. Remove clamps and withdraw air precleaner and turbine tip fan.

Prior to disassembly, mark the fan housings to ensure correct alignment when reassembling. Unbolt and remove check valve housing (19—Fig. 134) from turbine housing (17). Remove sound baffle (1) from inlet housing (2). Remove cap screws attaching inlet housing (2) to turbine fan housing, then separate the housings. Secure the fan shaft to prevent it from turning, remove locknut (3) and withdraw cover (4) and turbine wheel (5) from fan housing.

NOTE: It is not necessary to separate turbine housing (17) from discharge housing (2) unless renewal is necessary.

Remove snap ring (7) and grease retainer (8), then withdraw shaft far enough so "O" ring (13) can be cut and removed from its groove. Pull shaft assembly out of the housing. Remove bearing retainer (9) and shims (10) from shaft. Remove the bearing spacer (14) from housing bore. It is not necessary to remove the washer shields (15) and spring (16) unless spring is damaged.

1. Sound baffle
2. Inlet housing
3. Locknut
4. Cover
5. Fan wheel
7. Snap ring
8. Grease retainer
9. Retainer
10. Shim
11. Shaft & bearing assy.
13. "O" ring
14. Spacer
15. Washer
16. Spring
17. Turbine housing
18. Gasket
19. Inlet check valve housing
20. Fan discharge housing
21. Snap ring
22. Plug

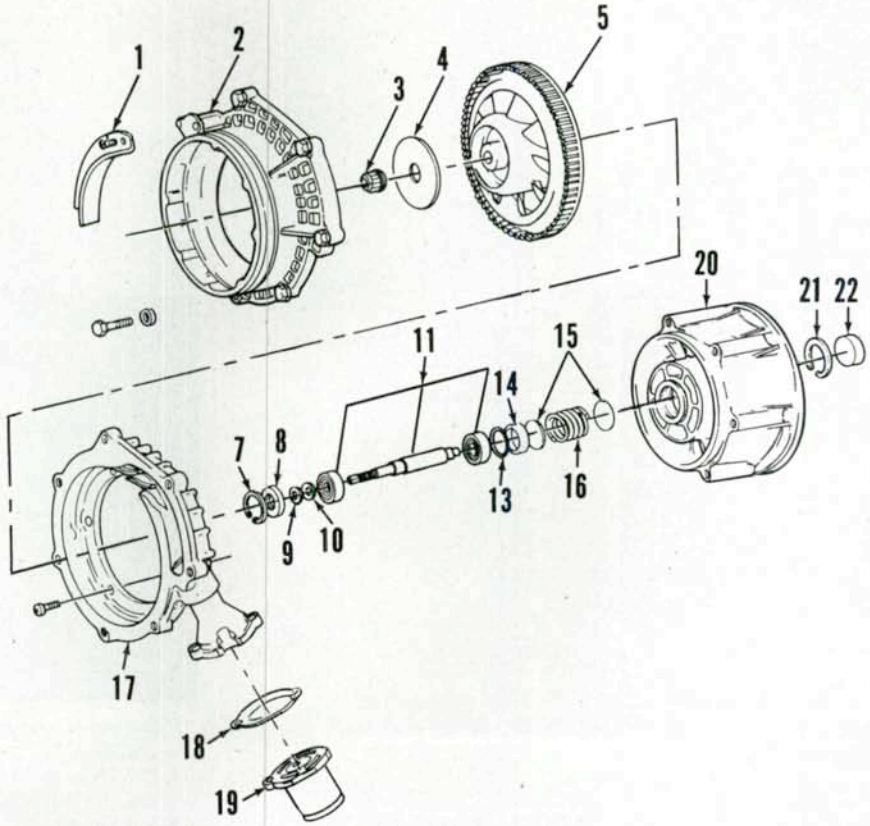


Fig. 134—Exploded view of intercooler tip turbine fan used on Model TW-35.

Clean all parts in noncaustic solution. Inspect parts for excessive wear or damage and renew as necessary. Fan shaft and bearings (11) are available only as an assembly. Inside diameter of turbine wheel bore should not exceed 0.4725 inch (12.0 mm). Outside diameter of fan shaft at turbine wheel location should not be smaller than 0.472 inch (11.98 mm). Bearing bores in discharge housing should not be larger than 1.2605 inches (32.014 mm). Leading and trailing edges of turbine wheel fan blades must be rounded, not worn to a sharp edge.

Reassembly procedure is the reverse of disassembly, however the following special instructions should be followed. The space between the bearing spacer and between the shaft bearings should be filled approximately ½ full with grease, Ford No. ESF-MIC-142-B. If discharge housing and turbine housing were separated, assemble housings, aligning assembly match marks. Tighten retaining screws to a torque of 100-120 in.-lbs. (11.3-13.5 N·m). Assemble turbine wheel on shaft, but do not tighten locknut (3) until correct thickness of shims (10) is determined.

With fan, bearings and shaft components assembled, mount a dial indicator on turbine housing as shown in Fig. 135. Zero the dial gage on mating surface (M) of housing, then reposition dial gage to contact fan wheel at surface (F). Rotate the fan wheel and take measurements at four different locations, then average the readings. The average difference in height between surface of housing and surface of fan wheel is the thickness of shims (10—Fig. 134) required. Install the correct thickness of shims, then tighten wheel retaining locknut to a torque of 145-155 in.-lbs. (16.4-17.5 N·m). Be sure fan wheel does not rub or bind when turned by hand. Renew turbine fan if wheel-to-housing contact cannot be corrected by shimming.

Install inlet housing (2) and tighten retaining screws to 140-160 in.-lbs. (15.8-18.1 N·m) torque.

89. HEAT EXCHANGER. General maintenance may be performed with heat exchanger (1—Fig. 136) on the engine. Tip turbine fan must be removed for inspection of fan side of heat exchanger. Clean dirt from face of heat exchanger using compressed air or steam cleaner through opening for tip turbine fan.

NOTE: Do not use petroleum base solvents for cleaning intercooler while installed on engine.

If removal of heat exchanger core is necessary, first remove intercooler assembly from the engine to prevent contaminants from entering intake manifold. Mark top of core so it can be reinstalled with same side up.

Renew gaskets whenever heat exchanger core is removed. Use alcohol or acetone to clean the gasket mating surfaces. Install new gaskets using mastic sealant (Ford No. ESE-M4G-195-A, or equivalent) to attach gaskets to the core. Allow sealer to cure a minimum of four hours before reinstalling core.

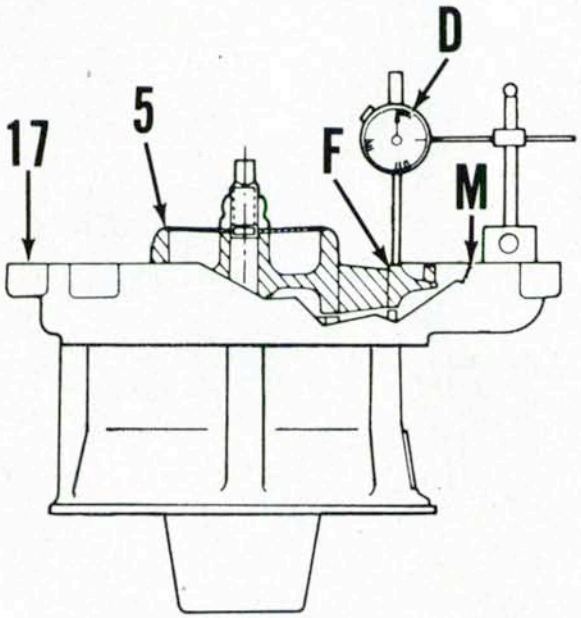


Fig. 135—View showing dial indicator placement to determine fan wheel shim thickness. Refer to text.

D. Dial indicator
F. Fan wheel surface
M. Housing mating surface
5. Fan wheel
17. Turbine housing

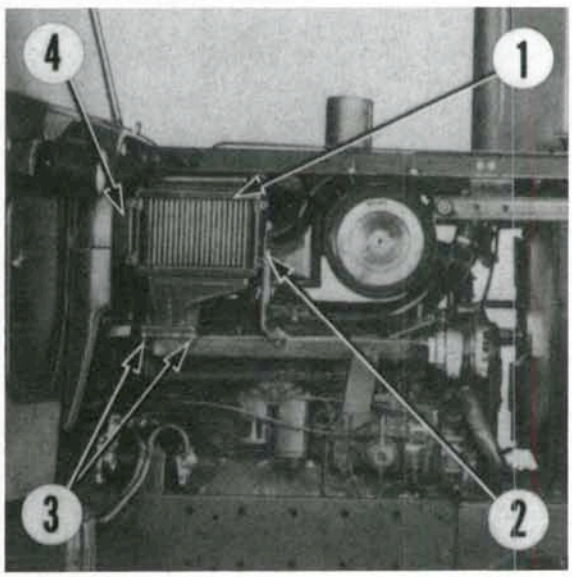


Fig. 136—View of intercooler core installed on the engine.

1. Intercooler core
2. Front mounting bracket
3. Base mounting bolts
4. Rear mounting bracket

COOLING SYSTEM

RADIATOR PRESSURE CAP AND THERMOSTAT

All Models

90. A 13 psi (90 kPa) radiator pressure cap is used on all models. All models are equipped with two thermostats (9—Fig. 137) which are located in the thermostat housing at front of cylinder block. The thermostats should start to open at a temperature of 178° F (81° C) and be fully open at 203° F (95° C).

The thermostats may be removed after draining the coolant and removing coolant outlet connection. Be sure to install thermostats so the heat sensing element is down.

FAN AND FAN DRIVE

All Models

91. A temperature sensing, viscous drive fan drive clutch (1—FIg. 137) is used on all models. The fan pulley (5) is supported by a shaft and bearing assembly (7) located in the front of the thermostat housing (8).

With the engine running, a noticeable increase in fan noise should be evident when fan clutch is engaged and a decrease in noise will be apparent when fan clutch disengages. With the engine stopped, the fan should turn smoothly by hand with only a slight amount of drag. If fan does not turn smoothly, does not turn at all, or looseness of bearings is evident, the fan drive should be renewed.

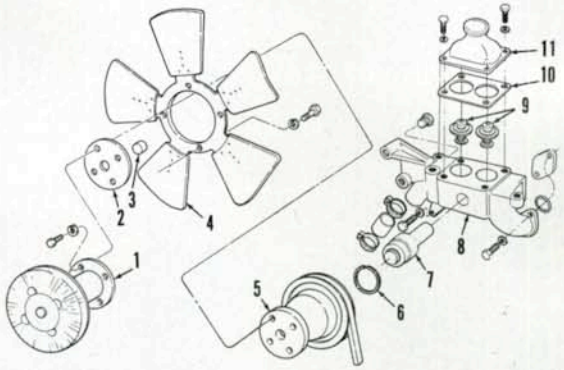


Fig. 137—Exploded view of thermostat housing and fan drive assembly used on all models.

1. Fan drive clutch
2. Spacer
3. Plug
4. Fan
5. Drive pulley
6. Retaining ring
7. Shaft & bearing assy.
8. Thermostat housing
9. Thermostats
10. Gasket
11. Coolant outlet housing

To remove fan and fan drive, first remove radiator as outlined in paragraph 92. Unbolt and remove fan drive from pulley. The fan drive clutch (1) is serviced only as a complete assembly.

To renew pulley support shaft and bearing assembly (7), remove thermostat housing (8) from cylinder head. Remove retaining ring (6) and plug (3) from fan pulley, then insert driver through hole in pulley to press shaft and bearing from pulley. Press bearing and shaft from thermostat housing. To install new shaft and bearing, reverse the removal procedure.

RADIATOR

All Models

92. To remove radiator, first drain the cooling system. Remove side panels, hood top panel, grille and grille side panels. Evacuate air conditioning system, if so equipped, and disconnect lines to condenser. Disconnect radiator hoses and hydraulic oil cooler lines. Remove retaining bolts, then lift radiator, oil cooler, condenser and fan shroud as an assembly from the tractor.

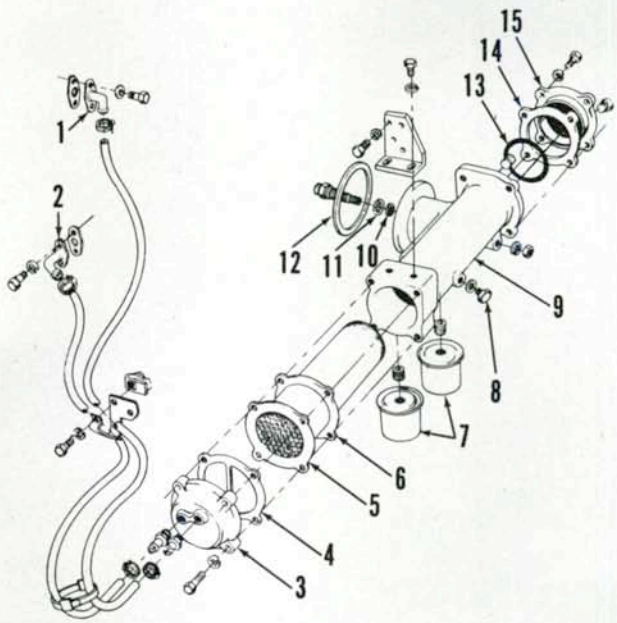


Fig. 138—Exploded view of engine oil cooler assembly used on Model TW-35.

1. Coolant outlet
2. Coolant inlet
3. End cap
4. Gasket
5. Cooler core
6. Gasket
7. Engine oil filters
8. Drain plug
9. Cooler housing
10. Seal ring
11. Seal ring
12. Gasket
13. "O" ring
14. Gasket
15. End cap

To reinstall radiator, reverse the removal procedure. It is recommended that a 50-50 mixture of water and ethylene glycol antifreeze be used in cooling system to protect against freezing and to provide a rust inhibitor.

ENGINE OIL COOLER

All Models

93. On Models TW-5, TW-15 and TW-25, the engine oil cooler is incorporated in the radiator lower tank. The radiator must be removed as outlined in paragraph 92 to service the oil cooler.

On Model TW-35, the engine oil cooler is mounted on left-hand side of the engine block. Refer to Fig. 138 for an exploded view of oil cooler assembly. Service normally consists of cleaning the unit if contamination of lubrication or cooling system occurs, or renewing cooler element or seals if leakage occurs.

WATER PUMP

All Models

94. To remove the water pump, first drain the cooling system. Loosen alternator mounting bolts and remove drive belt. Disconnect lower radiator hose and bypass hose from water pump. Remove water pump retaining cap screws and withdraw pump from engine.

To disassemble pump, use a suitable puller to remove pulley from pump shaft. Unbolt and remove rear cover (7—Fig. 140) from pump housing (2). Press shaft and bearing (3) out toward front of housing as shown in Fig. 141. Drive seal (4) out toward rear of housing.

Inspect all parts for wear or damage and renew as necessary.

Using a suitable size sleeve that contacts outer diameter of bearing, press new bearing and shaft into pump housing from the front until end of bearing is flush with front face of housing. Apply a thin coat of sealer to outer diameter of seal, then position seal over the shaft and into housing bore. Using tool No. 4672 or other suitable installing tool, press seal into housing until flange of seal is seated against housing. Support front of pump shaft (3—Fig. 142), then press impeller into shaft so impeller vanes (2) are flush with rear face of housing (4). Support rear end of shaft, then press pulley onto shaft until center of belt groove is 3-3/8 inches (86 mm) from rear face of housing as shown at (A—Fig. 143). Install rear cover with new gasket and tighten retaining cap screws to a torque of 20 ft.-lbs. (27 N·m).

Reinstall water pump by reversing the removal procedure. Tighten retaining cap screws to a torque of 25 ft.-lbs. (34 N·m). Adjust drive belt so belt deflects 1/2-3/4 inch (13-19 mm) when moderate finger pressure is applied between crankshaft and alternator pulleys.

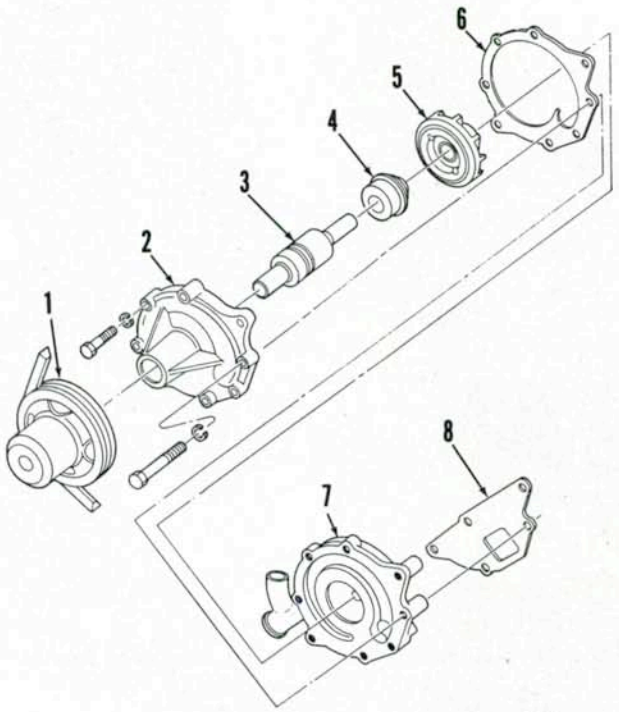


Fig. 140—Exploded view of water pump assembly used on all models.

1. Drive pulley
2. Pump housing
3. Shaft & bearing assy.
4. Seal assy.
5. Impeller
6. Gasket
7. Rear cover
8. Gasket

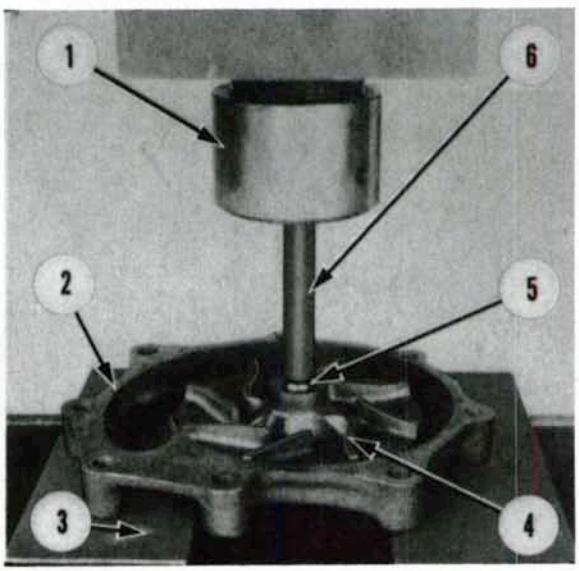


Fig. 141—Press bearing and shaft assembly out front of pump housing.

1. Press
2. Pump housing
3. Support
4. Impeller
5. Shaft & bearing assy.
6. Rod

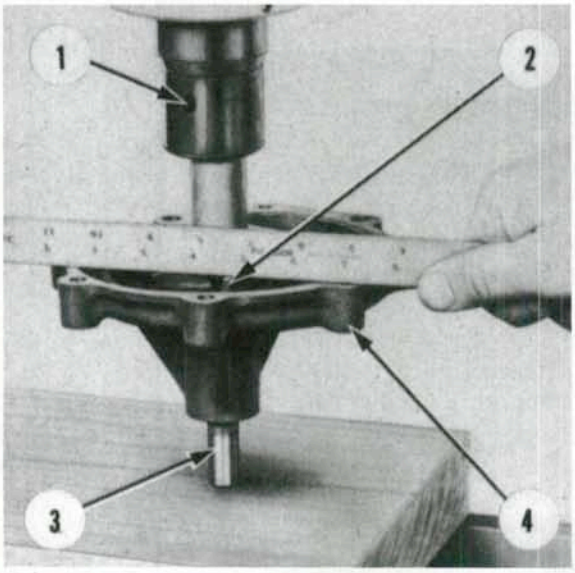


Fig. 142—Support impeller shaft (3) and press impeller onto shaft so impeller vanes (2) are flush with rear face of housing (4).

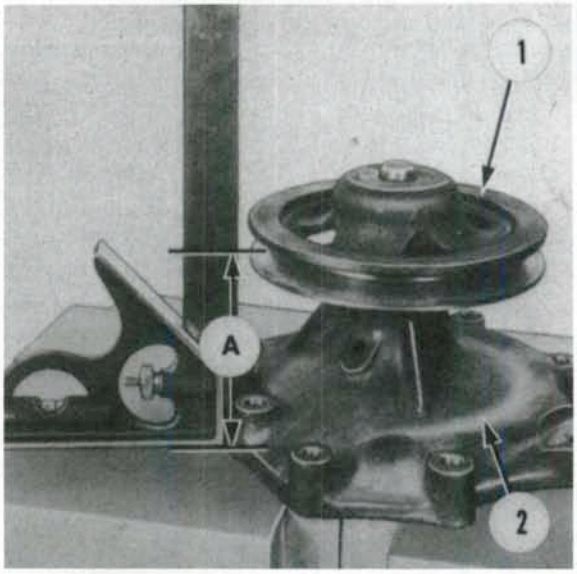


Fig. 143—Press pulley (1) onto pump shaft until distance (A) from center of pulley V-groove to rear face of housing (2) is 3-3/8 inches (86 mm).

ELECTRICAL SYSTEM

95. The electrical system consists of five basic systems which are: a 12-volt, negative ground battery, alternator with externally mounted regulator, starting motor, wiring and accessories. Electrical circuits are protected by fuses, circuit breaker and a fuse link. The fuses are located in a fuse block mounted on a bracket beneath the instrument console. The fuse link is connected to starter solenoid switch and is identified by the words "FUSE LINK" molded on the terminal insulator. The fuse link is designed to melt in case of severe electrical system overload. The fuse link should never be replaced by a standard wire.

When servicing the electrical system, the following precautions must be observed to avoid damage to charging circuit components.

a. When installing battery or connecting a booster battery, the negative post must be grounded.
b. Always disconnect battery ground cable before removing or installing any electrical components.
c. Do not connect or disconnect any charging circuit wiring when engine is running.
d. Never short across any terminal of alternator or regulator unless specifically recommended.

ALTERNATOR AND REGULATOR

All Models

96. TESTING. Prior to beginning test, be sure battery is fully charged, all connections are clean and tight and drive belt is properly adjusted.

NOTE: Do not disconnect any wires from alternator while engine is running as damage to alternator may result.

The following tests can be performed without removing any of the charging system components from the tractor.

97. BATTERY VOLTAGE TEST. With key switch OFF, connect the negative lead of a voltmeter to GROUND terminal (4—Fig. 145) of alternator and positive lead to OUTPUT terminal (3). Battery voltage should be registered. If no voltage is registered, check for an open circuit in wiring.

98. EXCITATION VOLTAGE TEST. With key switch OFF, connect voltmeter negative lead to GROUND terminal (4—Fig. 145) and positive lead to REGULATOR terminal (1). Turn key switch ON, but do not start the engine. Voltmeter should register about 1.5 volts.

If voltage is less than 1.5 volts, high resistance or an open circuit is indicated in connections between key switch and alternator, or voltage regulator is faulty.

If voltage exceeds 1.5 volts, a fault is indicated in voltage regulator or rotor (field) winding.

99. FIELD (ROTOR) CIRCUIT TEST. With key switch OFF, disconnect wire from alternator FIELD terminal (2—Fig. 145). Connect an ammeter in series between alternator OUTPUT terminal and FIELD ter-

minal. Current draw should be 2-2.5 amperes at battery voltage. If normal current draw cannot be obtained, field winding is grounded or shorted.

100. VOLTAGE REGULATOR VOLTAGE TEST. With key switch off, connect voltmeter negative lead to GROUND and positive lead to alternator OUTPUT terminal (3—Fig. 145). Start engine and run for a few minutes to stabilize temperature of alternator. The voltmeter reading should be 13.9-14.7 volts, depending on regulator ambient temperature.

If voltage exceeds specifications, check for a faulty connection at GROUND terminal of alternator. If GROUND connection is not faulty, renew the regulator. The regulator is mounted on the inside of right step bracket.

If voltage is lower than specifications, shut off engine and disconnect wire from FIELD terminal (2). Connect a jumper wire from FIELD terminal to REGULATOR terminal (1), then start engine and check output voltage at low rpm. If voltage is now above 13.9 volts, renew the regulator. If voltage is still low, the alternator is faulty.

101. ALTERNATOR OUTPUT TEST. With key switch OFF, connect voltmeter leads to alternator GROUND terminal and OUTPUT terminal as shown in Fig. 146. Connect ammeter positive lead to alternator OUTPUT terminal and negative lead to battery POSITIVE terminal. Connect a carbon pile across battery terminals.

Start the engine and operate at 1600 rpm. Load the battery with the carbon pile to obtain maximum output of the alternator. The ammeter should register a minimum of 67 amperes and voltmeter reading should be 13-15 volts. If specified output cannot be obtained, remove and overhaul alternator as outlined in paragraph 102.

102. DISASSEMBLY. Prior to disassembly, scribe match marks on alternator front and rear housings and stator frame to aid alignment when reassembling.

Remove retaining screws from brush cover (10—Fig. 148), disconnect field terminal wire from brush assembly. Remove retaining screws from brush holder and withdraw brush assembly (12) from alternator.

Remove the through-bolts (21), then pry front housing (5) with rotor (8) from stator frame (9). Remove nuts from rectifier diode studs then separate stator and rectifier diodes (16 and 17) from rear housing (19).

Remove retaining nut (1), pulley (2), fan (3) and Woodruff key and spacer (4) from rotor shaft. Disengage front bearing retaining ring (7) from its groove, then separate rotor (8) from front housing (5).

NOTE: When unsoldering or soldering stator leads to diodes, place needlenose pliers between diode and solder point as shown in Fig. 149 to act as a heat sink. Use a lightweight soldering iron to avoid applying excess heat to the diodes.

103. BRUSHES AND SPRINGS. The brushes should work freely in brush holder and be free of

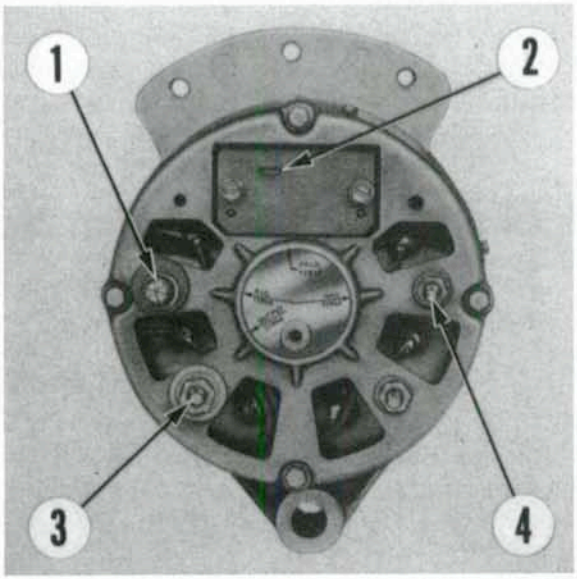


Fig. 145—Rear view of alternator showing location of terminals.

1. Regulator terminal
2. Field terminal
3. Output terminal
4. Ground terminal

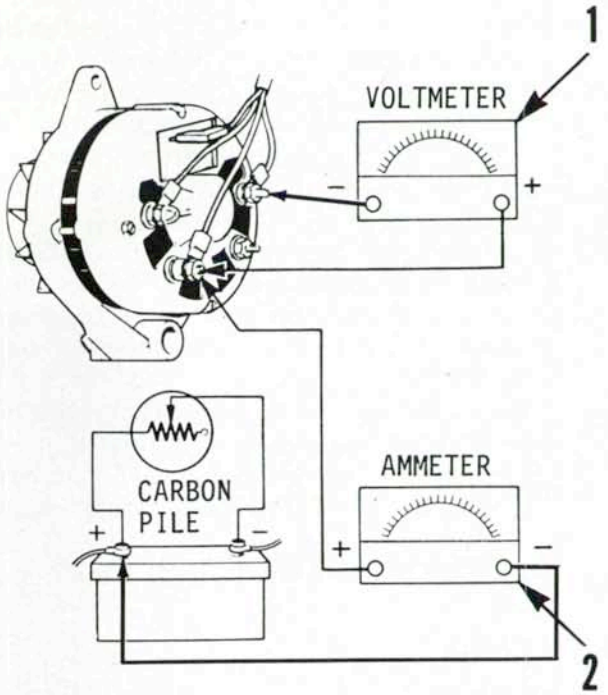


Fig. 146—To check alternator output, connect a voltmeter and ammeter as shown and use a carbon pile to load the battery. Refer to text.

grease or oil. Renew brushes if length is less than 5/16 inch (7.6 mm). Brush spring pressure should be minimum of 4 ounces (1.1 N) when end of brush is flush with end of holder. Use a battery powered test lamp or ohmmeter to check insulation and continuity of brushes and holder. There should not be continuity between the field terminal (4—Fig. 150) and brush holder frame (1). There should be continuity between field terminal and the insulated brush (3) and between holder frame and grounded brush (2).

104. STATOR WINDING. Renew stator if windings are discolored due to a short circuit and overheating. There should be continuity between the stator leads. There should not be continuity between stator leads and the stator frame.

105. RECTIFIER DIODES. The diodes act as one-way gates allowing electrical current to pass through in one direction only. The diodes may be checked us-

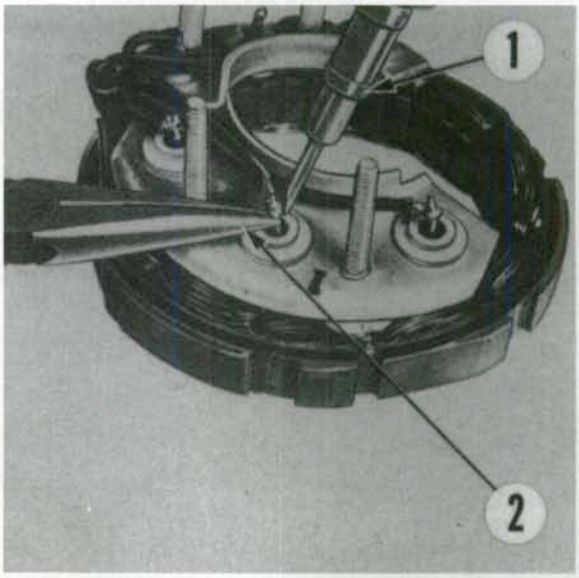
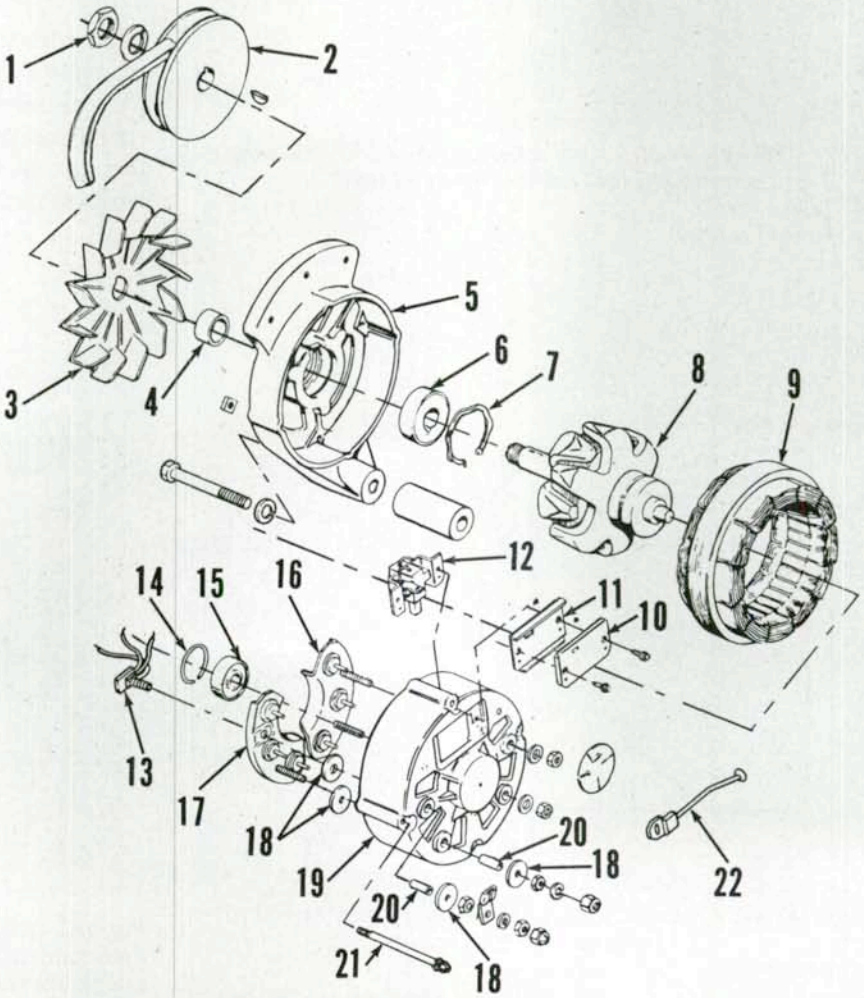


Fig. 149—When soldering stator leads to diodes, use needlenose pliers (2) as a heat sink to protect diodes from heat damage.



1. Nut
2. Pulley
3. Fan
4. Spacer
5. Front housing
6. Bearing
7. Retaining ring
8. Rotor
9. Stator
10. Brush cover
11. Gasket
12. Brush holder
13. Field diode
14. Retainer ring
15. Bearing
16. Negative diode assy.
17. Positive diode assy.
18. Insulating washers
19. Rear housing
20. Insulating sleeves
21. Through-bolt
22. Capacitor

Fig. 148—Exploded view of Motorola alternator used on all models.

ing an ohmmeter or a 12-volt battery and test light as shown in Fig. 151. Touch one test lead to diode connector pin (4) and the other lead to the heat sink (3), then reverse the test lead connections. The test light should come on during one half of the test only. If light does not come on or if it comes on with test leads in both positions, the diode is faulty. All diodes in the heat sink must test alike. Renew rectifier if any diode is defective.

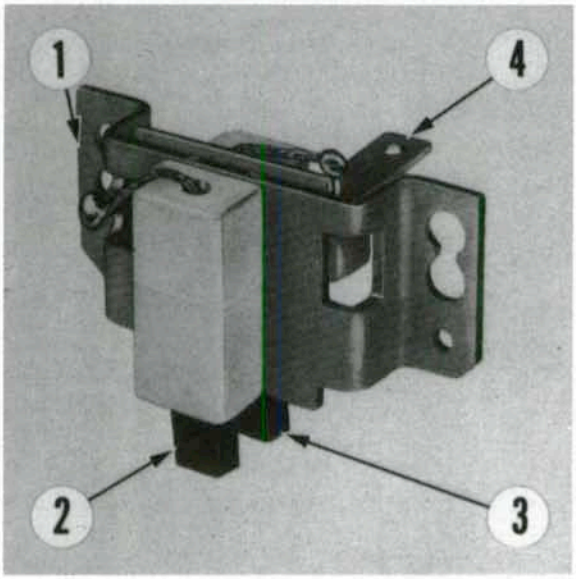


Fig. 150—View of brush holder assembly showing continuity test points. Refer to text.

1. Holder frame
2. Grounded brush
3. Insulated brush
4. Field terminal

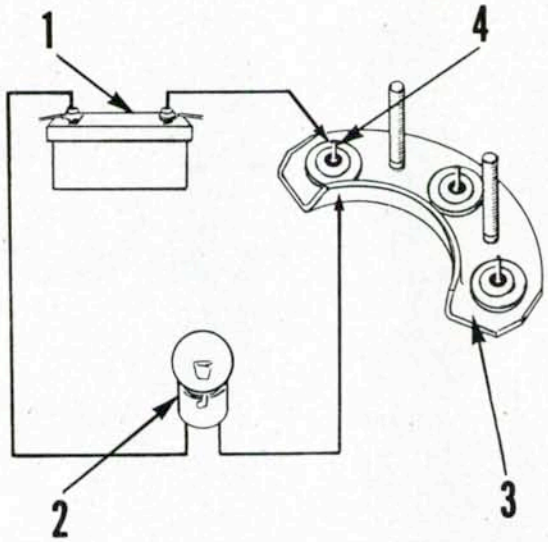


Fig. 151—A 12-volt battery and test light can be used to test rectifier diodes.

1. Battery
2. Test light
3. Heat sink
4. Diode connecting pin

106. ROTOR WINDING. Check rotor winding continuity and resistance simultaneously by connecting ohmmeter test leads to the two slip rings. Resistance should be 5-7 ohms. If there is no continuity or if resistance is not within specified range, renew the rotor. Check rotor winding insulation by connecting ohmmeter or 12-volt test light between each slip ring and rotor shaft. If there is continuity, slip ring is grounded and rotor must be renewed.

107. REASSEMBLY. To reassemble alternator, reverse the disassembly procedure while noting the following special instructions. Use some type of heat sink (such as needlenose pliers) on diode connector pins when soldering stator leads to diodes to protect diodes from heat damage. Use only resin core solder. Be sure insulating washers (18—Fig. 148) and sleeves (20) are installed on studs of positive rectifying diode assembly (17). Align scribe marks on front and rear housings when joining the housings.

STARTING MOTOR

All Models

108. TESTING. To check starting motor current draw with starter installed on engine, disconnect battery positive cable from starting motor solenoid. Connect ammeter positive lead to battery positive terminal and ammeter negative lead to solenoid battery terminal as shown in Fig. 153. Connect voltmeter test leads to battery terminals. With engine stop control

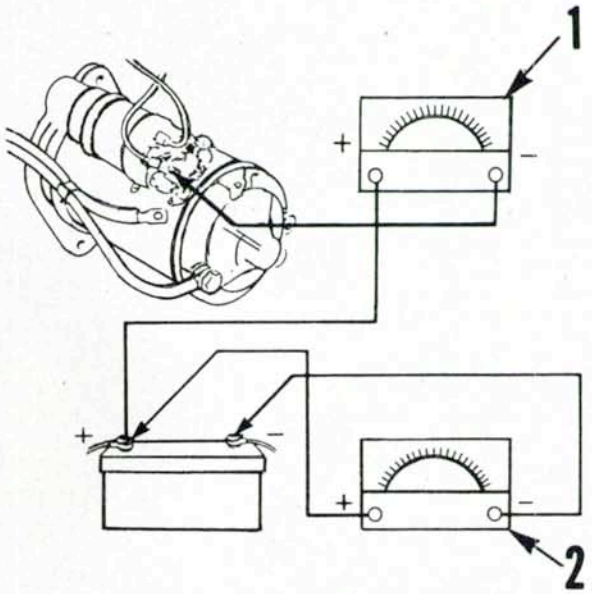


Fig. 153—Disconnect battery positive cable from solenoid and connect ammeter (1) and voltmeter (2) as shown to check current draw with starting motor installed on tractor.

pulled out, crank engine and note ammeter and voltmeter readings. Current draw should be 250-300 amperes at 12 volts.

To check starting motor no-load current draw with starter removed from engine, proceed as follows: Secure starting motor in a vise and connect ammeter and voltmeter leads to starting motor and a fully charged battery as shown in Fig. 154. Connect a variable load resistor (3) to battery terminals. Connect a jumper lead (5) between battery and switch terminals on starter solenoid. Adjust variable load resistor to obtain 12 volts and hold a tachometer (4) on end of armature shaft to measure rpm. Armature speed should be 5500-8000 rpm and current draw should not exceed 120 amperes.

109. OVERHAUL. To disassemble starting motor, remove two screws attaching brush holder (4—Fig. 155) to end cover (2). Remove through-bolts, then remove end cover and seal (7) from starter housing (8). Remove brush holder from the commutator. Remove solenoid assembly (1). Remove drive lever pivot pin (19), then withdraw drive end housing (26) and drive lever (20). Remove armature (14), center bearing plate (22) and drive assembly (23) from starter housing.

Check armature for short circuits using a "growler" or other suitable testing equipment. Check for continuity between armature core and each segment of commutator. If there is continuity, armature windings are grounded and armature must be renewed.

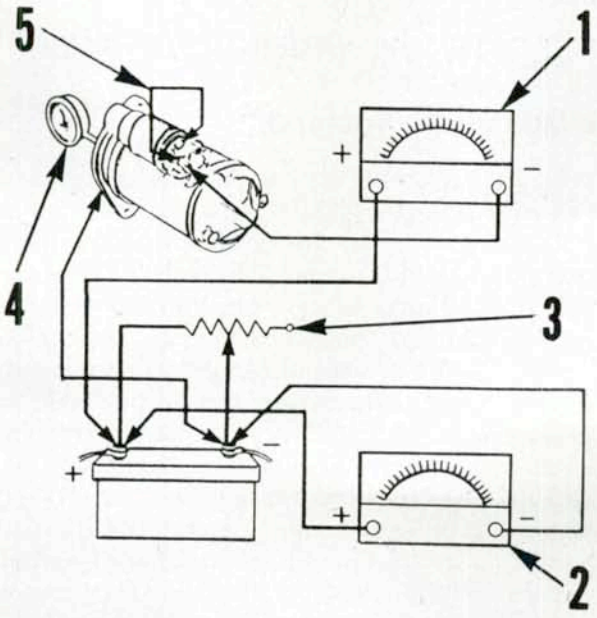


Fig. 154—Connect ammeter (1), voltmeter (2), variable load resistor (3) and jumper lead (5) as shown to check starting motor no-load current draw.

Check field coils for continuity between each of the insulated brushes and the field terminal on starter housing and the eyelet wire. No continuity indicates an open circuit in field coils. There should not be continuity between the field terminal and starter housing.

Inspect remaining components of starting motor for excessive wear or damage and renew as necessary. Refer to the following specifications.

Brush Spring Tension—	
Minimum	42 oz. (11.68 N)
Brush Length—	
Minimum	5/16 in. (8 mm)
Commutator Diameter—	
Minimum	1.5 in. (38 mm)

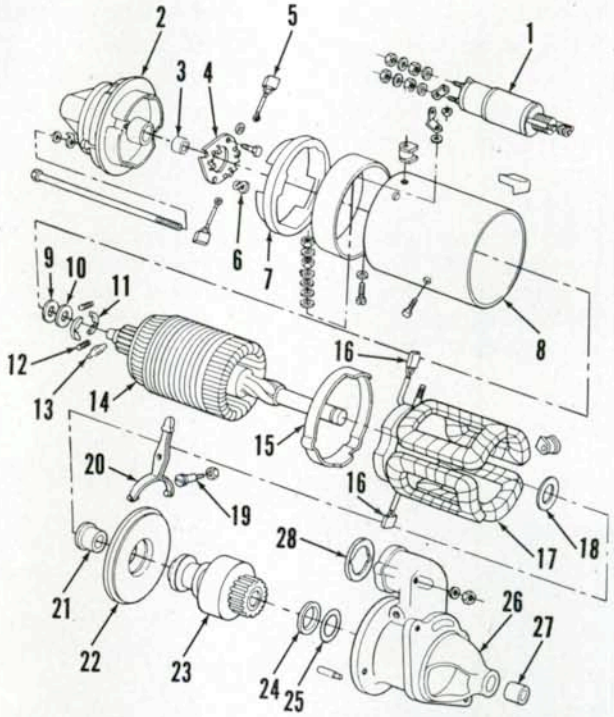


Fig. 155—Exploded view of starting motor assembly.

1. Solenoid
2. Brush end cover
3. Bushing
4. Brush holder
5. Brush
6. Spring
7. Seal
8. Starter housing
9. Fabric washer
10. Metal washer
11. Brake shoes
12. Springs
13. Pin
14. Armature
15. Insulator
16. Insulated brushes
17. Field coil
18. Shim
19. Pivot pin
20. Drive control lever
21. Bushing
22. Center bearing plate
23. Drive assy.
24. Stop collar
25. Retainer
26. Drive end housing
27. Bushing
28. Gasket

Armature Shaft Runout—
Maximum ..... 0.005 in. (0.13 mm)
Armature Shaft End Play—
Maximum ..... 0.025 in. (0.64 mm)
Drive Pinion Clearance
When Engaged ..... 0.015-0.025 in. (0.38-0.64 mm)

To reassemble starting motor, reverse the disassembly procedure while noting the following special instructions: When renewing the self-lubricating bronze bushings, new bushings should be soaked in light engine oil at room temperature for 24 hours prior to installation. Do not ream the bushings after installation as the self-lubricating properties will be damaged. Armature shaft end play is adjusted by installing shims (18—Fig. 155) as required between armature core and center bearing plate.

There should be a clearance of 0.015-0.025 inch (0.38-0.64 mm) between drive pinion and thrust collar when drive pinion is engaged. To check clearance, connect a 6-volt battery to solenoid switch terminal and to ground to engage drive pinion. Measure clearance with a feeler gage as shown in Fig. 156. To adjust clearance, loosen locknut and turn eccentric pivot pin (Fig. 157) as required to obtain proper clearance.

NOTE: The arrowhead marked on pivot pin must be positioned between the arrows marked on drive end housing. If proper pinion clearance cannot be obtained with pivot pin arrow in this position, renew drive control linkage.

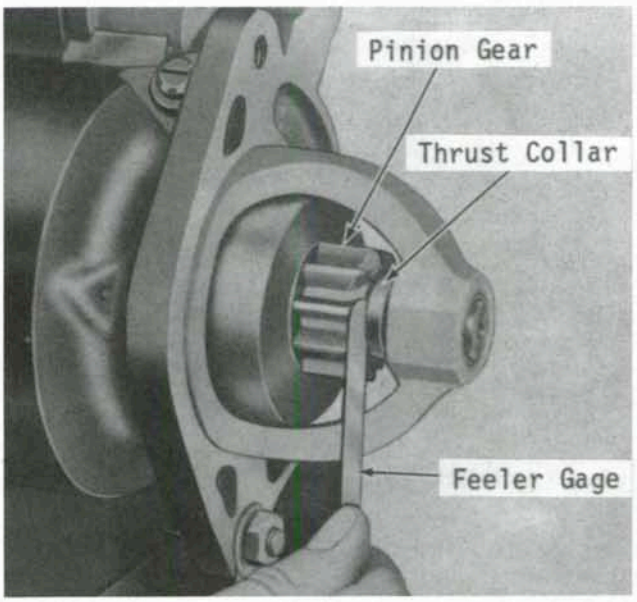


Fig. 156—Measure starting motor drive pinion clearance with pinion engaged as shown.

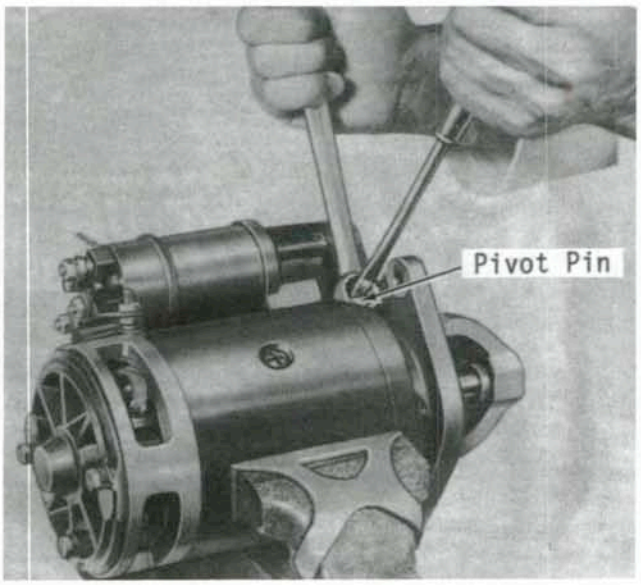


Fig. 157—Turn pivot pin as required to adjust drive pinion clearance.

SAFETY START SWITCH

All Models

110. The safety start switch is mounted on top of the clutch pedal support bracket. The switch prevents the starting motor from being energized until the clutch pedal is fully depressed.

To adjust safety start switch, loosen the switch mounting bracket bolts (3—Fig. 158). Fully depress the clutch pedal and adjust position of switch bracket so switch actuating ball (5) is completely depressed. Tighten bracket adjusting bolts and check for proper operation.

ELECTRONIC INSTRUMENT PANEL

All Models So Equipped

111. The electronic instrument panel contains 18 indicator lights, 4 bargraph style instrument displays and a selective digital readout display. The instrument panel monitors information received from a series of sending units to give warning of system malfunction or provide operating information.

Engine coolant temperature, engine oil pressure, transmission oil temperature and oil pressure and transmission parking brake engagement are considered to be critical tractor functions. If a malfunction occurs in one of these systems or if tractor is driven with parking brake not fully released, the appropriate warning lamp will light and an intermittent audio alarm will sound until malfunction is corrected. Also, if either the engine coolant temperature is too high or engine oil pressure is too low, the word "STOP" will flash on the digital display.

Battery condition, fuel level and air filter restriction are considered noncritical tractor functions. If a malfunction occurs in one of these systems, the warning lamp will light and the audio alarm will sound for five seconds only.

The following messages can appear on the digital display indicating a malfunction exists in a warning circuit. An "OPEN" message will appear and the function segment affected will flash to indicate that there is an open circuit to that particular function sender. A "SH:CR" message will appear and the function segment affected will flash to indicate that there is a short circuit to that particular function sender.

The "OPEN" or "SH:CR" messages will only occur for open or short circuits in the following functions: engine oil pressure, fuel level, engine rpm and tractor ground speed. However, a "PTO OPEN" or "FUEL SH:CR" message will occur if instrument panel is not correctly set to make the monitoring system compatible with the tractor. Refer to paragraph 112 for calibration instructions.

A "FAIL" message will appear on the digital display in the event of an electronic failure within the instrument panel module. The instrument panel module is serviced only as a complete unit.

112. INSTRUMENT PANEL. The electronic instrument panel is connected to main wiring harness by four 12-pin connectors (Fig. 160). The four connectors have different guide peg configurations to prevent incorrect installation. When checking for malfunctions in sender circuits, the appropriate connector and test pins must be correctly identified. Reference to test points in testing procedures are made first to the connector (A, B, C or D) and then the pin number (1 through 12).

If instrument panel is inoperative, first check for a blown fuse in position 4 of fusebox. Remove instrument panel and disconnect panel connector "A." Turn key switch on and check for approximately 12 volts between connector terminals A1 and A6. If no voltage is measured, check for fault in wiring. If 12 volts is measured, renew instrument panel module.

When installing a new instrument panel module, it will be necessary to set the program selector switches (Fig. 161) to make the monitoring system

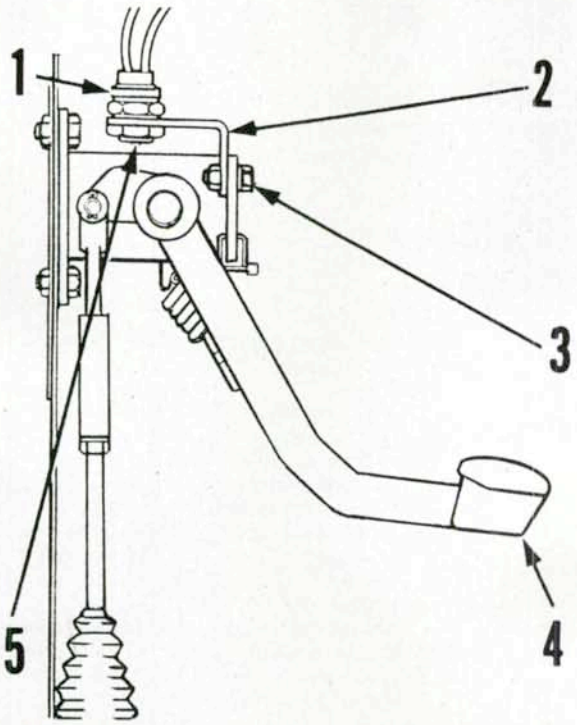


Fig. 158—Safety start switch is mounted on top of clutch pedal support bracket.

1. Safety start switch
2. Switch bracket
3. Adjusting bolt
4. Clutch pedal
5. Actuating ball

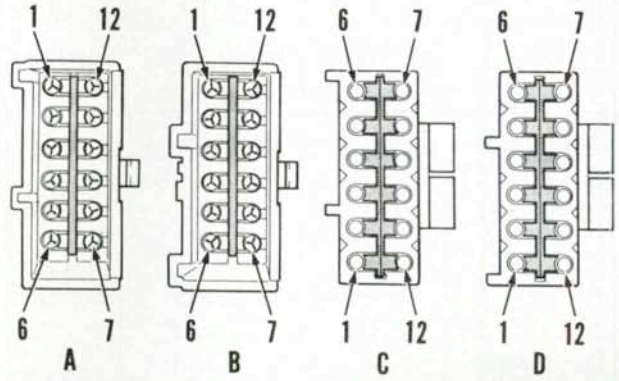


Fig. 160—Electronic instrument panel wiring connectors can be identified by their guide peg configuration. Reference to test points are made first to the connector letter, then the pin number (example: A12).

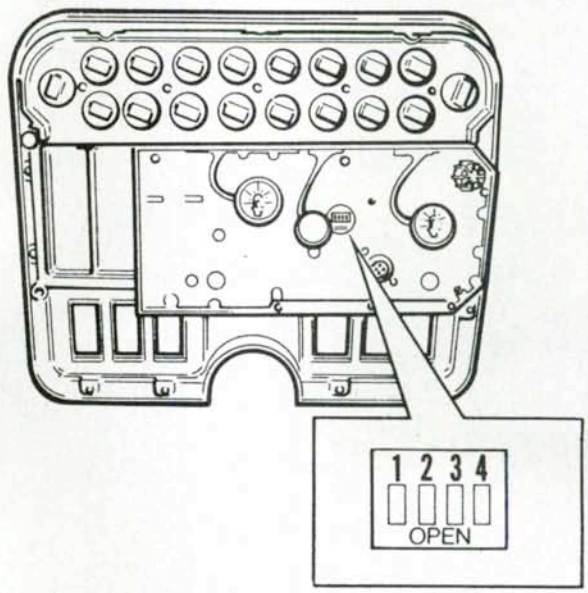


Fig. 161—When renewing electronic instrument panel, the program selector switches must be set to match the tractor build. Refer to Fig. 162.

compatible with the tractor build. The four switches are located in back of instrument panel behind a rubber grommet. Switches 1 and 2 determine readout of pto speed (540 and 1000 or 1000 only) relative to engine speed. Switch 3 programs the module to accept input from one or two fuel level senders, depending if auxiliary fuel tank is fitted. Switch 4 changes the digital display unit between imperial and metric. Refer to chart in Fig. 162 and position as required to suit specific tractor model and options.

If it is necessary to clean wiring connectors in the monitor system, use only a contact spray to clean the terminals. After cleaning apply a dielectric grease to terminal pins prior to reassembly. Contact spray cleaner and dielectric grease are available at electronic supply stores.

113. GROUND SPEED SENDER. The ground speed sender (B—Fig. 163) is located in left side of transmission housing. The ground speed circuit in the instrument panel is calibrated at the factory to match the rolling radius of tractor rear tires. If different size tires, weights or other equipment are installed that will alter tire rolling radius by more than ½ inch (13 mm), the module can be recalibrated to display accurate speed as follows:

Measure the distance from center of rear wheel hub to the ground, which is the rolling radius. Refer to chart in Fig. 165 and note calibration number that corresponds with measured rolling radius. Turn the key switch on and depress ground speed selector switch until calibration number that module is set to is displayed. If the number is the same as number de-

Tractor Model and Options	Switch Number			
	1	2	3	4
TW-5, TW-15, TW-25	Open	Open		
TW-35	Closed	Open		
One Fuel Tank			Closed	
Two Fuel Tanks			Open	
Imperial (MPH)				Open
Metric (Km/h)				Closed

Fig. 162—Table shows switch positions required to suit specific tractor models and options.

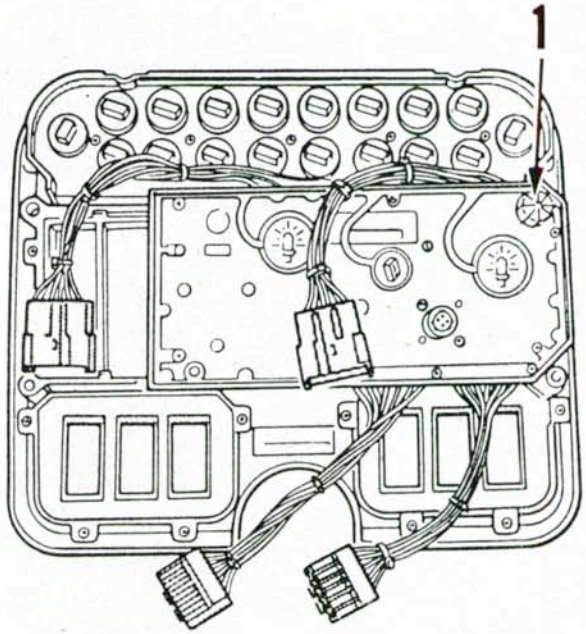
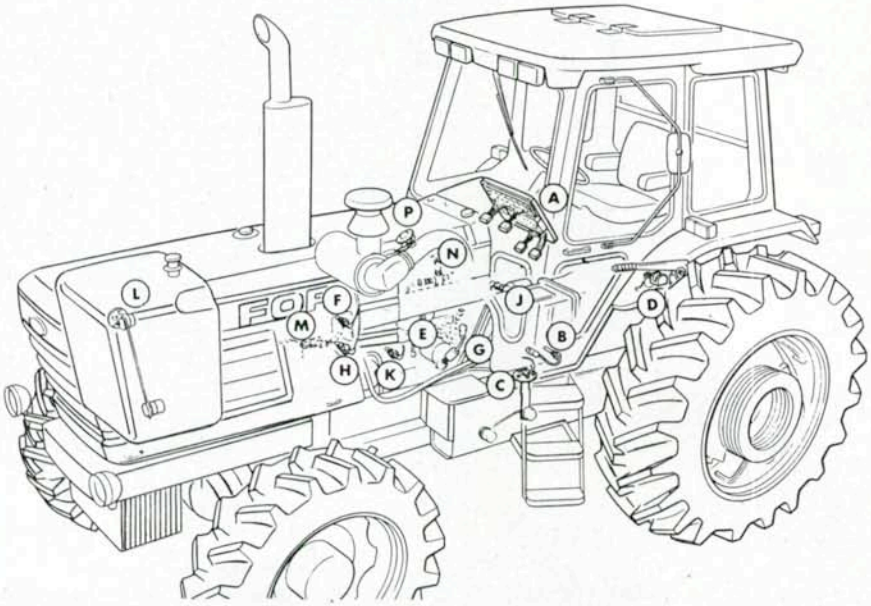


Fig. 164—Ground speed calibration knob (1) is located on rear of instrument panel module. Refer to text for adjustment procedure.



A. Electronic instrument panel
B. Ground speed sensor
C. Auxiliary fuel tank sender
D. Parking brake warning switch
E. Voltage regulator
F. Engine coolant temperature sender
G. Engine oil pressure sender
H. Engine coolant temperature warning switch
J. Transmission oil temperature switch
K. Engine oil pressure warning switch
L. Main fuel tank level sender
M. Engine speed sender
N. Transmission oil pressure switch
P. Air cleaner restriction switch

Fig. 163—Drawing of tractor showing location of tractor monitoring and warning senders and switches when equipped with electronic instrument panel.

termined from the chart, calibration is correct. If calibration number needs to be changed, remove the four retaining screws and lift out instrument panel. Rotate the ground speed calibration knob (1—Fig. 164) on rear of module until desired number is displayed. Reinstall instrument panel and momentarily depress the ground speed selector switch to return unit to normal operation.

To check for a faulty ground speed sender, disconnect wires from the sender. Measure the resistance between the terminals of sender. Renew sender if resistance is not within the range of 1000-3000 ohms. If ground speed does not register and sender is not faulty, disconnect instrument panel harness connector (B—Fig. 160) and check for open or short circuit at connector pin B7.

114. AUXILIARY FUEL TANK SENDER. The sender unit (C—Fig. 163) is located in the top of auxiliary fuel tank on left side of tractor. Movement of float and arm in tank causes a change in resistance in sender which is sensed by the instrument panel. The fuel level is displayed in segments according to the table shown in Fig. 166.

The instrument panel will display open circuit fault (OPEN) if resistance exceeds 900 ohms. The short circuit fault (SH:CR) is displayed if resistance is less than 14 ohms.

To check for faulty sender, disconnect wires from sender and remove sender from fuel tank. Measure the resistance between sender terminals. Resistance should be 30 ohms with float arm in FULL position and 250 ohms with arm in EMPTY position. If sender is not faulty, disconnect instrument panel connector (A—Fig. 160) and check for open or short circuit at connector pin A5.

Rolling Radius (In)	(mm)	Calibration Number
26.5	673	159
27.0	686	162
27.5	699	165
28.0	711	168
28.5	724	171
29.0	737	174
29.5	749	177
30.0	762	180
30.5	775	183
31.0	787	186
31.5	800	189
32.0	813	192
32.5	826	195
33.0	838	198
33.5	851	201
34.0	864	204
34.5	876	207

Fig. 165—Table showing ground speed calibration number that corresponds with rolling radius of rear tires.

115. MAIN FUEL TANK SENDER. The fuel level sender (L—Fig. 163) is located in the top of main fuel tank on TW-5 and TW-15 models and in right side of main fuel tank on TW-25 and TW-35 models. The operation of the sender is the same as auxiliary fuel tank sender described in paragraph 114. Electrical specifications are listed in table shown in Fig. 166.

If tractor is equipped with an auxiliary fuel tank, the instrument panel is programmed so the right four bars on fuel gage graph indicate the amount of fuel remaining in main fuel tank and the left four bars indicate portion of fuel remaining in auxiliary fuel tank.

Main fuel tank sender signal wire is located at wiring harness connector pin A3 (Fig. 160).

116. HAND BRAKE WARNING SWITCH. On models so equipped, the magnetic type warning switch (D—Fig. 163) is located beneath the hand brake control lever. With lever fully lowered (brake released), a steel tab locates within the switch and prevents the magnet from activating the switching element. When the lever is raised to apply brake, the steel tab is withdrawn from the switch which allows magnetic force to close the switching element, actuating the warning light and audible alarm if tractor is driven in excess of ½ mph (0.8 Km/h).

To check for faulty warning switch, use an ohmmeter or battery powered test light to check for continuity between switch signal wire terminal and ground. There should be continuity when hand brake lever is raised to apply brake and there should not be any continuity when lever is fully lowered.

Turn key switch on and ground the switch signal wire, warning light should come on. If light does not come on or if it stays on all the time, disconnect in-

Fuel Level	Sender Resistance	Segments Displayed
– 1/8	over 222 Ohms	1
+ 1/8	195 — 222 Ohms	2
+ 1/4	167 — 194 Ohms	3
+ 3/8	140 — 166 Ohms	4
+ 1/2	113 — 139 Ohms	5
+ 5/8	85 — 112 Ohms	6
+ 3/4	58 — 84 Ohms	7
+ 7/8	31 — 57 Ohms	8

Fig. 166—Table showing fuel level sender resistance values and corresponding segments displayed on instrument panel.

strument panel wiring connector (D—Fig. 160) and check for open or shorted circuit at connector pin D12.

117. ALTERNATOR REGULATOR. The instrument panel senses battery charge condition at the voltage regulator which is located on inside of right-hand step platform. The instrument panel displays charging voltage in segments according to the table shown in Fig. 167. An audible alarm will sound if battery voltage drops below 10.5 volts or rises above 16.5 volts. The charge warning lamp will light if the alternator is not charging.

118. ENGINE COOLANT TEMPERATURE SENDER. The engine coolant temperature sender (F—Fig. 163) is located in the left side of thermostat housing. The resistance of the sender changes according to coolant temperature and the instrument panel display is in segments according to table shown in Fig. 168. Note that "STOP" message will be displayed and audible alarm will sound when eight coolant temperature segments are illuminated.

To check coolant temperature sender, disconnect signal wire from sender and measure resistance between terminal and metal body of sender. Resistance should be between 100 ohms (hot engine) and 2500 ohms (cold engine). If sender is not faulty, disconnect instrument panel wiring connector (A—Fig. 160) and check for open or short circuit at connector pin A2.

119. ENGINE COOLANT TEMPERATURE SWITCH. The coolant temperature warning switch (H—Fig. 163) is located in left side of thermostat housing. The switch is normally open, but closes when engine coolant temperature exceeds 250° F (121° C) and completes electrical circuit to engine coolant temperature warning light.

With key switch on, engine coolant temperature warning light should come on when sender signal wire is grounded to engine or frame. Check for open or short circuit in signal wire at instrument panel wiring harness connector pin D3 (Fig. 160).

Battery Voltage	Segments
less than 10.5V	1
10.5V—11.5V	2
11.5V—12.5V	3
12.5V—13.5V	4
13.5V—14.5V	5
14.5V—15.5V	6
14.5V—16.5V	7
Over 16.5V	8

Fig. 167—Table showing voltage and corresponding instrument panel display segments.

120. ENGINE OIL PRESSURE SENDER. The engine oil pressure sender (G—Fig. 163) is located in left side of engine block. The sender operates on a 5-volt internal power supply from the instrument panel. Changes in oil pressure cause the sender to modulate the supply voltage and the instrument panel displays appropriate number of segments in bargraph as shown in specification table (Fig. 169).

The low oil pressure warning alarm is activated when both oil pressure and engine rpm are within a certain range as shown in Fig. 170. If sender output voltage is not within the operating range shown in Fig. 169, the "STOP" message is displayed, the warning alarm sounds and oil pressure bargraph segments flash.

If instrument panel displays "OPEN" fault in engine oil pressure circuit, disconnect oil pressure sender wiring connector. Short the signal wire pin to ground pin and turn key switch on. Instrument panel should display "SH:CR" message. If not, check for open circuit between signal pin and B2 pin (Fig. 160) of instrument panel. Measure voltage between sender wiring connector power supply pin and

Temperature		Sender Resistance	Segments
(°C)	(°F)	(Ohms)	
Up to 55	Up to 131	over 880	1
55—66	131—151	581—880	2
66—77	151—171	401—581	3
77—88	171—191	281—401	4
88—99	191—211	191—281	5
99—110	211—231	141—191	6
110—121	231—251	101—141	7
over 121	over 251	less than 101	8*

Fig. 168—Table showing electrical specifications of engine coolant temperature sender and corresponding instrument panel display segments.

Engine Oil Pressure (Psi)	Sender Output Voltage	Segments Displayed
0-10	1.18-1.55	1
10-20	1.55-1.91	2
20-30	1.91-2.28	3
30-40	2.28-2.64	4
40-50	2.64-3.01	5
50-60	3.01-3.37	6
60-70	3.37-3.73	7
70-80	3.73-4.10	8

Fig. 169—Table showing specifications for engine oil pressure sender.

ground pin. If voltage reading is between 4.5-5.0 volts, sender is faulty. If there is no voltage, check for open circuit between power pin and A4 pin (Fig. 160) of instrument panel connector.

If instrument panel display indicates "SH:CR" fault in engine oil pressure circuit, disconnect oil pressure sender wiring connector and turn key switch on. The "OPEN" fault should now be displayed on instrument panel. If not, disconnect instrument panel connector A (Fig. 160) and check for short circuit between signal pin and A4 connector. Measure voltage across power supply pin and ground pin in sender connector. If voltage reading is between 4.5-5.0 volts, sender is faulty.

121. ENGINE OIL PRESSURE WARNING SWITCH. The warning switch (K—Fig. 163) is located in the left side of the engine block. The switch opens when engine oil pressure rises above 10 psi (70 kPa). If oil pressure is below 10 psi (70 kPa), the switch closes and engine oil pressure warning light comes on.

Use an ohmmeter or test light to check continuity between terminal of switch and the switch body. With engine not running, there should be continuity. With engine running and oil pressure above 10 psi (70 kPa), there should not be continuity.

If warning light does not come on or if it stays on and sender is not faulty, disconnect instrument panel connector (D—Fig. 160) and check for open or short circuits between sender and D4 connector pin.

122. TRANSMISSION OIL TEMPERATURE WARNING SWITCH. The warning switch (J—Fig. 163) is located in hydraulic pump cover on right side of transmission housing. The switch is normally open, but closes when transmission oil temperature rises above 235° F (113° C) and turns on transmission oil temperature warning light.

There should not be continuity between terminal of switch and switch body when oil temperature is below 235° F (113° C). Ground the sender signal wire and turn key switch on. Instrument panel warning light should come on. If warning light does not come on or if it stays on, check for open or short circuit between sender and C4 connector pin (Fig. 160) in instrument panel wiring connector.

Engine Oil Pressure (Psi)	Engine Speed Rpm	Warning Alarm
Less than 10	500-1500	On
Less than 15	1500-2000	On
Less than 25	2000-2500	On

Fig. 170—Engine low oil pressure warning alarm is dependent on both oil pressure and engine speed.

123. TRANSMISSION OIL PRESSURE WARNING SWITCH. The warning switch (N—Fig. 163) is located in the Dual Power hydraulic line at upper right edge of transmission housing. The switch is normally closed, but opens when transmission oil pressure rises above 153 psi (1055 kPa). When engine is not running or transmission oil pressure is below 127 psi (875 kPa), the transmission oil pressure warning light should be on.

Check for continuity across terminals of switch when engine is not running. There should not be continuity across terminals when transmission oil pressure is greater than 153 psi (1055) kPa). Instrument panel warning light should illuminate when signal pin in switch wiring connector is shorted to the ground pin. If warning light does not come on or if it stays on, check for open or short circuit between switch connector and C5 connector pin (Fig. 160) instrument panel wiring connector.

124. ENGINE SPEED SENDER. The engine speed sender (M—Fig. 163) is located on rear of the fuel injection pump. The mechanical drive from the injection pump rotates a steel rotor within the sender which produces electromagnetic pulses in the sender coil. The instrument panel module converts the electrical pulses to engine rpm on the digital display.

If instrument panel display indicates "OPEN" fault in engine speed circuit, disconnect wiring connector from sender and measure resistance between terminals on sender. Renew sender if resistance is not within the range of 100-300 ohms. Ground the signal wire at sender connector; the instrument panel display should indicate "SH:CR" fault. If not, disconnect instrument panel connector (B—Fig. 160) and check for open circuit between B5 connector pin and sender connector.

If instrument panel display indicates "SH:CR" fault, disconnect wiring connector at sender. The instrument panel display should indicate "OPEN" fault. If not, disconnect wiring harness connector (B) and check for short circuit between B5 connector pin and sender connector.

125. AIR CLEANER RESTRICTION WARNING SWITCH. The switch (P—Fig. 163) is located in the air cleaner tube. The switch is normally open, but closes when vacuum in air intake tube exceeds 30 inches of water and illuminates air cleaner restriction warning light.

Check for continuity across terminals of warning switch. There should not be continuity when engine is not running. Ground the sender signal wire and turn key switch on. The warning light should come on. If light does not come on or if it stays on, disconnect instrument panel connector (C—Fig. 160) and check for open or short circuit between C11 connector pin and switch wiring connector.

CLUTCH

Model TW-5 is equipped with a 13 inch (330 mm) diameter dry single plate clutch assembly. Models TW-15, TW-25 and TW-35 are equipped with a 14-inch (355 mm) diameter dry single plate clutch.

PEDAL FREE TRAVEL ADJUSTMENT

All Models

126. Prior to adjusting clutch pedal free travel, disconnect control rod (9—Fig. 175) from clutch release shaft lever (11). Clutch release shaft free play, measured at center of clevis pin hole in release lever (11), should be within range of 0.9-1.2 inches (22.9-30.5 mm). If free play is not within specified limits, check for incorrect assembly of clutch or for excessively worn clutch components.

Reconnect clutch pedal control rod to release shaft lever, then measure clutch pedal free travel at the pedal pad. If free travel is not within specified range of 1-1/8 to 1-5/8 inches (28.5-41.1 mm), loosen locknut (8—Fig. 174) and adjust turnbuckle (7) to obtain desired free travel.

R&R CLUTCH ASSEMBLY

All Models

130. TRACTOR SPLIT. To split tractor between engine and transmission for clutch removal, proceed as follows: Disconnect battery cables. Remove hood side panels, radiator grille and side panels, hood top panel and cowl side panels. Disconnect power steering lines, hydraulic oil cooler lines at the cooler, air conditioner hoses (if so equipped) at the self-sealing couplers located at rear of cab, and heater hoses and engine coolant filter hoses at the shut-off valves. Remove auxiliary fuel tank (if so equipped) and step assembly from left side of tractor. Remove engine mounted auxiliary hydraulic pump if so equipped. Remove starting motor. Disconnect throttle cable, tachometer cable and fuel shut-off cable at the injection pump. Disconnect front main wiring harness connector at rear of engine. Disconnect drive shaft if equipped with front wheel drive axle.

Insert wooden wedges between front axle and support housing to prevent tipping. Remove weights from front end. Remove right and left frame rails. Support engine and transmission with suitable splitting stands, such as splitting kit tool No. 201387, and

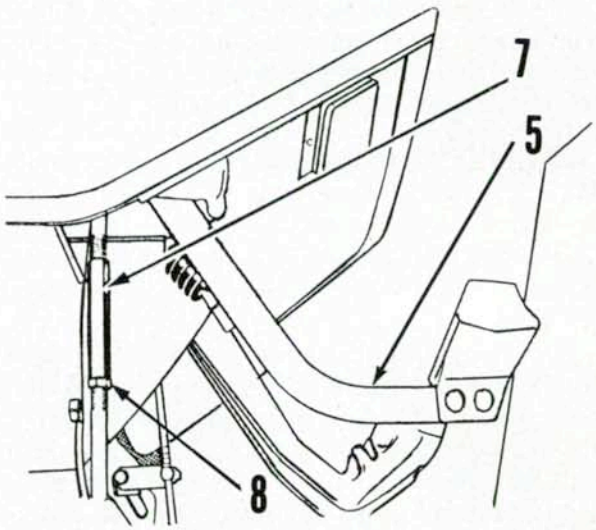


Fig. 174—To adjust clutch pedal (5) free travel, loosen locknut (8) and rotate turnbuckle (7).

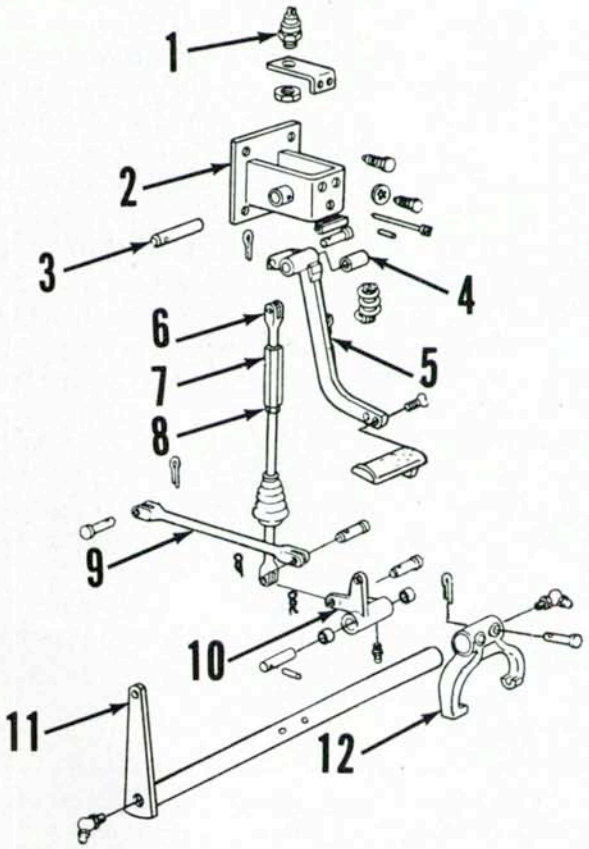


Fig. 175—Exploded view of clutch control linkage.

1. Safety start switch
2. Support bracket
3. Shaft
4. Bushing
5. Clutch pedal
6. Clevis rod
7. Turnbuckle
8. Jam nut
9. Control rod
10. Bellcrank
11. Clutch release shaft
12. Release fork

overhead hoist. Remove cap screws attaching engine to transmission housing, then carefully separate front end and engine from transmission.

To reconnect tractor, reverse the split procedure. Tighten the 5/8 inch engine-to-transmission bolts to 115 ft.-lbs. (155 N·m) and ¾ inch bolts to 200 ft.-lbs. (270 N·m) torque. Tighten side frame mounting cap screws to 200 ft.-lbs. (270 N·m) torque.

131. R&R CLUTCH. With tractor split as outlined in paragraph 130, evenly loosen cap screws retaining clutch cover to flywheel to avoid distortion of cover. Remove clutch assembly from flywheel.

To reinstall clutch assembly, lightly lubricate splines of clutch disc with a high temperature silicone grease. Align clutch disc to pilot bearing using the transmission input shaft.

NOTE: If a new pressure plate is being installed, be sure to clean protective film from friction face of plate using mineral spirits.

Install clutch cover and pressure plate, making certain that cover seats correctly on dowel pins in flywheel (TW-5 models). Tighten retaining cap screws evenly in a diagonal pattern to a torque of 31 ft.-lbs. (42 N·m) on TW-5 models and 23 ft.-lbs. (31 N·m) on all other models.

OVERHAUL CLUTCH

Model TW-5

132. The use of clutch overhaul and adjustment fixture (Nuday tool No. 2142) is recommended when servicing clutch pressure plate and cover assembly. To disassemble clutch, place pressure plate and cover on clutch tool fixture as shown in Fig. 177. Compress clutch springs by tightening the spindle nut (17) until clutch cover (5) contacts fixture base (18). Remove the four thrust plates (9) and release lever adjusting nuts (8).

NOTE: All components of clutch assembly should be marked prior to disassembly so they can be assembled in their original positions if reused.

Loosen spindle nut to relieve clutch spring tension, then lift clutch cover from pressure plate.

Examine clutch disc for evidence of damage from overheating, warpage or excessive wear and renew as necessary. Heat discoloration of clutch disc pads is normal. Thickness of clutch disc when new is 0.405 inch (10.29 mm). If there is evidence of oil on clutch disc, repair source of oil leak before installing a new disc.

Check face of pressure plate for cracks, scoring or distortion and renew if necessary. Note that friction surface of a new pressure plate has a protective film which must be removed using mineral spirits prior to installation.

Check clutch springs for discoloration or distortion due to overheating. Renew springs if they fail to meet the following specification: Spring pressure should be 135.5-145.5 pounds (603-647 N) at compressed length of 1.54 inches (39.1 mm).

To reassemble, position pressure plate, springs and cover on clutch fixture tool. Align reference marks made prior to disassembly if parts are being reused. Compress clutch springs so mounting cap screws can

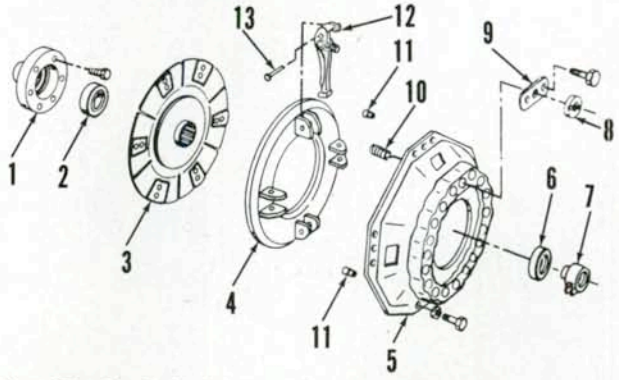


Fig. 176—Exploded view of clutch assembly used on TW-5 tractors.

1. Pto drive plate
2. Pilot bearing
3. Clutch disc
4. Pressure plate
5. Cover
6. Clutch release bearing
7. Release hub
8. Adjusting nut
9. Thrust plate
10. Spring
11. Dowels
12. Release lever
13. Pin

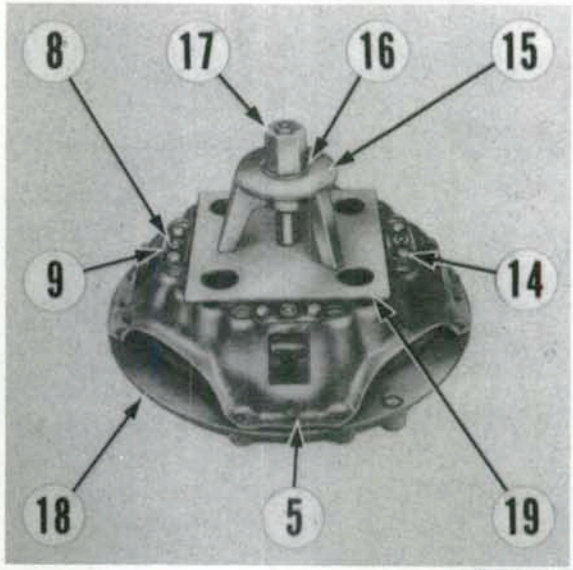


Fig. 177—Clutch fixture tool (Nuday No. 2142) should be used when servicing clutch assembly.

5. Clutch cover
8. Adjusting nut
9. Thrust plate
14. Cap screw
15. Bridge
16. Washer
17. Spindle nut
18. Fixture base
19. Adapter plate

be installed to secure clutch cover to fixture base. Install adjusting nuts (8—Fig. 176) on release lever yokes, then adjust release lever height as follows:

Install spacer, tool No. 1276, (A—Fig. 178) and release lever gage, tool No. 1267, (B) on fixture spindle. Adjust release lever height by turning each adjusting nut (8) until release levers (12) just contact bottom of gage. After lever height is set, stake the adjusting nuts.

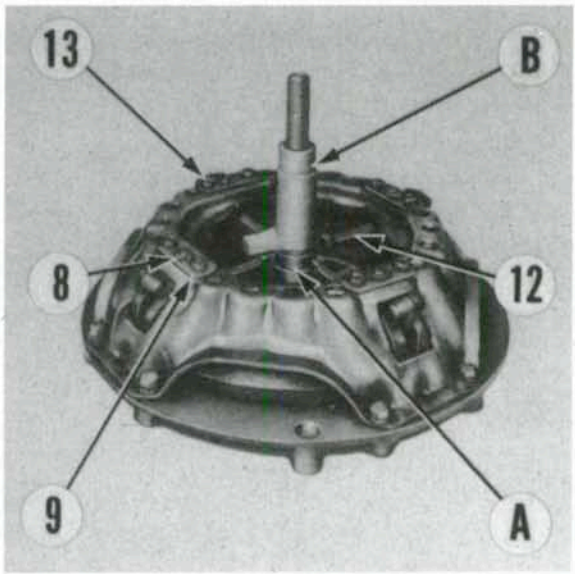


Fig. 178—Use gage spacer (A) and lever gage (B) on clutch fixture tool as shown to adjust release lever height. Refer to text.

A. Spacer (No. 1276)
B. Release lever gage (No. 1267)
8. Adjusting nut
9. Thrust plate
12. Release lever
13. Cap screw

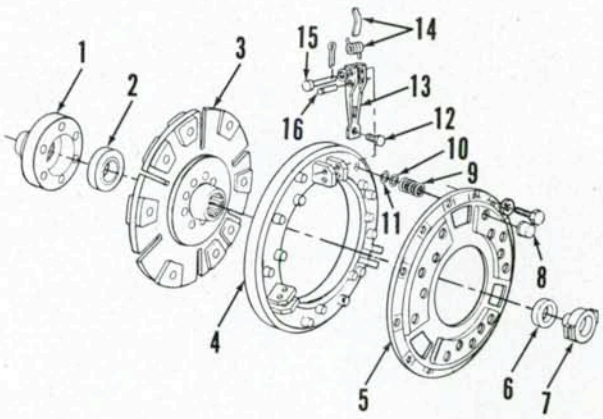


Fig. 180—Exploded view of clutch assembly used on TW-15, TW-25 and TW-35 tractors.

1. Pto drive plate
2. Pilot bearing
3. Clutch disc
4. Pressure plate
5. Cover
6. Clutch release bearing
7. Bearing carrier hub
8. Cup
9. Spring
10. Insulating washer
11. Retainer
12. Adjusting screw
13. Release lever
14. Antirattle spring
15. Clevis pin
16. Pivot pin

NOTE: Release lever height on a new clutch assembly should also be checked and adjusted if necessary.

Install the four thrust plates (9) and tighten retaining cap screws to a torque of 15 ft.-lbs. (20 N·m).

Models TW-15, TW-25 and TW-35

133. The use of clutch overhaul and adjustment fixture (Nuday tool No. 2142) is recommended when servicing clutch pressure plate and cover assembly.

To disassemble clutch, place pressure plate and cover on clutch tool fixture as shown in Fig. 181. Tighten spindle nut (19) to compress clutch springs until release lever clevis pins (15) can be removed.

NOTE: All components of clutch assembly should be marked prior to disassembly so they can be assembled in their original positions if reused.

Loosen spindle nut to relieve clutch spring tension, then lift clutch cover from pressure plate.

Check clutch disc for scoring, distortion or excessive wear. Thickness of new clutch disc is 0.463 inch (11.76 mm). Heat discoloration of clutch disc pads is normal.

Examine face of pressure plate for cracks, scoring or distortion and renew as necessary. Note that friction surface of a new pressure plate is coated with a protective film which must be removed using mineral spirits prior to installation.

Inspect clutch springs for discoloration or distortion due to overheating. The heat insulating asbestos

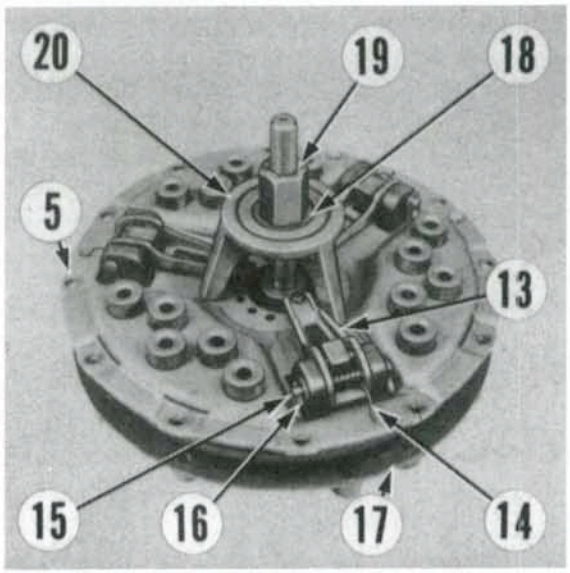


Fig. 181—Clutch fixture tool (No. 2142) is used in disassembly and assembly of clutch.

5. Clutch cover
13. Release lever
14. Spring
15. Clevis pin
16. Washer
17. Fixture base
18. Thrust washer
19. Spindle nut
20. Bridge

washers (10—Fig. 180) should be renewed if damaged or worn. Renew clutch springs if they fail to meet the following specification: Spring pressure should be 200-210 pounds (890-934 N) at compressed length of 1.54 inches (39.1 mm).

To reassemble, position pressure plate, springs and cover on clutch fixture tool. Align reference marks made prior to disassembly if parts are being reused. Tighten the fixture spindle nut to compress clutch springs until clevis pins can be inserted into release levers. Remove clutch assembly from the fixture tool. Mount the adapter ring (tool No. 1194) on the fixture base, then position the clutch in the adapter ring (B—Fig. 182) and secure with the 12 retaining cap screws. Adjust release lever height as follows:

Install spacer, tool No. 1193, (A—Fig. 182) and release lever gage, tool No. SW 510-2, (C) on fixture spindles. Adjust release lever adjusting screws (12) until head of each screw just contacts bottom of gage.

NOTE: Release lever height on a new clutch assembly should be checked and adjusted, if necessary, prior to installation.

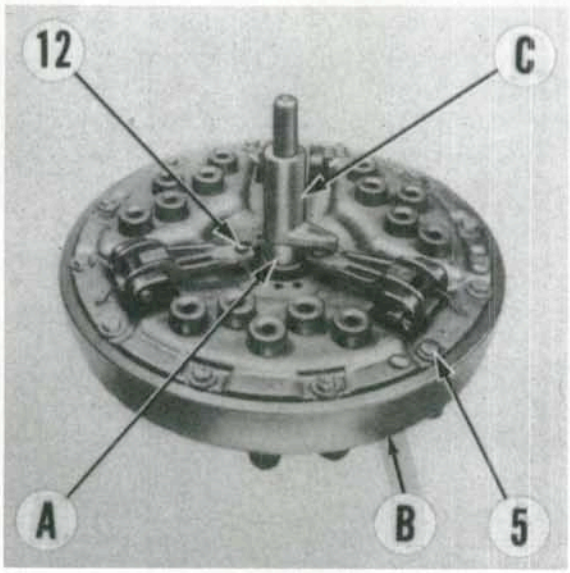


Fig. 182—Use spacer (A), adapter ring (B), lever gage (C) and clutch fixture tool to adjust release lever height. Refer to text.

A. Spacer (No. 1193)
B. Adapter ring (No. 1194)
C. Lever height gage (No. SW510-2)
5. Clutch cover
12. Adjusting screw

CLUTCH PILOT BEARING

All Models

134. The clutch shaft pilot bearing (2—Fig. 176 or 180) is located in the pto drive plate (1) which is mounted on rear of crankshaft. When renewing the pilot bearing, pack the area in front of bearing within the flywheel with high melting point grease. Install bearing into pto drive plate with shield side facing outward. Tighten drive plate retaining cap screws to a torque of 95 ft.-lbs. (129 N·m).

CLUTCH RELEASE BEARING

All Models

135. The clutch release bearing (1—Fig. 183) can be removed after splitting tractor between engine and transmission as outlined in paragraph 130. Remove clevis pins (2) from release fork (4), then withdraw cross shaft (3) and remove bearing and hub.

To reinstall release bearing, reverse the removal procedure. Lubricate bore and lugs of bearing carrier hub with high melting point grease.

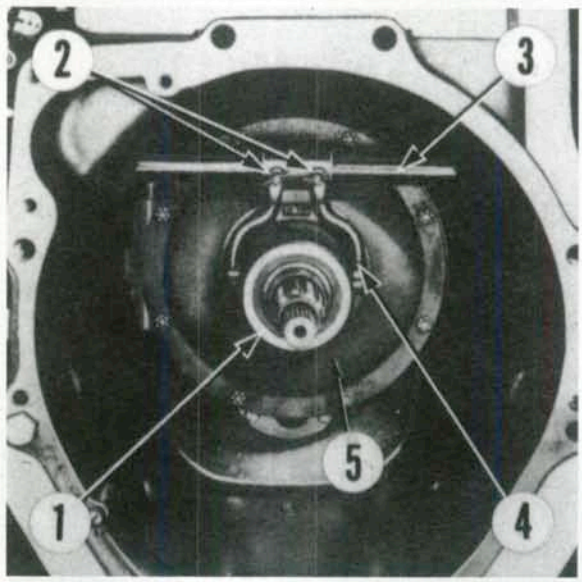


Fig. 183—View of clutch release bearing and hub assembly.

1. Release bearing & hub
2. Clevis pins
3. Cross shaft
4. Release fork
5. Cover

DUAL POWER

The Dual Power unit consists of a planetary gear set and two hydraulically operated clutches enclosed in a housing and mounted in forward compartment of transmission case. Dual Power provides either direct drive or underdrive to transmission input shaft. A hydraulic control valve, located on side of plane-

tary housing, directs oil from the low pressure hydraulic system pump to engage either the direct drive or underdrive clutch.

PRESSURE TESTING

All Models

136. The Dual Power clutches are engaged by hydraulic pressure from the low pressure hydraulic system. This test procedure tests all functions of low pressure hydraulic system. If pressure reading is low in only one step of the test, leakage is indicated in the particular function being checked. If pressure readings are low in all tests, the pressure regulator valve or hydraulic pump is probably faulty.

To check hydraulic system pressure, first operate tractor until oil is at normal operating temperature. Remove plug from pto supply tube fitting and install a 0-300 psi (0-20000 kPa) pressure gage as shown in Fig. 185. Start engine and set speed at 1000 rpm.

Check pressure with Dual Power in underdrive and in direct drive. With Dual Power in direct drive, check pressure with pto engaged and then, with pto and differential lock engaged. On TW-35 tractor only: With Dual Power in direct drive and pto engaged, check pressure with left wheel brake engaged and then, with both brakes applied.

Pressure readings should be 185-220 psi (1275-1517 kPa) in all tests. With Dual Power in direct drive and engine running at 2200 rpm, pressure reading should be 185-235 psi (1275-1620 kPa).

NOTE: If pressure readings are normal but harsh shifting and/or clutch slippage is experienced, check for a plugged filter screen (2—Fig. 187) located inside the pressure line fitting on the Dual Power control valve. A plugged screen will cause low oil flow to Dual Power clutches, but hydraulic pressure will check normal at pto supply tube test port.

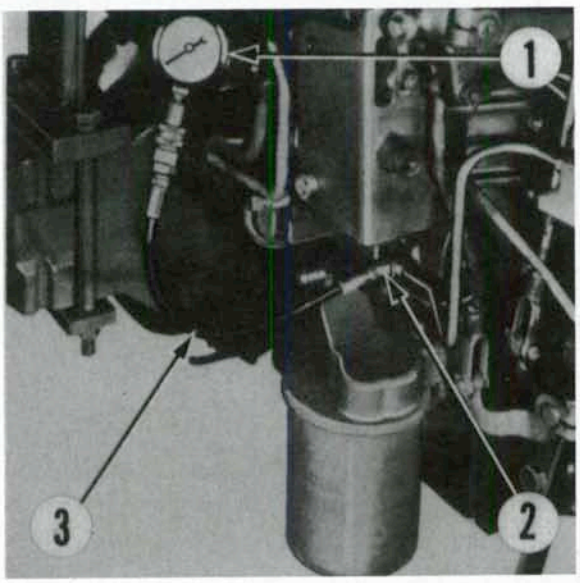


Fig. 185—Connect pressure gage (1) to pto supply tube fitting (2) to check low pressure hydraulic system pressure.

Refer to LOW PRESSURE HYDRAULIC SYSTEM section for service procedures covering pressure regulating valve and hydraulic pump.

CONTROL VALVE

All Models

137. The Dual Power solenoid and control valve assembly can be removed without draining the oil from transmission or separating engine from transmission. Disconnect Dual Power pressure line (5—Fig. 186) and lubricant cooler outlet lines (4). Remove access cover (2) from side of transmission housing. Disconnect wire to Dual Power solenoid and pull the wire inside transmission housing. Unbolt and remove control valve assembly from planetary housing.

To disassemble valve, remove plug (3—Fig. 187) from bottom of valve body. Unscrew solenoid and pilot valve assembly (10) from valve body and remove valve spool (8).

Inspect valve body and spool for scratches or other damage and renew as necessary.

Renew all "O" rings and lubricate valve spool with hydraulic oil when reassembling.

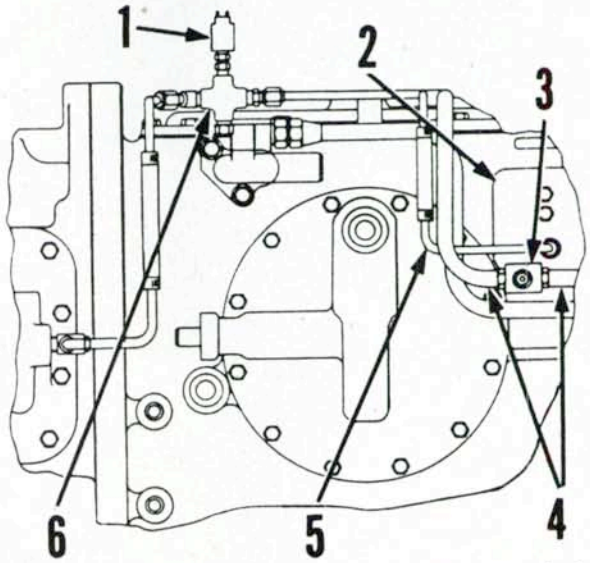


Fig. 186—View of right-hand side of transmission housing.

1. Transmission oil pressure switch
2. Access plate
3. "T" fitting
4. Lubricant cooler outlet lines
5. Dual Power pressure line
6. Connector

When reinstalling control valve, apply a suitable liquid gasket to control valve body and planetary housing mating surfaces. Tighten control valve retaining cap screws to a torque of 32 ft.-lbs. (43 N·m). Do not overtighten pressure tube connector into control valve body. Specified torque is 8 ft.-lbs. (11 N·m). Hold connector with a wrench when tightening pressure tube fitting.

R&R DUAL POWER

All Models

138. To remove Dual Power unit, drain oil from transmission housing and split tractor between engine and transmission as outlined in paragraph 130. Disconnect Dual Power pressure line (5—Fig. 186) and lubricant cooler outlet lines (4). Remove access cover (2) from side of transmission housing. Unbolt and remove solenoid and control valve assembly from planetary housing. Remove clevis pins (2—Fig. 183) from clutch release fork (4). Withdraw cross shaft (3) and remove release fork and clutch release bearing hub (1). Unbolt and remove planetary cover (5). Remove ring gear and shaft assembly (51—Fig. 187), then carefully withdraw planetary carrier (48), sun gear (44), shaft (46) and direct drive clutch assembly as a complete unit from transmission case.

NOTE: The planetary carrier and direct drive clutch assembly may be withdrawn with the ring gear due to planetary shaft (46) being a tight fit in ring gear pilot bearing (49). If so, the planetary shaft can be removed from pilot bearing using a slide hammer puller after ring gear, planetary carrier and direct drive clutch assembly are removed from transmission housing.

Remove thrust washer (31) from housing. Remove cap screws retaining planetary housing (19) in transmission case, then withdraw planetary housing and underdrive clutch assembly from the case.

NOTE: If planetary cover, bearing, ring gear, planetary carrier, sun gear, direct drive clutch or planetary housing is renewed, planetary end play must be adjusted as outlined in paragraph 140 prior to installing planetary components.

To reinstall Dual Power unit, reverse the removal procedure while observing the following special instructions. Tighten planetary housing retaining cap

1. Pressure supply line
2. Inlet screen
3. Plug
4. "O" ring
5. Gasket
6. Control valve body
7. "O" ring
8. Valve spool
9. "O" ring
10. Solenoid pilot valve assy.
11. Foot operated control switch
12. Cap
13. Boot
16. Bearing
17. Seal
18. Seal
19. Planetary housing
20. Piston inner seal
21. Underdrive clutch piston
22. Piston outer seal
23. Dowel
24. Return spring
25. Rear plate
26. Separator plate
27. Clutch discs
28. Pressure plate
29. Retainer ring
30. Snap ring
31. Thrust washer
32. Seal rings
33. Direct drive clutch housing
34. Direct drive clutch piston
35. Outer seal ring
36. Inner seal ring
37. Separator plates
38. Friction plates
39. Pressure plate
40. Snap ring
41. Piston return spring
42. Spring retainer
43. Snap ring
44. Sun gear
45. Seal
46. Planetary shaft
47. Thrust washer
48. Planetary carrier assy.
49. Pilot bearing
50. Oil seal
51. Ring gear & shaft assy.
52. Shim
53. Bearing
54. Oil seal
55. Gasket
56. Cover

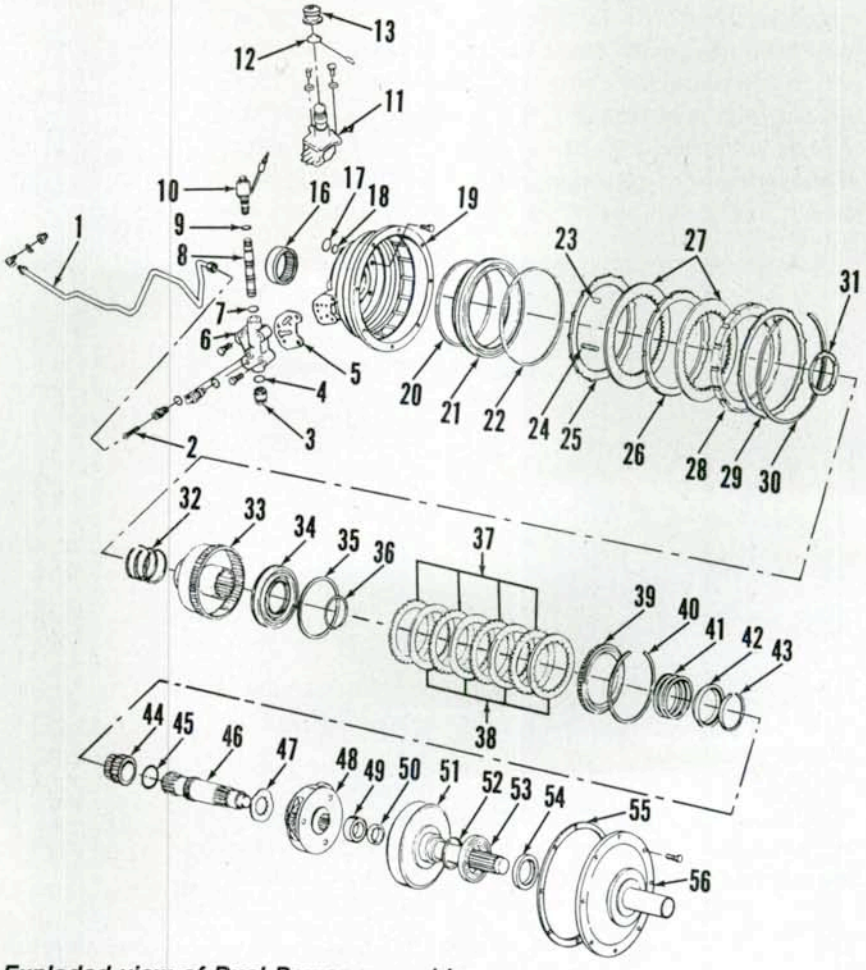


Fig. 187—Exploded view of Dual Power assembly.

screws to a torque of 77 ft.-lbs. (104 N·m). Be sure that thrust washer (31—Fig. 187) is installed with the tab located in notch of planetary housing. Install planetary cover (56) with the word "TOP" upward to ensure drilled lubrication oil passage is correctly located. Note that cover should easily seat against planetary housing. If not, incorrect assembly is indicated. Tighten cover retaining cap screws evenly to a torque of 32 ft.-lbs. (43 N·m). Install control valve using a suitable liquid gasket on mating surfaces and tighten retaining cap screws evenly to a torque of 32 ft.-lbs. (43 N·m).

OVERHAUL DUAL POWER

All Models

139. To overhaul Dual Power unit, remove unit as outlined in paragraph 138, separate major components and proceed as follows:

To disassemble direct drive clutch, compress the piston return spring as shown in Fig. 188 and remove snap ring (43). Release spring tension and remove spring retainer (42) and spring. Remove clutch pressure plate snap ring (40—Fig. 187) and withdraw pressure plate (39) and clutch pack (37 and 38) from clutch housing (33). Remove seal rings (32). Position clutch housing with front face downward on workbench, then apply air pressure to hole between middle and rear seal ring grooves to remove piston (34).

To disassemble underdrive clutch, compress piston return springs using angle iron restraining clamps as shown in Fig. 189, or other suitable means, and remove snap ring (30) from housing (19). Release spring pressure and remove retainer plate (29—Fig. 187), pressure plate (28), friction plates (27), separator plate (26), springs (24), dowels (23) and rear plate (25). Position planetary housing with front face downward, then apply air pressure to pressure supply port in housing to remove piston (21).

To remove shaft (46) from planetary carrier (48), use a suitable puller to remove pilot bearing (49). Withdraw shaft and thrust washer (47) from carrier. Planetary carrier is available as a unit only and should not be disassembled.

Inspect all parts for wear or damage and renew as necessary. Renew all piston seals, direct drive clutch housing seal rings and oil seals.

To reassemble Dual Power unit, reverse the disassembly procedure while observing the following special instructions. Apply petroleum jelly to inner and outer seals on clutch pistons prior to assembly in housings. Be sure that gap of snap ring (30—Fig. 187) retaining underdrive clutch pack is aligned with lubrication port in planetary housing (19). Lubricate direct drive clutch hub seal rings (32) with petroleum jelly and position rings so end gaps are staggered around hub. If any of the major components of Dual Power unit are renewed, the planetary end play must be adjusted as outlined in paragraph 140.

140. PLANETARY END PLAY ADJUSTMENT. To determine correct thickness of shims (52—Fig. 187) required to obtain specified planetary end play of 0.004-0.020 inch (0.10-0.50 mm), proceed as follows:

Assemble planetary carrier (48), thrust washer (47), shaft (46) and sun gear (44) into direct drive clutch housing. Press pilot bearing (49) onto planetary shaft

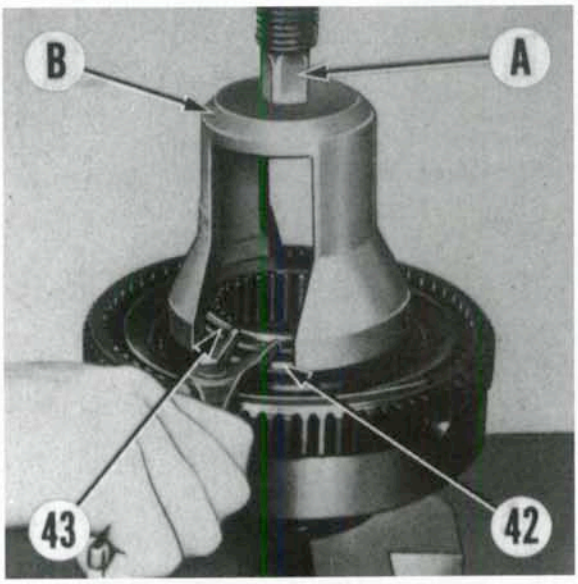


Fig. 188—Use a press and suitable horseshoe shaped tool to compress direct drive clutch piston return spring when removing and installing snap ring.

A. Press ram
B. Compressor tool (No. 1312)
42. Spring retainer
43. Snap ring

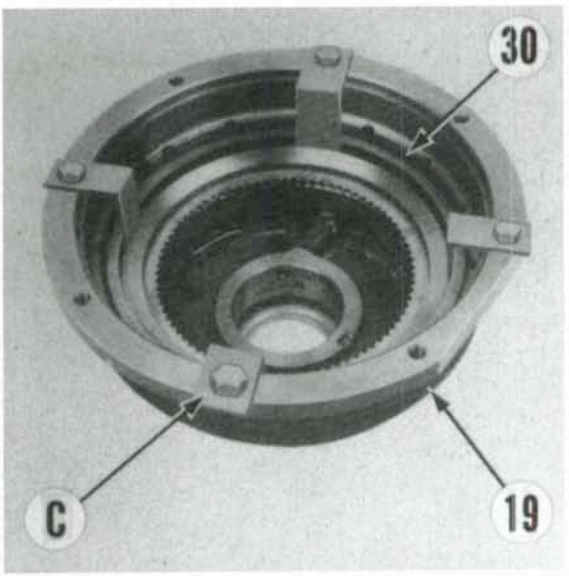


Fig. 189—Restraining clamps (C) can be fabricated from angle iron and installed as shown to compress underdrive clutch return spring when removing and installing snap ring (30) from planetary housing (19).

(46), then install thrust washer (31) and direct drive clutch and planetary assembly into planetary housing (19). Make sure that direct drive clutch and planetary is fully seated in the housing and that rear end of planetary shaft (46) does not contact workbench. Install ring gear and shaft (51) without shim (52) or bearing (53). Place gage tool (Nuday No. 1303) on step of ring gear shaft. Place cover (56) on planetary housing, then use a feeler gage to measure gap between cover and housing at three different locations. If the average of the three measurements is within the range of 0.046-0.060 inch (1.17-1.52 mm), no shims are needed. If gap is less than 0.046 inch (1.17 mm), refer to following table for correct shim size.

Average Gap Measurement	Required Shim Thickness
0.001-0.013 in.	0.045 in.
(0.025-0.33 mm)	(1.14 mm)
0.014-0.026 in.	0.032 in.
(0.35-0.66 mm)	(0.81 mm)
0.027-0.032 in.	0.026 in.
(0.68-0.81 mm)	(0.66 mm)
0.033-0.045 in.	0.013 in.
(0.83-1.14 mm)	(0.33 mm)

Shims are available in thicknesses of 0.013 inch (0.33 mm) and 0.032 inch (0.18 mm).

If tool No. 1303 is not available, assemble Dual Power unit with bearing (53) and original shim (52) on ring gear shaft. Install cover, then measure end play of ring gear shaft. Remove bearing and install shims as required to obtain specified end play of 0.004-0.020 inch (0.10-0.50 mm).

Remove cover, ring gear, planetary carrier, sun gear and direct drive clutch assembly from planetary housing. Dual Power unit may now be installed in transmission case as outlined in paragraph 138.

LOW PRESSURE HYDRAULIC SYSTEM

All models are equipped with a low pressure hydraulic system. A gerotor type pump, rated at 8 U.S. gallons/minute (30.3 liters/minute), supplies low pressure oil to operate pto clutch and brake, differential lock clutch, Dual Power clutches and power assisted brakes (TW-35 tractor). The pump also provides lubricating oil to the drive train components. The pump is mounted on rear end of transmission and is driven by the main pto shaft.

Refer to Fig. 190A for schematic drawing of Models TW-5, TW-15 and TW-25 low pressure hydraulic system. System pressure is regulated by a pressure regulating valve (4), which is mounted on right-hand side of transmission housing just above the shift cover. After requirements of Dual Power (2), differential lock (6) and pto (11) circuits have been satisfied, the pressure regulating valve opens allowing remainder of oil flow to pass to transmission oil cooler (14) and lubrication circuit (9). A relief valve (3) located in the pressure regulating valve housing protects the oil cooler and lubrication system from excess pressure by allowing surplus oil to return to sump.

Refer to Fig. 190B for schematic drawing of Model TW-35 low pressure hydraulic system. Pressurized oil from the pump (7) is first directed to regulating valve (5) and brake priority valve (4). After power brake circuit (1) requirements have been satisfied, brake priority valve opens allowing pressure oil to pass to Dual Power control valve (3), differential lock valve (17) and pto control valve (13). After these components have been actuated, pressure regulating valve opens and allows pressure oil to pass to transmission oil cooler (18) and lubrication circuit (11). A relief valve (6) located in pressure regulator valve housing protects oil cooler and lubrication circuit from excess pressure by allowing surplus oil to return to sump.

141. PRESSURE TESTING. Refer to paragraph 136 for low pressure system pressure testing.

GEROTOR PUMP

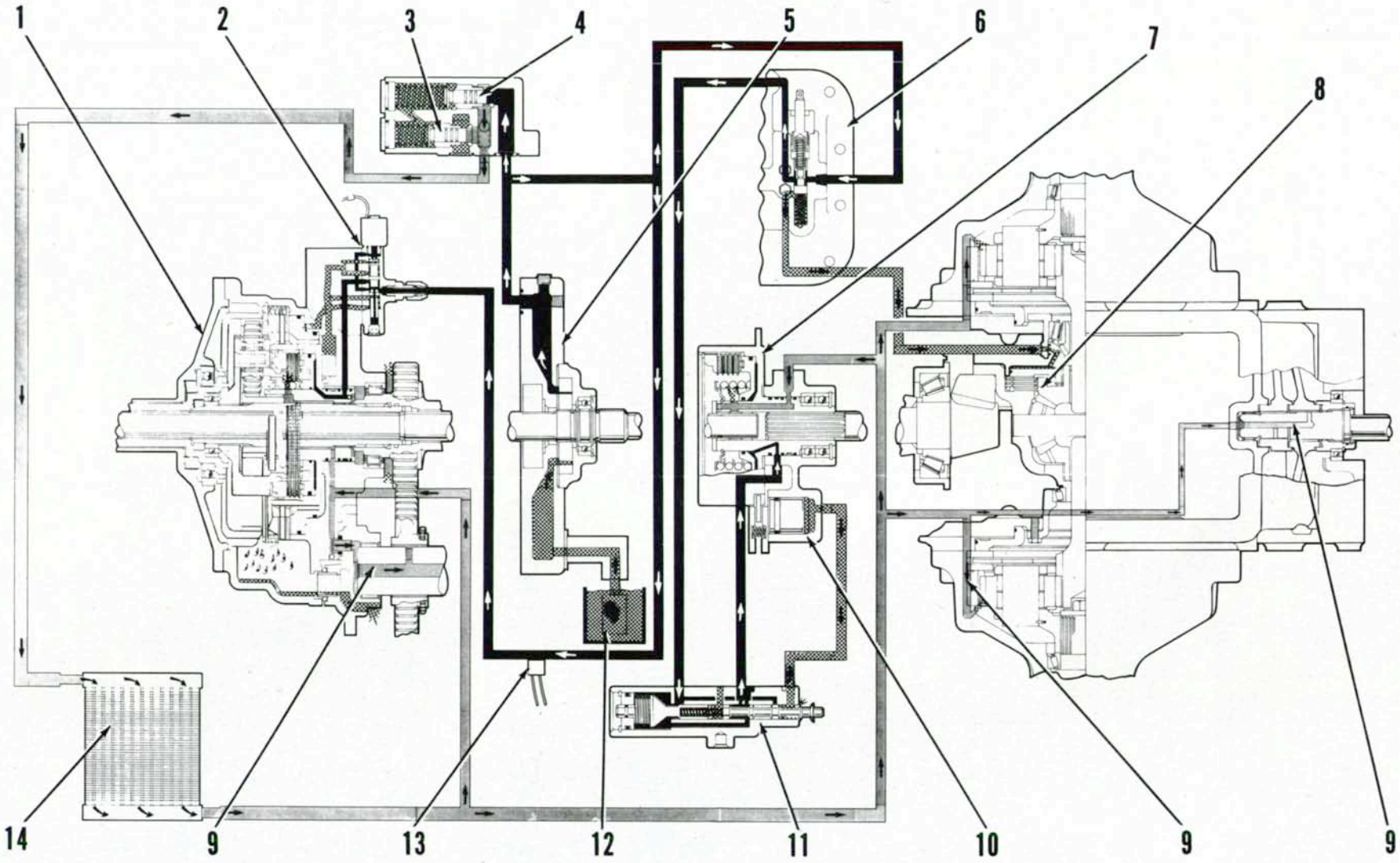
142. The gerotor pump can be removed after splitting tractor between transmission and rear axle center housing as outlined in paragraph 162. Remove retaining cap screws from pump housing, then withdraw pto shaft (2—Fig. 191) and pump (4) as an assembly from rear of transmission housing.

Remove outer snap ring (1) and tap pto shaft and bearing out of pump housing. Remove two screws retaining backing plate to pump housing and separate inner and outer rotor from housing. If pump is worn or damaged, it must be replaced as a complete unit.

PRESSURE REGULATING VALVE

143. R&R AND OVERHAUL. To remove regulating valve (2—Fig. 192), first disconnect oil lines to valve, then remove cap screws retaining valve to transmission housing.

When disassembling valve, tag spools (Fig. 193A or 193B) and springs for later identification, as the spools and springs are not interchangeable. Note that



1. Dual Power assy.
2. Dual Power control valve
3. Oil cooler/lubrication circuit relief valve
4. System pressure regulating valve
5. Gerotor pump
6. Differential lock valve
7. Pto clutch
8. Differential lock
9. Lubrication circuit
10. Pto brake
11. Pto control valve
12. Filter screen
13. Transmission oil pressure switch
14. Oil cooler

System Pressure Oil

Lubrication Pressure Oil

Reservoir, Suction and Exhaust Oil

Fig. 190A—Schematic of Model TW-5, TW-15 and TW-25 low pressure hydraulic system.

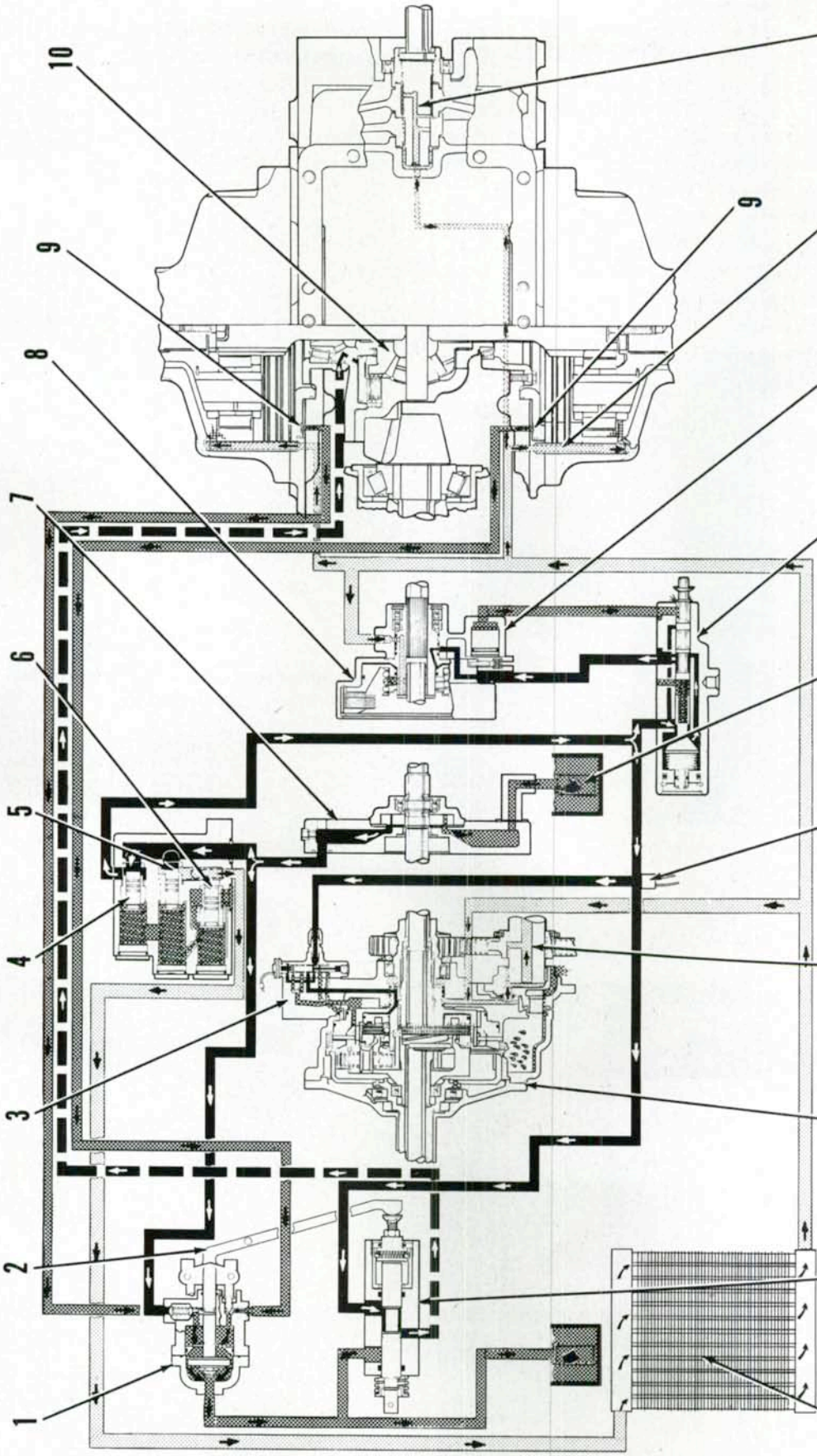


Fig. 190B—Schematic of Model TW-35 low pressure hydraulic system.

system pressure valve spool (6) has an orifice while remaining valve spool(s) does not have an orifice. Be sure wire strainer (if used) and orifice are clean.

Effective with transmission date code 7D15 (TW-5, TW-15 and TW-25) and 7D24 (TW-35) a new style pressure regulating valve was used. The wire strainer was eliminated from system pressure valve spool and a notch (N—Fig. 193A or 193B) was cut in front land of lubrication pressure valve spool (4). The notch allows a small amount of oil to flow behind the valve spool and cushion operation of the spools. When reassembling valve, be sure that notched end of spool is toward the spring. The new style regulating valve can be used on early production tractors, but must be installed as a complete valve assembly.

Inspect valve spools for excessive wear, scoring and binding in their respective bores and renew as necessary. Make sure all orifices and passageways are clean.

Use new "O" rings when installing valve assembly on transmission housing.

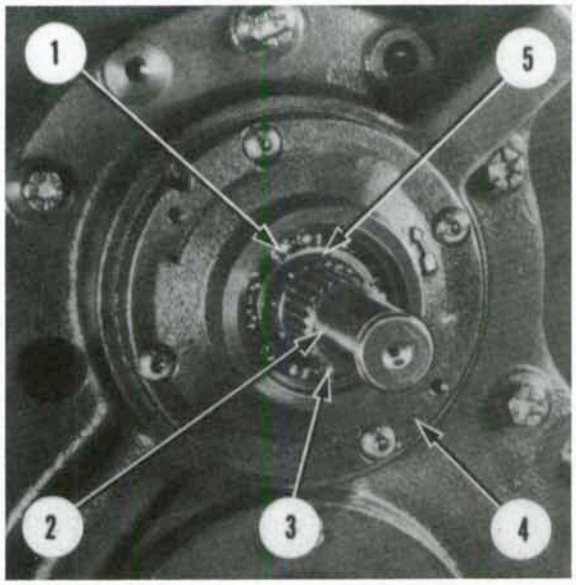


Fig. 191—Low pressure hydraulic pump is mounted on rear of transmission housing.

1. Snap ring
2. Pto shaft
3. Bearing
4. Pump assy.
5. Snap ring

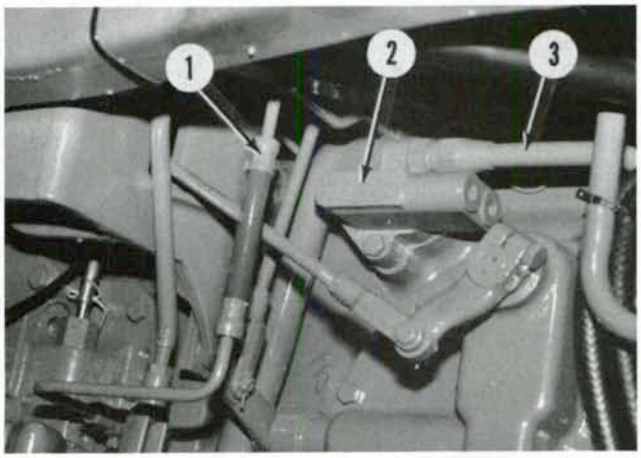


Fig. 192—Low pressure hydraulic system pressure regulating valve is mounted on right side of transmission housing.

1. Pressure inlet line
2. Regulating valve assy.
3. Outlet line to oil cooler

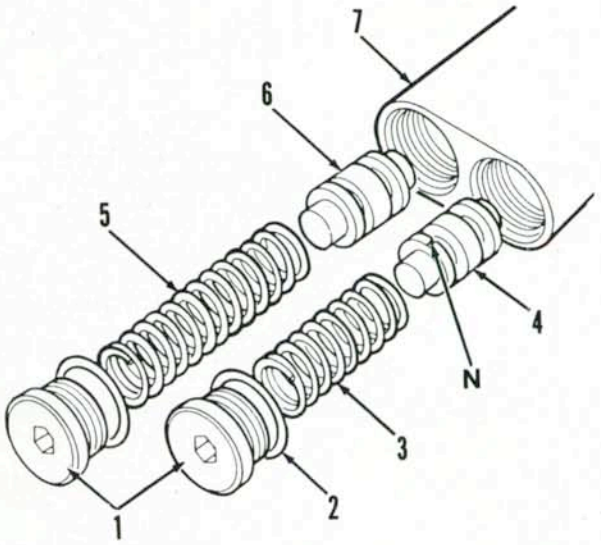


Fig. 193A—Low pressure regulating valve used on TW-5, TW-15 and TW-25 tractors.

1. Plugs
2. "O" ring
3. Spring (13 coils)
4. Lubrication pressure valve spool
5. Spring (19 coils)
6. System pressure valve spool
7. Valve body

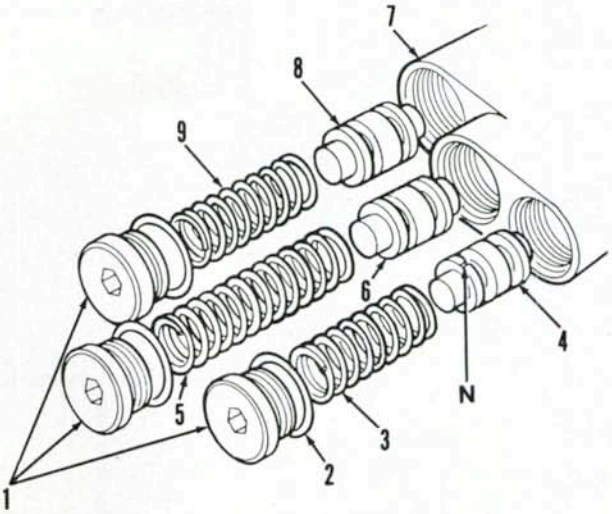


Fig. 193B—Low pressure regulating valve used on TW-35 tractor.

1. Plugs
2. "O" ring
3. Spring (13 coils)
4. Lubrication pressure valve spool
5. Spring (19 coils)
6. System pressure valve spool
7. Valve body
8. Brake priority valve spool
9. Spring (14 coils)

TRANSMISSION

All models are equipped with a constant mesh gear type transmission providing eight forward speeds and two reverse speeds.

LUBRICATION

All Models

145. The transmission is pressure lubricated by the low pressure hydraulic system. A gerotor pump, which is mounted on rear of transmission and driven by pto mainshaft, supplies oil to low pressure system. Refer to LOW PRESSURE HYDRAULIC SYSTEM section for service procedures covering gerotor pump and pressure regulating valve.

Lubricant capacity for transmission and rear axle is as follows: 18.25 gallons (69.1 liters) on all models without Dual Power; 19.75 gallons (74.8 liters) on TW-5, TW-15 and TW-25 tractors with Dual Power; 23 gallons (87 liters) on all TW-35 tractors. Recommended lubricant is Ford M2C134-C oil. It is recommended that lubricant be renewed after every 1200 hours of operation.

146. LUBRICATION PRESSURE TEST. To check transmission lubrication oil pressure, first operate tractor until hydraulic oil is at normal operating temperature. Connect a 0-300 psi (0-2000 kPa) pressure gage to oil cooler inlet line using a "T" fitting as shown in Fig. 195.

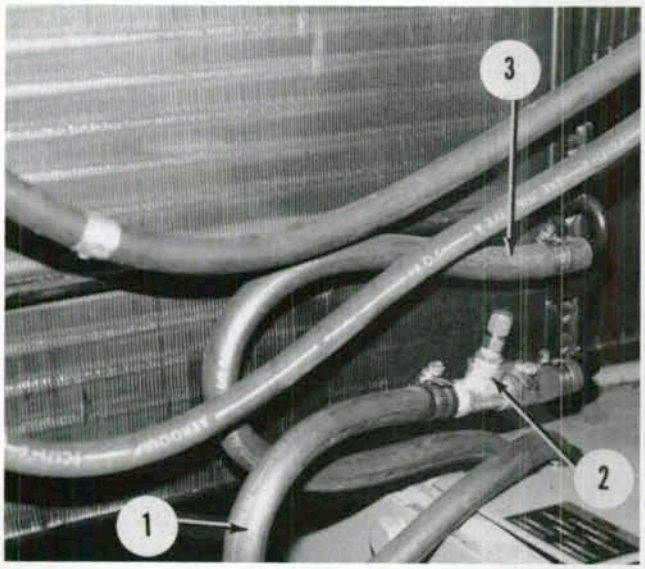


Fig. 195—To check transmission lubrication pressure, install a "T" fitting (2) in oil cooler inlet line (1) and connect a pressure gage to "T" fitting.

Pressure gage reading should be approximately 35-55 psi (240-380 kPa) at 1000 engine rpm and 95-120 psi (655-825 kPa) at 2200 engine rpm. If pressure is too low, pressure regulating valve spool may be stuck open or spring is broken or weak. Regulating valve is located on right-hand side of transmission; refer to paragraph 143 for service.

PARKING BRAKE

All Models

147. LINKAGE ADJUSTMENT. The high-low shift lever also is used to actuate parking brake pawl in transmission. To adjust parking brake linkage, remove cover plate from cab platform for access to transmission top cover. Move shift lever to park position making sure that park pawl rests on top of a tooth on sliding coupler. It may be necessary to raise rear of tractor and rotate a rear wheel to position pawl on coupler. In this position, the index mark (M—Fig. 196) should be aligned with inside edge of stop arm (5). If not, loosen adjusting bolts (4) and alternately retighten until correct alignment is obtained.

Move shift lever out of park position. Disconnect control rod (1) from actuator lever (3) and turn clevis (2) to obtain maximum control rod length, but still be able to attach rod to lever without binding.

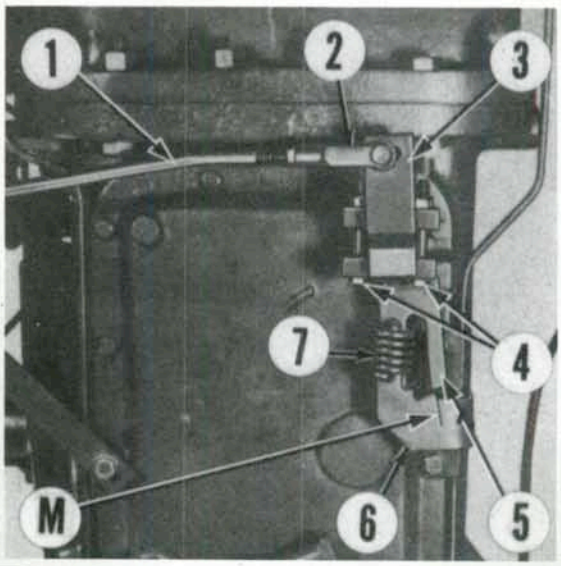


Fig. 196—View of parking brake linkage. Refer to text for adjustment.

M. Index mark
1. Control rod
2. Clevis
3. Actuator lever
4. Adjustment bolts
5. Stop arm
6. Spring anchor
7. Actuator spring

148. R&R PARKING BRAKE LINKAGE. To remove linkage, first remove cover plate from cab platform for access to transmission top cover. Disconnect hydraulic lines as necessary for removal of transmission top cover. Disconnect parking brake control rod (1—Fig. 196) from actuator lever (3). Use a pry bar or adjustable wrench to hold spring anchor (6) against spring tension, then loosen rear retaining bolt and remove front retaining bolt from anchor. Turn the anchor to relieve spring tension (Fig. 197), remove rear bolt and withdraw anchor and spring (7). Remove cap screws attaching top cover to transmission case. Lift and pivot cover to gain access to parking brake rod (5—Fig. 198) and brake pawl (2), then remove pin (1) attaching brake rod to pawl. Remove the cover from transmission case. Drive roll pin (4) from brake actuator hub (3) and remove hub, shaft, internal brake lever and rod from cover. Refer to paragraph 159, Transmission Overhaul, for removal of parking brake pawl (2).

To reinstall transmission top cover and parking brake linkage, reverse the removal procedure. Adjust linkage as outlined in paragraph 147.

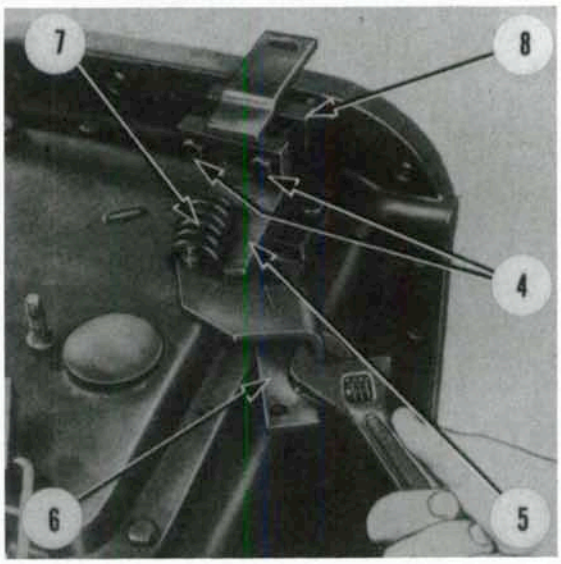


Fig. 197—Parking brake actuator removal and installation.
4. Adjusting bolts
5. Actuator lever
6. Anchor
7. Spring
8. Actuating hub

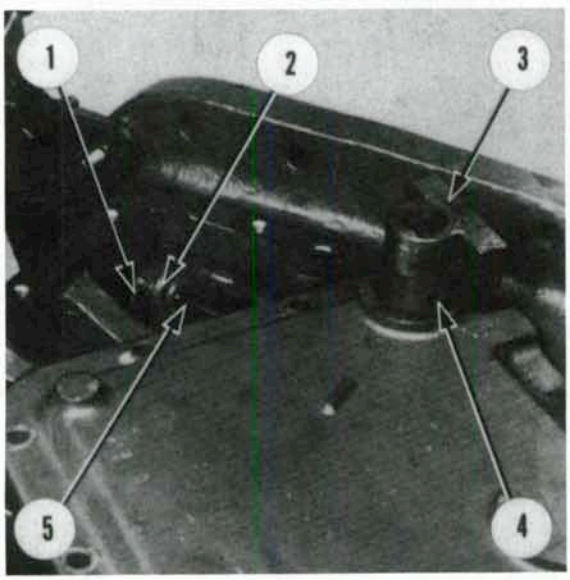


Fig. 198—Transmission top cover must be pivoted as shown to gain access to pin (1) securing parking brake rod (5) to brake pawl (2) before cover can be removed.

TRANSMISSION SHIFT LEVERS AND LINKAGE

All Models

149. Refer to Fig. 200 for exploded view of transmission shift levers and linkage. To remove shift linkage, slide boot up shift levers (1 and 2), loosen clamp bolts and detach shift levers. Disconnect parking brake rod (35), interlock control rod (23), gearshift control rod (18) and high-low control rod (21). Unbolt and remove shift bracket (24) assembly.

To disassemble shift mechanism, remove interlock shift arm (34) and park brake bellcrank (31) with detent ball (29) and spring (30). Unbolt and remove support pin (27). Remove gearshift bellcrank support pins and remove bellcrank (15). Remove trunnion bolt, trunnions (6), high-low selector lever (5), high-low bellcrank (11) and park brake bellcrank (9). Note the order of washers (7) and shims (8) for reassembly. Remove interlock pin (13) from the housing.

Inspect all parts for wear and renew as necessary.

To reassemble, reverse the disassembly procedure while observing the following special instructions. Use a dry lubricant, such as powdered graphite or molybdenum disulfide, on pivot points. Use of oil or grease will cause an accumulation of dirt resulting in rapid wear of components. Be sure that notch on gearshift bellcrank yoke (16—Fig. 200) faces forward. Assemble high-low bellcrank (11—Fig. 201) and parking brake bellcrank (9) with shims (8) and washers (7) on high-low selector lever (5), making sure that notch on high-low selector lever faces rearward. Place the bellcrank assembly in the main support, install bellcrank trunnions (6) and tighten trunnion retaining bolt (B) to a torque of 12 ft.-lbs. (16 N·m). Measure end play of bellcranks (9 and 11); if end play exceeds 0.009 inch (0.23 mm), add shims (8) as necessary to obtain end play of 0.000-0.009 inch (0.00-0.23 mm). Assemble detent spring (30—Fig. 200) and ball (29), park bellcrank (31) and connector link (25). Loosen cap screws retaining support pin (27), then rotate park bellcrank and support plate counterclockwise until foot of parking brake bellcrank (9) is cen-

tered in interlock pin (13). Tighten support pin cap screws to a torque of 6 ft.-lbs. (8 N·m).

Reinstall shift mechanism and adjust linkage as outlined in paragraph 150.

150. SHIFT LINKAGE ADJUSTMENT. Disconnect high-low shift rod (21—Fig. 200) from shift arm (20) and place shift arm in neutral. Adjust length of shift rod so high-low bellcrank (11) is centered in interlock pin (13) when the shift rod is connected to shift arm.

Move high-low shift lever (1) to high range position and move gearshift lever (2) to 4th gear position. Check clearance between side of shift levers and shift lever guard rail. The clearance should not be less than ½ inch (13 mm). To adjust, loosen shift lever clamp bolts and rotate lever until correct clearance is obtained.

Move high-low shift lever to "Park" position. Adjust park lock indicator bracket on shift lever guard rail, if necessary, so the shift lever engages the detent notch in the bracket. Check the tractor on a slope to make sure transmission is locked with lever in "Park" position.

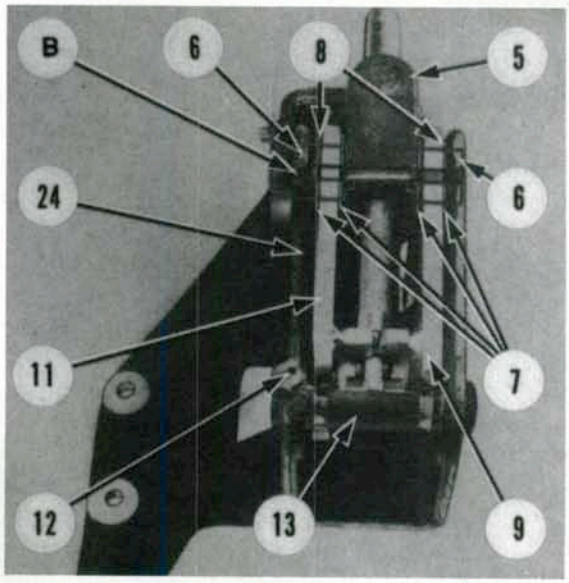


Fig. 201—View of assembled shift mechanism. Refer to Fig. 200 for legend.

1. High-low shift lever
2. Gearshift lever
3. Pivot pin
4. Pin
5. High-low selector lever
6. Trunnions
7. Washers
8. Shims
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 shift arm
21. High-low shift rod
22. Interlock arm
23. Interlock rod
24. Shift bracket
25. Park connector link
26. Bushing
27. Support pin
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

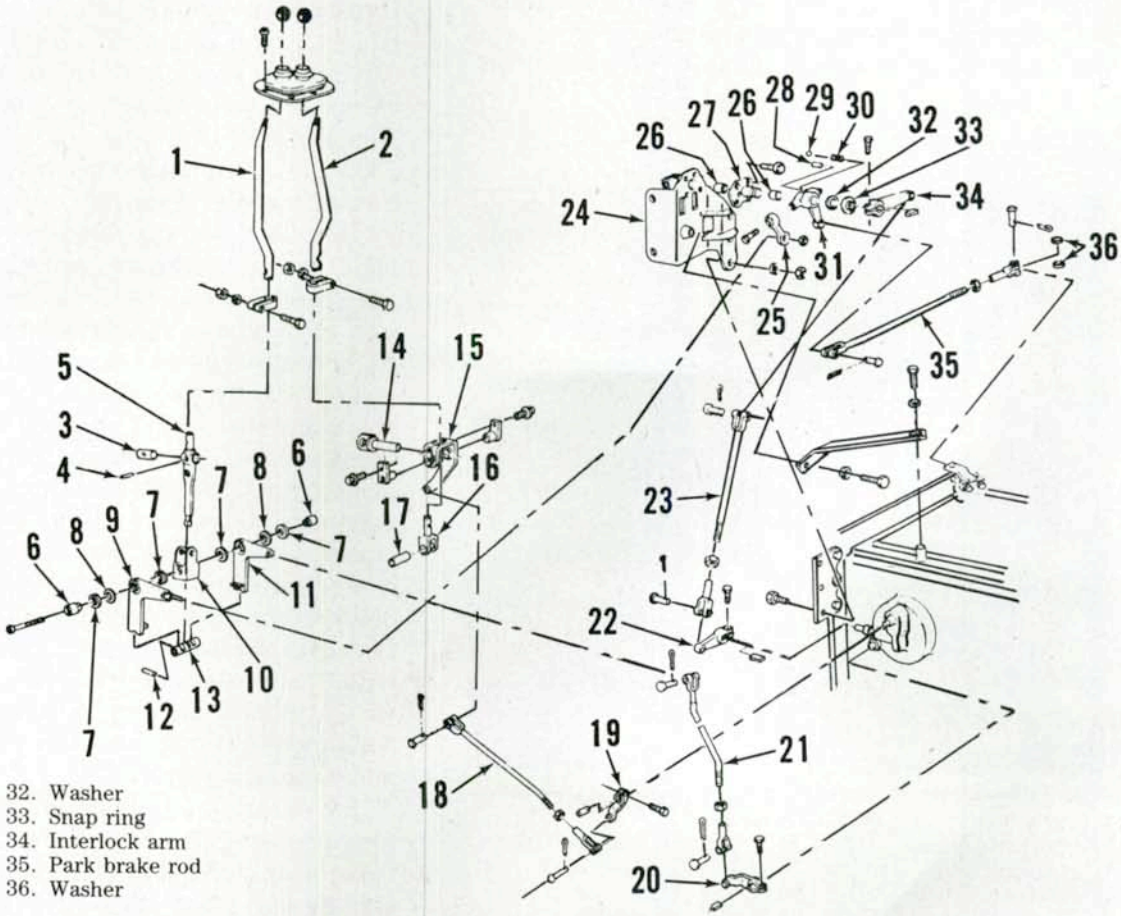


Fig. 200—Exploded view of transmission shift linkage used on all models.

GEARSHIFT COVER AND INTERLOCK MECHANISM

All Models

151. R&R AND OVERHAUL. To remove gearshift cover (31—Fig. 202), first drain oil from transmission case. Remove battery and battery box. Remove Dual Power (if so equipped) oil pressure line (1) and lubricant cooler inlet line (2). Shift transmission into neutral, then disconnect interlock control rod (28) and gearshift control rod (27). Unbolt and remove shift cover assembly from transmission case.

Remove clamp bolt from interlock shift finger (32—Fig. 203). Pull interlock shaft (29) out until interlock finger can be removed. Remove key from interlock shaft, then withdraw shaft from shift cover. Remove gearshift arm (27) and key from control shaft (26). Remove clevis pin from control shaft support (24), pull control shaft out until shift control finger (33) can be removed, then pull control shaft out from the inside of cover and remove transmission gearshift interlock (34) and detent ball and spring (22).

Inspect all parts for excessive wear or damage and renew as necessary.

To reassemble shift cover, install gearshift interlock (34), detent spring and ball (22), shaft support (24) and control shaft (26) in the cover. Tighten shaft support cap screws to a torque of 32 ft.-lbs. (43 N·m). Position control shaft so clevis pin groove in shaft faces upward. Install shift control finger (33) between fingers of interlock with chamfered edge of splines toward shift cover. Insert clevis pin into control shaft support. Be sure that shift finger moves an equal distance both forward and rearward of interlock fingers. If not, reposition shift finger on control rod. Install interlock control shaft (29), key and interlock finger (32) into cover. Install shift arms (27 and 28) and tighten clamp bolts to a torque of 23 ft.-lbs. (31 N·m).

Install cover assembly with a new gasket and tighten cap screws to a torque of 32 ft.-lbs. (43 N·m). Complete installation by reversing the removal procedure.

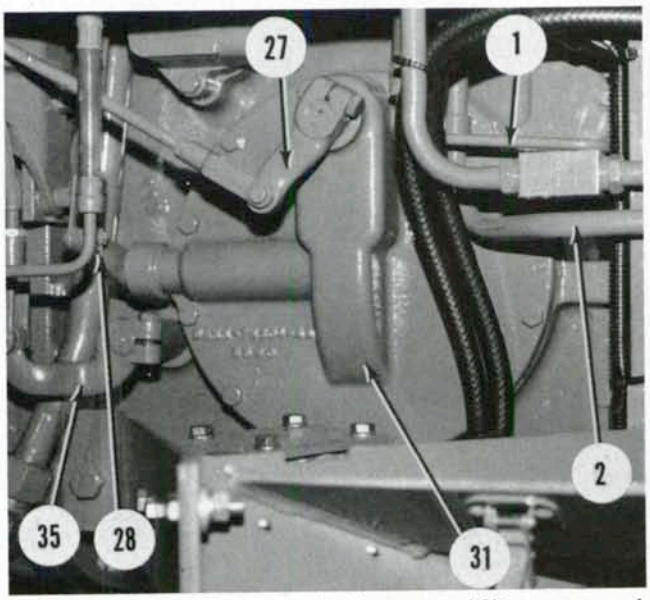


Fig. 202—View of transmission gearshift cover and control linkage.

1. Dual Power line
2. Lubricant oil cooler line
27. Gearshift control lever
28. Interlock control lever
31. Gearshift cover
35. High-low control lever

R&R TRANSMISSION ASSEMBLY

All Models

155. Removal of cab or platform is optional when removing transmission. The transmission can be removed with cab or platform left in place on rear axle housing while supporting front of cab or platform with suitable stands or overhead hoist. However, some mechanics prefer to remove the cab or platform to provide additional working space. If removal of cab or platform is desired, refer to appropriate paragraph 266, 267 or 268.

To remove transmission, first drain lubricant from transmission and rear axle center housing, approximately 20 U.S. gallons (76 liters). Disconnect battery cables and remove battery box and right-hand step assembly. Remove auxiliary fuel tank and left-hand step assembly.

Disconnect clutch linkage rod. Disconnect rear axle lubrication line from left side of rear axle center housing. Remove brake lines from transmission housing. If equipped with air conditioning, disconnect the self-sealing couplings at rear of cab. It is not necessary to discharge the air conditioning system.

Tag the four power steering hoses to ensure correct reassembly, then disconnect the hoses at left side of engine. Disconnect auxiliary hydraulic pump hydraulic lines. Disconnect throttle control cable, tachometer cable and fuel shut-off cable from injection pump and remove all clips retaining cables to the engine. Close coolant shut-off valves and disconnect heater hoses and engine coolant filter hoses. Remove bolt retaining front main wiring harness plug at rear of engine and disconnect wiring harness. If equipped with Dual Power, disconnect Dual Power solenoid wire at plug connector located above transmission bell housing. If equipped with front wheel drive, remove the drive shaft.

Disconnect pto pressure line and differential lock pressure line (TW-35) from pump adapter plate. Remove gear shift lever boot, shift lever clamp bolts and the shift levers. Disconnect interlock control rod (1—Fig. 220), parking brake rod (8), gear shift rod (5)

and high-low shift rod (7). Unbolt and remove gear shift support and shift mechanism assembly (6) from transmission housing.

If equipped with a cab, remove scuff plates from sides of cab floor, pull the floor mat back and remove cab front mounting bolts.

NOTE: There may be shims located between front insulators and the cab rails. Tag the shims so they can be reinstalled in their original positions.

Support sides of cab with suitable stands (Fig. 205), or remove two roof retaining bolts located midway along each side of cab, install a suitable spreader bar and support cab with an overhead hoist.

IMPORTANT: Do not tilt cab or platform rearward as rear mounting brackets could be damaged.

If equipped with a platform, support sides of platform with suitable stands, then remove platform front mounting bolts.

Unbolt and remove left-hand and right-hand frame members. Position wooden wedges between front axle and axle support to prevent tipping. Support the rear axle assembly and the engine and transmission assembly with suitable splitting stands.

IMPORTANT: Be sure to support rear axle center housing at front of housing and at rear of drawbar to prevent tipping.

Remove cap screws attaching transmission to rear axle center housing, then carefully separate transmission from axle center housing.

Remove hydraulic hoses from transmission as necessary. Remove starting motor. Support transmission with a hoist, then unbolt and remove transmission from engine.

Installation of transmission is the reverse of removal procedure. To facilitate installation, two alignment dowels may be threaded into rear axle housing bolt holes to aid in aligning transmission to axle housing. Be sure that transmission output shaft

1. Spring anchor
2. Actuator spring
3. Adjusting bolt
4. Parking brake lever
5. Brake actuator hub
6. Pin
7. Washer
8. Shaft
9. "O" ring
10. Cover
11. Brake lever
12. Control rod
13. Pin
14. Park brake pawl
15. High-low shift lever
16. High-low shift fork
17. 1st/2nd fork
18. Detent balls
19. Springs
20. 3rd/reverse fork
21. 4th fork
22. Detent ball & spring
24. Control shaft support
25. Seal
26. Control shaft
27. Gearshift arm
28. Interlock shift arm
29. Interlock shaft
30. Seal
31. Shift cover
32. Interlock shift finger
33. Gearshift control finger
34. Gearshift interlock
35. High-low shift arm
36. "O" ring
37. Bushing
38. Plug
39. Spring
40. Detent ball
41. Main shift rail
42. Snap ring
43. High-low shift rail
44. Transmission case
45. Side cover

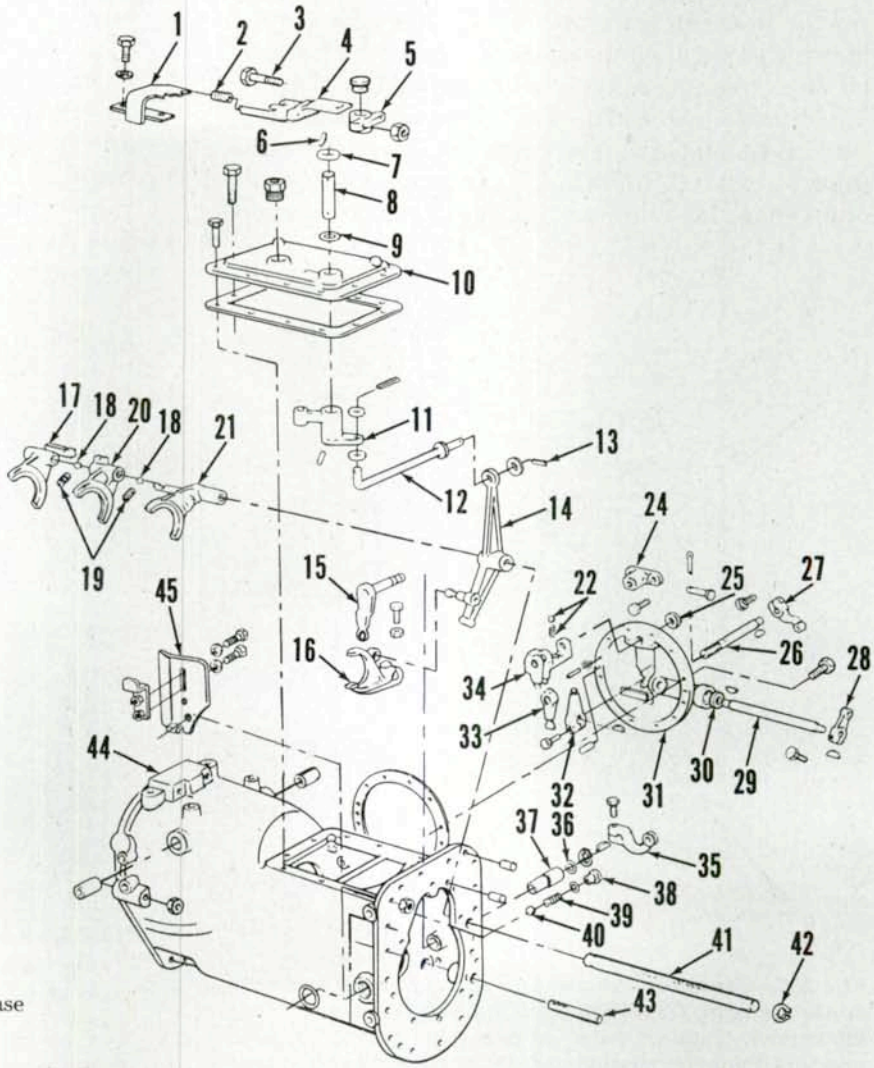


Fig. 203—Exploded view showing transmission case, gearshaft and parking brake components.

and pto shaft splines engage the couplings in rear axle housing and that low pressure oil supply tube located in rear axle center housing correctly enters opening in countershaft bearing retainer. If necessary, remove hydraulic pump and adapter plate assembly from rear axle center housing as outlined in paragraph 199 or 235, and working through opening, guide shafts and oil tube into proper position. Tighten the ¾ inch transmission to engine bolts at top and bottom of housing to a torque of 200 ft.-lbs. (271 N·m) and 5/8 inch bolts at both sides to 112 ft.-lbs. (152 N·m). Tighten the 5/8 inch bolts (at top and bottom) retaining transmission to rear axle to a torque of 155 ft.-lbs. (210 N·m) and ½ inch bolts at both sides to 77 ft.-lbs. (104 N·m). Tighten side frame cap screws to a torque of 200 ft.-lbs. (271 N·m).

TRANSMISSION OVERHAUL

Rear Cover and High-Low Gears

156. The high-low gears, shift rail and low pressure hydraulic pump can be removed after splitting tractor between transmission and rear axle center housing as outlined in paragraph 162 or with transmission removed as outlined in paragraph 155.

Remove four screws (6—Fig. 206) securing low pressure oil pump (1) to rear cover (4). Carefully withdraw pto shaft (5) and pump as an assembly. Remove outer snap ring retaining pto shaft bearing in pump housing, then tap pto shaft and bearing out of pump housing. Oil pump is available as a unit only and must be serviced as an assembly.

Remove cap screws retaining rear cover (4) to transmission housing, then thread two screws into jack screw holes (3) and tighten evenly to remove the cover. Remove screws securing output shaft bearing retainer (2) and remove retainer from rear cover carefully to avoid damaging output shaft bearing adjustment shims.

Pull output shaft (42—Fig. 207) with gear (45) out rear of transmission. Use a press or puller to remove gear and rear bearing cone from shaft. Remove front bearing cone if worn or damaged.

Withdraw secondary countershaft (35) from rear of transmission. Remove snap ring (31—Fig. 210) and thrust bearing (32) from front of countershaft. Inspect roller bearing (33) located in web of transmission. If bearing is worn or damaged, it can be removed and a new bearing installed without further disassembly, providing care is taken to remove any dislodged rollers from the housing.

To remove high-low shift fork, first remove detent plug (38—Fig. 203), spring (39) and ball (40) from side of transmission housing. Remove high-low sliding coupling (Fig. 208) from shift fork fingers. Loosen set screw in high-low shift fork. Withdraw the high-low shift rail and remove shift fork from parking brake pawl.

Inspect bearings, gears, shafts and shift components for excessive wear or damage and renew as necessary.

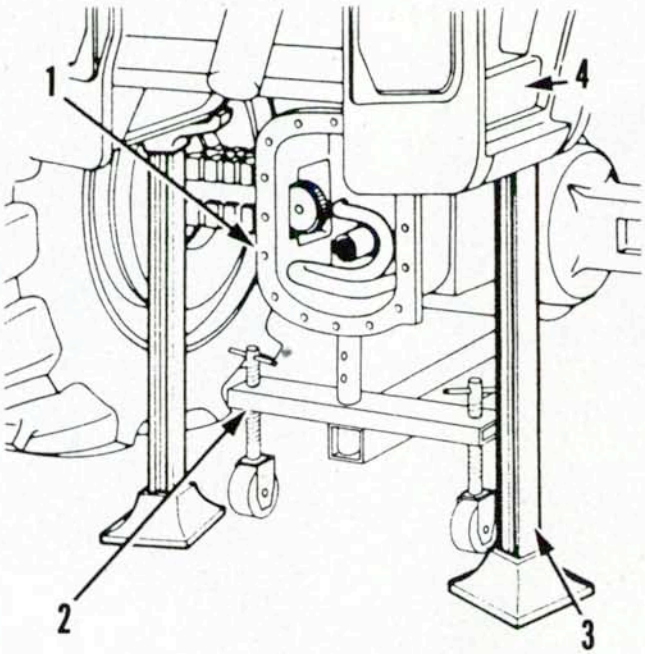


Fig. 205—Transmission can be separated from rear axle center housing (1) with cab left in place on axle housing as shown. Support front of cab with stands (3) and support rear axle housing at front of housing and at rear of drawbar to prevent tipping.

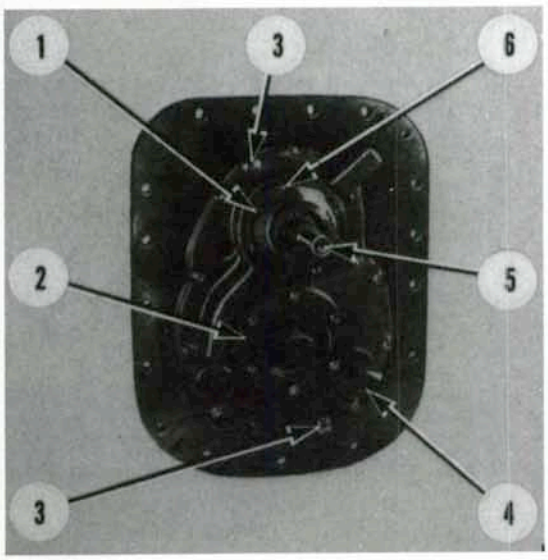


Fig. 206—View showing rear of transmission.

1. Low pressure pump
2. Output shaft bearing retainer
3. Jack screw holes
4. Rear cover
5. Pto shaft
6. Pump retaining screws

NOTE: Excessive wear of gears, bearings and other components in rear section of transmission would indicate that the transmission should be completely disassembled and inspected.

To reassemble rear section of transmission, proceed as follows: If removed, install new roller bearing (33—Fig. 210) in transmission web and new bearing cup (39) in rear end of main countershaft (37). Place high-low shift fork (Fig. 208) on lug on parking brake pawl, then insert shift rail (detent end first) through the shift fork. Align indentation in rail with shift fork set screw, then tighten screw and locknut. Install detent ball, spring and retaining plug in right side of transmission housing. Place high-low sliding coupling in shift fork fingers with parking brake teeth to the rear. Shift the coupling forward to engage with dog teeth on main countershaft.

Assemble spacer (34—Fig. 210), thrust washer (32) and snap ring (31) on front of secondary countershaft (35). Install the countershaft assembly in transmission case.

Install bearing cone on front end of output shaft (42). Place gear (45) on output shaft with dog teeth forward, then install thrust washer (46) and rear bearing cone (47). Insert output shaft assembly so splines on front end of shaft enter sliding coupling (41) and bearing cone is seated in cup in main countershaft.

Install rear cover (48) with bearing (44) on rear of transmission case. Tighten the cover retaining screws evenly in a diagonal pattern to a torque of 32 ft.-lbs. (43 N·m). Check secondary countershaft (35) end play, which should be 0.004-0.028 inch (0.10-0.70 mm). If end play is not within specified range, disassemble and find the cause.

Install bearing (56) and snap rings (55) on pto shaft (36), then install low pressure pump assembly (54) onto pto shaft and bearing and secure with snap ring (57). Coat the splines on front end of pto shaft with grease to prevent damage to mainshaft front oil seal, then insert pto shaft with oil pump into transmission. Tighten oil pump retaining screws to a torque of 25 ft.-lbs. (34 N·m).

Install output shaft bearing retainer (53) with original shims (51) onto rear cover.

NOTE: If output shaft, bearings or thrust bearings were renewed, the original shim pack may not be thick enough to provide desired bearing preload and bearings or retainer could be damaged when retainer cap screws are tightened. Rotate output shaft while tightening retainer cap screws; if shaft binds, remove the retainer and add shims as necessary.

Tighten output shaft bearing retainer cap screws evenly to a torque of 32 ft.-lbs. (43 N·m), then check and adjust output shaft bearing preload as follows:

Place high-low sliding coupling in neutral. Rotate the output shaft several turns to seat the bearings, then wrap a cord around the shaft and attach a spring scale to the cord. Measure the pull required to rotate the shaft at a steady rate. Bearings are correctly adjusted when a pull of 12 pounds (5.4 kg) or

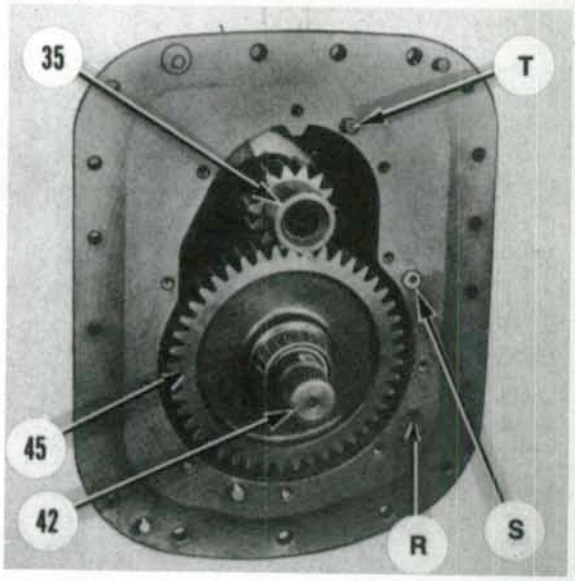


Fig. 207—Secondary countershaft, output shaft and gear are removed from rear of transmission.

R. High-low shift rail
S. Gearshift rail
T. Dowel
35. Secondary countershaft
42. Output shaft
45. Gear

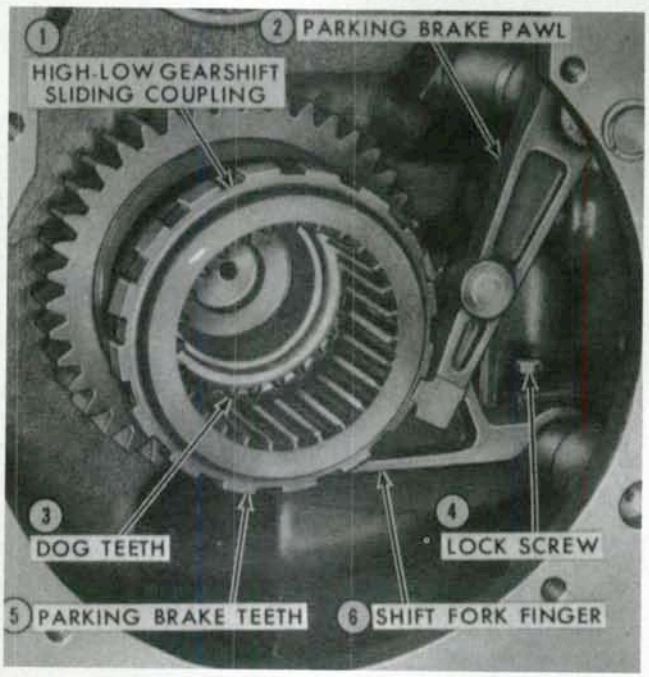


Fig. 208—View of rear of transmission with output shaft and secondary countershaft removed. Note brake pawl engagement with high/low sliding coupling.

less is obtained and there is no end play of shaft in bearings. Decrease thickness of shims (51) to remove end play, or add shims if pull required to turn shaft is greater than 12 pounds (5.4 kg).

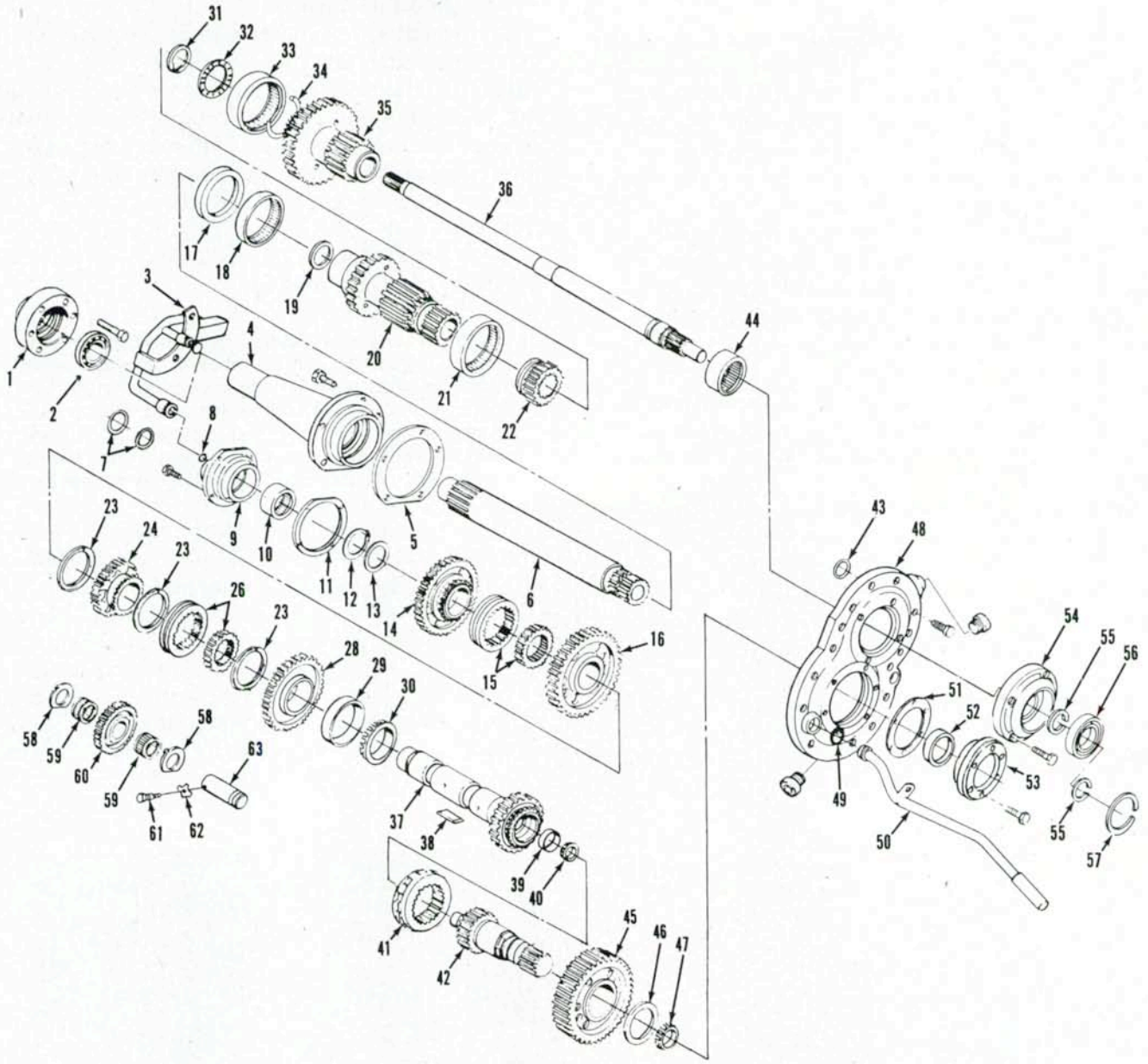


Fig. 210—Exploded view of transmission gears, shafts and related components.

1. Pto drive flange
2. Bearing
3. Oil lube tube
4. Clutch release bearing support
5. Gasket
6. Transmission input shaft
7. "O" rings
8. "O" ring
9. Bearing support
10. Needle roller bearing
11. Gasket
12. Snap ring
13. Thrust washer
14. Second gear
15. Sliding coupling
16. First gear
17. Oil seal
18. Needle roller bearing
19. Oil seal
20. Mainshaft
21. Needle roller bearing
22. Sliding gear coupling
23. Thrust washers
24. Reverse gear
26. Sliding gear coupling
28. Third gear
29. Bearing cup
30. Bearing cone
31. Snap ring
32. Thrust bearing
33. Needle roller bearing
34. Spacer
35. Secondary countershaft
36. Pto shaft
37. Main countershaft
38. Key
39. Bearing cup
40. Bearing cone
41. High-low sliding coupling
42. Output shaft
43. "O" ring
44. Needle roller bearing
45. Gear
46. Thrust washer
47. Bearing cone
48. Rear cover
49. "O" ring
50. Oil pump inlet tube
51. Shim
52. Bearing cup
53. Bearing retainer
54. Low pressure oil pump
55. Snap ring
56. Bearing
57. Snap ring
58. Thrust washer
59. Bearing
60. Reverse idler gear
61. Set screw
62. Locking tab
63. Idler shaft

Input Shaft Oil Seals

157. Oil leakage into clutch compartment can be from damaged or worn oil seal (17—Fig. 210) in clutch release bearing support (4) or pto shaft oil seal (19) in front end of transmission mainshaft (20). The following procedure for input shaft seal renewal does not apply to tractors with Dual Power, as seal is not used with Dual Power unit.

Oil seal (17) in release bearing support can be renewed after splitting tractor between engine and transmission housing as outlined in paragraph 130. Drain oil from transmission and rear axle center housing, approximately 20 U.S. gallons (76 liters). Remove pins (11—Fig. 211) from clutch release fork (9), then pull cross shaft (10) from transmission case and remove the fork and release bearing (8). Remove lubrication inlet tube (2), manifold (3) and supply tube (5). Pull transmission input shaft (4) from support housing. Unbolt and remove release bearing support (1) from transmission.

Remove and discard needle roller bearing (18—Fig. 210) and oil seal (17) from rear end of release bearing support. Install new oil seal with lip to the rear; drive seal in until it lightly contacts shoulder in support. Install new needle roller bearing by driving on lettered side of bearing.

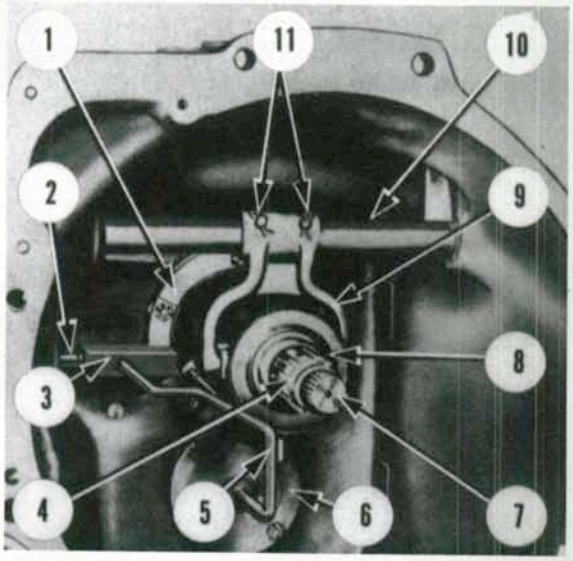


Fig. 211—View of front of transmission on models not equipped with Dual Power.

1. Clutch release hub support
2. Lubrication inlet tube
3. Lube manifold
4. Transmission input shaft
5. Lubrication supply tube
6. Main countershaft bearing retainer
7. Pto shaft
8. Clutch release hub & bearing assy.
9. Release fork
10. Cross shaft
11. Pins

158. To renew pto shaft oil seal (19—Fig. 210) in mainshaft (20), the mainshaft must be removed from transmission as follows: With transmission separated from engine, remove Dual Power Unit (if so equipped) as outlined in paragraph 138, or remove clutch release bearing support (without Dual Power) as outlined in paragraph 157. Remove main countershaft bearing retainer (6—Fig. 211) from front of transmission case to allow countershaft to drop down. Remove parking brake actuator and transmission top cover as outlined in paragraph 148. Remove cap screw (61—Fig. 210) and locking washer (62), then slide reverse idler shaft rearward and remove idler gear (60) and thrust washers (58). Engage sliding coupling (22) with dog teeth on front end of secondary countershaft. Withdraw mainshaft (20) from transmission. Remove old seal and install new seal using a suitable step plate driver. Drive the seal in until it seats against shoulder in mainshaft.

Lubricate mainshaft bushing, oil seal and pto shaft, then carefully install mainshaft over pto shaft, making sure mainshaft engages sliding gear coupling. Working through input shaft opening in transmission case, pry countershaft gear up with a screwdriver and install countershaft bearing retainer. Tighten retainer cap screws to a torque of 32 ft.-lbs. (43 N·m). Position reverse idler gear, with step in hub towards the front, and thrust washers in case, then push idler shaft through gear and thrust washers. Tighten idler shaft retaining screw to a torque of 15 ft.-lbs. (20 N·m) and secure with locking washer. Reinstall parking brake actuator and top cover. Install Dual Power unit

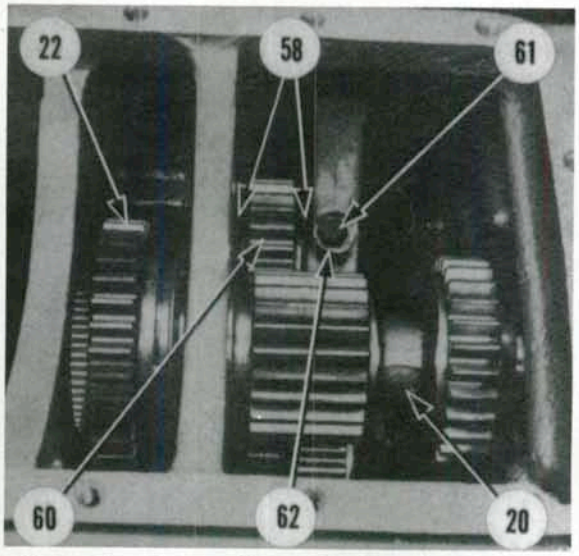


Fig. 212—View of top of transmission showing reverse idler gear and mainshaft.

20. Mainshaft
22. Sliding coupling
58. Thrust washers
60. Reverse idler gear
61. Locking bolt
62. Tab washer

or clutch release bearing support, bearing, release fork and cross shaft. Install input shaft in release hub support, making sure that splines on input shaft mesh with internal splines of the mainshaft. Reconnect transmission to engine.

Overhaul Complete Transmission

NOTE: Improper preload setting of output shaft bearings can cause excessive transmission noise. Before disassembling transmission to investigate noise complaint, check output shaft preload as outlined in paragraph 156 and check transmission sump for metal particles or other evidence of transmission damage. If bearing preload setting is not correct and no other apparent cause for noise can be found, adjust bearing preload and reinstall transmission in tractor.

159. Remove transmission from tractor as outlined in paragraph 155. Remove parking brake actuator and top cover as outlined in paragraph 148. Remove gear shift cover as outlined in paragraph 151. Remove rear cover and high-low gears as outlined in paragraph 156. Remove input shaft (4—Fig. 211) as outlined in paragraph 157. Unbolt and remove main countershaft front bearing retainer (6).

Remove set screw (61—Fig. 212) and washer (62), then slide reverse idler shaft rearward and remove idler gear (60) and thrust washers (58). Pull the mainshaft (20) forward from transmission case. Remove sliding gear coupling (22).

Remove snap ring (12—Fig. 210) and thrust washer (13) from front end of main countershaft (37). Disengage the three snap rings (2—Fig. 213) from grooves in shift rail; snap rings must be slid along the shift rail as it is being removed. Install a bolt and jam nut in rear end of shift rail, then use a wrench to turn shift rail so detent passage (8) on shift rail aligns with detent passages (6) on shift forks. The detent balls and springs can then be removed as the shift rail is withdrawn. Remove shift rail from rear of transmission case. Remove 1st-5th and 2nd-6th shift fork (7), 3rd-7th reverse gear shift fork (5) and parking brake pawl (3) from transmission. Tag all parts in order of removal to facilitate reassembly. The 4th-8th shift fork (4) is removed following countershaft removal.

Reinstall main countershaft front bearing retainer (9—Fig. 210) to support front of countershaft, using substitute cap screws or studs at least ½ inch (12.7 mm) longer than original to allow countershaft to move forward to provide access to keys (38). Move front sliding gear coupling and connector (15) and 47 tooth gear (14) forward as far as possible. Separate the gears until 55 tooth gear (16) is fully rearward and 43 tooth gear (28) contacts rear bulkhead. Use a magnet to remove key from front of countershaft.

Move rear sliding gear coupler (26—Fig. 210) forward to engage dog teeth of 51 tooth gear (24). Move the coupler and 51 tooth gear forward using a long screwdriver until countershaft rear key is accessible. Remove rear key with a magnet. Withdraw countershaft (37) through rear of transmission case while removing countershaft components through top opening. Arrange all parts in sequence to facilitate reassembly.

NOTE: Transmission gear shift sliding connector and coupling assemblies (15 and 26—Fig. 210) are furnished as matched sets. If connectors and couplings are to be reused, be sure they are identified and reassembled as matched sets. The outer coupling and inner connector are etched with timing marks to ensure they are mated correctly when reassembled.

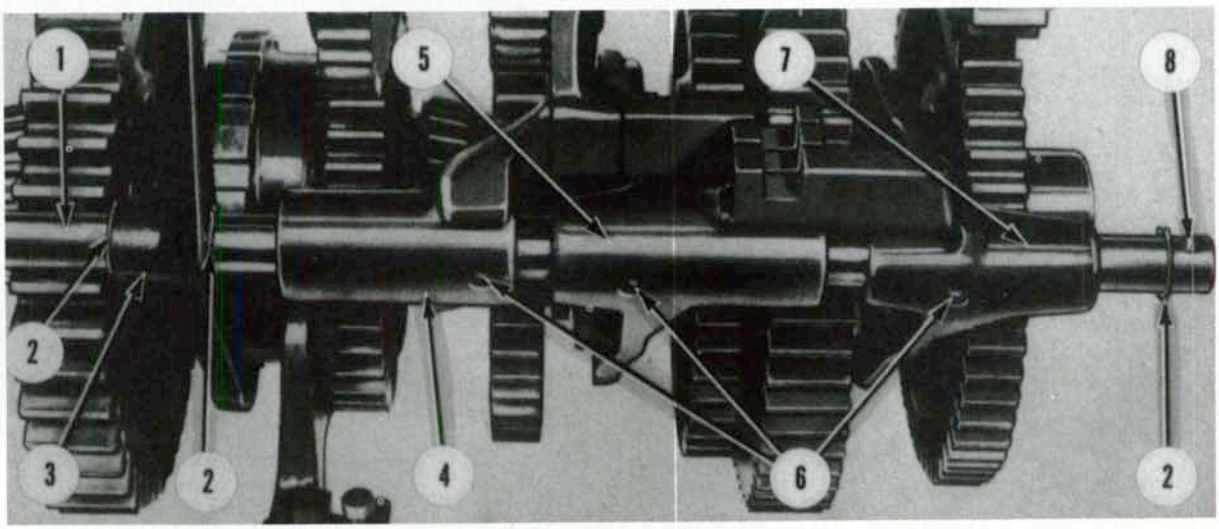


Fig. 213—View of gearshift components and main countershaft components removed from transmission housing.

1. Shift rail
2. Snap rings
3. Parking brake pawl
4. 4th-8th shift fork
5. 3rd-7th, reverse shift fork
6. Shift fork detents
7. 1st-5th, 2nd-6th shift fork
8. Shift rail detent passage

Remove 4th-8th gear shift fork from transmission case. Remove clamp bolt on high-low shift arm and remove the arm. Withdraw shift shaft from transmission case and remove "O" ring seal.

Carefully clean and inspect all parts and thoroughly clean transmission housing. Check all bearings and renew any scored 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 a suitable size driver that will fully contact flat (lettered) side 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. Inspect bushing in mainshaft (20—Fig. 210) for excessive wear; mainshaft should be renewed if bushing is worn or damaged as bushing is not available separately. Renew all "O" rings and seals.

Prior to reassembling transmission, temporarily assemble gears, thrust spacers, sliding shift connectors and couplings in proper assembly order on the transmission countershaft, then install front thrust washer and snap ring; refer to Fig. 214 for assembly guide. Check clearance between front thrust washer (13) and snap ring (12) with a feeler gage. If clearance is not within specified limits of 0.0073-0.0193 inch (0.185-0.490 mm), select a new thrust washer (13), which is available in various thicknesses, to provide proper clearance. Disassemble countershaft components, then proceed as follows to reassemble transmission.

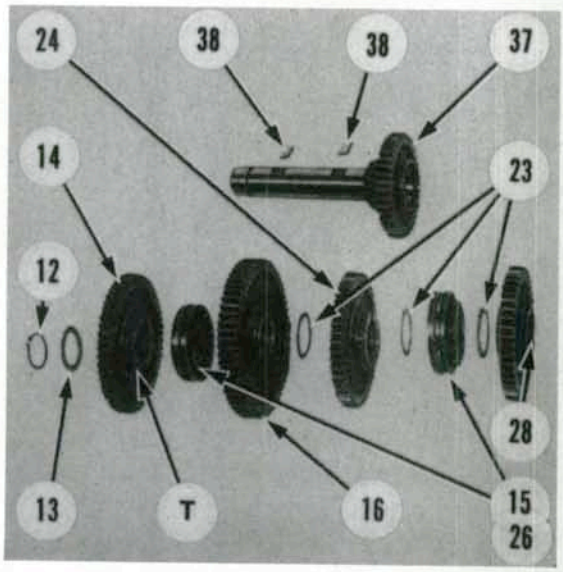


Fig. 214—Exploded view of main countershaft and components.

T. Dog teeth
12. Snap ring
13. Thrust washer
14. 47-tooth gear
15. Sliding coupling
16. 55-tooth gear
23. Thrust washers
24. 51-tooth gear
26. Sliding coupling
28. 43-tooth gear
37. Main countershaft
38. Keys

Install high-low shift shaft and arm and secure with the clamp bolt. Position the three gear shift forks in transmission case. Install the countershaft from rear of transmission case while assembling gears, thrust washers and shift connectors and couplings (Fig. 214) on the shaft as shaft is moved forward.

NOTE: Be certain that timing marks on shift couplings and connectors (15 and 26—Fig. 214) are aligned and that chamfered end of connector bores face rearward.

Move 43 tooth gear (28) rearward and remaining gears and couplings forward as far as possible and position countershaft so rear keyway is exposed. Install rear key with beveled edge up and slide rear coupler over the key. Move 51 tooth gear (24) and 55 tooth gear (16) rearward and 47 tooth gear (14) and coupler forward to expose front keyway. Install key in countershaft keyway, then slide front coupler over the key.

Install previously selected thrust washer (13) on front of countershaft and secure components on shaft with snap ring (12).

Insert front end of shift rail (rear end has two snap ring grooves) through rear face of transmission case. Position two snap rings and parking brake pawl (3—Fig. 213) on shift rail before the rail reaches first web in transmission case, then push the rail through the web while sliding snap rings and parking brake pawl along the rail. Align detent access hole in rail with holes in shift forks, then install the three shift forks and their detent springs and balls on the rail. Be sure the two main countershaft shift forks (5 and 7) engage sliding couplings correctly and 4th-8th shift fork (4) is positioned correctly to engage sliding gear coupling on secondary countershaft. Rotate shift rail so tapped hole in rear end of rail is at three o'clock position. Install the third snap ring in groove at front end of rail. Move brake pawl snap rings until they engage grooves in rail to hold pawl in place. Position sliding gear coupling (22—Fig. 212) in fingers of 4th-8th shift fork with coupling gear teeth facing rearward.

Install mainshaft (20—Fig. 212) in case from the front with splines of shaft engaging sliding gear coupling (22). Install reverse idler shaft (63—Fig. 210), gear (60) and thrust washers (58). Stepped hub side of reverse idler gear should be facing forward. Secure reverse idler shaft with locking tab and cap screw.

Complete remainder of reassembly by reversing disassembly procedure and adjust output shaft bearings as outlined in paragraph 156.

TRANSMISSION HAND BRAKE

An auxiliary transmission hand brake is available as an option on all TW-15, TW-25 and TW-35 tractors. The transmission hand brake is a parking brake only and should not be used to slow or stop tractor movement except in an emergency.

For tractors with front wheel drive, refer to appropriate Transfer Case paragraphs in FRONT WHEEL DRIVE section for service procedures covering hand brake. For two-wheel drive models, proceed as follows:

160. R&R AND OVERHAUL. Drain oil from transmission and rear axle center housing, approximately 20 U.S. gallons (76 liters). Disconnect hand brake control cable from actuating lever on brake housing. Support brake housing, remove housing retaining cap screws and remove housing from rear axle center housing.

To disassemble, drive roll pin (7—Fig. 215) into idler gear shaft (8). Push shaft out of the housing and withdraw idler gear (3), bearings (6) and spacers (2). Unbolt and remove brake housing end cover (20), then pull brake driven gear and shaft assembly (15) from the housing. Remove retaining ring (1—Fig. 216) and shim washers (2) from brake lever shaft, then withdraw brake lever and shaft (4) from housing. Remove snap ring from brake anchor pin. Remove screws (14—Fig. 215), then remove brake retaining plate (13). Note that the retaining plate is a tight fit on the alignment dowels and the use of a puller may be required to free plate from dowels. Remove brake discs (9) and actuator assembly (12) from brake housing.

Clean all parts and check for wear and damage. If bearings (10 and 19) are renewed, retain shim washers (18) located behind front bearing cup for use in assembly. Check brake discs and spacers (9) for wear, scoring or distortion. Brake discs and plates must be renewed as a set. Disconnect return springs from brake actuator (12), separate the two halves and inspect operating balls and ramps for wear or damage. Renew actuator assembly if necessary. Inspect idler gears (3) and driven gear and brake shaft (15) for wear

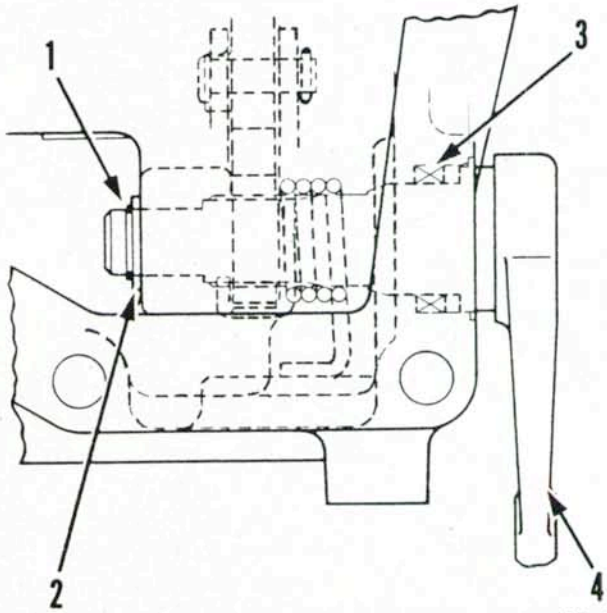
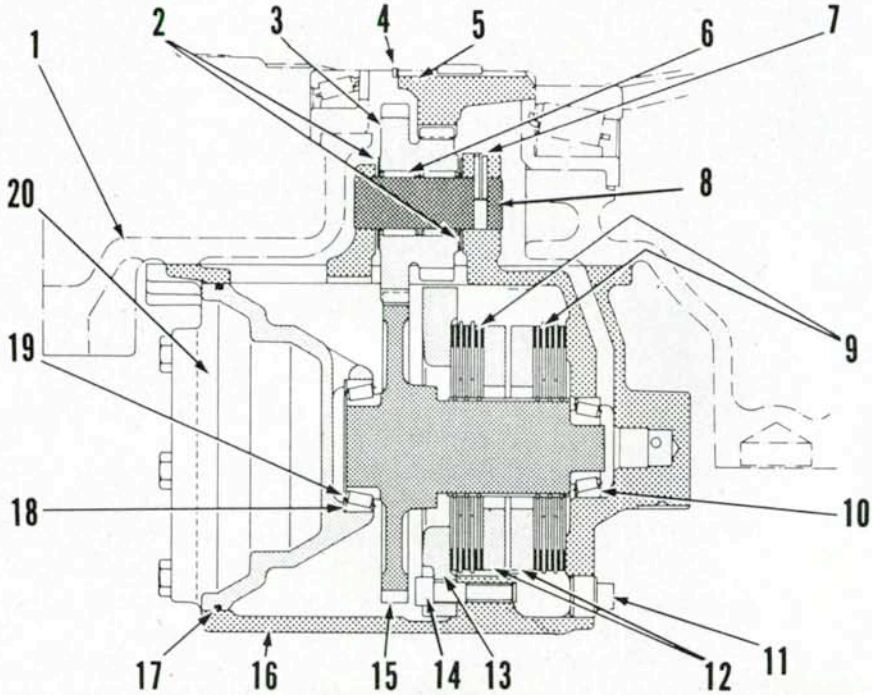


Fig. 216—Install shim washers (2) as necessary to obtain zero end play of brake actuating lever and shaft (4).

1. Snap ring
2. Shim washer
3. Oil seal
4. Lever & shaft



1. Rear axle center housing
2. Spacers
3. Idler gears
4. Retaining ring
5. Drive gear
6. Bearing
7. Roll pin
8. Idler shaft
9. Brake plates
10. Bearing
11. Drain plug
12. Actuator assy.
13. Brake retaining disc
14. Retaining screw
15. Driven gear & shaft assy.
16. Handbrake housing
17. Seal ring
18. Shim
19. Bearing
20. Brake housing end cover

Fig. 215—Cross-sectional view of transmission handbrake assembly used on two wheel drive tractors.

or damage and renew as necessary. Renew "O" ring (17—Fig. 215) and brake lever shaft seal (3—Fig. 216).

To reassemble, install brake discs and actuator assembly in brake housing. Align the splines of brake discs using special alignment tool No. 0562, or by other suitable means. Connect actuating linkage (5—Fig. 217) to actuator assembly (6) and lever (2), then install splined brake lever and shaft assembly (4) so it is positioned at 49° angle as shown. Install shim washers (2—Fig. 216) and snap ring (1) on brake lever shaft to obtain zero shaft end play. Install brake retaining plate (13—Fig. 215) and tighten socket headed retaining screws to a torque of 90 ft.-lbs. (120 N·m). Install anchor pin snap ring. Fully apply the brake to hold brake discs in alignment, then remove spline alignment tool if used. Install driven gear and brake shaft assembly (15).

NOTE: If brake housing end cover (20—Fig. 215), driven gear and shaft assembly (15), bearings (10 and 19) or hand brake housing (16) have been renewed, it will be necessary to adjust bearing free play as follows:

Install original shim washers (18—Fig. 215), plus some additional shims, beneath front bearing cup. Install end cover (20) and tighten retaining screws finger tight. Measure the gap at several locations between end cover and brake housing using a feeler gage and average the measurements. Remove end cover and bearing cup, and delete shim washers equal to average measured gap plus 0.002 inch. This will provide recommended bearing free play of 0.001-0.003 inch.

Reinstall end cover with correct thickness shims and bearing cup in place and using a new "O" ring. Tighten retaining cap screws evenly to a torque of 90 ft.-lbs (120 N·m). Drive the roll pin (7) out of idler shaft (8), then install idler gear (3) and shaft with bearings and spacers. Secure idler shaft with the roll pin.

Install hand brake housing on rear axle center housing and tighten retaining cap screws to a torque of 55 ft.-lbs. (75 N·m). Refill transmission with fluid.

Adjust hand brake control cable as follows: Place hand brake operating lever (beside operator's seat) in "OFF" position. Move and hold transmission brake lever (4—Fig. 218) upward in "applied" position. Loosen jam nuts (2) and turn cable adjusting nut (1) until clevis (3) can be attached to brake lever, then turn cable adjuster five revolutions to lengthen cable and provide recommended clearance of brake discs. Install clevis pin and tighten jam nuts.

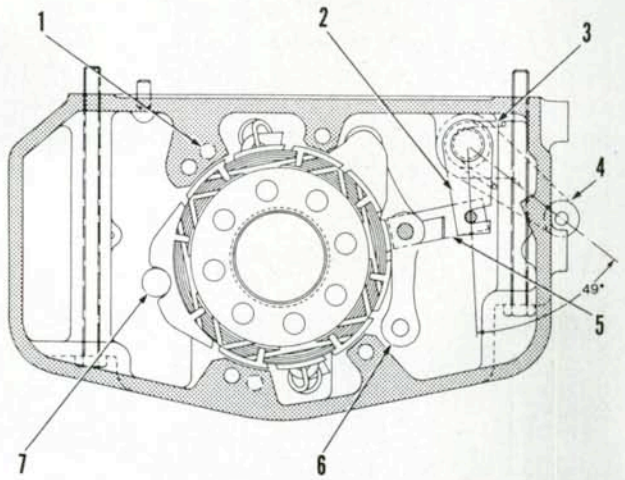


Fig. 217—Handbrake actuating lever (4) should be positioned at approximately 49 degree angle as shown when linkage is correctly installed

1. Dowel
2. Lever
3. Spring
4. Actuating lever
5. Link
6. Brake actuator assy.
7. Torque pin

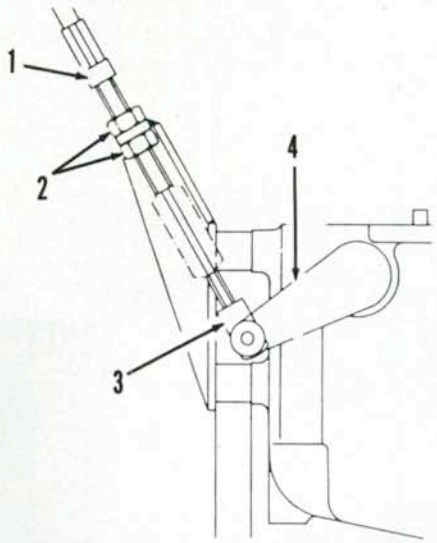


Fig. 218—Refer to text for transmission handbrake linkage adjustment procedure.

1. Cable adjusting nut
2. Jam nuts
3. Clevis
4. Brake lever

DIFFERENTIAL AND BEVEL DRIVE GEARS

LUBRICATION

161. On all models, the transmission and rear axle center housing serve as a common sump for lubricating and hydraulic system oil. Low pressure hydraulic oil is used to operate the differential lock clutch on all models. Low pressure oil is also used to pressure lubricate Dual Power unit, pto clutch, rear axle

planetary reduction gears and pto stub shaft. Refer to paragraph 145 for recommended lubricant and system capacity.

TRACTOR REAR SPLIT

162. Removal of the cab or platform is optional when splitting tractor between transmission housing and rear axle center housing. The cab or platform can be left attached to either the rear axle or transmission while supporting front or rear of cab or platform with suitable stands or overhead hoist. However, some mechanics prefer to remove the cab or platform to provide additional working space. If cab or platform removal is desired, refer to appropriate paragraph 266, 267 or 268.

To separate tractor between transmission and rear axle center housing, proceed as follows: Drain oil from rear axle center housing, approximately 20 U.S. gallons (76 liters). Disconnect the battery. Remove auxiliary fuel tank and left-hand step assembly.

Remove clamp bolts from shift levers and withdraw shift levers from shift mechanism. Disconnect shift interlock control rod (1—Fig. 220), gear shift control rod (5), high-low shift rod (7) and parking brake rod (8). Unbolt and remove gear shift mechanism (6).

Disconnect all wiring and hydraulic tubes between front transmission and rear axle housing. Disconnect wire at transmission oil temperature switch (1—Fig. 221) if so equipped. Disconnect brake lines, pto clutch pressure line (3), and differential lock and power brake supply line (TW-35). Disconnect differential lock pedal linkage (2) at pump adapter plate (TW-5, TW-15 and TW-25). If equipped with auxiliary hydraulic pump, disconnect suction line (4) from intake filter manifold, and disconnect pressure line from priority valve pack. Disconnect lubrication tube from left front side of axle center housing.

If equipped with front wheel drive, remove the drive shaft. If equipped with Dual Power, disconnect solenoid wire at plug connector located above transmission bell housing.

If transmission is to be separated from rear axle center housing with cab or platform remaining attached to rear axle housing, tag four power steering hoses to ensure correct reassembly, disconnect hoses and plug all openings. Disconnect air conditioner hoses at self-sealing connectors located at left rear of cab. It is not necessary to discharge the air conditioning system. Support front of cab or platform with stands on each side or with an overhead hoist and spreader bar attached to threaded lifting points located on each side of cab roof.

IMPORTANT: Do not tilt cab rearward as rear mounting brackets may be damaged.

If rear axle center housing is to be removed from tractor with cab or platform remaining attached to transmission housing, disconnect hydraulic lift control rod, hydraulic system selector rod, variable flow control rod, remote cylinder control rods, remote cyl-

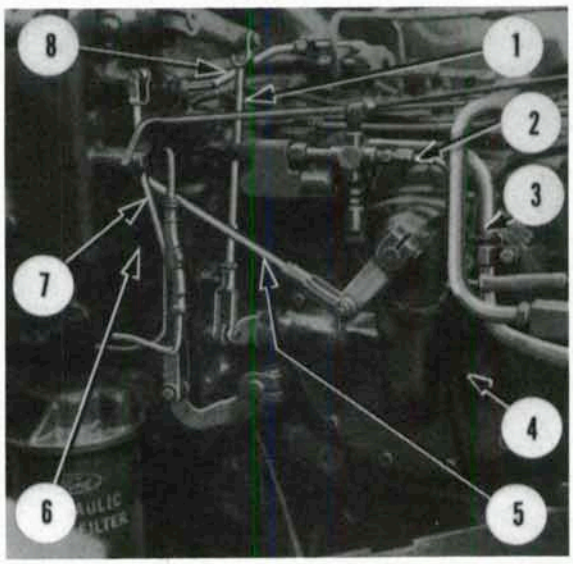


Fig. 220—View of gearshift linkage on TW-35 tractor. Other models are similar.

1. Interlock control rod
2. Dual Power line
3. Lubricant oil cooler line
4. Gearshift cover
5. Gearshift control rod
6. Gearshift mechanism
7. High-low control rod
8. Parking brake control rod

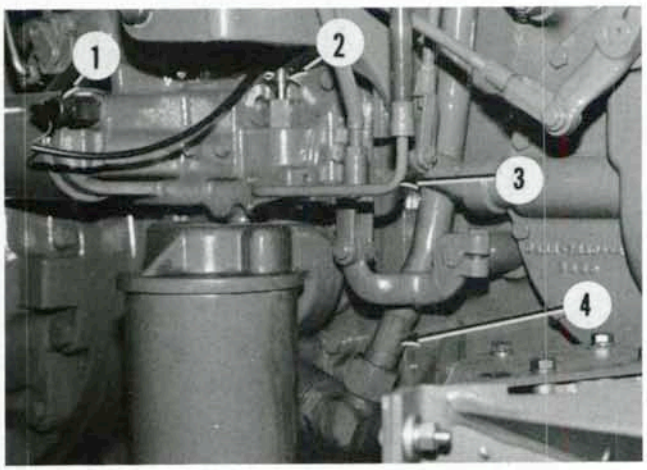


Fig. 221—Disconnect points when splitting tractor between rear axle center housing and transmission housing.

1. Transmission oil temperature switch
2. Differential lock control valve
3. Pressure line to pto valve
4. Auxiliary pump suction tube

inder flow control cables (early style hydraulic system), pto control linkage and transmission hand brake control cable (if so equipped) at rear of cab or platform. Support rear of cab or platform with an overhead hoist and spreader bar attached to threaded lifting points on each side of cab roof. Remove cab or platform rear mounting bracket bolts.

Insert wooden wedges between front axle and front support assembly to prevent tipping. Support front of tractor beneath transmission and support rear of tractor beneath axle center housing using suitable rolling splitting stands.

IMPORTANT: Be sure to use a splitting stand that will support rear axle center housing at front of housing and at rear of drawbar to prevent axle housing from tipping.

Remove cap screws retaining transmission to rear axle center housing, then carefully roll front of tractor away from rear axle center housing or roll rear axle housing away from transmission.

To reconnect tractor, reverse the splitting procedure. Tighten ½ inch cap screws on sides of transmission housing to a torque of 77 ft.-lbs. (104 N·m) and 5/8 inch cap screws on top and bottom of housing to a torque of 155 ft.-lbs. (210 N·m).

On early style cab (prior to November 1985) or platform, tighten front mounting bolts to a torque of 200 ft.-lbs. (270 N·m). Tighten cab rear mounting bolts to a torque of 280 ft.-lbs. (380 N·m) and mounting bracket to rear axle housing bolts to a torque of 200 ft.-lbs. (270 N·m). Tighten platform rear mounting bolts to a torque of 40 ft.-lbs. (55 N·m).

On late production cab, tighten cab front mounting bolts to a torque of 250 ft.-lbs. (340 N·m) and rear mounting bracket bolts to a torque of 280 ft.-lbs. (380 N·m). Tighten rear mounting bracket to rear axle housing bolts to a torque of 200 ft.-lbs. (270 N·m) if not equipped with lift assist ram, or to a torque of 250 ft.-lbs. (340 N·m) if equipped with lift assist ram.

DIFFERENTIAL

163. REMOVE AND REINSTALL. To remove differential assembly, first remove rear axle center housing from tractor as outlined in Tractor Rear Split, paragraph 162. Remove hydraulic lift cover as outlined in paragraph 207 or 245. Remove both rear axle housings as outlined in paragraph 171.

Unbolt pto upper shaft rear bearing retainer (top link bracket) from rear axle center housing. Withdraw retainer, pto drive gears and upper shaft (4—Fig. 225) from center housing. Remove rear axle and pto lubrication tubes and fittings (2 and 3) and differential lubrication tube (6). Disconnect differential lock hydraulic tube (5) from differential bearing carrier.

Support differential assembly with a suitable hoist and sling. Unbolt and remove differential bearing carriers (2—Fig. 226) from axle center housing, taking care not to damage shims (3) and to keep shims from each carrier separate and identified for reassembly. Lift the differential assembly from rear axle center housing.

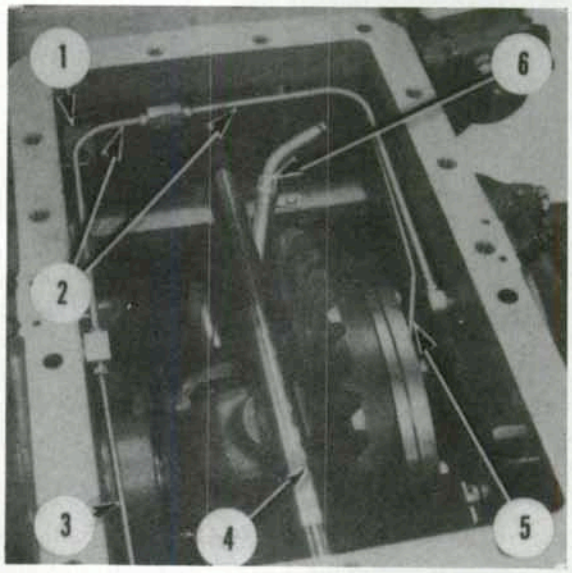


Fig. 225—View of rear axle center housing with hydraulic lift housing removed.

1. Pto valve shift fork
2. Rear axle lubrication tubes
3. Pto lubrication tube
4. Pto upper shaft
5. Differential lock hydraulic tube
6. Differential lubrication tube

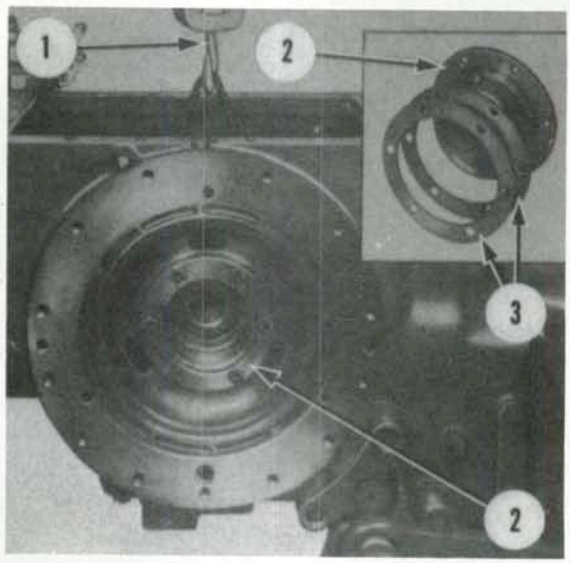


Fig. 226—Use a sling and hoist (1) to support differential assembly. Be sure to keep shims (3) separate and identified with the bearing carriers (2) for correct reassembly.

NOTE: If differential housing, bearing carriers or bearings, rear axle center housing or 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 outlined in paragraph 164. If none of the above parts were renewed, install bearing carriers with same shims as removed.

To reinstall, lower differential into axle center housing and install bearing carriers with shims. Tighten carrier retaining cap screws to a torque of 55 ft.-lbs. (75 N·m). Reconnect hydraulic lines. Install pto drive shaft and gears as outlined in paragraph 184. Install rear axle assemblies as in paragraph 171 and hydraulic lift cover as in paragraph 207 or 245.

164. ADJUST DIFFERENTIAL CARRIER BEARING PRELOAD AND BEVEL GEAR BACKLASH. Carrier bearing preload is adjusted by varying thickness of shims (3—Fig. 226) between bearing carriers (2) and rear axle center housing. Backlash between main drive bevel pinion and ring gear is adjusted by transferring shims from one bearing carrier to carrier on opposite side. Carrier bearing preload should be adjusted prior to adjusting backlash between the bevel gears.

To adjust bearing preload, support differential assembly in rear axle center housing with sling and hoist. Install left bearing carrier with same shims removed on disassembly and tighten retaining cap screws to a torque of 55 ft.-lbs. (75 N·m). Install right bearing carrier without shims and tighten retaining cap screws only enough to remove end play of differential carrier bearings, but DO NOT preload the bearings. Check to be sure some backlash exists between bevel pinion and ring gear; decrease shim thickness at left bearing carrier if no backlash is noted.

Measure gap at several points between flange of right carrier and rear axle center housing using a feeler gage as shown in Fig. 227. Loosen and tighten opposite cap screws until measurement is equal at all points. Remove right bearing carrier and install shims equal in thickness to measured gap minus 0.001-0.006 inch. Reinstall right carrier with shims and tighten retaining cap screws to 55 ft.-lbs. (75 N·m) torque.

NOTE: Measure shim thickness with a micrometer; thickness of individual shims may vary up to 0.004 inch.

With carrier bearing preload properly adjusted, measure backlash of bevel ring gear to bevel pinion using a dial indicator as shown in Fig. 228. Check backlash at several points around ring gear to be sure backlash is within limits at all points. Be sure that dial indicator plunger is positioned at a right angle against outer end of ring gear tooth.

Backlash should be within limits of 0.010-0.020 inch (0.25-0.51 mm). Transfer shims from left bearing carrier to right bearing carrier if backlash is less than 0.010 inch (0.25 mm). If backlash exceeds 0.020 inch (0.51 mm), transfer shims from right bearing carrier to left carrier. Tighten bearing carrier retaining cap screws to a torque of 55 ft.-lbs. (75 N·m) before rechecking backlash.

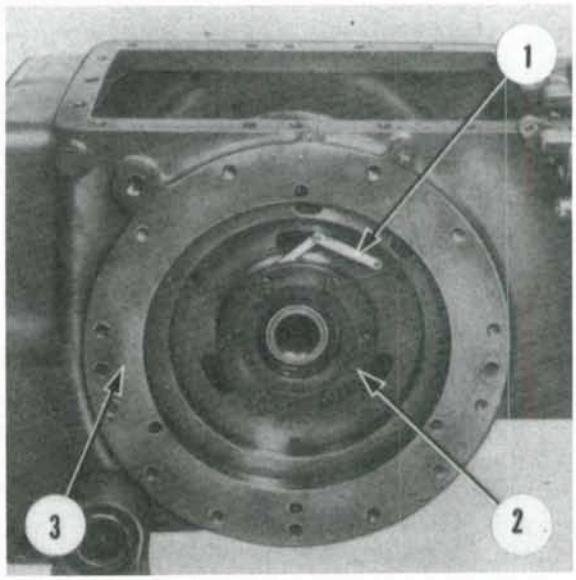


Fig. 227—Use a feeler gage (1) to measure gap between right-hand bearing retainer (2) and rear axle housing (3) to determine proper shim pack thickness required for adjustment of differential carrier bearing preload. Refer to text.

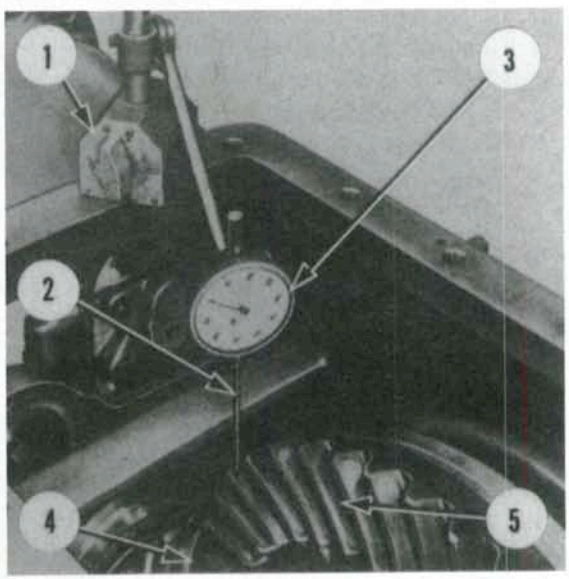


Fig. 228—Check backlash between ring gear and bevel pinion using a dial indicator as shown.

1. Magnetic base
2. Plunger
3. Dial indicator
4. Pinion
5. Ring gear

NOTE: Do not increase or decrease total thickness of carrier shim pack as carrier bearing preload would then be affected.

165. OVERHAUL DIFFERENTIAL OR RENEW BEVEL RING GEAR. With differential assembly removed as outlined in paragraph 163, remove cap screws retaining the cover plate (26—Fig. 229) to differential case (6) and ring gear (4). Separate cover from case and remove the differential lock discs (20 and 21), thrust washer (19), bearing (18) and right-hand side gear (17). Drive out roll pins (10 and 11) retaining pinion shafts (12 and 16) in differential case, then remove pinion shafts, spider (15), gears (13), thrust washers (14), side gear (9) and thrust washer (8).

The differential lock piston (22) may be removed from cover plate (26) by applying compressed air at oil port located between sealing ring grooves in hub of cover. Be sure piston is facing downward against workbench before applying air pressure. To remove bevel ring gear (4), support outer edges of gear in a press and press differential case out of the gear.

NOTE: The bevel ring gear and pinion are a matched set. If renewal of ring gear is necessary, refer to paragraph 166 and install mating bevel pinion gear.

Clean and inspect all parts for excessive wear or damage. Bushings (7 and 25) in case and cover may be renewed if excessively worn or scored. Bushings are presized and should not require reaming if carefully installed. Check thrust washers (8, 14 and 19) and bearing (18) for wear or scoring and renew as necessary. If differential pinion gears (13) and side gears (9 and 17) are worn or damaged, it is recommended that they be renewed as a complete set. Renew differential lock piston seal rings (23 and 24). Lubricate piston, rings and bore in cover before installing piston. Check differential lock friction discs (20 and 21) and friction surface of differential case for distortion or excessive wear and renew as necessary.

To reassemble, proceed as follows: If bevel ring gear was removed, support gear in a press as shown in Fig. 230. Position differential case in the ring gear, aligning bolt holes in case and gear. Thread all retaining cap screws through case into gear as shown, then press case downward into ring gear. Remove assembly from press and remove the cap screws.

Lubricate all parts, then assemble thrust washers, side gears, spider, pinion shafts and gears in differential case. Align pinion shaft roll pin holes and drive roll pins in flush with surface of differential case. In-

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. Side gear
10. Pin
11. Pin
12. Pinion shafts
13. Differential pinions
14. Thrust washers
15. Spider
16. Pinion shaft
17. Side gear
18. Bearing
19. Thrust washer
20. Differential lock discs
21. Differential lock plates
22. Differential lock piston
23. Seal ring, inner
24. Seal ring, outer
25. Bushing
26. Cover plate
27. Seal rings
28. Bearing cone
29. Bearing cup
30. Shims
31. Right carrier bearing support
32. Fitting

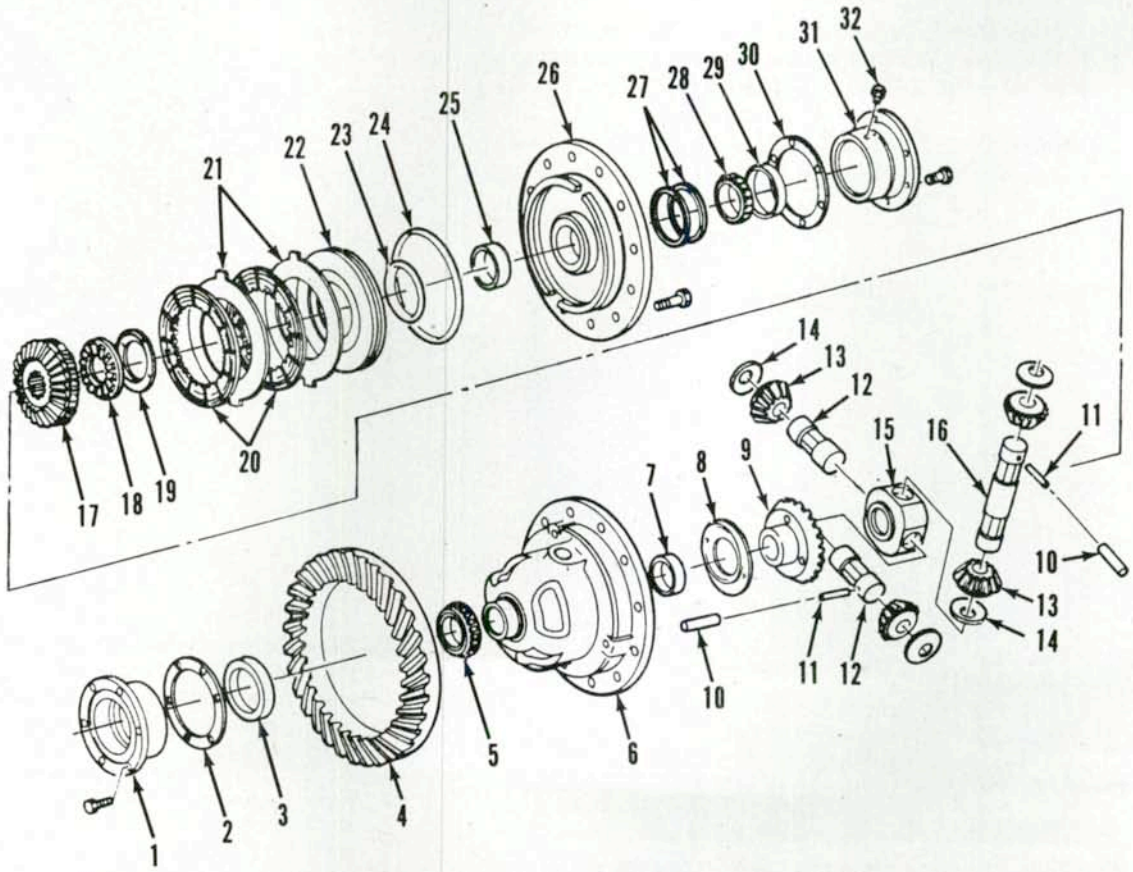


Fig. 229—Exploded view of differential assembly. Fluid for operation of differential lock piston (22) enters right carrier bearing support through fitting (32) and is transmitted to cover (26) through a bore in hub of cover.

stall differential lock discs alternately, beginning with a splined disc (20—Fig. 229). Install cover with differential lock piston and tighten retaining cap screws to a torque of 180 ft.-lbs. (245 N·m).

MAIN DRIVE BEVEL PINION

166. REMOVE AND REINSTALL. To remove main drive bevel pinion, separate tractor between front transmission and rear axle center housing as outlined in paragraph 162. Remove hydraulic lift cover as outlined in paragraph 207 or 245 and remove both rear axle housings as outlined in paragraph 171. Remove differential and ring gear assembly as outlined in paragraph 163. Remove power take-off clutch assembly as outlined in paragraph 187. Remove drive coupling (45—Fig. 231) from front of pinion shaft (35). Straighten tabs on washer (44) and remove adjusting nuts (43).

On tractors without transmission hand brake or front wheel drive, use a brass drift to drive bevel pinion rearward until free of front bearing cone (42).

On tractors equipped with transmission hand brake or front wheel drive, remove hand brake housing or transfer case from rear axle center housing. Use a brass drift to drive bevel pinion rearward a maximum distance of 1-1/4 inches (30 mm) to free pinion from front bearing.

IMPORTANT: Driving pinion rearward more than 1-1/4 inches (30 mm) may result in damage to drive gear (47—Fig. 231) mounted on pinion shaft.

Remove front bearing assembly from center housing. Remove snap ring (46) retaining handbrake or front wheel drive gear on pinion. Wedge a piece of wood between the drive gear and center housing, then use a brass drift to drive pinion rearward until free of drive gear.

Withdraw pinion with rear bearing from center housing. Remove bearing sleeves (39 and 40) with bearing cups (37 and 41) from center housing.

Inspect bearings and pinion and renew if excessively worn or scored. Bevel pinion and ring gear must be renewed as a matched set.

NOTE: Pinion mesh position is controlled by shim spacers (38—Fig. 231) between rear sleeve (39) and bearing cup (37); take care not to lose or damage spacers when removing rear bearing cup. If spacers are lost or damaged, or if a new ring gear and pinion or rear axle center housing is being installed, correct thickness of spacers can be determined as outlined in paragraph 167.

To reinstall bevel pinion, install front and rear bearing sleeves in center housing. Install bearing cups into sleeves with same thickness of shim spacers (38) as were removed, or with correct thickness as determined in paragraph 167. Insert pinion and rear bearing cone through rear bearing cup, front wheel drive or transmission handbrake drive gear (if so equipped)

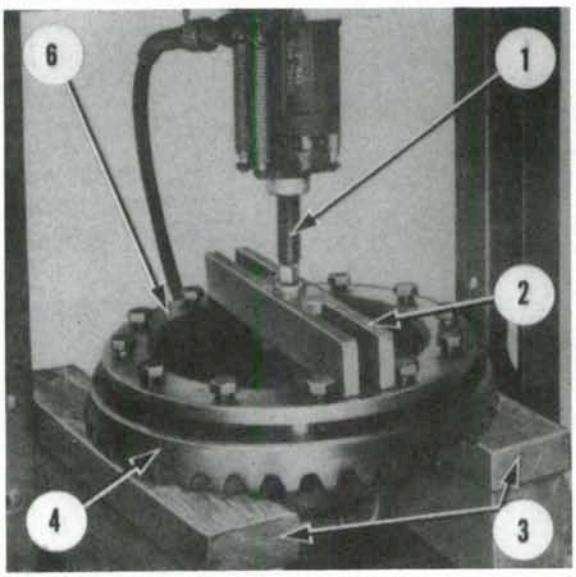


Fig. 230—Installing bevel ring gear (4) to differential case (6). Gear is aligned with case by installing retaining cap screws, then case is pressed into gear.

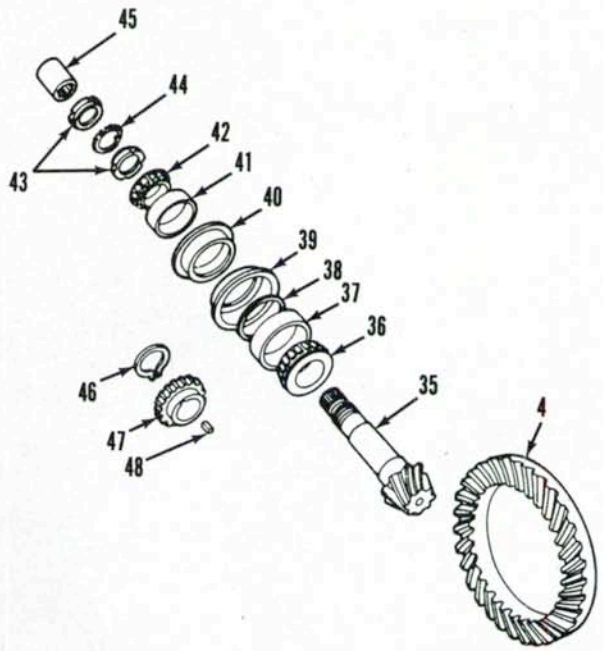


Fig. 231—Exploded view of bevel pinion assembly. Pinion bearing cups (37 and 41) are supported in sleeves (39 and 40) which fit in bores of rear axle center housing. Bearing preload is adjusted by nuts (43).

4. Bevel ring gear
35. Bevel pinion
36. Bearing cone
37. Bearing cup
38. Shim
39. Sleeve
40. Sleeve
41. Bearing cup
42. Bearing cone
43. Nuts
44. Locking washer
45. Drive coupling
46. Snap ring
47. Front wheel drive gear
48. Key

and front bearing cup. Hold in position with a hydraulic jack and wood blocks as shown in Fig. 232, then use a suitable size sleeve to drive front bearing cone onto pinion until bearing cone is seated in front bearing cup.

Install rear adjusting nut (43—Fig. 231) and tighten to obtain proper bearing preload as follows: Wrap a cord around pinion shaft and attach a pull scale to the cord as shown in Fig. 233. Pull on the scale and note scale reading with pinion turning steadily. Turn adjusting nut (43—Fig. adjusting nut until a steady pull of 10-20 pounds (4.5-9 Kg) is obtained.

NOTE: If scale reading is greater than 20 pounds (9 Kg), it will be necessary to loosen adjusting nut and bump pinion rearward, then retighten nut as required to obtain specified bearing adjustment.

With bearings properly adjusted, install locking washer (44—Fig. 231) and front adjusting nut. Tighten front nut securely while holding rear nut. Recheck bearing adjustment; if adjustment remains within specification, bend tabs of washer into notches of adjusting nuts and install drive coupling (45) on pinion shaft.

To complete reassembly of tractor, reverse the disassembly procedure. Do not install pto clutch locating pin until splines of transmission pto shaft and splines of pto clutch are aligned and pto control valve spool contacts the shift arm. Tighten pto clutch locating pin to a torque of 85 ft.-lbs (115 N·m). Tighten transmission to rear axle housing cap screws to a torque of 77 ft.-lbs. (104 N·m) for ½ inch cap screws and 155 ft.-lbs. (210 N·m) for 5/8 inch cap screws.

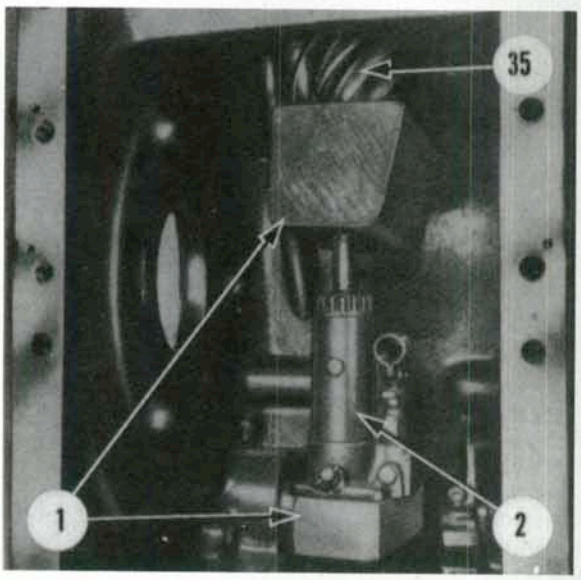


Fig. 232—Hold bevel pinion (35) in place with hydraulic jack (2) and wood blocks (1) as shown when installing front bearing cone.

167. BEVEL PINION MESH POSITION. Mesh position of the main drive bevel pinion is controlled by shim spacers (38—Fig. 231) located between pinion rear bearing cup (37) and bearing sleeve (39). Thickness of spacers required is determined by measurement of rear axle center housing and pinion gear at the factory. Normally, required spacer thickness is 0.041 inch (1.04 mm). If required thickness is different than 0.041 inch (1.04 mm), difference is stamped on rear axle center housing in location shown in Fig. 234 and/or pinion is marked as shown in Fig. 233.

In example shown in Fig. 234, the standard spacer thickness of 0.041 inch (1.04 mm) must be increased by 0.012 inch (0.304 mm). If a negative sign (-) appears in front of number on housing, subtract the value from standard 0.041 inch (1.04 mm) value. If no number is stamped on housing, required spacer thickness is standard 0.041 inch (1.04 mm).

Check for number stamped on front of pinion as shown at (4—Fig. 233). If no number is stamped on pinion, no further adjustment of spacer thickness is required. If pinion 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 sleeve. If number on pinion is -0.007, that thickness of spacer is to be added to basic spacer pack between bearing cup and sleeve.

Spacers are available in thicknesses of 0.018-0.022, 0.022-0.026, 0.026-0.030, 0.030-0.034 and 0.033-0.037 inch.

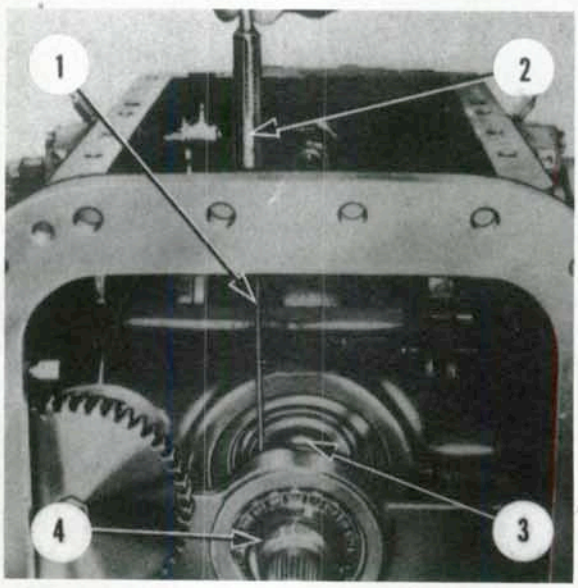


Fig. 233—Wrap a cord around bevel pinion shaft and use a pull scale to measure force required to rotate shaft when adjusting bearing preload. Note any numbers (4) marked on pinion shaft when setting bevel pinion mesh position. Refer to text.

1. Cord
2. Spring scale
3. Pinion shaft
4. Pinion setting numbers

NOTE: Since thickness of individual spacer may vary up to 0.004 inch (0.10 mm), it will be necessary to select spacers by measuring thickness with a micrometer.

DIFFERENTIAL LOCK VALVE

Models TW-5, TW-15 and TW-25

168. The differential lock valve is contained in hydraulic pump cover located on right-hand side of rear axle center housing. Differential lock valve spool is connected to a foot pedal, which when depressed engages the differential lock. The differential lock will disengage when foot pedal is released.

The valve receives its hydraulic power supply from the low pressure hydraulic system. Refer to paragraph 136 for pressure test procedure and to paragraph 240 for service procedure covering differential lock valve.

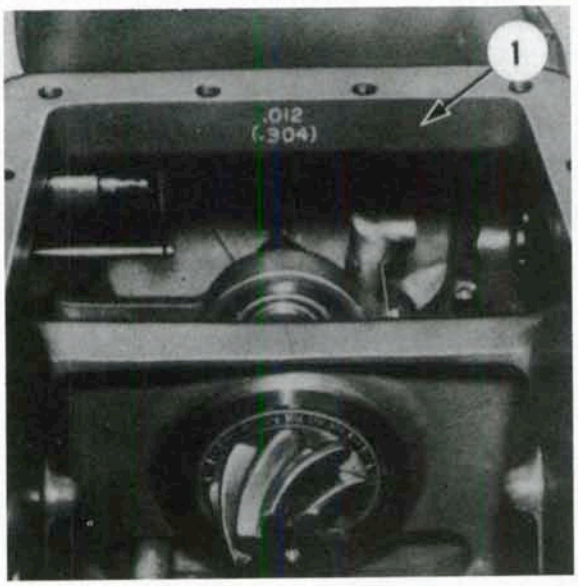


Fig. 234—Normal shim thickness for pinion mesh adjustment is 0.041 inch (1.04 mm). If other than this thickness is required, it is indicated by stamping on rear axle center housing (1) or on pinion shaft (4—Fig. 233).

Model TW-35

169. The differential lock valve (3—Fig. 235) is mounted below the power brake valve on right front side of cab. The differential lock is engaged when differential lock valve foot pedal is depressed. The differential lock will not disengage until either one or both brake pedals are depressed.

The differential lock valve receives its hydraulic supply from the low pressure hydraulic system. Refer to paragraph 136 for pressure test procedure.

To remove differential lock valve, first remove the hood. Disconnect oil tubes from the valve. Remove clevis pin from valve spool (4). Remove retaining cap screws and withdraw valve assembly.

The differential lock valve is serviced as a complete assembly.

To reinstall valve, reverse the removal procedure. Adjust the valve as follows: With differential lock engaged, turn adjustment bolt (1) to obtain 0.050 inch (1.3 mm) clearance between head of bolt and differential lock release pins (2).

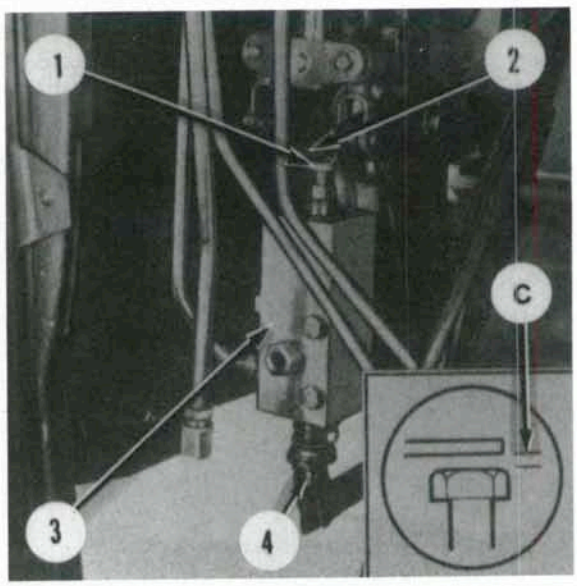


Fig. 235—View of differential lock actuating valve used on Model TW-35.

1. Adjusting screw
2. Differential lock release pin
3. Differential lock valve
4. Valve spool

FINAL DRIVE AND REAR AXLES

170. R&R REAR WHEEL. To remove rear wheel and tire, first raise rear of tractor and support with a suitable safety stand. Turn rear wheel so wedge retaining bolts (1—Fig. 236) are positioned below axle shaft. Remove the two thread protector bolts (2) and loosen center wedge retaining bolt about 2 inches (50 mm). Remove the two outer wedge retaining bolts (1), insert them in holes (2), and tighten evenly until wheel wedge (3) loosens.

IMPORTANT: Do not apply more than 300 ft.-lbs. (400 N·m) torque to retaining bolts. If wedge does not loosen, apply penetrating oil to wedge and loosen the three bolts retaining upper wedge on inside of wheel to help free lower wedge. If necessary, a tool can be fabricated using dimensions shown in Fig. 237 that will slide over axle and contact wedge. Strike the tool to loosen the wedge. Do not strike the wedge retaining bolts as damage to wedge may result.

Use a suitable wheel dolly or hoist to support rear wheel, then pull wheel and tire assembly off axle shaft.

To reinstall wheel assembly, position wheel on axle with loose wedge positioned below axle shaft. Remove two wedge retaining bolts from holes (2—Fig. 236) and reinstall in original holes (1). Tighten the three wedge retaining bolts alternately in 50 ft.-lbs. (68 N·m) increments until final specified torque of 290 ft.-lbs. (393 N·m) is reached. Install the two thread protector bolts in holes (2). If loosened, tighten three bolts retaining upper wedge on inside of wheel to a torque of 290 ft.-lbs. (393 N·m). Drive the tractor about 200 yards (200 m) and recheck retaining bolt torque, then recheck again after one hour and eight hours of operation under load.

171. R&R REAR AXLE AND FINAL DRIVE ASSEMBLY. Drain oil from rear axle center housing, approximately 20 U.S. gallons (76 liters). If removing both rear axle assemblies, drive wood wedges between front axle and front support to prevent tipping. Raise rear of tractor and support under axle center housing with suitable safety stand. Remove rear wheel and tire as outlined in paragraph 170. Support rear of cab or platform, then remove cab or platform rear mounts from axle housings. Use a suitable hoist and sling to support axle housing. Unbolt axle housing from center housing and move axle housing outward until clear of dowel pins and inner axle shaft (planetary drive sun gear). Be careful not to allow brake discs or inner axle shaft to fall out as axle and final drive assembly is removed.

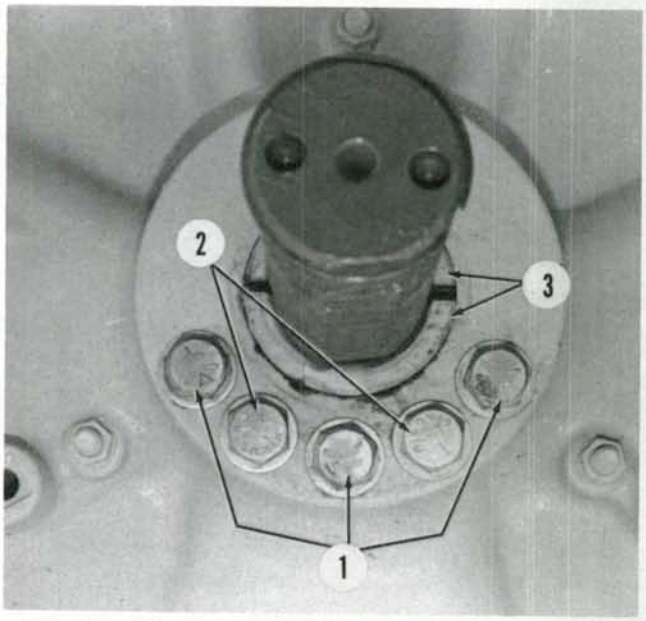


Fig. 236—View of rear wheel wedge retaining bolts.

1. Wedge retaining bolts
2. Thread protector bolts
3. Wheel wedges

To reinstall, insert inner axle shaft into differential side gear. Remove the brake disc guide pins (17—

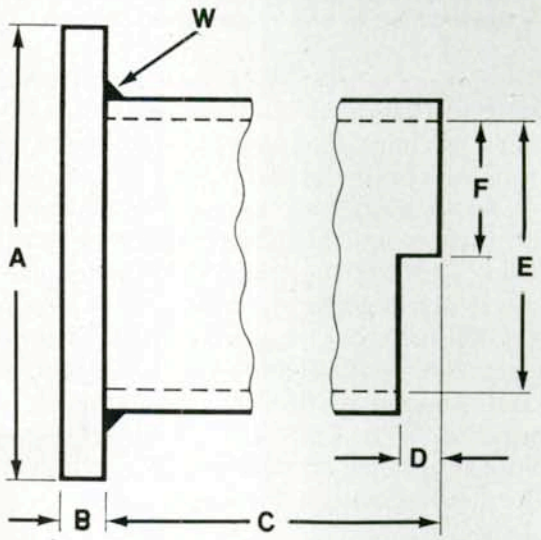


Fig. 237—A special tool can be fabricated using dimensions shown for use in loosening rear wheel wedges. Tool should be made from ½ inch (13 mm) steel plate and ¼ inch (6 mm) wall thickness steel tubing.

A. 5 inches (130 mm)
B. 0.5 inch (13mm)
C. 15 inches (380 mm)
D. 0.5 inch (13 mm)
E. 3.5 inches (89 mm) for TW-5, TW-15 & TW-25 3.75 inches (95mm) for TW-35
F. Half of diameter "E"
W. Weld 360°

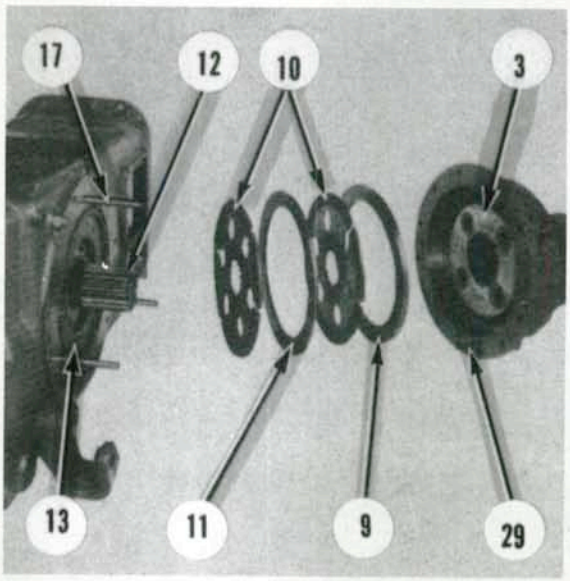


Fig. 238—View showing Model TW-35 axle housing and brake components removed from axle center housing. One brake disc (10) is used on Models TW-5, TW-15 and TW-25.

3. Planetary carrier assy.
9. Outer disc
10. Brake discs
11. Inner disc
12. Sun gear
13. Brake piston
17. Locating pins
29. Axle housing

Fig. 238) from axle housing and install them in rear axle center housing.

NOTE: Be sure that hollow guide pin is installed at top location to ensure proper lubrication.

Place brake discs on inner axle shaft and guide pins. Place a new gasket on the dowel pins, then lift axle housing assembly into place, aligning holes in axle housing with brake disc guide pins and meshing teeth on planetary gears with sun gear teeth on inner axle shaft. Tighten axle housing retaining cap screws to a torque of 110 ft.-lbs. (150 N·m). Tighten cab rear mount to axle housing retaining bolts to a torque of 200 ft.-lbs. (270 N·m) on tractors without lift assist ram or 250 ft.-lbs. (340 N·m) if equipped with lift assist ram. Tighten cab to rear mount retaining bolt to a torque of 280 ft.-lbs. (380 N·m). Install rear wheel and tire as outlined in paragraph 170. Refill rear axle center housing with lubricant.

172. OVERHAUL REAR AXLE SHAFT AND BEARINGS. With rear axle and final drive assembly removed as outlined in paragraph 171, remove axle shaft as follows: Remove lockplate (6—Fig. 239), retaining cap screw (7), washer (5) and shims (4). Withdraw planetary carrier (3) with gears from axle housing. Drill a hole in face of axle shaft oil seal (25), then pry seal out of housing, taking care not to damage seal surface of axle shaft or bore in housing. Bump axle shaft outward through inner bearing cone and housing.

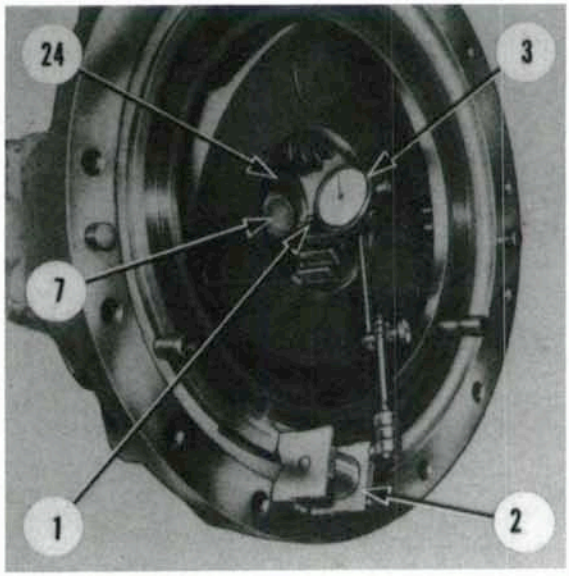
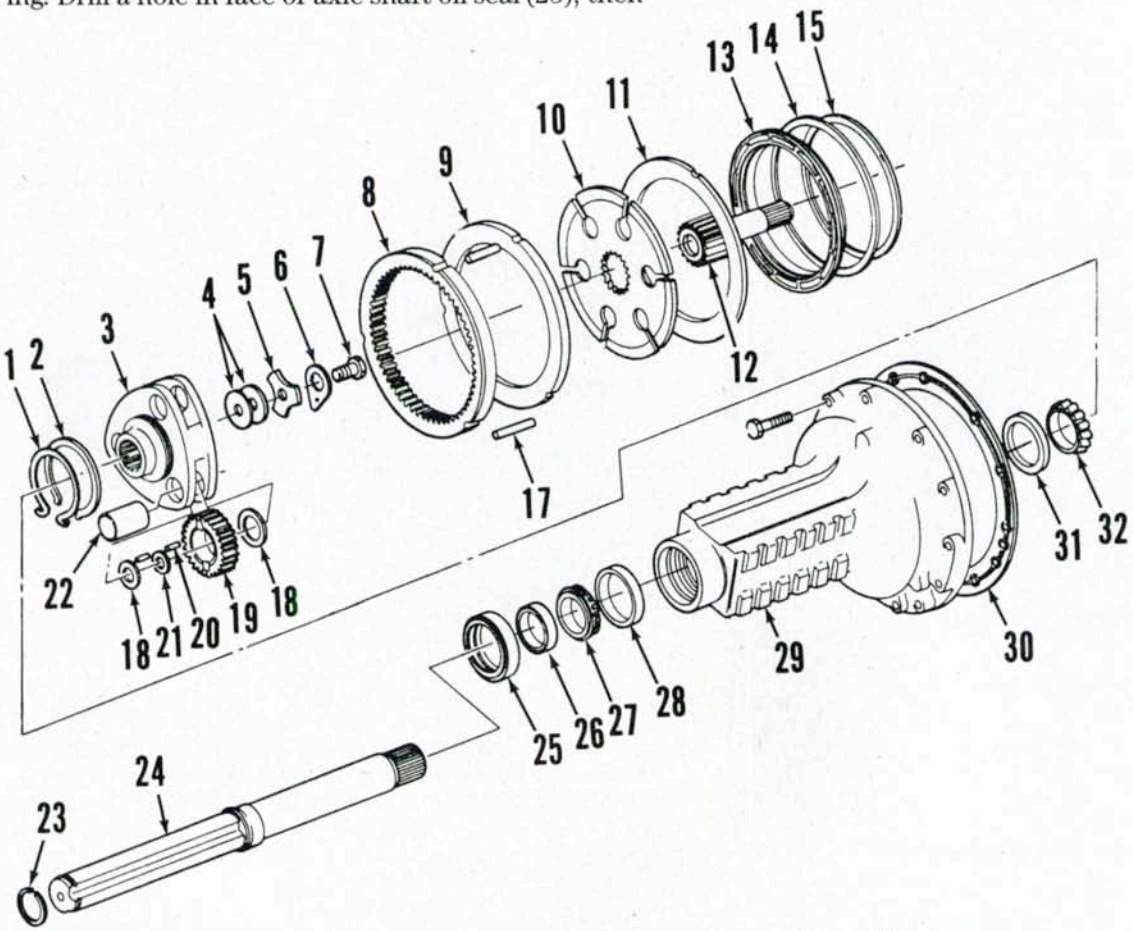


Fig. 240—Axle shaft end play can be checked using a dial indicator as shown.

1. Plunger
2. Magnetic base
3. Dial indicator
7. Axle retaining bolt
24. Axle shaft



1. Lock wire
2. Retaining ring
3. Planetary carrier
4. Spacers
5. Washer
6. Lock
7. Cap screw
8. Ring gear
9. Outer disc
10. Brake disc
11. Inner disc
12. Sun gear
13. Brake piston
14. Seal ring
15. Seal ring
17. Locating pin
18. Thrust washers
19. Planet gear
20. Bearing needle
21. Spacer
22. Planet gear shaft
23. 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

Fig. 239—Exploded view of rear axle assembly and brake components.

Inspect bearings for wear or damage. Use a slide hammer puller to remove bearing cups (28 and 31) from axle housing. Use a press or suitable puller to remove outer bearing cone (27) from axle shaft. Inspect oil seal contact ring (26) for wear or damage and renew if necessary. Apply sealant to inside diameter of new seal ring before installing on axle shaft.

To reassemble, press new oil seal ring against shoulder on axle shaft, then press outer bearing cone against seal ring. Install inner and outer bearing cups in axle housing. Install axle shaft and position inner bearing cone on the shaft. Install ring gear and planetary carrier with gears in axle housing.

Adjust axle shaft bearing preload as follows: Install axle retaining cap screw and washer with two of the thickest shims (4) available. Tighten cap screw to a torque of 440 ft.-lbs. (600 N·m). Use a dial indicator with plunger positioned against head of retaining cap screw to measure axle shaft end play as shown in Fig. 240. Remove cap screw, retainer and shims, and use a micrometer to measure shim thickness. Subtract measured end play plus an additional 0.006 inch (0.15 mm) from shim thickness. The resulting figure is thickness of spacers to be installed to provide correct bearing preload.

Install selected spacer shim, washer and retaining cap screw. Tighten cap screw to a torque of 440 ft.-lbs. (600 N·m), then install cap screw lock. Apply sealant to outer diameter of axle shaft oil seal. Lubricate lip of seal and axle shaft, then carefully slide seal over axle shaft. Use a suitable size sleeve to drive seal into axle housing until flush with outer face of housing.

173. OVERHAUL PLANETARY FINAL DRIVE. With axle and final drive removed as outlined in paragraph 171 and planetary carrier and gears removed as in paragraph 172, proceed as follows:

Cut and remove locking wire (1—Fig. 241) from planet gear shaft retaining snap ring (2). Pull ends of snap ring together to disengage ring from planet gear shafts (22), then drive the shafts out snap ring side of carrier.

NOTE: Planetary assembly used on TW-35 model has four pinions and is disassembled in same manner.

Remove planetary gears (19—Fig. 239) and thrust washers (18). There are 54 loose needle bearings (20) and a spacer (21) in each gear.

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.

To reassemble, use grease to hold spacer and two rows of 27 needle rollers in each planet gear. Position planet gear in carrier and insert gear shaft from snap ring side of carrier. Seat retaining snap ring in notches in shafts. Push a new locking wire under the snap ring and secure wire by wrapping ends around snap ring projections as shown in Fig. 241.

Insert brake disc guide pins into 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 axle center housing. Install planetary carrier assembly, spacer shim, washer and retaining cap screw. Tighten cap screw to 440 ft.-lbs. (600 N·m) torque.

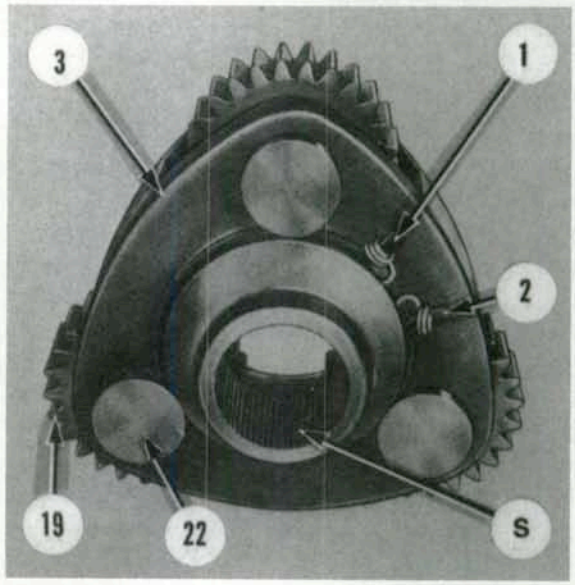


Fig. 241—Planet gear shafts (22) are retained in carrier (3) by retainer ring (2).

BRAKES

All Models Except TW-35

174. ADJUSTMENT. The rod connecting the brake pedal trunnion to master cylinder piston must be adjusted in length to provide 1/8 inch (3.2 mm) pedal free travel, measured at pedal stop pad (2—Fig. 242).

NOTE: If pedal is spongy, bleed brakes as outlined in paragraph 175 prior to adjusting.

Adjust each brake pedal individually. Insert a 1/8 inch (3.2 mm) spacer between pedal (1) and rubber stop (2). Loosen locknut (3) on brake rod (4), then turn rod until all free play in rod is just removed. While holding brake rod, retighten locknut. Repeat procedure for the other pedal.

IMPORTANT: Do not adjust rods beyond zero free play. If rods are too long, compensating port in master cylinder will be blocked and brakes will drag or lock as brake fluid warms up and expands.

175. FLUID AND BLEEDING. Models TW-5, TW-15 and TW-25 use a separate reservoir for brake fluid. Brake reservoir dipstick and filler tube are located on top right-hand side of cowl panel in front of the instrument panel.

IMPORTANT: Hydraulic system fluid or commercial grade automotive type brake fluid MUST NOT BE USED. Ford part No. IQ-M6C34-A fluid ONLY should be used to avoid possible damage to rubber seal rings and resulting loss of brake fluid. If any other fluid has been used, it is recommended that the entire system be thoroughly flushed and approved fluid installed.

To bleed air from brake system, first make sure that brake reservoir is full. Brake bleeder fittings are located at each side of rear axle center housing just above axle housing flange. Depress either right or left brake pedal and loosen brake bleeder fitting on same side. Tighten bleeder fitting while holding pedal down. Release pedal and repeat until air-free fluid is discharged at bleeder fitting. Add fluid while bleeding to maintain adequate fluid level. Repeat bleeding operation for brake on opposite side.

176. OVERHAUL MASTER CYLINDER. For access to brake master cylinder, remove hood side panels from right side of tractor. Disconnect brake lines from master cylinder. Remove two screws retaining oil level indicator tube to firewall. Remove master cylinder retaining cap screws and remove assembly from tractor.

To disassemble, remove reservoir cover (7—Fig. 244) and drain brake fluid from master cylinder. Remove rubber boots and two retaining rings (1) from cylinder bores. Withdraw pistons (2), seals (3) and springs (4).

Thoroughly clean cylinder bores and reservoir. Be sure that orifice and port in bottom of reservoir are open. Inspect all parts for wear, scoring or other damage and renew as necessary. Reservoir and cylinder casting is serviced as a complete master cylinder assembly. All other parts are available separately or as a master cylinder repair kit, which includes parts for servicing both cylinders of unit.

Lubricate master cylinder parts with approved Ford brake fluid and reassemble by reversing disassembly procedure. Reinstall master cylinder assembly, fill reservoir with fluid and bleed air from system as outlined in paragraph 175.

TW-35 Models

Power to actuate brakes on TW-35 tractors is provided by the low pressure oil pump. Pressurized oil is routed to power brake valve shown in Fig. 248, then to individual rear brakes as required.

177. ADJUSTMENT. With the engine off, depress both brake pedals and insert special tool No. 7446 (1—Fig. 246) between rocker arm links (2) and power brake valve housing. Loosen adjusting nuts (1—

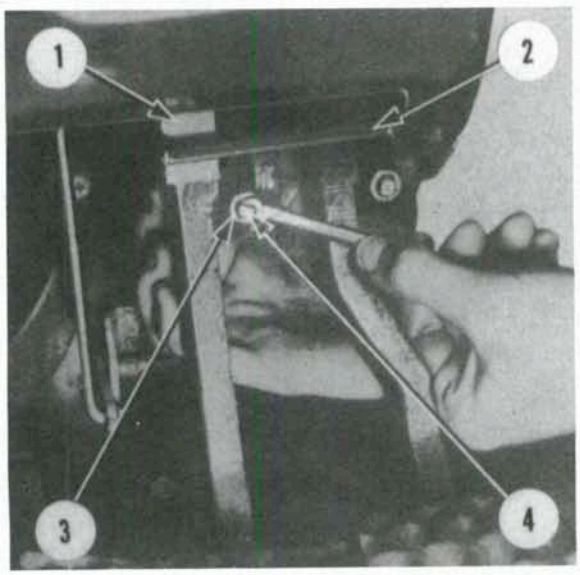


Fig. 242—Brake pedals should be adjusted individually to provide 1/8 inch (3.2 mm) free travel, measured at pedal stop pad (2).

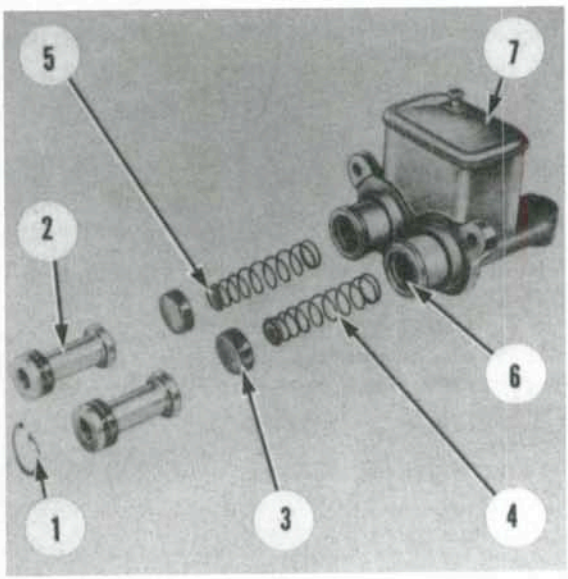


Fig. 244—Exploded view of brake master cylinder assembly used on TW-5, TW-15 and TW-25 models.

1. Snap ring
2. Piston
3. Seal
4. Spring
5. Cap
6. Cylinder
7. Reservoir cover

Fig. 247) and locknuts (2) on both pedals. Adjusting one pedal at a time, tighten adjusting nut until pedal just begins to move. Adjustment is correct when corner of gage can be moved with a heavy drag without depressing the pedal. When adjustment is correct, tighten locknut and repeat adjustment procedure for other pedal.

178. FLUID AND BLEEDING. The power brake system uses transmission/hydraulic fluid supplied by the low pressure hydraulic pump.

To bleed brake system, start engine and depress left brake pedal. Loosen bleed screw located in top of left rear axle housing until air-free fluid flows from bleed screw. Tighten bleed screw while maintaining pedal pressure. Repeat procedure for right brake.

179. R&R AND OVERHAUL POWER BRAKE VALVE. To remove power brake valve, disconnect oil tubes (1, 2, 9 and 12—Fig. 248) from brake valve (14). Remove valve mounting bolts (13) and rocker arm retaining pin (10), then remove valve assembly.

To disassemble, remove check valve (13—Fig. 249) and ball (13A) from valve body. Remove rocker arm assembly (1) by removing retaining rings (8) and retaining pins (7). Unbolt and remove cap (23), then withdraw valve spool assembly. Remove locknut (21), washer (20), seal retainer (19), actuating piston (18), spacer sleeve (17), and spacer (15). Apply heat to directional valve retainers (3) to loosen thread locking compound, then use a spanner socket (Tool No. 7445) or other suitable tool to remove the retainers. Remove valve plungers (4), then force directional valve needles (6) and "O" rings (5) from valve body with a small punch.

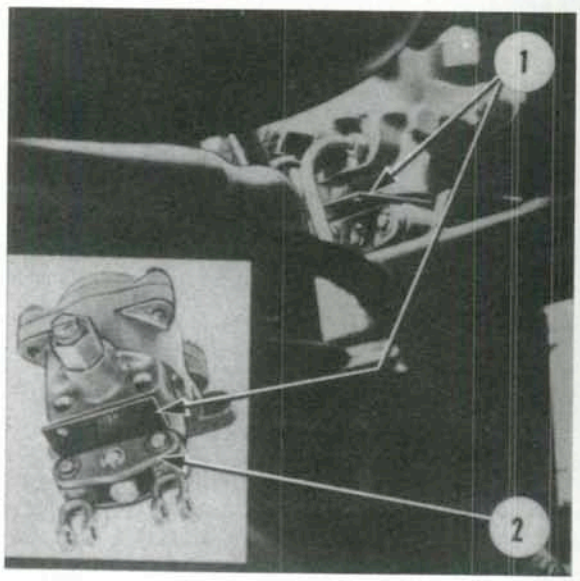


Fig. 246—View of Ford brake adjusting tool No. 7446 (1) installed between rocker arm links (2) and valve body. See text for brake adjustment on Model TW-35.

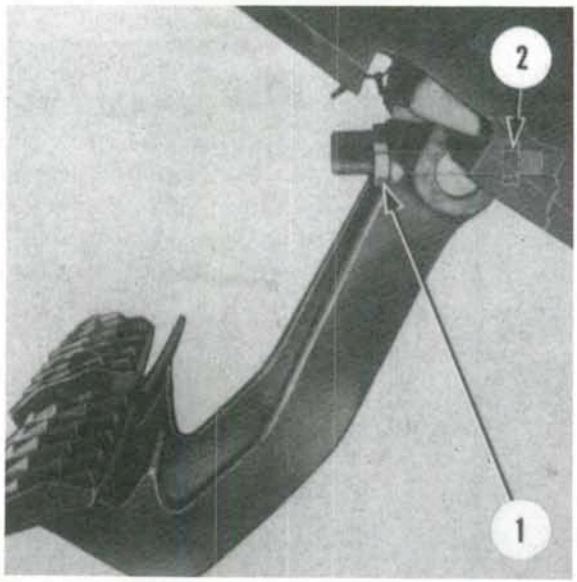


Fig. 247—Model TW-35 brake pedal adjustment points.

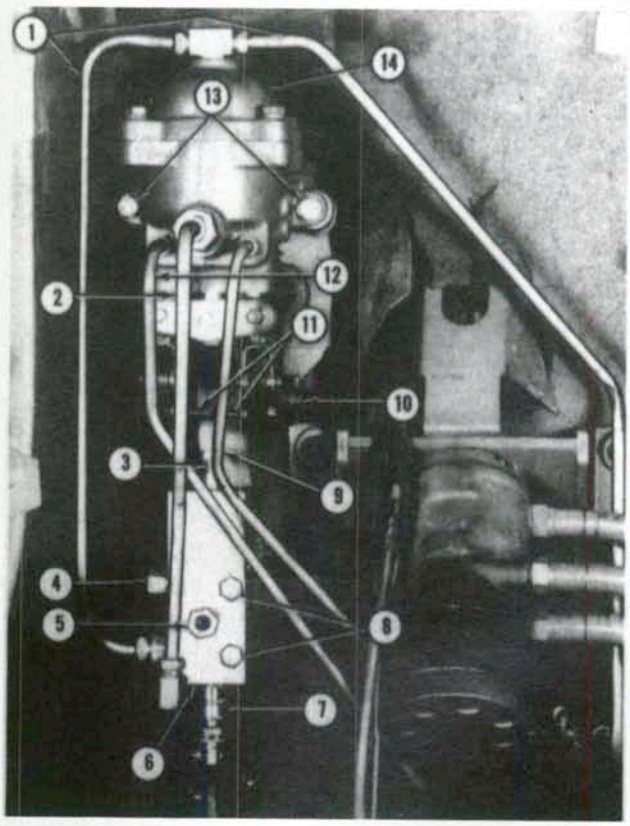


Fig. 248—View of power brake valve and differential lock valve on Model TW-35.

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 assy.

Inspect all parts for excessive wear, scoring or other damage and renew as necessary.

During reassembly, apply two or three drops of a suitable thread locking sealer to threads of retainers (3), making sure no sealer contacts plungers (4) or inside diameter of retainers. Remainder of reassembly procedure is reverse of disassembly procedure.

Install brake valve and bleed brakes as outlined in paragraph 178. Adjust brakes as outlined in paragraph 177.

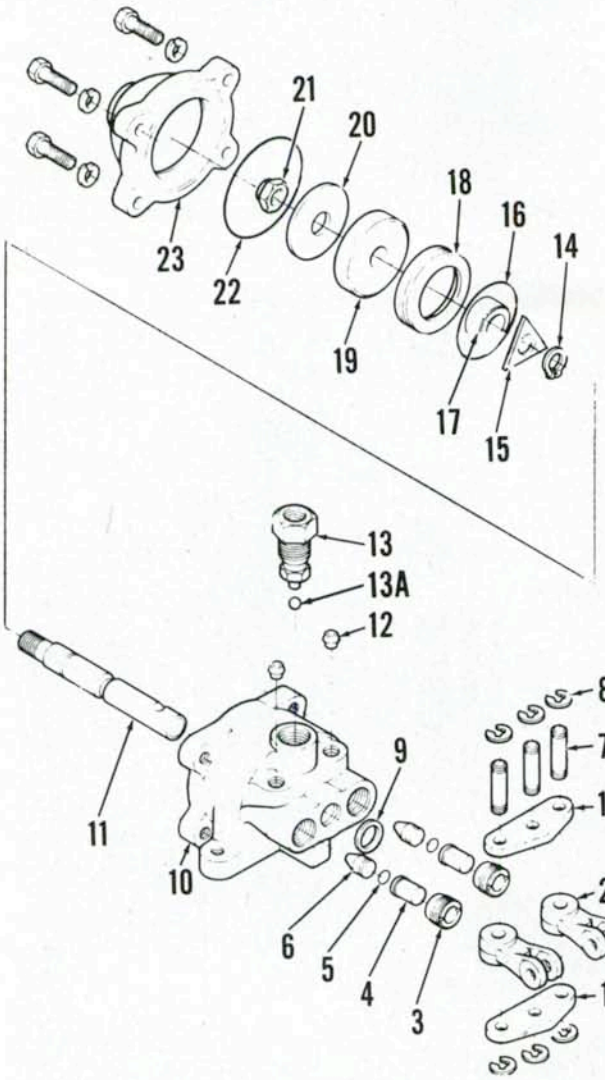


Fig. 249—Exploded view of power brake valve used on Model TW-35.

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. Locknut
22. "O" ring
23. Valve housing cap

All Models

180. 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 171. The brake discs can then be removed as shown in Fig. 250. Use compressed air at brake line pressure port, if necessary, to remove brake piston (13) from axle center housing.

IMPORTANT: Clean brake discs and piston with mineral spirits or kerosene. Use of any other solvents may cause premature wear, deterioration or flaking of brake friction material.

Inspect piston for warpage, scoring or cracks. If piston is serviceable, renew inner and outer seal rings. Inspect brake plates (9 and 11—Fig. 250) for warpage or wear. Renew plates that are warped more than 0.004 inch (0.10 mm). Place brake disc (10) between brake plates. Use a feeler gage to measure clearance between discs and plates. Renew discs if clearance at any point exceeds 0.010 inch (0.25 mm). Place a straightedge across both sides of brake discs to check that splines are clear of straightedge. Renew discs if splines contact straightedge on either side.

To reassemble, lubricate brake piston and seal rings and install in axle center housing being careful not to damage seal rings. Assemble brake discs and plates on locating pins (17—Fig. 250), then reinstall rear axle and final drive assembly by following procedure outlined in paragraph 171.

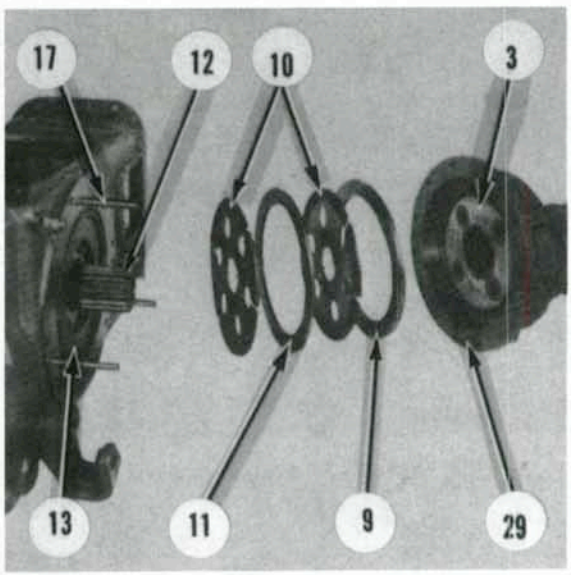


Fig. 250—View of Model TW-35 brake components. A single brake disc (10) is used on Models TW-5, TW-15 and TW-25.

3. Planetary carrier
9. Outer brake plate
10. Brake discs
11. Inner brake plate
12. Sun gear
13. Brake piston
17. Locating pins
29. Rear axle housing

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. The pto clutch input shaft is driven by a splined hub in center of the engine flywheel. The pto clutch output shaft drives reduction gears located in rear compartment of axle center housing to provide both 540 and 1000 rpm output shaft speeds on Models TW-5, TW-10 and TW-15. On Model TW-35, 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 tractors, a 21-spline 1000 rpm output shaft is used. On all models, the output shaft supports the reduction gears and acts as a bearing surface.

IMPORTANT: The tractor must not be operated without pto output shaft in place. Severe damage may be caused if driven gears are not supported by the output shaft.

Hydraulic oil is supplied to pto clutch control valve from the gerotor pump (low pressure), which is mounted on rear end of front transmission.

TROUBLE-SHOOTING

181. When trouble-shooting pto malfunctions, refer to the following:

1. PTO CLUTCH WILL NOT ENGAGE. Could be caused by:
   a. Pto control linkage broken, disconnected or improperly adjusted.
   b. Pto actuating arm in center housing disengaged from control valve spool.
   c. Failure of low pressure hydraulic pump or relief valve.
   d. Extremely cold oil in rear axle center housing.

2. PTO STOPS UNDER LOAD. Could be caused by:
   a. Pto system pressure too low due to worn pump or leaking pump relief valve.
   b. Pto clutch plates worn or damaged.

3. PTO WILL NOT STOP. Could be caused by:
   a. Extremely cold hydraulic oil.
   b. Pto control linkage disconnected or improperly adjusted.
   c. Pto actuating arm in center housing disengaged from control valve spool.
   d. Pto clutch plates warped or damaged.
   e. Pto brake pads worn.
   f. Cut, broken or missing "O" ring on pto brake piston.

4. PTO SYSTEM PRESSURE TOO LOW (WARNING LIGHT ILLUMINATES). Could be caused by:
   a. Low pressure hydraulic system pressure control valve spool stuck open or springs broken or weak.
   b. Brake priority valve spool stuck closed (Model TW-35).
   c. Low pressure hydraulic pump defective.
   d. Low pressure pump oil pickup tube seal damaged.
   e. Cut or broken "O" rings on pto clutch piston.
   f. Worn or broken seal rings on pto clutch support.
   g. Pto pressure regulating valve stuck open.
   h. Leak in differential lock or Dual Power system.

PRESSURE TEST

182. To check pto and differential lock system pressure, first operate tractor until oil in rear axle housing is at normal operating temperature. Stop engine and connect a 0-500 psi (0-3500 kPa) pressure gage at tee fitting on pto supply tube (Fig. 251). Start engine and set engine speed at about 1000 rpm; pressure gage reading should be 185-220 psi (1275-1515 kPa). Increase engine speed to 2200 rpm; pressure reading must be 185-235 psi (1275-1620 kPa).

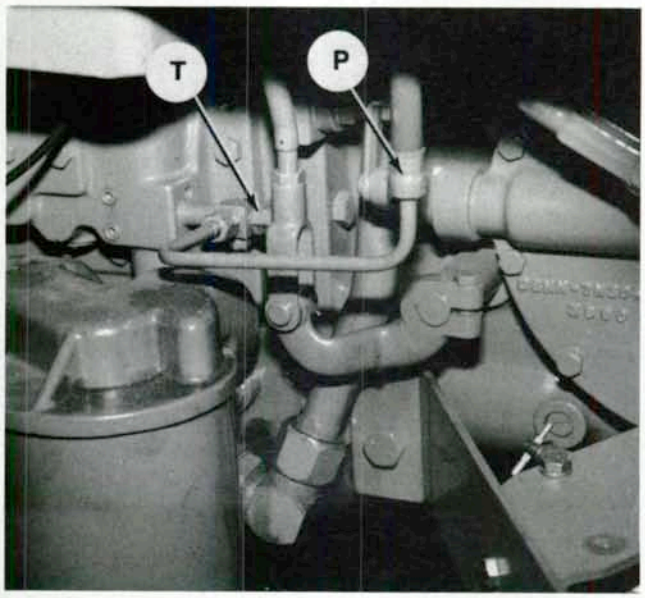


Fig. 251—Pto system pressure can be checked at tee fitting (T) on pto supply tube (P).

CONTROL LINKAGE ADJUSTMENT

183. To adjust pto control rod, refer to Fig. 252 and place pto control handle (1) in OFF position. Adjust turnbuckle (T) so control handle is 4 inches (102 mm) from front of slot (2) in control console.

R&R AND OVERHAUL

184. PTO UPPER (CLUTCH OUTPUT) SHAFT AND REDUCTION GEARS. To remove pto clutch output shaft and drive gears, first remove hitch top link from top link bracket. Unbolt and remove top link bracket (8—Fig. 253) along with drive gear (5), bearings and upper shaft (1) as a unit from rear axle center housing. Remove snap ring (2—Fig. 254) from upper shaft, then remove shaft from rear bearing and drive gear. Be sure to retain any shims (3) that may be located between gear and snap ring.

To remove pto output shaft (19) and driven gears (11 and 13), first remove swinging drawbar and drain oil from rear axle center housing. Remove cover from bottom of rear axle center housing. Remove safety cap (23) and retaining ring (18), then withdraw output shaft. Unbolt and remove output shaft bearing retainer (22). Support driven gears and remove sleeve (14) bearing (15) assembly. The driven gears (11 and 13) can then be removed from bottom of rear axle center housing.

NOTE: On dual speed models, there are two drive and driven gears while there is only one drive and driven gear on 1000 rpm only models. Spacer (12) is used in place of 540 rpm drive gear (11) on single speed models.

Inspect needle bearing (9), located in blind hole in rear axle center housing, and renew if worn or damaged. Bearing (15) can be pressed from sleeve (14) after removing snap ring (16). Renew "O" ring (17) in sleeve. Renew oil seal (20) in bearing retainer (22).

To reassemble, stick thrust washer (10) in place against front needle bearing using grease. Press rear bearing (15) onto sleeve (14) and secure with snap ring.

On dual speed models, pilot the 1000 rpm driven gear (13) onto hub of 540 rpm gear (11) with a thrust washer (10) between them, then position gears in housing. On 1000 rpm only models, install a thrust washer (10) in spacer (12) and install spacer and driven gear (13) in housing so concave side of gear is next to spacer.

On all models, insert a thrust washer (10) between sleeve (14) and gear (13) and install sleeve and rear bearing assembly. Lubricate oil seal (20) and install retainer (22) with new gasket. Tighten retainer cap screws to a torque of 35 ft.-lbs. (47 N·m). Install output shaft (19) and secure with snap ring.

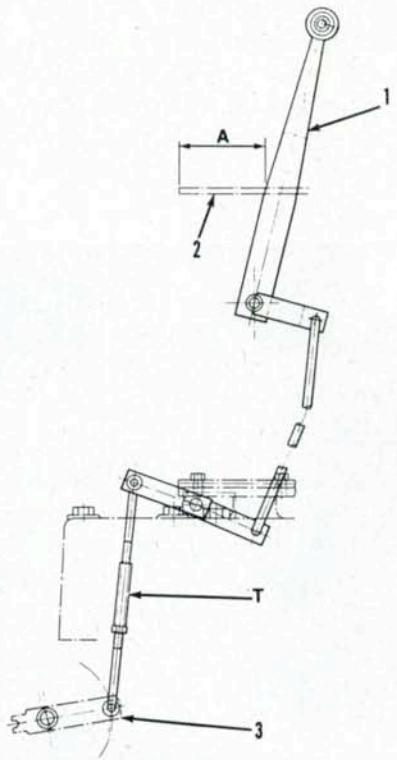


Fig. 252—View showing adjustment points for pto control linkage.

A. 4 inches (102 mm)
T. Turnbuckle
1. Control lever
2. Console slot
3. Pto control arm

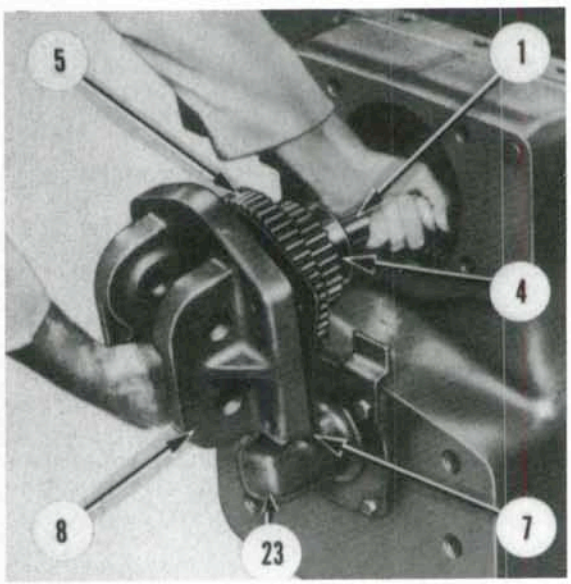


Fig. 253—View showing removal of pto upper shaft and drive gear assembly.

1. Pto upper shaft
4. Front bearing
5. Drive gear assy.
8. Top link bracket & bearing retainer
23. Pto output shaft cap

Install bearings (4 and 6) on drive gear (5). Insert drive shaft (1) in gear using same thickness of shims as removed on disassembly and secure with snap ring (2).

NOTE: If upper drive shaft, bearings and/or drive gears have been renewed, drive shaft end play should be checked as outlined in paragraph 185. End play is controlled by shims (3).

Position retainer bracket (8) with new gasket on drive shaft rear bearing, then install assembly in rear axle housing. Tighten retaining cap screws to a torque of 80 ft.-lbs. (108 N·m).

185. CLUTCH SHAFT END PLAY. End play of clutch output shaft (1—Fig. 254) should be 0.001-0.029 inch (0.03-0.74 mm) and is controlled by shims (3) placed between rear snap ring (2) and shoulder on pto drive gear (5). Shaft end play should be checked and adjusted, if necessary, whenever upper shaft, bearings, drive gear and/or clutch are renewed.

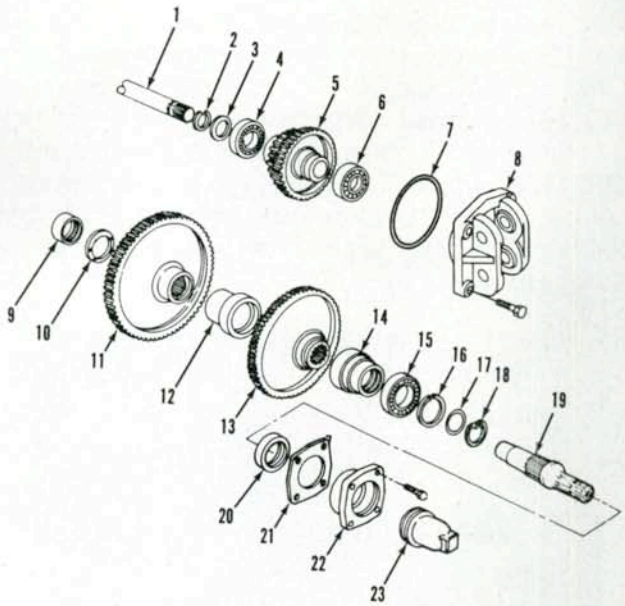


Fig. 254—Exploded view showing pto reduction gears, clutch output shaft and pto output shaft. On 1000 rpm models only, drive gear (5) is a single gear and spacer (12) is used in place of 540 rpm driven gear (11).

1. Clutch output (upper) shaft
2. Snap ring
3. Shims
4. Bearing
5. Drive gear
6. Bearing
7. Gasket
8. Bearing retainer
9. Needle roller bearing
10. Thrust washer (3 used)
11. 540 rpm driven gear
12. Spacer (1000 rpm only)
13. 1000 rpm driven gear
14. Bearing sleeve
15. Bearing
16. Retaining ring
17. "O" ring
18. Retaining ring
19. Pto output shaft
20. Oil seal
21. Gasket
22. Bearing retainer
23. Safety cap

If hydraulic lift cover is removed, end play can be checked by pushing shaft forward and measuring gap between snap ring and drive gear hub with a feeler gage. If end play is not within specified limits, remove the shaft and gear assembly and install shims as necessary. Be sure that bearing retainer cap screws are tightened to a torque of 80 ft.-lbs. (108 N·m) when making end play check.

If the hydraulic lift cover is not removed, end play may be checked as follows: With bearing retainer, gears and shaft removed as outlined in paragraph 184, install shims approximately 0.125 inch (3 mm) thick onto shaft. Reinstall the assembly without a mounting gasket (7) and tighten retaining cap screws gradually until snap ring just contacts clutch housing and there is no end play of shaft. Measure gap between bearing retainer and rear axle center housing using a feeler gage. Remove drive gear and shaft assembly. Use a micrometer to measure thickness of test shim pack and a new mounting gasket, and add the two measurements together. From this combined thickness, subtract measured gap plus an additional 0.001-0.029 inch (0.03-0.74 mm). The result is shim pack thickness required to provide specified end play.

For example: If combined test shim pack thickness and gasket thickness was 0.140 inch (3.56 mm) and gap between retainer and housing was 0.045 inch (1.14 mm), resulting value would be 0.095 inch (2.41 mm). Desired shim pack thickness would be 0.001 to 0.029 inch (0.03-0.74 mm) less than this value, 0.066-0.094 inch (1.68-2.39 mm).

Assemble selected shim pack on shaft, then reinstall shaft, drive gear and retainer assembly with a new gasket in rear axle center housing. Tighten retaining cap screws to a torque of 80 ft.-lbs. (108 N·m).

186. PTO OUTPUT SHAFT. The pto output shaft (19—Fig. 254) can be withdrawn after removing safety cap (23) and retaining snap ring (18).

When installing output shaft, be sure that sealing "O" ring (17) is in proper groove as shown in Fig. 255 and that bearing surfaces of shaft are not scored.

187. R&R PTO CLUTCH AND VALVE ASSEMBLY. To remove pto clutch and valve assembly, separate tractor between transmission and rear axle center housing as outlined in paragraph 162.

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 (42—Fig. 258) and shift fork (44) cannot easily be seen for alignment.

Remove hydraulic lift cover, if desired, from center housing as outlined in paragraph 207 or 243. Remove pto drive hub (2) and thrust washer (3). Dis-

connect pto lubrication line (L—Fig. 256) from fitting on wall of center housing. Disconnect pto pressure line (H) from control valve (V). Remove shoulder bolt (1—Fig. 257), over-center spring (2), locating pin (6) and stop pin (3) from pto control linkage. Turn control valve lever (49) so shift fork will be released from control valve spool.

On Models TW-5, TW-15 and TW-25, slide pto clutch and valve assembly forward off shaft and remove from center housing.

On Model TW-35, remove 3-point hitch top link from top link bracket. Remove retaining cap screws from top link bracket, then withdraw bracket and clutch output (upper) shaft assembly from rear axle center housing while supporting clutch assembly. Turn and slide pto clutch (P—Fig. 256) and control valve forward past the hydraulic pump gear (G) and out center housing opening.

To reinstall pto clutch assembly, reverse removal procedure. Be sure that clutch assembly is pushed fully rearward on pto upper shaft. Rotate the assembly until control valve spool engages shift arm. If hydraulic lift cover was not removed, a mirror and long wire may be needed to aid in alignment of valve spool with shift arm. Finger tighten locating pin (6—Fig. 257), connect pto lube line (L—Fig. 256) and pressure supply line (H), then tighten locating pin to a torque of 82 ft.-lbs. (110 N·m). On TW-35 tractor, tighten pto clutch upper shaft bearing retainer cap screws to a torque of 80 ft.lbs. (108 N·m).

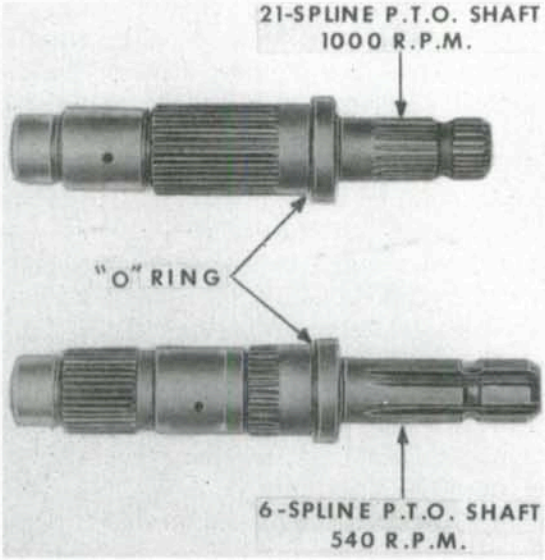


Fig. 255—View showing 1000 rpm output shaft (top) and 540 rpm output shaft (bottom). Note location for sealing "O" ring.

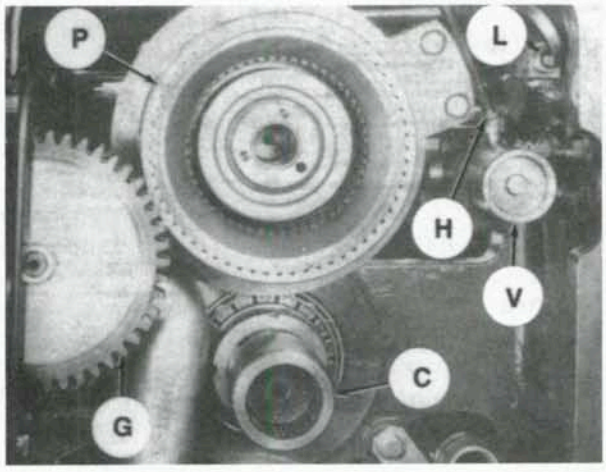


Fig. 256—Pto clutch assembly is located in front of rear axle center housing.

C. Coupler
G. Hydraulic pump gear
H. Pto pressure line
L. Pto lubrication line
P. Pto clutch assy.
V. Pto control valve

188. OVERHAUL PTO CLUTCH AND CONTROL VALVE ASSEMBLY. To disassemble pto clutch unit, refer to Fig. 258 and remove brake pad bolts, brake pads (16 and 18) and spacers (19). Remove clutch pack assembly and brake disc (20) from support (21). Unbolt and remove control valve (40) from support. Use compressed air to remove brake piston (22) from support. Remove clutch plate retaining ring (6) and separate clutch components from clutch housing (15).

TW-5, TW-15 and TW-25 tractors have five internally splined friction drive plates (8), nine externally splined driven plates (9) and a feathering spring (10). TW-35 tractor has four internally splined friction drive plates and four externally splined driven plates secured by four retaining pins (1). Feathering spring (10) is not used on TW-35.

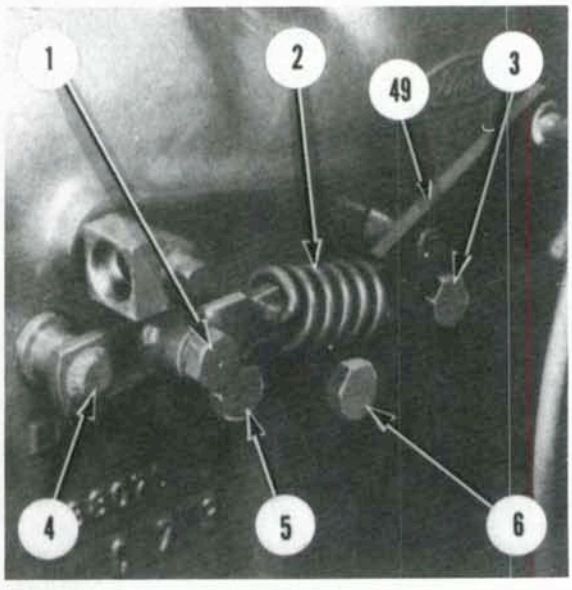


Fig. 257—View of pto shift mechanism located on left side of rear axle center housing.

1. Shoulder bolt
2. Over-center spring
3. Valve spool limiting bolt
4. Shift fork shoulder bolt
5. Locating bolt
6. Locating pin

Using Ford tool No. 1312, or other horseshoe shaped tool, compress piston return spring as shown in Fig. 259 and remove retaining ring (4). Release spring pressure and remove spring retainer (5—Fig. 258) and piston return spring (11). Apply compressed air to port between front and center seal ring grooves in clutch housing hub to unseat piston (13) from housing.

Refer to Fig. 258 for exploded view of control valve assembly. To disassemble, withdraw control valve spool (42), pressure regulating valve spring (39) and rod (38). Remove retaining ring (31) and withdraw regulating valve guide (33), return spring (36) and pressure regulating valve spool (37).

Inspect and renew any components that have excessive wear or damage. Renew all seals and "O" rings.

Lubricate all parts with hydraulic fluid before reassembly. Install new seal rings (12 and 14) in clutch piston. Carefully install piston in clutch housing and secure with retainer and snap ring after compressing clutch spring as shown in Fig. 259.

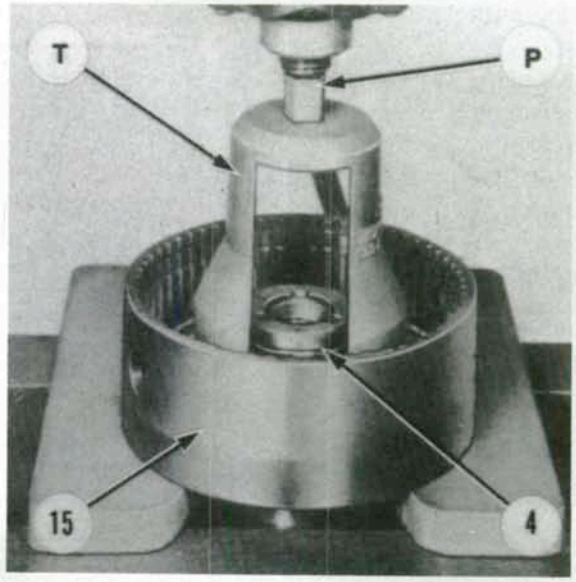


Fig. 259—Use Ford tool No. 1312, or other suitable horseshoe shaped tool, to compress piston return spring so snap ring (4) can be removed.

P. Press
T. Tool No. 1312
4. Retaining ring
15. Pto clutch housing

1. Retaining pin (TW-35)
2. Drive hub
3. Thrust washer
4. Retaining ring
5. Spring retainer
6. Retaining ring
7. Pressure plate
8. Internal spline discs
9. External spline discs
10. Feathering spring (TW-5, TW-15 & TW-25)
11. Piston return spring
12. Seal ring
13. Piston
14. Seal ring
15. Clutch housing
16. Brake pad
17. Brake pad spring
18. Brake pad
19. Spacers
20. Brake rotor
21. Support housing
22. Brake piston
23. Seal
24. Ball
25. Elbow
26. Snap ring
27. Support bearings
28. Seals
29. Snap ring
30. Output shaft
31. Snap ring
32. "O" ring
33. Valve guide
34. Ball
35. Valve seal
36. Return spring
37. Pressure regulator valve
38. Push rod
39. Valve spring
40. Valve body
41. Gasket
42. Control valve spool
43. Lubrication tube
44. Shift fork
45. "O" ring
46. Stop pin
47. Bushing
48. Seal
49. Shift lever
50. Over-center spring
51. Bushing
52. Bellcrank
53. Locating pin

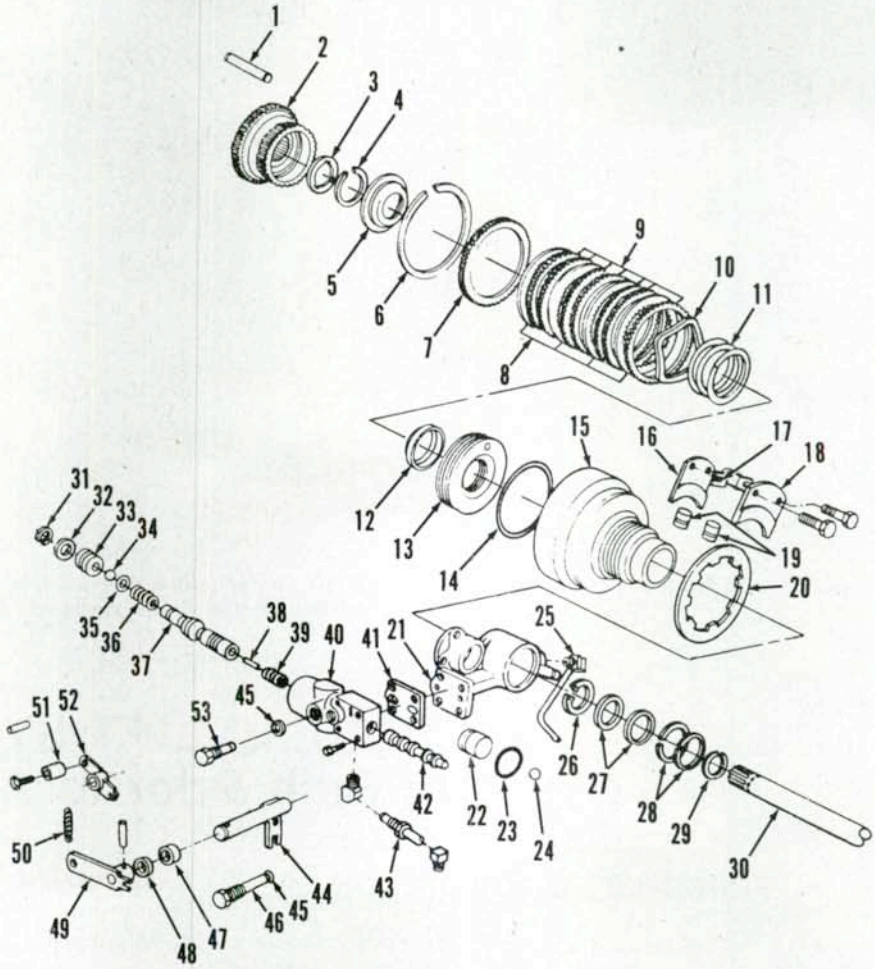


Fig. 258—Exploded view of pto clutch, brake and control valve assembly used on Models TW-5, TW-15 and TW-25. Model TW-35 pto unit is similar except that four internally splined drive discs and four externally grooved driven discs secured with four retaining pins (1) are used, and feathering spring (10) is not used.

Beginning with a steel driven plate (9), assemble clutch pack in clutch housing, alternating friction drive plates (8) and steel driven plates. Note that two steel driven plates are installed between friction drive discs on Models TW-5, TW-15 and TW-25 as shown in Fig. 260. On Model TW-35, be sure that clutch plate retaining ring (6—Fig. 258) is positioned to cover the four retaining pin grooves in clutch housing and ends of ring are located around stop pin in housing to prevent ring from rotating.

Install brake piston (22—Fig. 258) with new seal ring (23) in support (21). Place brake disc (20) on clutch housing, then assemble clutch housing to support. Install brake pads, spacers and spring and tighten retaining cap screws securely.

Assemble pressure regulating valve (37) and control valve spool (42) in control valve body. Attach pto control valve assembly to support. Tighten retaining screws evenly to a torque of 18 ft.-lbs. (24 N·m).

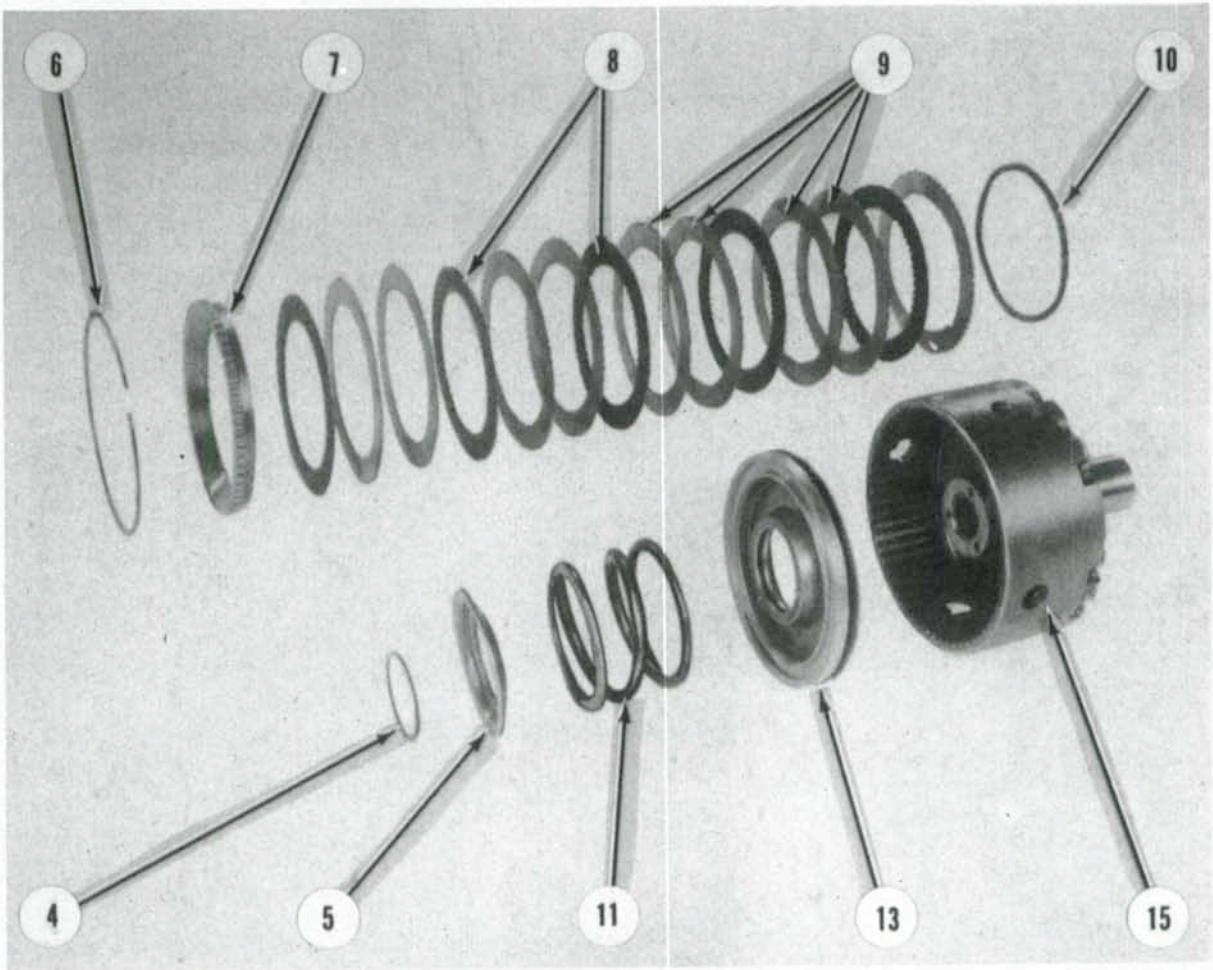


Fig. 260—On Models TW-5, TW-15 and TW-25, two externally splined driven plates (9) are installed between internally splined friction drive plates (8).

HYDRAULIC LIFT SYSTEM (Tractors Built Prior to April 1985)

PRINCIPLES OF OPERATION

190. 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. Fluid for the system is common with transmission and differential lubricant. Hydraulic power is supplied by a gear type pump that is mounted in right side of rear axle center housing. Pump is driven by a gear machined on pto clutch input hub. Various control valves, circuit relief valves and check

valves control flow of hydraulic fluid and protect system from overload conditions.

Refer to Fig. 265 for a schematic diagram of hydraulic system with control valve in neutral position. Pump pressure oil flows across system relief valve (6) first, then on to the remote control valves (4). The remote valves, when used, take priority over hydraulic lift system. Oil flow is then directed back to pump cover (8) and passes across flow control valve (7), which returns oil to sump through filter (10) when control valve (14) is in neutral or lowering position. Oil is trapped in the lift cylinder (16) by spring loaded drop valve (15).

When control valve (14) is placed in raising position (moved outward), pressure is directed to pilot circuit (13). Pilot pressure moves flow control valve to the left, closing return to sump passage and directing pressure fluid flow to check valve (11), drop valve (15) and lift cylinder (16). Pilot oil pressure combined with spring pressure holds exhaust valve (12) closed when control valve is in raise position.

When control valve (14) is placed in lowering position (moved inward), oil supply to pilot circuit is shut off, flow control valve opens and pump flow is directed to sump. Drop valve (15) is forced open by the control valve, allowing fluid in lift cylinder to return to sump past the exhaust valve (12). The exhaust valve automatically restricts return oil flow in proportion to the amount of pressure in lift cylinder, thus maintaining a controlled drop rate under all lift linkage load conditions.

The manually operated variable flow valve (9) is used to restrict fluid flow to lift cylinder pressure line, causing flow control valve to direct part of pump flow to sump. Thus, rate of lift can be varied, depending upon position of variable flow valve. When control valve lever is placed in full raise position, override linkage moves variable flow valve to full flow

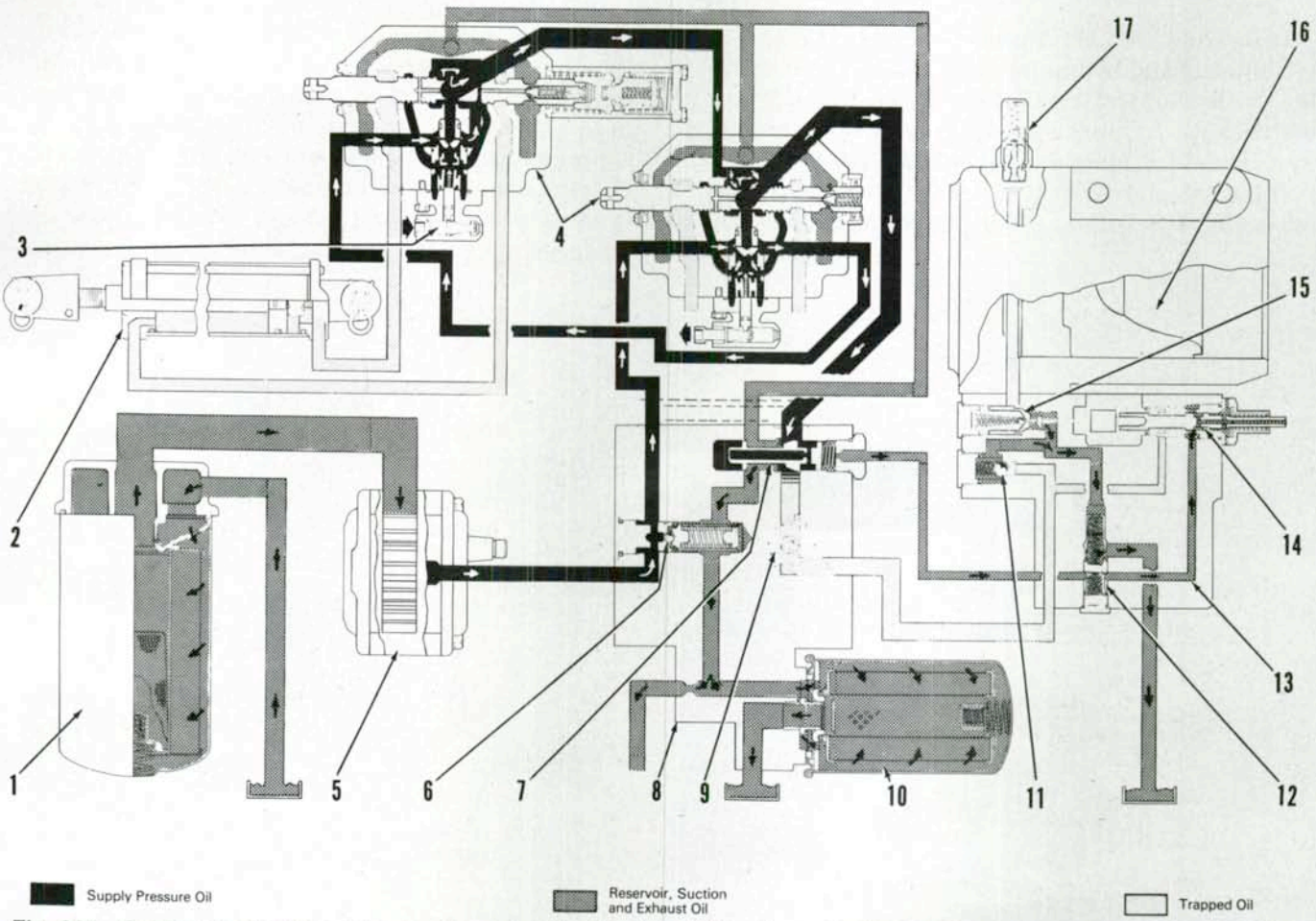


Fig. 265—Schematic diagram of hydraulic system for tractors built prior to April 1985. Diagram shows system in neutral position. In this system, the remote control valves (4), when used, take priority over hydraulic lift circuit.

1. Intake filter
2. Remote cylinder
3. Remote flow valve
4. Remote control valves
5. Hydraulic pump
6. System relief valve
7. Flow control valve
8. Pump adapter plate
9. Variable flow valve
10. Return filter
11. Check valve
12. Exhaust valve
13. Pilot pressure line
14. Control valve
15. Drop valve
16. Lift cylinder
17. Lift cylinder safety valve

position. After raising, variable flow valve returns to previously set flow rate.

The lift system is provided with position control and automatic draft control. A selector lever on operator's console controls position of selector shaft (Fig. 266), which moves rear end of actuating rod attached to control valve lever to position control (top view) or draft control (bottom view) position. Also, detent positions between full position control and full draft control provide varying degrees of draft control.

Automatic draft control is provided by lower link sensing through a torsion bar and control linkage. See Fig. 267. When selector lever is in draft control position, lift control valve position is controlled by draft on lower links. An increase or decrease in draft on lower links rotates lift link hangers against tension of torsion bar, thus rotating draft control lever which actuates lift control valve to raise or lower implement.

HYDRAULIC FLUID AND FILTERS

191. Fluid used in transmission and rear axle center housing and hydraulic system must be compatible with the wet type disc brakes, Dual Power clutches, pto clutch and differential lock clutch. Recommended lubricant is Ford M2C134-C fluid.

Transmission/rear axle oil capacity (less Dual Power) is 18.2 U.S. gallons (69 liters) for all models. Oil capacity for tractors (except Model TW-35) with Dual Power is 20 U.S. gallons (76 liters). Model TW-35 oil capacity is 23 U.S. gallons (87 liters). On all models equipped with front wheel drive, increase oil capacity by 5-1/2 U.S. quarts (5.2 liters).

Hydraulic/transmission fluid should be drained and new fluid installed after each 1200 hours of service or yearly, whichever comes first. Before draining fluid, operate tractor to warm oil to operating temperature and be sure that 3-point lift arms are lowered. Fluid level should be maintained at FULL mark on dipstick located at left rear side of lift cover. Check fluid level with tractor level, with 3-point hitch lift arms in raised position and any remote cylinders extended.

Hydraulic system oil filters (1 and 2—Fig. 268) should be renewed after every 300 hours of operation.

TROUBLE-SHOOTING

192. The following are symptoms which may occur during the operation of hydraulic lift system and their possible causes. Use this information in conjunction with testing and adjusting information outlined in this section when servicing hydraulic system. As a preliminary step in trouble-shooting procedure, check the most obvious areas first, such as damaged or misadjusted external linkage, incorrect hydraulic oil level, plugged hydraulic filters or external oil leaks.

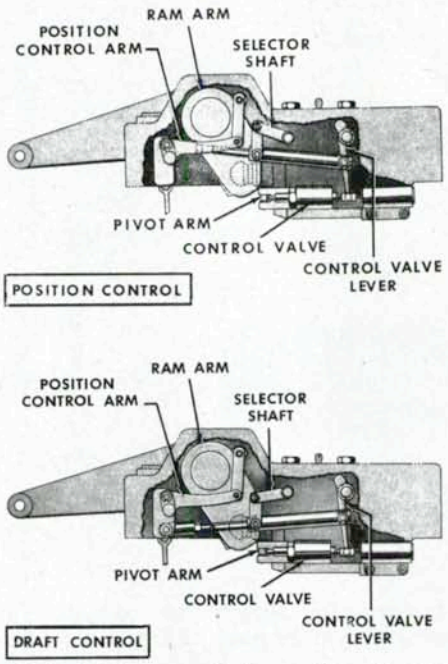


Fig. 266—Selector lever controls position of selector shaft which moves rear end of actuating rod attached to control valve lever to position control or draft control. Also, detent positions between full position control and full draft control provide varying degrees of draft control.

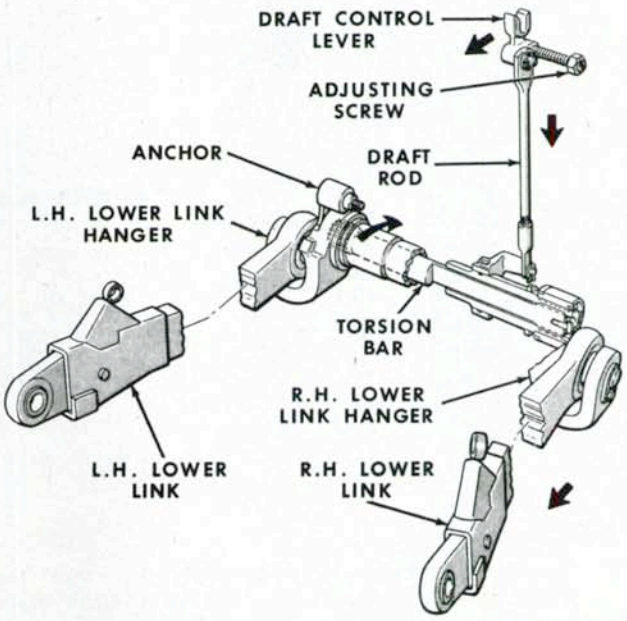


Fig. 267—Automatic draft control is provided by lower link sensing through draft control torsion bar and control linkage. Draft on lower links rotates lift link hangers against tension of torsion bar, thus rotating draft control lever which is connected to lift control valve.

1. FAILURE TO LIFT UNDER ALL CONDITIONS. Could be caused by:
   a. Flow control valve stuck in open position.
   b. Faulty hydraulic pump or relief valve.
   c. Control linkage damaged or disconnected.
   d. Leak in pump suction (intake) pipe.
   e. Sticking or improperly installed exhaust pressure valve.

2. FAILURE TO LIFT UNDER LOAD. Could be caused by:
   a. Faulty hydraulic pump.
   b. System pressure relief valve opening at too low a pressure.
   c. Safety relief valve faulty.
   d. Exhaust pressure valve sticking.
   e. "O" ring seals damaged or missing in hydraulic pump inlet or outlet port.
   f. "O" ring seals damaged or missing between control valve body and lift cylinder.
   g. Damaged lift piston seal.
   h. Flow control valve incorrectly sized to pump cover bore.

3. OCCASIONALLY FAILS TO LIFT NOT DUE TO OVERLOADING. Could be caused by:
   a. Flow control valve spool sticking occasionally.
   b. Exhaust pressure valve sticking occasionally.

4. EXCESSIVE LIFT CORRECTIONS (WILL NOT HOLD LOAD AFTER STOPPING ENGINE). Could be caused by:
   a. Lift drop poppet leaking.
   b. Lift piston seal leaking.
   c. "O" ring seals between control valve body and cylinder leaking.
   d. Safety valve leaking.

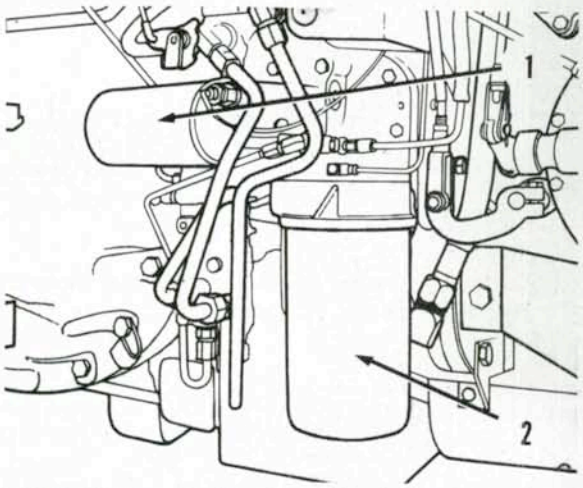


Fig. 268—Hydraulic oil return filter (1) and suction filter (2) should be changed after every 300 hours of operation.

5. LIFTS TOO SLOWLY. Could be caused by:
   a. Lift control linkage improperly adjusted.
   b. Flow control valve scored, sticking or not properly fit in valve bore.
   c. Faulty hydraulic pump.
   d. Variable flow control valve stuck in slow lift position.

6. NO DRAFT RESPONSE. Could be caused by:
   a. Draft control linkage out of adjustment.
   b. Roller disengaged from draft sensing yoke.

7. OVERCORRECTS IN DRAFT CONTROL. Could be caused by:
   a. Lift control valve improperly adjusted.
   b. Binding draft control linkage.

HYDRAULIC TESTS

193. RELIEF VALVE PRESSURE TEST. Hydraulic system relief pressure should be 2450-2550 psi (16895-17580 kPa) for all models.

To check system pressure, connect a 0-5000 psi (0-35000 kPa) pressure gage into Raise coupler of a remote valve as shown in Fig. 269. Start engine and set speed at 1400 rpm for TW-5, TW-15 and TW-25 tractors, or 1200 rpm for TW-35 tractor. Move and hold remote valve control lever in Raise position and observe pressure gage reading.

If tractor is not equipped with remote control valves, the manifold plate (1—Fig. 272) on top of pump adapter plate can be modified as shown in Fig. 270 and a test gage installed as shown in Fig. 271 to check system pressure. Insert test gage return hose

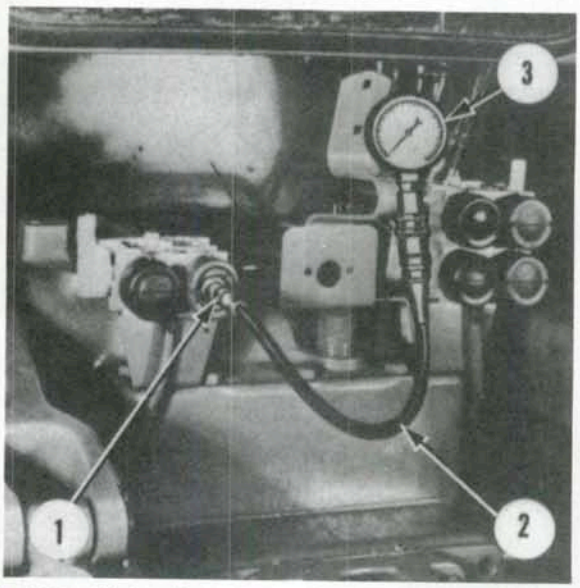


Fig. 269—Hydraulic system relief valve opening pressure can be checked by connecting a pressure gage (3) to remote valve (1) as shown.

in rear axle housing oil filler plug opening, open shut-off valve and start engine. Close shut-off valve only long enough to observe pressure reading. After checking system pressure with modified manifold, either install a new manifold or close external opening in manifold with a pipe plug.

If pressure setting is not within specifications, pressure can be adjusted by adding or removing shims (5—Fig. 272) between relief valve body cap and spring. To remove relief valve, first disconnect differential lock pedal linkage (TW-5, TW-15 and TW-25 tractors only) from actuating rod (13). Unscrew differential lock valve guide cap (14) and remove actuating rod to provide access to relief valve body (11). Unscrew relief valve from pump cover. Remove snap ring (3) to disassemble valve.

Every 0.010 inch (0.25 mm) change in shim thickness will change relief valve pressure setting approximately 100 psi (700 kPa). Maximum allowable shim pack thickness is 0.080 inch (2 mm). If specified system relief pressure cannot be obtained with maximum thickness of shims installed, relief valve ball and seat are not sealing properly or a worn hydraulic pump should be suspected.

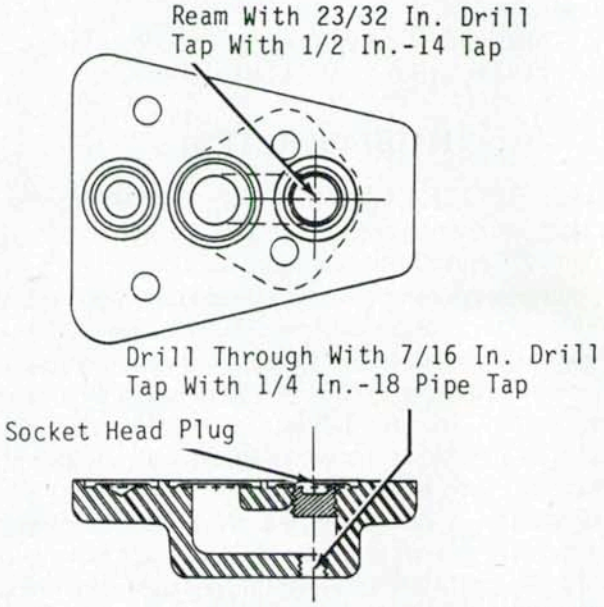


Fig. 270—On tractors not equipped with remote control valve, pump manifold plate can be modified as shown to permit installing a pressure gage for checking hydraulic system relief pressure and flow.

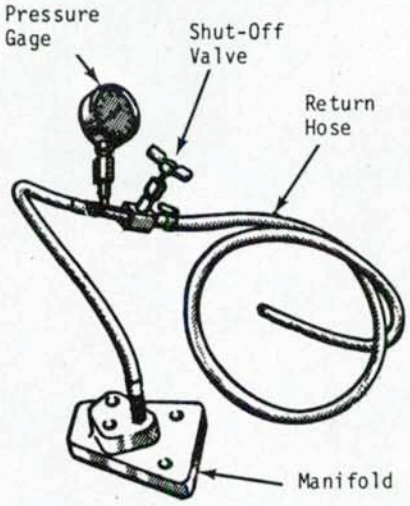


Fig. 271—With manifold on top of pump adapter plate modified as shown in Fig. 270, connect pressure gage and shut-off valve to manifold and insert return hose through filler opening in lift cover.

194. PUMP FLOW RATE TEST. The hydraulic pump used on TW-5, TW-15 and TW-25 tractors is rated at 15.3 U.S. gallons/minute (58 liters/minute) at a pressure of 2500 psi (17240 kPa) and engine speed at 2200 rpm. On Model TW-35, pump is rated at 20 U.S. gallons/minute (75 liters/minute) at a pressure of 2500 psi (17240 kPa) and engine speed at 2200 rpm.

The output of hydraulic pump can be checked using a suitable hydraulic flow meter connected to an outlet of remote control valve. If tractor is not equipped with remote control valves, the manifold

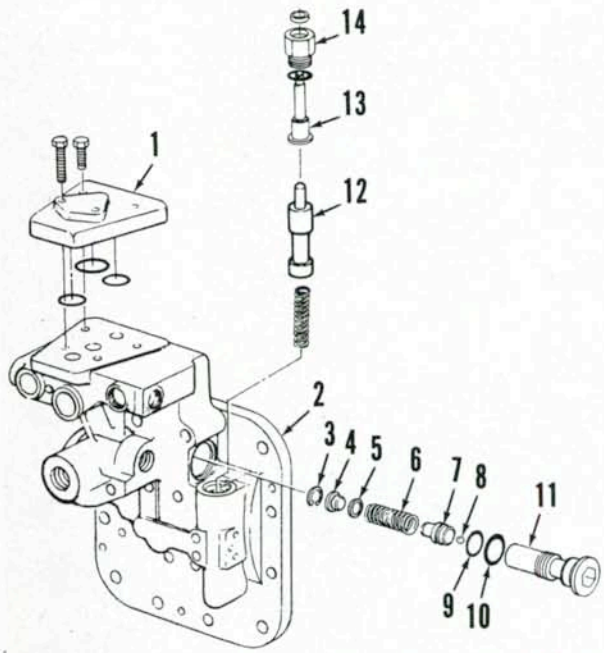


Fig. 272—Exploded view of differential lock valve and hydraulic system pressure relief valve.

1. Manifold plate
2. Pump adapter plate
3. Snap ring
4. Spring seat
5. Shim
6. Spring
7. Ball retainer
8. Ball
9. "O" ring
10. "O" ring
11. Relief valve body
12. Differential lock valve
13. Valve actuating rod
14. Guide cap

plate (1—Fig. 272) on top of pump adapter plate can be modified as shown in Fig. 270 and flow meter inlet hose installed in tapped hole in the plate. Insert flow meter return hose in rear axle housing oil filler plug opening. Be sure the return hose is securely fastened in filler opening to prevent it from coming out during flow test.

Fully open flow meter load valve, then start engine and operate until hydraulic fluid temperature is approximately 120° F (50° C). Set engine speed at 2200 rpm and manually hold remote control valve lever to direct pump flow to flow meter. Record flow meter reading under no load (pressure), then slowly close flow meter load valve until pump pressure reaches 2200 psi (15170 kPa) and record flow meter reading.

To calculate percentage of pump efficiency, divide flow reading under pressure by flow reading with no pressure and multiply the result by 100. If pump efficiency is less than 80 percent, pump is excessively worn or damaged and should be overhauled or renewed. Example: Flow under pressure is 14 U.S. gpm (53 lpm) and flow with no pressure is 15.5 U.S. gpm (58.7 lpm); 14 divided by 15.5 equals .90, multiplied by 100 equals 90 percent efficiency.

ADJUSTMENTS

NOTE: The adjustments outlined in following paragraphs 195 through 198 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.

195. LOWER LINK HANGER STOP. An adjustable eccentric stop (Fig. 273) is located behind left-hand lift link hanger to limit rearward movement of hanger and twist of torsion bar.

Gap (G) between left-hand lower link hanger and eccentric stop should be 0.330-0.340 inch (8.4-8.6 mm). To adjust, loosen cap screw and turn eccentric stop until correct gap is obtained. Hold stop in position and retighten cap screw securely.

196. LIFT CONTROL LEVER LINKAGE ADJUSTMENT. The lift control console lever (L—Fig. 274) should move control lever (6—Fig. 275) on lift cover through full range of travel without the lever (L) contacting either end of slot in console. If control lever can be moved against end of slot, adjust link (1—Fig. 275) as follows:

Disconnect lower end of link (1) from lever (6), then rotate end of lever on lift cover fully clockwise. Move console lever (L) so front edge of lever is 1/8 to ¼ inch (3-6 mm) from lower end of slot in console. Adjust turnbuckle on lift control link (1) to lengthen or shorten rod until rod fits into control lever on lift cover without moving either the console lever or control lever.

After adjusting and reconnecting linkage, check to be sure control lever can be moved through full range of travel without contacting either end of slot in console.

197. POSITION CONTROL ADJUSTMENT. After adjusting lift control valve linkage as outlined in paragraph 196, check position control as follows: Move selector lever (S—Fig. 275) fully rearward to position control setting. Start engine and move lift control lever (L) fully forward; the lift arms should then move to fully lowered position. Slowly move lift control lever rearward; lift arms should start to raise when

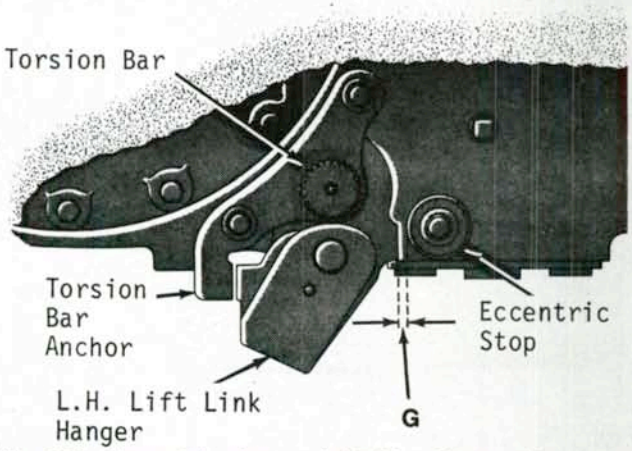


Fig. 273—Eccentric stop on left side of rear axle center housing is adjusted to provide a gap (G) of 0.330-0.340 inch (8.4-8.6 mm) between stop and left lift link hanger.

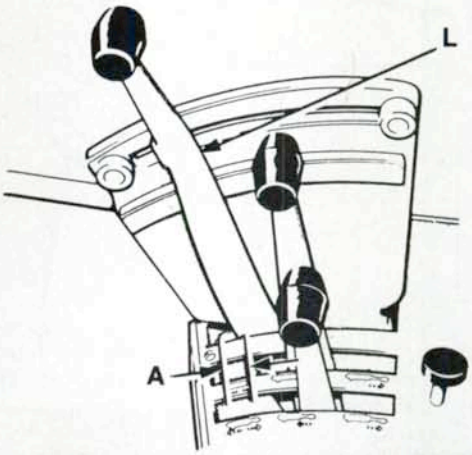


Fig. 274—Lift control lever (L) linkage must be adjusted to provide full travel of lift control lever on lift housing while maintaining clearance (A) of 1/8-1/4 inch (3-6 mm) between lever and end of console slot.

control lever is ½ to 1 inch (13-25 mm) away from front end of slot in console. If lift arms do not start to raise until control lever is more than 1 inch (25 mm) away from end of slot, adjust position control pivot as follows:

Position lift control lever (L) so that it is ½ to 1 inch (13-25 mm) from front end of console slot. Loosen locknut (N1—Fig. 276) on position control adjustment pivot (P) and turn pivot until punch mark is positioned at 3 o'clock. This provides a starting point for adjustment. Start engine and set speed at 800 rpm. Turn position control pivot slowly clockwise until lift arms just start to raise without moving control lever. Hold adjustment pivot and tighten locknut securely.

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 just start to raise. Readjust position control pivot if front edge of control lever is not within ½ to 1 inch (13-25 mm) from front end of slot in console.

198. DRAFT CONTROL ADJUSTMENT. After lift control valve linkage and position control are correctly adjusted, check draft control adjustment as follows: Place selector lever (S—Fig. 275) in draft control (fully forward) position. With engine running, move lift control lever (L) forward until lift arms are fully lowered, then slowly move lever towards rear of console. When rear edge of control lever is ½ to 1 inch (13-25 mm) away from rear end of slot, the lift arms should start to raise. If lift arms do not raise with control lever in this position, adjust draft control as follows:

Position rear edge of lift control lever ½ to 1 inch (13-25 mm) from rear end of console slot. Loosen locknut (N2—Fig. 276) on draft control adjustment pivot (D) and turn pivot until punch mark is positioned at 6 o'clock. This will provide a starting point for adjustment. Start engine and set speed at 800 rpm. Slowly turn draft control adjustment clockwise until lift arms start to raise. Hold adjustment pivot and tighten locknut securely. Recheck draft control adjustment and readjust pivot if necessary.

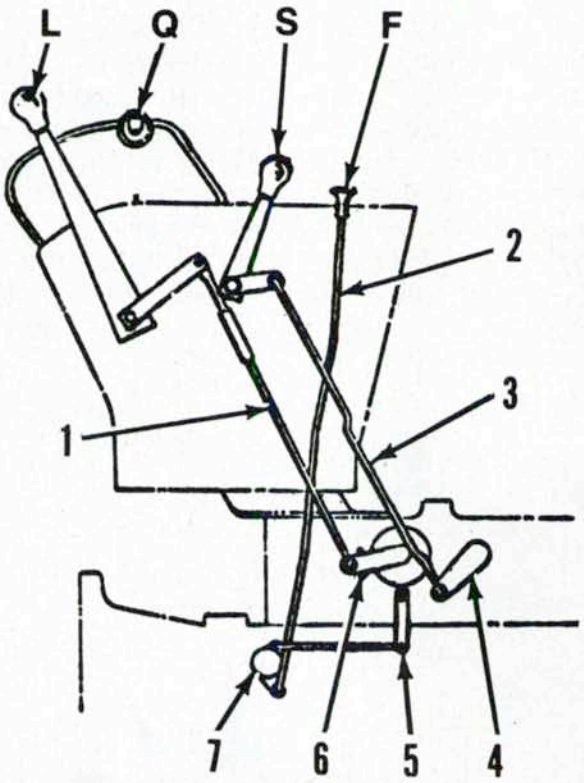


Fig. 275—Drawing showing hydraulic lift control linkage. Lift control link (1) is adjustable.

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

HYDRAULIC PUMP

All Models

199. R&R PUMP. To remove hydraulic pump and adapter plate from right side of rear axle center housing, proceed as follows: Thoroughly clean pump adapter plate and surrounding area. Drain oil from rear axle center housing, approximately 20 U.S. gallons (76 liters).

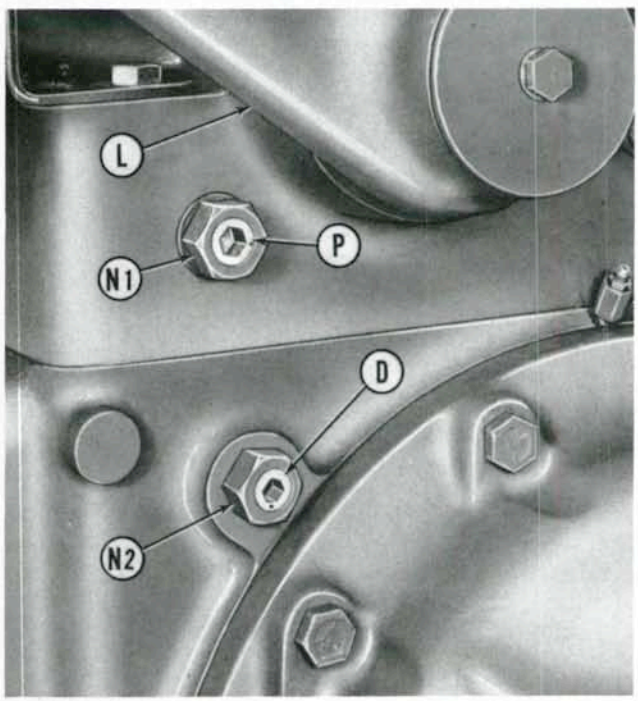


Fig. 276—View showing location of position control eccentric pin (P) and draft control eccentric pin (D) at right rear corner of lift cover and rear axle center housing. Refer to text for adjustment procedure.

Remove remote control valve access panel and transmission access panel from right side of cab or platform. Remove cap screws attaching remote control valve and manifold to pump adapter plate. Raise remote control valve stack clear of pump adapter plate and wire to adjacent tractor components to hold in place above adapter plate.

Disconnect pilot pressure tube (4—Fig. 277) and system pressure tube (5). Disconnect flow control actuating rod and flow control override rod (2) and spring from pump adapter plate. Remove cap screws retaining inlet filter manifold (7—Fig. 278) to axle center housing. On TW-5, TW-15 and TW-25 models, disconnect differential lock pedal from differential lock valve actuating rod, and remove pto/differential lock pressure line. On TW-35 tractor, disconnect differential lock pressure line (8—Fig. 278) and remove pto pressure line (9). On all models, remove hydraulic return oil filter. Remove pump cover retaining cap screws and carefully pry adapter plate with pump from center housing. Unbolt and remove pump from adapter plate.

Reinstall pump using new "O" rings and gaskets. Tighten pump to adapter plate cap screws to a torque of 22 ft.-lbs. (30 N·m) and adapter plate to center housing cap screws to a torque of 35 ft.-lbs. (47 N·m). Be sure that both tubes (3 and 7—Fig. 279) enter inlet filter manifold (4). Tighten manifold retaining cap screws to a torque of 25 ft.-lbs. (34 N·m). Reconnect control rods and hydraulic lines. Install remote control valves with new "O" rings and tighten retaining cap screws to a torque of 23 ft.-lbs. (30 N·m). Install new oil filters and refill rear axle center housing with oil.

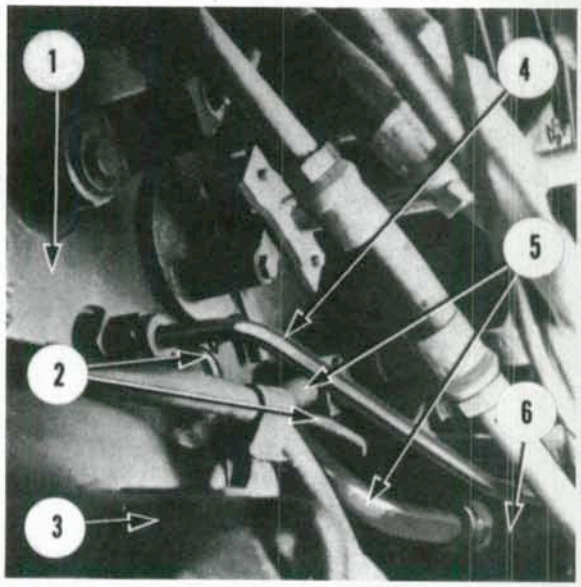


Fig. 277—Hydraulic lift cover linkage and tubes as viewed from rear of pump adapter plate.

1. Lift cover
2. Override rod
3. Axle housing
4. Pilot pressure tube
5. System pressure tube
6. Hydraulic pump adapter plate

Models TW-5, TW-15, TW-25 and Late TW-35

200. OVERHAUL PUMP. To disassemble pump, refer to Fig. 280 and proceed as follows: Remove drive gear retaining nut (2), then remove drive gear using a suitable puller. Remove Woodruff key from pump shaft. Remove cap screws retaining front and rear covers to body. Lightly tap pump shaft with a soft mallet to remove rear cover (12) from locating dowels (13), then tap gear shafts with mallet to remove front cover (7) from dowels. Withdraw gears (10) and bearings (11). Keep components in order as removed. Remove pressure loading rings (5), back-up ring (14) (TW-35) and seal rings (4) from front and rear covers.

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; renew pump assembly if gear track wear exceeds 0.0025 inch (0.06 mm). Maximum runout across gear face to tooth edge is 0.001 inch (0.025 mm) and width of gears must be within 0.0002 inch (0.005 mm) of each other. Gear journals must be within 0.0005 inch (0.013 mm) of each other. Inspect shaft seal (8) in front cover and renew if necessary, being careful not to damage front cover bore.

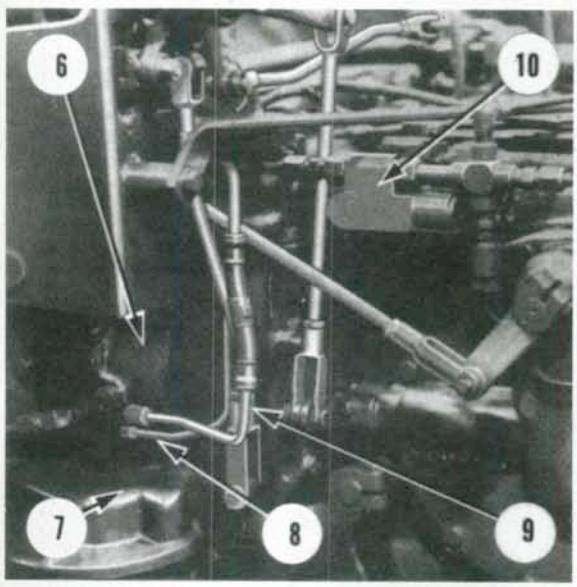


Fig. 278—Disconnect points for removal of hydraulic pump and adapter plate. Model TW-35 is shown: other models are similar except that the separate hydraulic line (8) for differential lock is not used.

6. Pump adapter plate
7. Intake filter manifold
8. Differential lock pressure line
9. Pto pressure line
10. Low pressure hydraulic system regulating valve

NOTE: If wear or scoring is extensive, it is usually more economical to renew the pump assembly rather than attempt repairs.

When reassembling pump, lightly lubricate each component with a high temperature grease to protect pump from heat damage during initial start up. Place front and rear bearings over pump gears making sure that recess (2—Fig. 281) in each bearing is against gear faces and that relief grooves (1) will be on outlet side of pump. Install gears and bearings in pump body. Pack cavity around shaft seal with high temperature grease. Install new seals and pressure rings in front and rear covers, then install covers and tighten retaining cap screws evenly to a torque of 67 ft.-lbs. (91 N·m). Install Woodruff key, drive gear and retaining nut. Tighten nut to a torque of 48 ft.-lbs. (65 N·m) and install cotter pin.

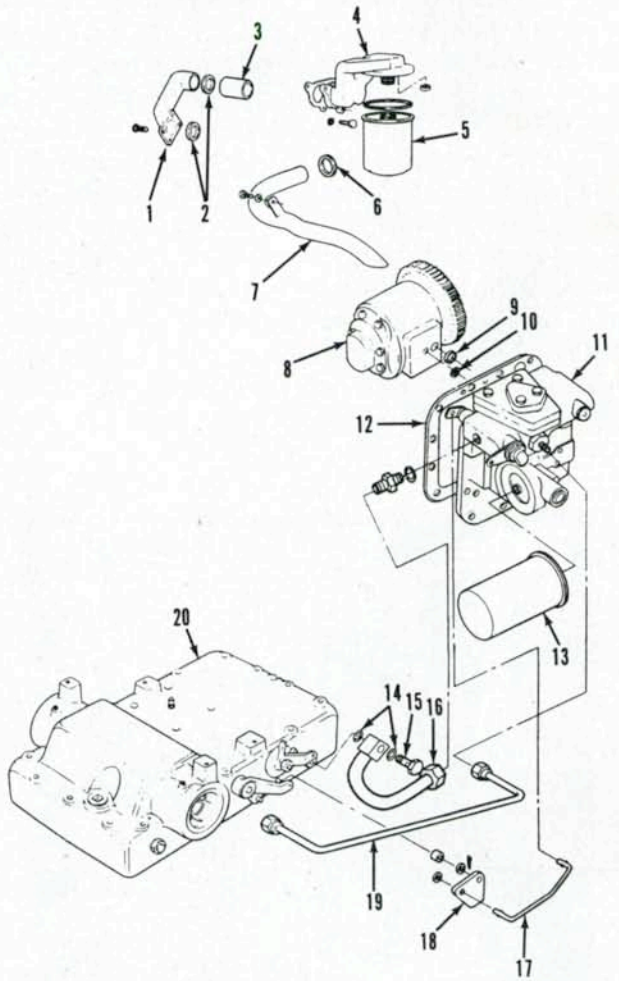


Fig. 279—View showing connections between lift cover and pump adapter plate.

1. Inlet manifold
2. "O" rings
3. Tube
4. Inlet filter manifold
5. Inlet filter
6. Seal
7. Suction tube
8. Hydraulic pump
9. Seal
10. Seal
11. Pump adapter plate
12. Gasket
13. Return oil filter
14. "O" rings
15. Banjo bolt
16. System pressure line
17. Override link
18. Override arm
19. Pilot pressure line
20. Lift cover

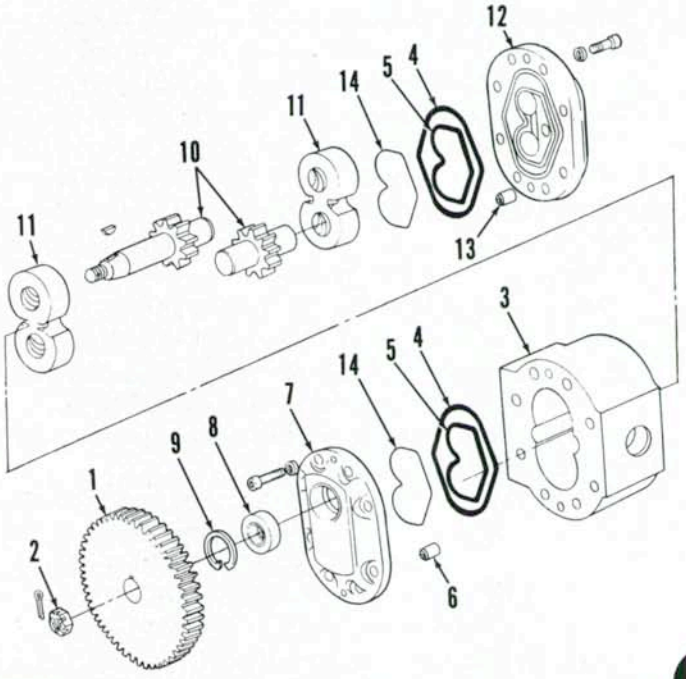


Fig. 280—Exploded view of hydraulic pump used on Models TW-5, TW-15, TW-25 and late production TW-35 (March 1984 and after).

1. Pump drive gear
2. Nut
3. Pump body
4. Seal ring
5. Pressure seal
6. Dowel
7. Front cover
8. Shaft seal
9. Snap ring
10. Pump gears
11. Bearings
12. Rear cover
13. Dowel
14. Back-up ring

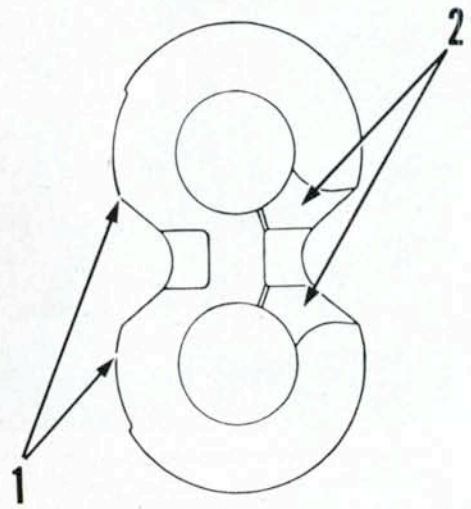


Fig. 281—Make certain that relief groove side (1) of bearings is toward outlet side of pump and that recess (2) in each bearing is against face of pump gears.

Early Model TW-35

201. OVERHAUL PUMP. Hydraulic pump shown in Fig. 282 was used on early production (prior to March 1984) tractors. To disassemble pump, proceed as follows: Remove cotter pin and nut retaining pump drive gear (2), then remove gear using a suitable puller. Remove Woodruff key from pump shaft. Remove cap screws holding pump together while noting location of shorter screw. Lightly tap rear cover (11) with a soft mallet to remove cover from dowel pins. With rear cover removed, tap gear shaft with mallet to remove front cover (4). Keep components in order as removed.

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; renew pump assembly if wear track is deeper than 0.0025 inch (0.06 mm). Runout across gear face to tooth edge should not exceed 0.00035 inch (0.009 mm) and face width of paired gears must be within 0.0005 inch (0.013 mm) of each other. Journal size on each side of the gears must be within 0.0005 inch (0.013 mm) of each other. Inspect remaining components and renew as necessary.

NOTE: If wear or scoring is extensive, it is usually more economical to renew the pump assembly rather than attempt repairs.

When reassembling pump, lightly lubricate components with high temperature grease to protect pump from heat damage during initial start up. Install a black pressure preload seal (6) in front and rear covers (4 and 11). Install a blue pressure load seal (7) on top of black pressure preload seals. Install ring seal (10) in front and rear covers. Install wear plates (8) in covers with bronze side facing outward. Note that diamond shaped holes in wear plates are positioned over intake ports (larger holes) in covers and that wear plates fit inside diameters of seal rings (10). Install gear set in front cover, then install pump body (9) and rear cover (11) making sure dowels enter dowel holes. Install retaining screws and tighten evenly to a torque of 35 ft.-lbs. (47 N·m). Install Woodruff key and drive gear. Tighten gear retaining nut to a torque of 48 ft.-lbs. (65 N·m) and install cotter pin.

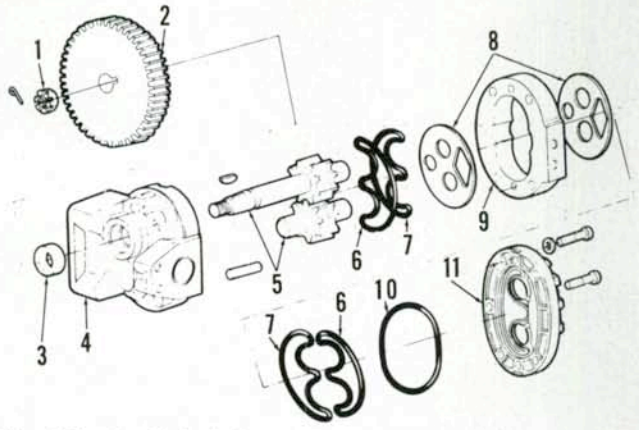


Fig. 282—Exploded view of hydraulic pump used on early production TW-35 tractors.

1. Nut
2. Pump drive gear
3. Shaft seal
4. Front cover
5. Pump gears
6. Preload seal (black)
7. Pressure load seal (blue)
8. Wear plates
9. Pump body
10. Seal ring
11. Rear cover

PUMP ADAPTER PLATE AND VALVE ASSEMBLIES

All Models

202. R&R AND OVERHAUL. To remove adapter plate assembly, refer to hydraulic pump removal procedure outlined in paragraph 199. Refer to exploded view of pump adapter plate and hydraulic valves in Fig. 283 and to appropriate following paragraphs 203 through 206. The pump adapter plate (27) is not available separately; if excessively worn or damaged, it must be renewed as a complete plate and valve assembly.

203. DIFFERENTIAL LOCK VALVE. On Model TW-35, the differential lock valve is not located in pump adapter plate. For service procedures covering TW-35 differential lock, refer to paragraph 169.

On all other models, proceed as follows: Unscrew valve rod guide (42—Fig. 283) and remove actuator rod (40), valve spool (39) and spring (38) from adapter plate (27). Clean and inspect all parts including valve bore in pump adapter housing. Renew worn or damaged parts. Be sure to install a new seal (43) in rod guide. Installation of valve is reverse of removal procedure.

204. SYSTEM PRESSURE RELIEF VALVE. To remove system relief valve, first remove differential lock valve (except TW-35) as outlined in paragraph 203. On all models, unscrew valve body (36—Fig. 283) from adapter plate.

To disassemble relief valve, push valve cap (29) in to compress valve spring (31) and remove snap ring (28). Be careful not to lose shims (30) or valve ball (33).

Inspect parts for wear or damage and renew as necessary. Relief valve opening pressure is adjusted by shims (30). If any parts of valve assembly are renewed, system relief pressure should be checked and adjusted as outlined in paragraph 193.

205. FLOW CONTROL VALVE. The flow control valve spool (24—Fig. 283) can be removed from adapter plate after removing connector fitting (21) and spring (23). Due to close fit of valve spool in adapter plate bore, it may be necessary to thread a puller screw into internal threads in outer end of valve spool to facilitate removal of valve.

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 (0.013-0.028 mm) in bore. The valves and pump adapter plate are color coded for size identification as listed in the following chart.

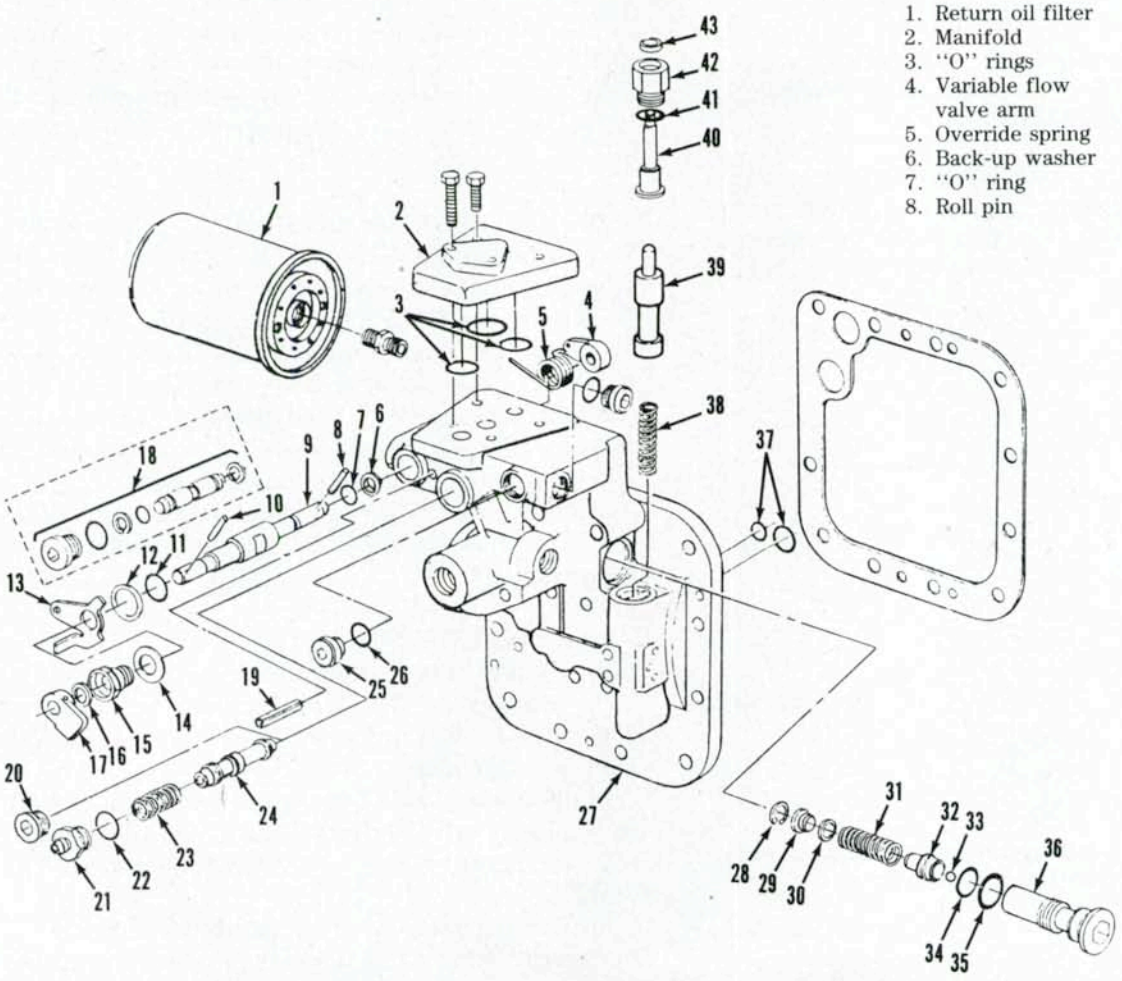
VALVE BORE IDENTIFICATION

Color Code	Valve Bore ID
Blue/white	0.9376-0.9379 in. (23.815-23.823 mm)
White	0.9379-0.9382 in. (23.823-23.830 mm)
Blue	0.9382-0.9385 in. (23.830-23.838 mm)
Yellow	0.9385-0.9388 in. (23.838-23.846 mm)
Green	0.9388-0.9391 in. (23.846-23.853 mm)

VALVE SPOOL IDENTIFICATION

Color Code	Valve Spool OD
Blue/white	0.9368-0.9371 in. (23.795-23.802 mm)
White	0.9371-0.9374 in. (23.802-23.810 mm)
Blue	0.9374-0.9377 in. (23.810-23.818 mm)
Yellow	0.9377-0.9380 in.) (23.818-23.825 mm)
Green	0.9380-0.9383 in. (23.825-23.833 mm)

Lubricate valve spool, then insert it in adapter plate bore with tapped end of spool outward. If fit is correct, valve should just slide through bore with-



1. Return oil filter
2. Manifold
3. "O" rings
4. Variable flow valve arm
5. Override spring
6. Back-up washer
7. "O" ring
8. Roll pin
9. Variable flow valve
10. Roll pin
11. "O" ring
12. Thrust washer
13. Valve lever
14. Spring washer
15. Gland
16. Shim
17. Valve arm
18. Plug assy.
19. Roll pin
20. Plug
21. Connector
22. "O" ring
23. Spring
24. Flow control valve spool
25. Plug
26. "O" ring
27. Pump adapter plate
28. Snap ring
29. Spring seat
30. Shim
31. Relief valve spring
32. Ball retainer
33. Ball
34. "O" ring
35. "O" ring
36. Relief valve body
37. "O" rings
38. Spring
39. Differential lock valve spool
40. Valve actuator rod
41. "O" ring
42. Guide
43. Seal ring

Fig. 283—Exploded view of hydraulic pump adapter plate and valve assemblies. Adapter plate (27) is serviced as a complete plate and valve assembly only; all other parts are available separately. Plug assembly (18) is used in place of variable flow valve (9) on tractors not equipped with hydraulic lift.

out binding. Install spring and connector fitting with a new "O" ring.

206. VARIABLE FLOW VALVE. To remove variable flow valve (9—Fig. 283), drive roll pins (8 and 10) from each end of valve and remove arms (4 and 17). Remove shims (16) if so equipped. Unscrew gland nut (15) and remove spring washer (14), lever (13) and friction washer (12). Push valve out towards outside of adapter plate. Remove two back-up washers (6) and "O" rings (7) from valve. Inspect all parts for wear or damage and renew as necessary.

Reassemble using new "O" rings and back-up washers as follows: Install a new "O" ring (7) and back-up ring (6) on each end of valve with back-up rings at outside of "O" rings. Lubricate valve, then install valve (long end first) in bore with flow control notch up. Position friction washer (12) on adapter plate and hold in place with a small amount of grease. Place spring washer (14) and lever (13) on gland nut (15) with cupped side of spring washer toward the lever. Screw gland into adapter plate. Place shims (16), if used, and arm (17) onto shaft and secure with roll pin (10). Place override spring (5) and arm (4) on other end of shaft and secure with roll pin (8). Be sure override spring has approximately one turn of tension.

Check end play of variable flow control valve. If end play is not within range of 0.010-0.025 inch (0.25-0.64 mm), add or remove shims (16) as necessary. Be sure valve does not bind after reinstalling arm.

LIFT COVER, CYLINDER AND CONTROL VALVE

207. R&R LIFT COVER, CYLINDER AND VALVE ASSEMBLY. It will be necessary to either remove cab or platform or tilt cab or platform forward to provide clearance for removal of lift cover. Refer to appropriate paragraph 266 through 269 for removal or tilting procedure.

Disconnect remote couplers from remote valves. Remove quick coupler mounting bracket and quick couplers from tractor. Disconnect lift rods from lift arms. Disconnect pilot pressure tube (4—Fig. 277), lift pressure tube (5) and override rod (2) from lift cover and pump adapter plate. Disconnect position control linkage and selector lever linkage from lift cover control arms.If equipped with lift assist cylinder, disconnect hydraulic line from sleeve at front of lift cover. Disconnect pto control rod and remove lever and bracket assembly from top of lift cover.

NOTE: If lift cylinder and control valve assembly is to be removed from lift cover, it is recommended that lift cylinder retaining cap screws (located under pto control lever and bracket assembly) be loosened prior to removing lift cover.

Remove cap screws retaining lift cover to rear axle center housing. Attach a suitable lifting fixture (such as Ford tool No. 1302) to lift cover and use a hoist to raise and remove lift cover assembly as shown in Fig 285.

When reinstalling lift cover, be sure that the roller (4—Fig. 285) on draft and position control guide enters the draft sensing yoke (3). Tighten cover retaining cap screws to a torque of 155 ft.-lbs. (210 N·m). Complete installation by reversing the removal procedure.

208. OVERHAUL CONTROL VALVE. With lift cover removed as outlined in paragraph 207, remove control valve assembly (2—Fig. 286) as follows: Remove oil pressure connecting sleeve (3) and pilot pressure tube connector sleeve (4) from lift cover. Remove four cap screws retaining lift cylinder to cover and remove cylinder and control valve as an assembly. Unbolt and remove control valve block from lift cylinder.

To disassemble valve, refer to Fig. 287 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.

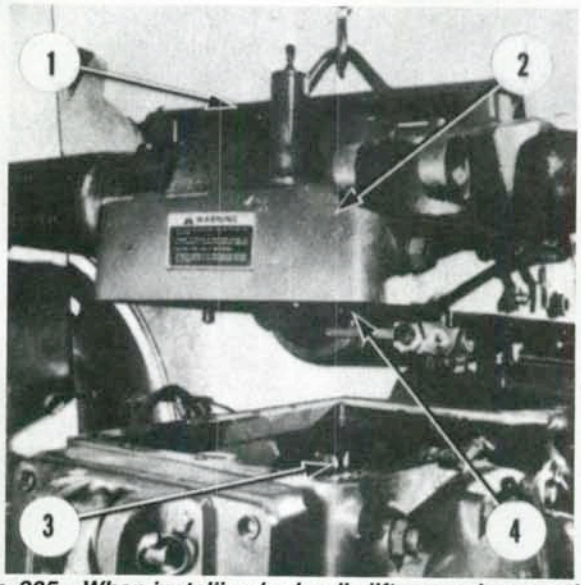


Fig. 285—When installing hydraulic lift cover, be sure that roller (4) engages draft sensing yoke (3).

1. Lifting fixture, tool No. 1302
2. Lift cover
3. Draft sensing yoke
4. Roller

Unscrew plug (39) and remove exhaust valve pressure spring (37), exhaust pressure valve (36), 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. Renew all "O" rings.

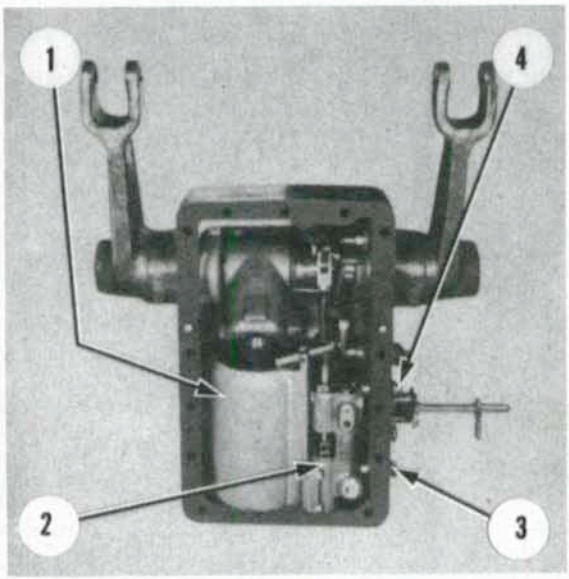


Fig. 286—Bottom view of lift cover assembly.

1. Lift cylinder
2. Control valve assy.
3. Oil pressure connecting sleeve
4. Pilot pressure sleeve

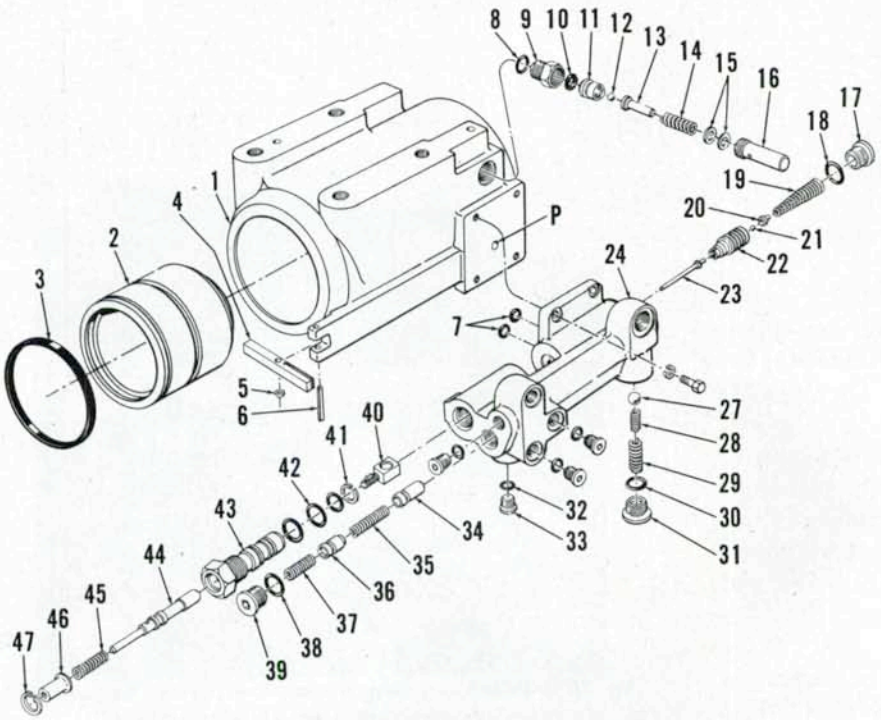
To reassemble valve, reverse disassembly procedure while observing the following special instructions. Be sure that exhaust pressure valve (36) is installed small end first; if valve is installed backward, the lift arms will not raise or lower. Tighten exhaust valve plug (39) to a torque of 65 ft.-lbs. (88 N·m). Tighten poppet valve plug (17) and check valve plug (31) to a torque of 90 ft.-lbs. (122 N·m). Tighten lift control valve bushing (43) to a torque of 135 ft.-lbs. (183 N·m).

After reassembly, adjust control valve keeper (40) as follows: Insert a 1/8 inch (3 mm) diameter pin or drill bit through hole in control valve (44—Fig. 288) and bushing (43) to lock control valve in neutral position. Measure gap between keeper and drop poppet actuator with a feeler gage. Turn keeper into or out of control valve spool to obtain a gap of 0.013-0.016 inch (0.3-0.4 mm), then remove drill bit.

NOTE: If keeper threads into valve freely, either renew keeper or apply Loctite 262 Threadlocker or other suitable thread locking compound to threads of keeper. Be sure that threads of keeper and valve are clean before applying locking compound.

Assemble valve block to cylinder using new "O" rings. Tighten retaining screws to a torque of 22 ft.-lbs. (30 N·m).

209. OVERHAUL SAFETY VALVE. With lift cylinder and control valve assembly removed as outlined in paragraph 208, unscrew safety valve body (9—Fig.



P. Pressure port
1. Lift cylinder
2. Piston
3. Piston seal 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. Ball seat
21. Ball
22. Drop poppet valve
23. Actuator rod
24. Control valve body
27. Check valve ball
28. Check valve spring
29. Guide
30. "O" ring
31. Plug
32. "O" rings
33. Plug
34. Exhaust control valve
35. Control spring
36. Exhaust pressure valve
37. 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. Spring
46. Spring seat
47. Snap ring

Fig. 287—Exploded view showing hydraulic lift cylinder and control valve assemblies. When in fully raised position, piston skirt (2) 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 (18270-18960 kPa), preventing damage due to shock loads.

287) from lift cylinder. Disassemble valve by unscrewing valve cap (16) from body.

When assembling valve use a new seal ring (10). If any parts other than seal ring are renewed, valve pressure setting must be checked using appropriate adapters and pressure test pump capable of maintaining 2800 psi (19300 kPa) pressure at 0.5 U.S. gpm (1.9 Lpm) flow. If such test equipment is not available, renew complete valve assembly. Safety valve should open at 2650-2750 psi (18270-18960 kPa), and should not leak at below pop-off pressure. Vary shims (15) as required to obtain specified opening pressure.

210. LIFT CYLINDER AND PISTON. With lift cylinder and control valve assembly removed as outlined in paragraph 208, unbolt and remove control valve from lift cylinder. Remove pivot pin (6—Fig. 287), and pivot arm (4). Using low air pressure applied at fluid passage (P) in cylinder, force piston from cylinder.

CAUTION: A sudden blast of high pressure air will eject the piston at a dangerous speed.

Inspect piston (2) and cylinder bore for scoring or other damage and renew if necessary. Renew piston seal ring (3). Lubricate piston, seal and cylinder with hydraulic fluid, then install piston (closed end first) into cylinder.

211. OVERHAUL LIFT COVER. With lift cover removed as outlined in paragraph 207, remove lift cylinder and control valve from cover as outlined in paragraph 208.

212. CONTROL LINKAGE. To disassemble control linkage, remove snap ring (31—Fig. 291) from eccentric pin (29). Remove snap ring (4—Fig. 290) from control lever shaft and remove pin from selector shaft (24), then remove the spring loaded actuator rod assembly (63) with control lever (65—Fig. 292), position control arm (30) and draft/position control guide (51).

If necessary to disassemble spring loaded actuator rod, loosen locknut (N—Fig. 292) and unscrew hex rod 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 spring and bushings.

To disassemble draft/position guide assembly, refer to Fig. 293. Drive out retaining pins (49) and remove draft roller and pin (53) and the position control lever pin (52). Drive out pins retaining detent spring mounting pins (45), detent spring and spacer. Drive out pin (50) and remove yoke pin (56) and yoke (57) from guide (51).

To remove control lever shaft (5—Fig. 291), 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—Fig. 291), remove snap ring (17), lever (16) and Woodruff key (25). 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.

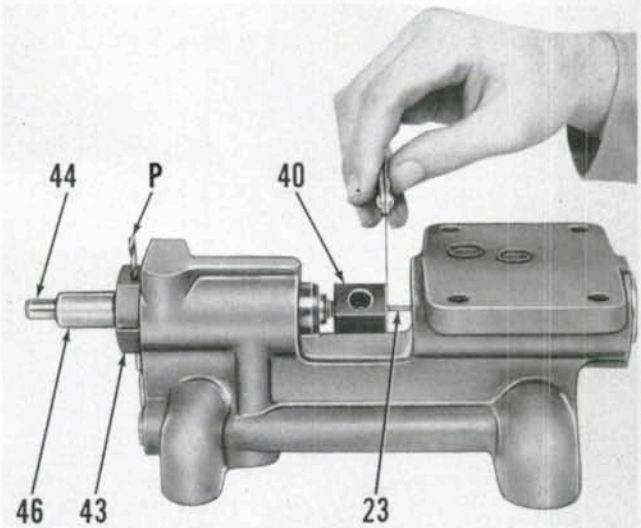


Fig. 288—Checking adjustment of valve keeper. Insert a 1/8 inch (3 mm) diameter pin (P) or drill bit through valve spool (44) and bushing (43) to lock control valve in neutral position. Use a feeler gage to measure clearance between keeper and actuator rod (23).

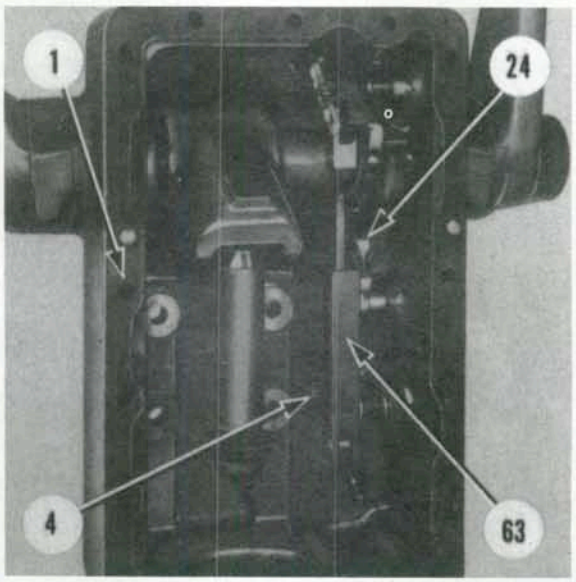


Fig. 290—View of hydraulic lift cover with lift cylinder and control valve removed.

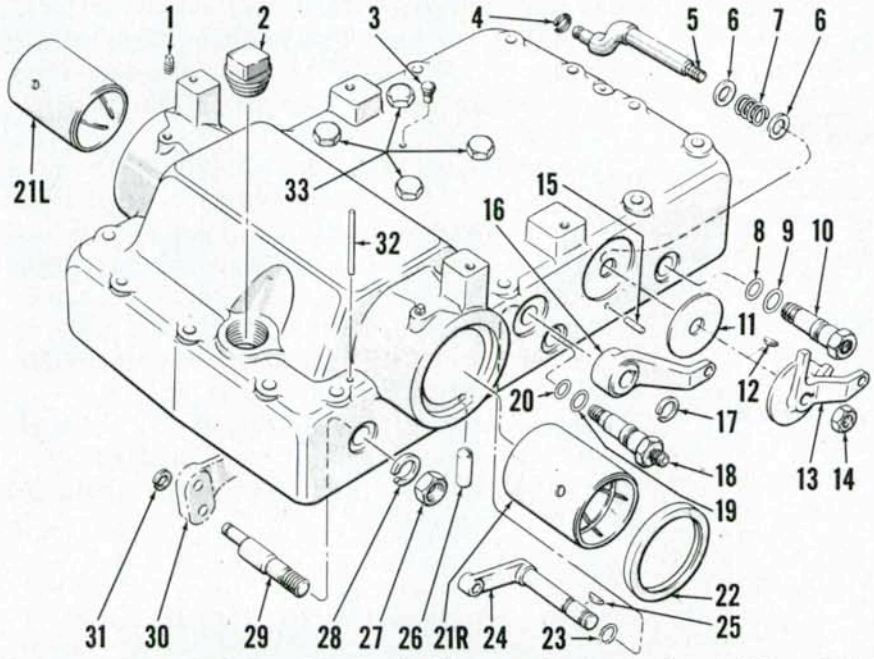
1. Lift cover
4. Retaining ring
24. Selector shaft
63. Actuator rod assy.

Reassemble linkage and install in lift cover by reversing disassembly procedure. Length (L—Fig. 294) of the spring loaded actuator rod must be adjusted to 13.77-13.80 inches (349.6-350.4 mm) from center to center of pin holes. To adjust length, loosen locknut (N) and turn hex rod (58) in or out of yoke (57), then tighten locknut.

213. LIFT SHAFT AND BUSHINGS. With control linkage removed as outlined in paragraph 212, remove cap screws (40—Fig. 292) from each end of lift shaft (36) and remove the lift arms (39). Note that lift shaft must be removed out left side of lift cover as inside diameter of right bushing is smaller than inside diameter of left bushing. Disengage snap rings (37) from their grooves and move snap rings and lift cylinder arm (38) to the right while bumping lift shaft to left side of cover until snap rings and lift arm can be removed from shaft, then withdraw shaft from cover.

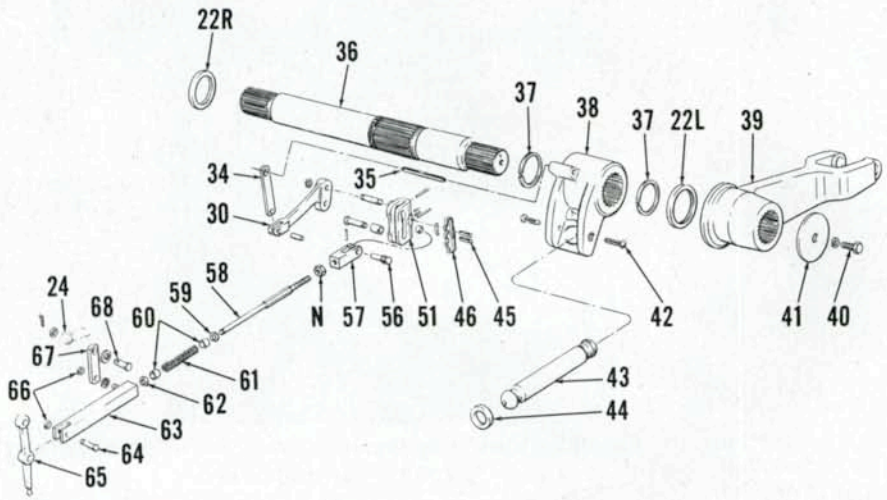
The bushings (21L and 21R—Fig. 291) and shaft seals (22) can be removed from cover after removing lift shaft. Install new bushings with suitable driver, then install new seals with lip of seals inward.

NOTE: It is not necessary to remove lift shaft to renew seals. Remove seals by drilling a small hole in seal case, then thread a metal screw into hole and pull seal with a slide hammer. Install new seals over lift shaft and tap into place with a mallet.



1. Pipe plugs
2. Filler tube
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
22. Lift shaft seal
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

Fig. 291—Exploded view of hydraulic lift cover. Pressure sleeve (10) and pilot sleeve (18) thread into control valve body. Cap screws (33) retain lift cylinder to lift cover.



N. Locknut
22. Lift shaft seals
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. 292—Exploded view showing lift shaft and control linkage as removed from lift cover. Bumper ring (44) on piston rod (43) prevents rod from striking cylinder if lift arms are raised with piston in lowered position.

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 lift arm retaining cap screws to a torque of 75 ft.-lbs. (102 N·m).

LOWER LINK HANGERS, TORSION BAR AND DRAFT CONTROL LINKAGE

214. TORSION BAR. To remove torsion bar (12—Fig. 295), first remove hitch lower link from left lower link hanger (3). Remove cap screw (15) from right end of torsion bar. Unbolt and remove torsion bar anchor (11), then withdraw torsion bar from lift link hanger (3). If bar is broken or seized, remove snap ring (14) and flat washer (13) from right end of lower link hanger (3), then use suitable drift to drive torsion bar from right to left out of the hanger.

NOTE: Be careful not to chip, dent or scratch torsion bar as stress points may result, leading to torsion bar failure.

Install torsion bar by reversing the removal procedure. Be sure that alignment mark on torsion bar is aligned with marks on torsion bar anchor (11) and left hanger (3), and that index mark on right hanger (9) is aligned with mark on end of left hanger. Tighten retaining cap screw (15) to a torque of 22 ft.-lbs. (30 N·m) and anchor retaining cap screws to a torque of 55 ft.-lbs. (75 N·m).

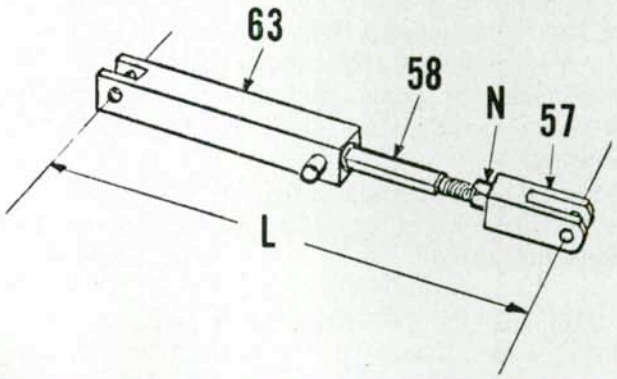


Fig. 294—Length (L) of assembled actuator rod must be adjusted to 13.77-13.80 inches (349.6-350.4 mm). To adjust, loosen locknut (N) and turn hex rod (58) in yoke (57).

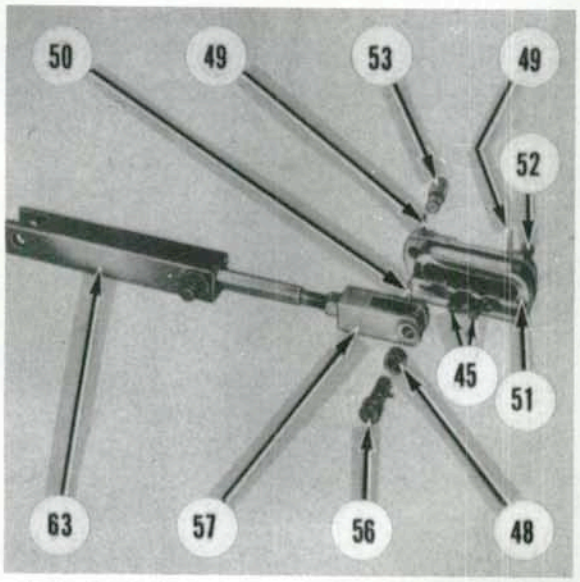


Fig. 293—Exploded view of draft/position control guide and detent mechanism. Head of pin (56) detents in notches formed in detent spring. Spring is mounted in split pins (45) which are retained in guide (51) by roll pins. Roller (53) engages yoke on draft control lever.

45. Split pins
48. Roller
49. Roll pins
50. Roll pin
51. Guide & detent spring
52. Position control pin
53. Draft control pin & roller
56. Yoke pin
57. Yoke
63. Actuator sleeve

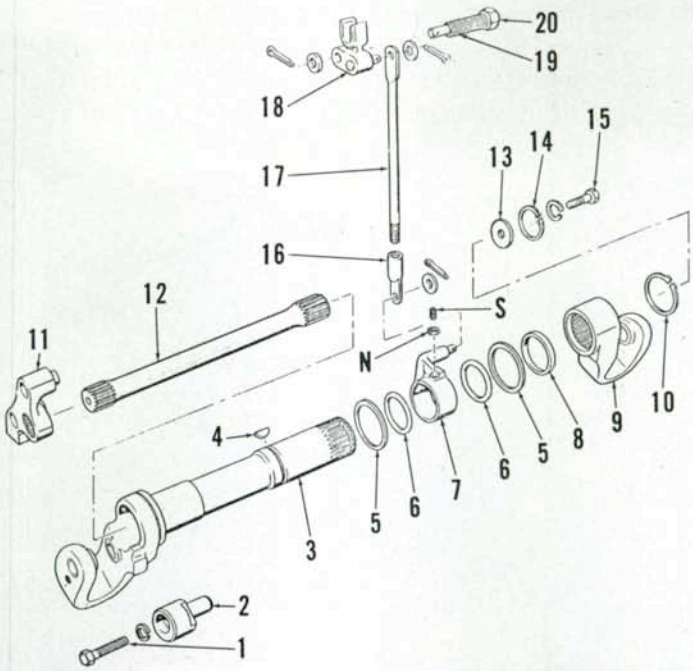


Fig. 295—Exploded view showing torsion bar, lower link hangers and draft control linkage. Refer to Fig. 296 for adjustment of draft control link (16 and 17).

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

215. LOWER LINK HANGERS. To remove lower link hangers (3 and 9—Fig. 295), first drain oil from rear axle center housing. Remove lower links from the hangers. Remove cap screw (15) and snap rings (10 and 14), then remove right hanger from end of left hanger.

To remove left hanger (3), remove lift cover as outlined in paragraph 207. Remove torsion bar anchor (11) and torsion bar (12). Loosen locknut (N) and remove set screw (S) from draft control arm (7). Pull left hanger out far enough to remove Woodruff key (4), then remove hanger from rear axle center housing.

Renew back-up washers (5) and "O" rings (6). Reverse the removal procedure to reinstall hangers, while noting index marks on torsion bar and hangers.

216. DRAFT CONTROL LINKAGE. To service draft control linkage shown in Fig. 295, lift cover must first be removed as outlined in paragraph 207. 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 215 for removal of left lower link hanger (3).

When draft control linkage is reassembled and prior to installing lift cover, the link (16 and 17—Fig. 296) must be adjusted for proper length as follows: Loosen locknut on eccentric pin (19) and turn pin so eccentric is in "up" position. Measure distance (D) between center of dowel pin hole (H) in rear axle center housing to center of yoke in lever (18). If distance does not measure 5-5/8 inches (143 mm), back out eccentric pin until lever can be removed from pin. If measurement is less than 5-5/8 inches (143 mm), turn link rod (17) into link end (16). If measurement is more than 5-5/8 inches (143 mm), turn rod out of link end.

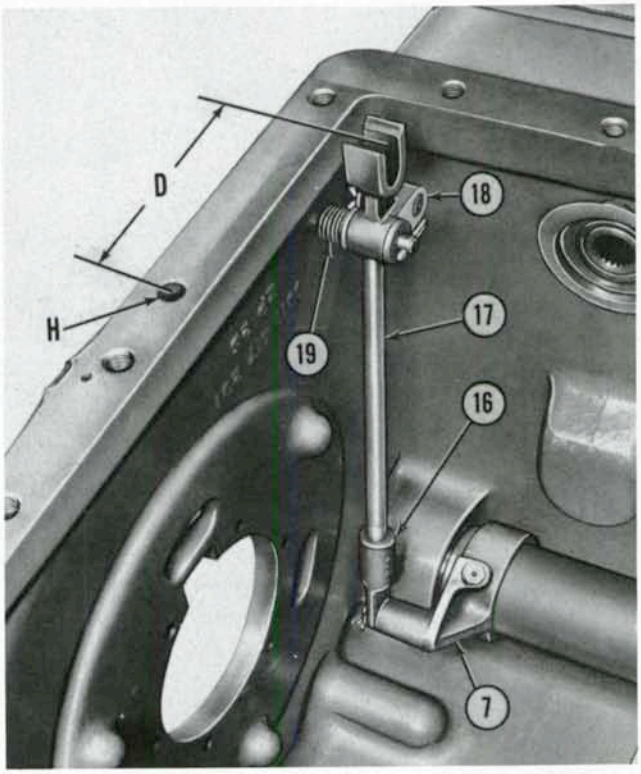


Fig. 296—With eccentric pin (19) in "up" position, adjust link (17) by turning link into or out of link end (16) so that distance (D) between center of dowel hole (H) in rear axle center housing to center of draft control lever yoke is 5-5/8 inches (143 mm).

REMOTE CONTROL VALVES

Remote control valves for operation of remote cylinders may be installed between manifold and top face of hydraulic 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. Remote valves have a flow control valve which may be used to vary the volume of flow to a remote cylinder.

217. CHECK AND ADJUST REMOTE CONTROL VALVE DETENT PRESSURE. Connect a suitable hydraulic flow meter to "Raise" quick coupler of remote valve being checked, or install a 3000 psi (20000 kPa) pressure gage and shut-off valve using a tee fitting similar to that shown in Fig. 298 at "Raise" coupler. Oil return hose of testing equipment may be con-

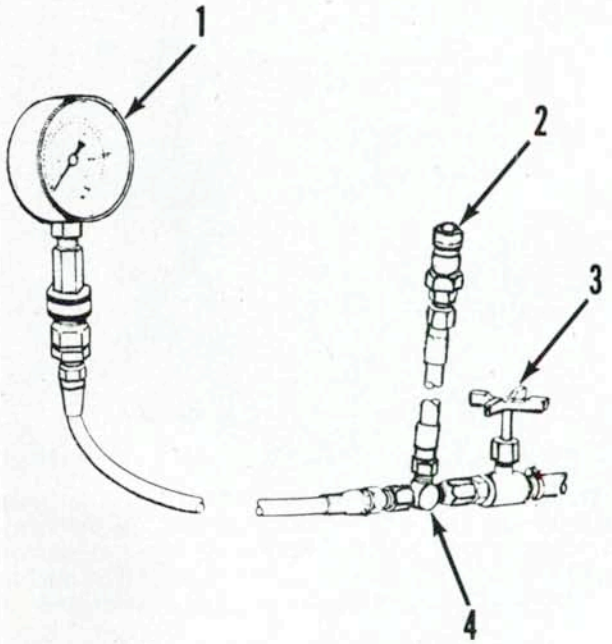


Fig. 298—To check and adjust remote control valve detent pressure, connect a hydraulic flow meter or a pressure gage and shut-off valve with a tee fitting similar to that shown in "Raise" remote coupler. Route return hose from flow meter or pressure gage into oil filler tube on top of lift cover. Refer to text.

nected to "Lower" quick coupler or routed into filler tube.

Start the engine and set speed at 1500 rpm. Move control lever of remote valve being checked to "Raise" position. Slowly close load valve on flow test equipment while noting pressure gage reading. Remote valve lever should return to "Neutral" position when pressure reaches 1900-2200 psi (13100-15170 kPa). Detent pressure may also be checked in "Lower" position, if desired, in same manner by plugging test equipment into "Lower" quick coupler.

NOTE: The remote control valve may be binding which would give a high pressure reading or would not allow valve to return to "Neutral" automatically. Some possible causes of binding are overtightened cap screws (1—Fig. 299) retaining detent unit to valve body, misaligned or damaged detent components or dirt in remote valve causing valve spool to stick in valve body bore.

If control valve lever will not return to neutral within specified pressure range and valve spool is not binding, adjust detent pop-off pressure as follows: Remove remote control valve access panel from cab or platform floor and work through opening in floor, or remove remote valve from tractor as outlined in paragraph 219.

NOTE: Place remote valve in "Lower" position to put detent balls in detent slot in guide ring so that balls will not fall out when detent mechanism is disassembled.

Remove four cap screws that retain detent mechanism to valve body. Remove end cap (2—Fig. 299), sleeve (3), spring (4) and stop ring (5). Unscrew detent guide (14) from valve spool (29). Do not remove detent ring (15) as detent balls will fall out. Turn adjusting screw (23) in end of valve spool in or out as necessary to obtain desired detent release pressure setting. One turn of adjusting screw will change detent release pressure approximately 200 psi (1340 kPa).

Reassemble detent unit to valve spool. Before tightening detent retaining screws, pull control valve spool out to "Float" position (last detent) to align detent components, then tighten the four cap screws evenly to a torque of 8 ft.-lbs. (11 N·m). Recheck detent release pressure.

218. ADJUST REMOTE CONTROL VALVE LEVER LINKAGE. The remote control valve linkage should be adjusted as necessary to align control lever with markings on console when remote valve is

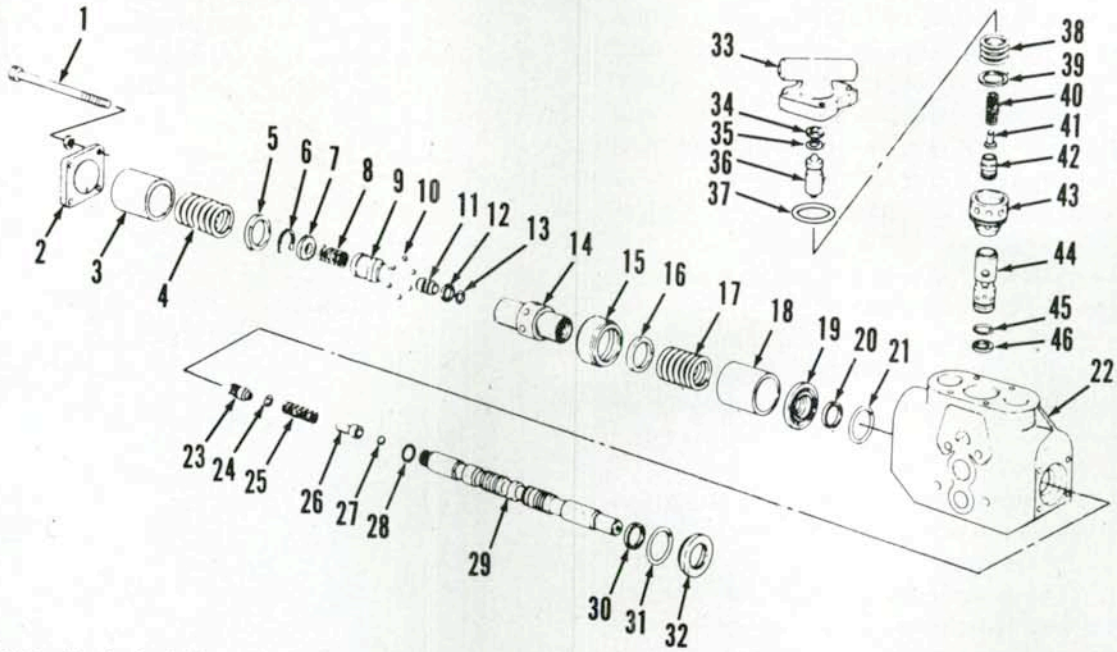


Fig. 299—Exploded view of remote control valve assembly used on tractors produced prior to April 1985.

1. Retaining screw (4)
2. End cap
3. Sleeve
4. Centering spring
5. Stop
6. Snap ring
7. Spacer
8. Detent spring
9. Detent piston
10. Balls
11. Piston end
12. Back-up ring
13. "O" ring
14. Detent guide
15. Detent ring
16. Stop
17. Centering spring
18. Sleeve
19. Valve plate
20. Quad ring
21. "O" ring
22. Valve body
23. Adjusting screw
24. "O" ring
25. Relief spring
26. Seat
27. Check ball
28. "O" ring
29. Valve spool
30. Quad ring
31. "O" ring
32. Valve plate
33. Flow control housing
34. Back-up ring
35. "O" ring
36. Flow control poppet
37. "O" ring
38. Flow valve spring
39. Washer
40. Flow relief spring
41. Relief poppet
42. Flow piston
43. Flow sleeve
44. Flow guide
45. "O" ring
46. Back-up washer

in raise, lower or float positions. To adjust, disconnect lower control rod from control valve bellcrank and turn control rod turnbuckle as necessary for proper lever alignment. Make certain that raise and float detent positions can be obtained without control lever contacting either end of console slot.

219. R&R REMOTE CONTROL VALVE. To remove remote control valve, first remove access panel from floor of cab or platform. Disconnect hydraulic tubes from valve fittings and plug all openings. Disconnect control lever rod and flow control cable. Remove cap screws retaining manifold and valve to pump adapter plate and slide valve and manifold outward.

Reinstall valve and manifold using new "O" rings. Tighten retaining cap screws evenly to a torque of 23 ft.-lbs. (30 N·m).

220. OVERHAUL REMOTE VALVE. To disassemble remote valve, remove pin attaching control linkage to valve spool. Unbolt and remove linkage bracket from valve body. Pull the valve spool out to first detent position to hold detent balls in place when detent mechanism is removed. Remove four cap screws (1—Fig. 299) retaining detent assembly to valve body and remove end cap (2), sleeve (3), spring (4) and stop ring (5). Unscrew detent guide (14) from valve spool. Remove stop ring (16), centering spring (17) and sleeve (18). Push valve spool far enough into linkage end of valve body so that valve plate (32), "O" ring (31) and quad ring (30) can be removed, then pull valve spool out linkage end of body. Remove valve plate, "O" ring and quad ring from detent end of valve body.

Compress the detent guide assembly in a press or vise as shown in Fig. 300 so snap ring (6) can be removed. Release detent spring tension and remove spacer (7—Fig. 299), detent spring (8), detent piston (9) and balls (10). Push detent piston end (11) out of detent guide.

Insert a screwdriver in linkage attaching hole of valve spool or clamp linkage end of valve spool in a vise to hold spool stationary. Count the number of turns required to remove adjusting screw (23) from valve spool. When reassembling, the screw can then be installed the same number of turns to obtain original detent release pressure setting. Remove adjusting screw, spring (25), seat (26) and ball (27).

Scribe alignment marks on flow control valve housing (33) and valve body to ensure correct reassembly, then unbolt and remove the housing. Pull flow control poppet (36) from valve housing. Remove flow valve spring (38), relief spring (40), relief poppet (41), flow piston (42), sleeve (43) and valve guide (44) from remote valve body.

Inspect all parts for excessive wear, nicks, burrs, scoring or other damage and renew as necessary. Complete valve assembly must be renewed if either valve spool or body is worn or damaged. Flow control valve housing (33) and flow poppet (36) are also serviced as an assembly if worn or damaged. Make certain that bleed holes in valve spool and detent adjusting screw are not plugged. Use compressed air or a fine wire to clean bleed holes if necessary.

Lubricate all parts with hydraulic oil during reassembly. Renew all "O" rings, back-up rings and seals.

Install flow control valve assembly in valve body. Be sure that flow piston (42) is installed wide end first into flow guide and that flow control housing (33) is properly positioned on valve body. Tighten housing retaining cap screws to a torque of 12 ft.-lbs. (16 N·m).

Install detent ball, seat, spring and adjusting screw in valve spool. Turn adjusting screw in to its original setting that was noted prior to disassembly, otherwise detent release pressure must be checked as outlined in paragraph 217.

Install quad ring (30), "O" ring (31) and valve plate (32) in linkage end of valve body. Lubricate valve spool, then insert into detent end of valve body. Push the spool through the valve body until it extends just far enough out of linkage end of body so that quad ring (21), "O" ring (20) and valve plate (19) can be installed in detent end of body. Then, carefully push valve spool back through detent end of valve body. Install "O" ring (28) over threaded end of spool being careful not to damage the "O" ring.

Install detent piston end (11) and piston (9) into detent guide (14). Use grease to hold detent balls in detent guide, then slide detent ring (15) over guide and

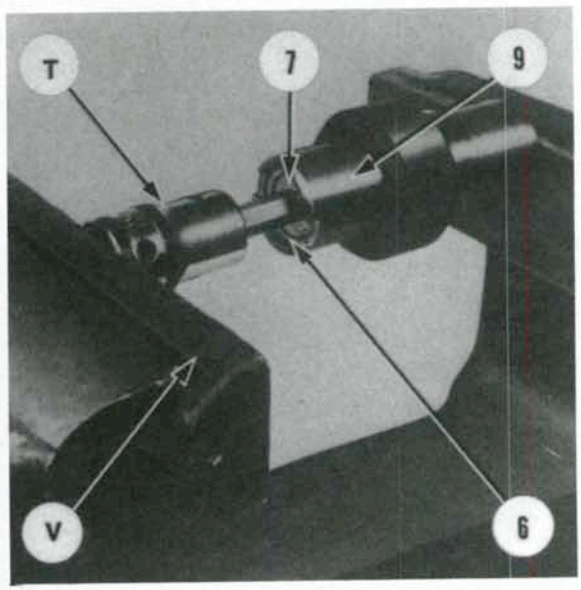


Fig. 300—Use a socket (T), bolt or other suitable tool in a press or vise (V) as shown to depress spacer (7) and spring into detent guide (9) so that retaining ring (6) can be removed or installed.

balls. Be sure detent is positioned so that slot on inside of ring will be toward valve body when detent unit is installed. Install detent spring (8) and spacer (7), compress the assembly in a vise and install retaining ring (6).

Place stop (16), centering spring (17) and sleeve (18) on threaded end of detent guide. Be sure that end of sleeve with the groove on the inside is toward detent guide. Insert a screwdriver through linkage attachment hole in end of valve spool to hold spool stationary, then thread detent guide assembly on valve spool and tighten securely. Place stop (5), centering spring (4) and sleeve (3) on other end of detent guide, making sure grooved end of sleeve is toward the guide.

Position end cap (2) and retaining screws (1) over detent assembly and compress the assembly so the screws can be threaded into valve body three to four turns. Pull valve spool out to "Float" position (last detent) to center detent components, then tighten retaining cap screws evenly to a torque of 8 ft.-lbs. (11 N·m).

Install linkage bracket and attach linkage to valve spool. Reinstall remote valve, adjust control linkage and check detent pressure as outlined in paragraphs 217, 218 and 219.

HYDRAULIC LIFT SYSTEM (Tractors Built April 1985 and After)

OPERATION

225. 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 remote cylinder control valves. Fluid for the system is common with transmission and differential lubricant.

Hydraulic power is supplied by dual constant displacement gear type pumps. The main hydraulic pump is mounted on right side of rear axle center housing and is driven by a gear machined on pto clutch input hub. A second pump is mounted on left side of the engine, with the pump driven by a gear on rear end of engine camshaft. Oil flow from the engine mounted pump supplements oil flow from main pump to the remote valve circuit.

Various control valves, circuit relief valves and check valves control flow of hydraulic fluid and protect system from overload conditions.

Refer to Fig. 302 for a schematic diagram of hydraulic system with lift control valve (12) in neutral position. Main hydraulic pump (3) pressure oil flows first across the system relief valve (4) located in pump mounting plate, then to the flow control valve (24) located in priority valve pack which is mounted on top of pump adapter plate. The flow control valve provides priority flow of main pump oil to hydraulic lift circuit, then directs remainder of main pump flow to remote valve circuit.

The auxiliary pump (2) oil flow goes directly to priority valve pack (21). The unload check valve (22) allows auxiliary pump oil to join main pump oil going to remote valves, but prevents main pump flow from entering auxiliary pump supply line. At no time does the auxiliary pump oil flow supplement the main pump oil flow to hydraulic lift circuit.

With lift control valve (12) and remote valves (17) in neutral position, pump oil pressure moves unloading valve (23) to the left open position and main and auxiliary pump flow is returned to sump through the return filter (8) and rear axle lubrication circuit. Oil is trapped in lift cylinder (18) by spring loaded drop valve (20). A safety relief valve (19) protects the lift cylinder from damage due to shock loads.

When lift control valve (12) is placed in raising position (moved outward), pressure oil is directed to pilot circuit (9). Pilot pressure causes flow control valve (24) to move to the right (close), thus directing main pump oil to hydraulic lift circuit. The rate of oil flow to lift circuit corresponds to the pressure in pilot circuit, which is determined by position of variable flow control restrictor (5). With flow control restrictor in slow raise position, pilot pressure moves the flow control valve partially to the right, directing some of main pump oil to lift circuit. Main pump oil that is not directed to lift circuit flows around flow control valve to the unload valve and returns to sump as in neutral. With flow control restrictor in fast raise position, pilot pressure forces flow control valve fully to the right and total main pump output is made available to actuate the lift cylinder.

When lift control valve (12) is placed in lowering position (moved inward), oil supply to pilot circuit (9) is shut off, flow control valve moves left (opens) and main pump flow is directed to the unload valve (23), combining with auxiliary pump flow to remote circuit or to sump as in neutral. Drop valve (20) is forced open by the control valve, allowing fluid in lift cylinder to return to sump past the exhaust valve (11). The exhaust valve automatically restricts return oil flow in proportion to the amount of pressure in lift cylinder, thus maintaining a controlled drop rate under all lift linkage load conditions.

The lift system is provided with position control and automatic draft control. A selector lever on operator's console controls position of selector shaft (Fig. 303), which moves rear end of actuating rod attached to control valve lever to position control (top view) or draft control (bottom view) position. Also, detent positions between full position control and full draft control provide varying degrees of draft control.

When selector lever is in full position control (rearmost detent on quadrant), hitch lift arm position is controlled by manually moving the lift control lever on the console. The draft control linkage will have no effect on lift control valve when operating in this mode.

When selector lever is in draft control position, automatic draft control is provided by hitch lower link

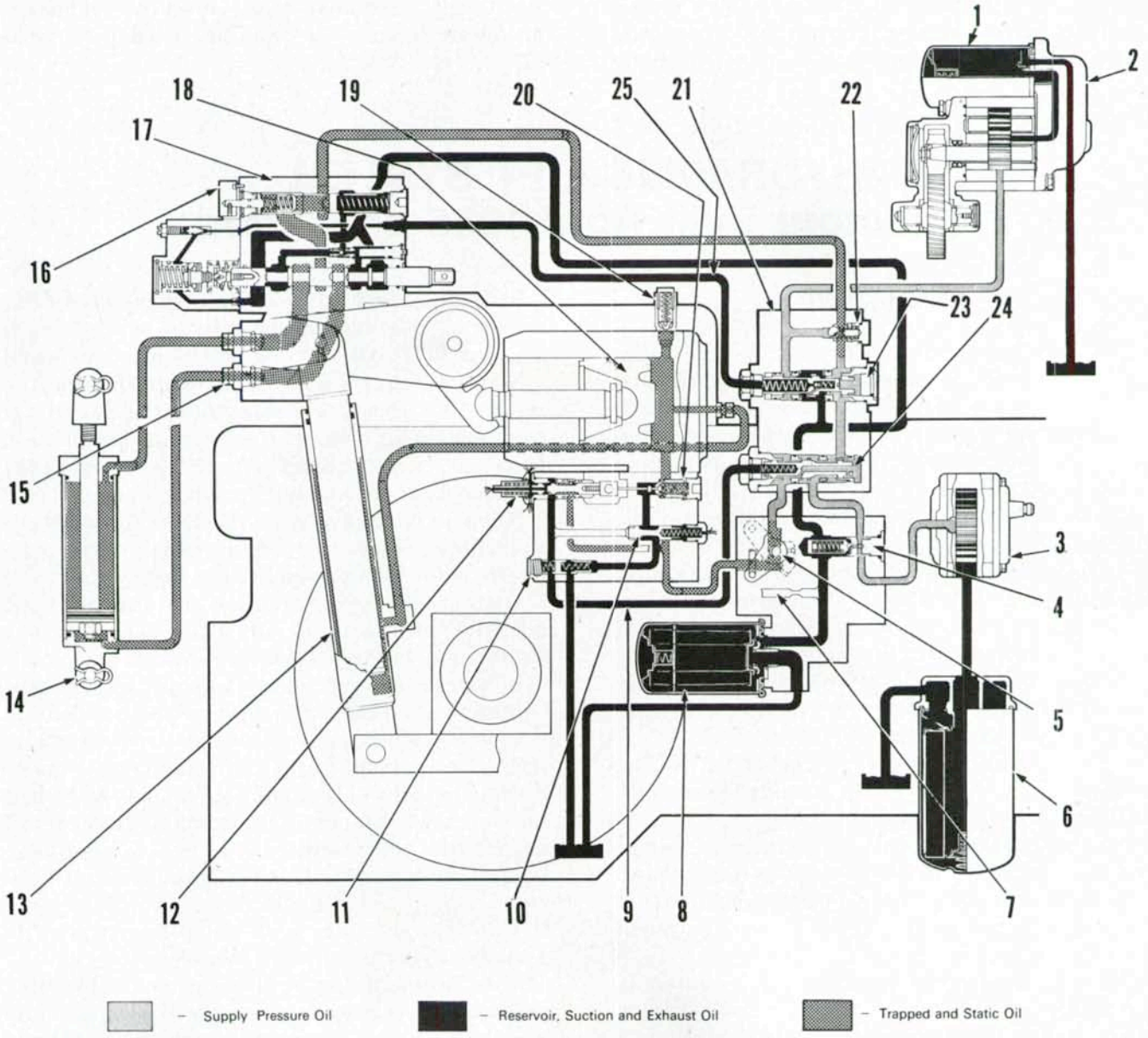


Fig. 302—Schematic of hydraulic system used on tractors built in April 1985 and after. System is shown in "neutral" position.

1. Auxiliary pump inlet filter
2. Auxiliary hydraulic pump
3. Main hydraulic pump
4. System relief valve
5. Variable flow valve
6. Main pump inlet filter
7. Rear axle lubrication circuit
8. Return oil filter
9. Lift circuit pilot pressure line
10. Lift blocking valve
11. Exhaust valve
12. Lift control valve
13. Lift assist ram
14. Remote cylinder
15. Remote valve coupler
16. Remote valve flow control
17. Remote valve assy.
18. Lift piston
19. Lift cylinder safety valve
20. Drop valve
21. Priority valve pack
22. Unload check valve
23. Unload valve
24. Flow control valve
25. Remote valve pilot pressure line

sensing through a torsion bar and control linkage. See Fig. 304. Implement depth and resulting amount of draft load is initially set by moving the lift control lever on the console. Moving control lever rearward decreases draft loading and moving it forward increases draft loading. With control lever at a set position, the lift control valve position is automatically controlled by draft on lower links.

An increase in draft on lower links (Fig. 304) rotates the lift link hangers against tension of the torsion bar. The twisting force on the torsion bar pulls the draft rod downward, thus rotating draft control lever which is attached to lift control valve by a connecting rod. The control valve is moved to raise position to lift implement slightly and reduce the draft load.

The opposite action takes place when draft load decreases. The torsion bar unwinds, which moves the linkage and lift control valve to lower position. The implement will lower slightly to increase the depth and draft and maintain desired load on tractor.

HYDRAULIC FLUID AND FILTERS

226. The rear axle center housing and transmission housing serve as a common reservoir for lubricating and hydraulic oil. Oil used in transmission and rear axle center housing and hydraulic system must be compatible with the wet type disc brakes, Dual Power clutches, pto clutch and differential lock clutch. Recommended lubricant is Ford M2C134-C fluid.

Transmission/rear axle oil capacity (less Dual Power) is 18.2 U.S. gallons (69 liters) for all models. Oil capacity for tractors (except Model TW-35) with Dual Power is 20 U.S. gallons (76 liters). Model TW-35 oil capacity is 23 U.S. gallons (87 liters). On all models equipped with front wheel drive, increase oil capacity by 5.5 U.S. quarts (5.2 liters).

Hydraulic/transmission fluid should be drained and new fluid installed after each 1200 hours of service or yearly, whichever comes first. Before draining fluid, operate tractor to warm oil to operating temperature and be sure that 3-point lift arms are lowered. Fluid level should be maintained at FULL mark on dipstick located at left rear side of lift cover. Check fluid level with tractor level, with 3-point hitch lift arms in raised position and any remote cylinders extended.

Hydraulic system oil filters (1 and 2—Fig. 305) should be renewed after every 300 hours of operation.

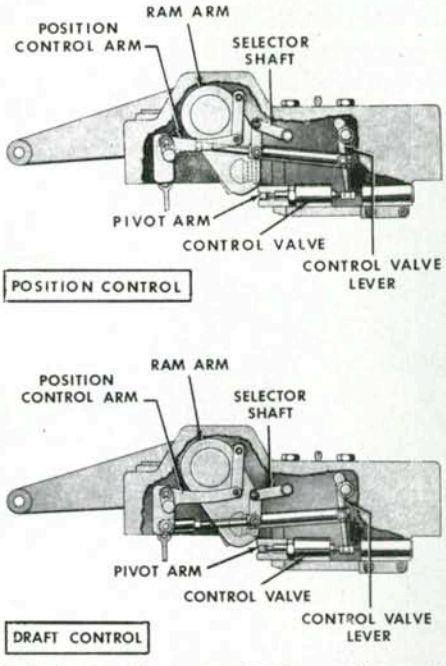


Fig. 303—Selector lever controls position of selector shaft, which moves rear end of actuating rod attached to control valve lever to position control (top view) or draft control (bottom view) position on position control arm. Also, detent positions between full position control and full draft control provide varying degrees of draft control.

TROUBLE-SHOOTING

227. The following are symptoms which may occur during the operation of hydraulic lift system and their possible causes. Use this information in conjunction with testing and adjusting information outlined in this section when servicing hydraulic system. As a preliminary step in trouble-shooting procedure, check the most obvious areas first, such as damaged

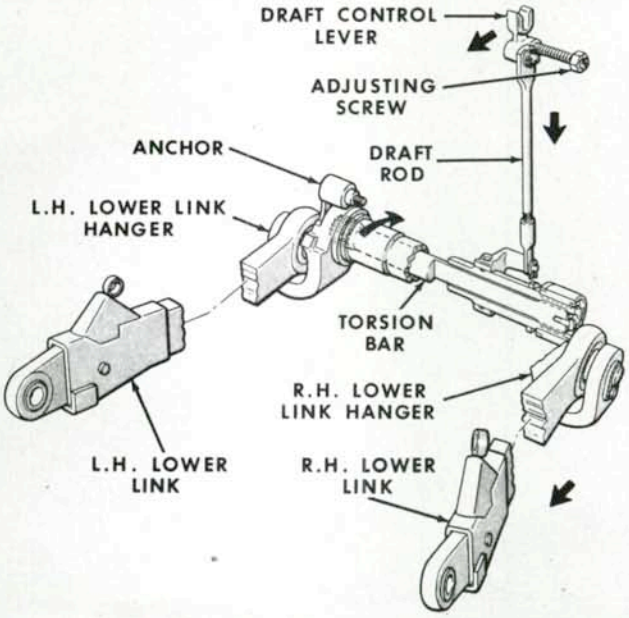


Fig. 304—Cutaway view showing draft control torsion bar and control linkage. Draft on lower links rotates lift link hangers against tension of torsion bar, thus rotating draft control lever. When selector lever is in neutral position, lift control valve is controlled by draft on lower links.

or misadjusted external linkage, incorrect hydraulic oil level, plugged hydraulic filters or external oil leaks.

1. FAILURE TO LIFT UNDER ALL CONDITIONS. Could be caused by:
   a. Faulty hydraulic pump or relief valve.
   b. Flow control valve stuck in open position.
   c. Exhaust pressure valve installed backward or stuck.
   d. Control linkage damaged or disconnected.
   e. Leak in pump suction (intake) pipe.

2. FAILURE TO LIFT UNDER LOAD. Could be caused by:
   a. Faulty hydraulic pump or relief valve.
   b. Safety relief valve faulty.
   c. Exhaust pressure valve sticking.
   d. Damaged or missing "O" ring seals between lift cylinder and control valve, between pump and adapter plate or on oil pressure connecting sleeve.

3. EXCESSIVE LIFT CORRECTIONS (WILL NOT HOLD LOAD AFTER STOPPING ENGINE). Could be caused by:
   a. Safety valve leaking.
   b. Damaged lift cylinder piston seal.
   c. Lift drop poppet leaking.
   d. Damaged "O" ring seals between lift cylinder and control valve.

4. LIFTS TOO SLOWLY. Could be caused by:
   a. Lift control linkage incorrectly adjusted.
   b. Variable flow control valve stuck in slow lift position.

5. OVER CORRECTS IN DRAFT CONTROL. Could be caused by:
   a. Lift control valve not properly adjusted.
   b. Binding draft control linkage.

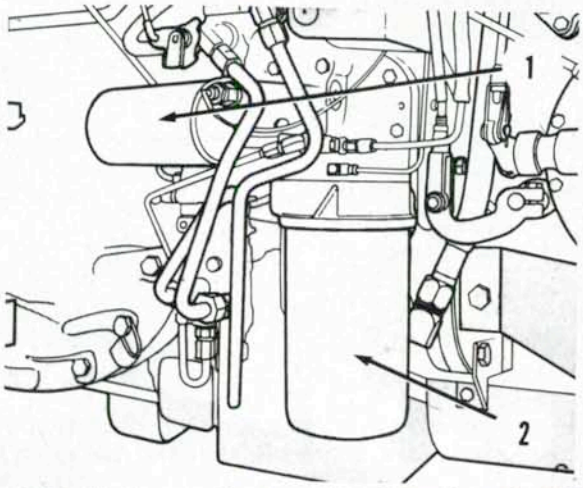


Fig. 305—Hydraulic oil return filter (1) and suction filter (2) should be changed after every 300 hours of operation.

PRESSURE TESTING

228. SYSTEM RELIEF VALVE PRESSURE TEST. The hydraulic system incorporates a system relief valve, located in main pump adapter plate, that protects main pump and lift circuit from excessive pressure. Hydraulic system relief pressure should be 2500-2600 psi (17240-17930 kPa) for all models.

To check system pressure, connect a 0-5000 psi (0-35000 kPa) pressure gage into "Raise" coupler of a remote valve as shown in Fig. 306. Start engine and set speed at 1400 rpm for TW-5, TW-15 and TW-25 tractors, or 1200 rpm for TW-35 tractor. Move and hold remote valve control lever in "Raise" position and observe pressure gage reading.

If pressure setting is not within specifications, pressure can be adjusted by adding or removing shims (8—Fig. 307) between relief valve body cap and spring. To remove relief valve, first disconnect differential lock pedal linkage (TW-5, TW-15 and TW-25 tractors only) from actuating rod (2). Unscrew differential lock valve guide cap (1) and remove actuating rod to provide access to relief valve body (13). Unscrew relief valve from pump cover. Use a press or vise to depress relief valve cap (7) and spring (9), then remove snap ring (6) to disassemble valve.

Every 0.010 inch (0.25 mm) change in shim thickness will change relief valve pressure setting approximately 100 psi (700 kPa). Maximum allowable shim pack thickness is 0.080 inch (2 mm). If specified system relief pressure cannot be obtained with maximum thickness of shims installed, relief valve ball and seat are not sealing properly, remote control valve circuit relief valve opening pressure is too low or a worn hydraulic pump should be suspected.

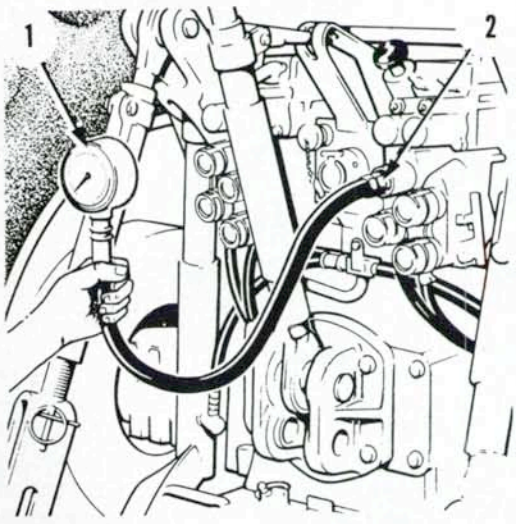


Fig. 306—To check system relief valve opening pressure, connect a 0-5000 psi (0-35000 kPa) pressure gage (1) to "Raise" outlet of remote control valve (2). Refer to text.

229. REMOTE CIRCUIT RELIEF VALVE PRESSURE TEST. The unload valve, located in priority valve pack, incorporates a pilot operated relief valve to protect auxiliary pump and remote valve circuit from excessive pressure. The valve is set to open at 2700-2750 psi (18615-18960 kPa) on all models.

To check relief pressure, connect a 0-5000 psi (0-35000) kPa pressure gage to "Raise" coupler of No. 1 remote valve as shown in Fig. 306. Start the engine and set engine speed at 1100 rpm. Completely lower the lift arms and push variable flow control knob down to obtain maximum flow to lift cylinder. Hold remote valve control lever in "Raise" position and note pressure gage reading, which should be 2500-2600 psi (17240-17930 kPa). Then, move lift control lever to fully raise the lift arms and note pressure gage reading as lift arms are raising. Pressure should increase to 2700-2750 psi (18615-18960 kPa).

If there is no pressure increase as the lift arms are raising, remote circuit relief valve is leaking or misadjusted. To check or adjust relief valve, the priority valve assembly must be removed and unload valve (5—Fig. 308) disassembled as outlined in paragraph 244. Turn adjusting screw (9) into valve spool to increase relief valve opening pressure.

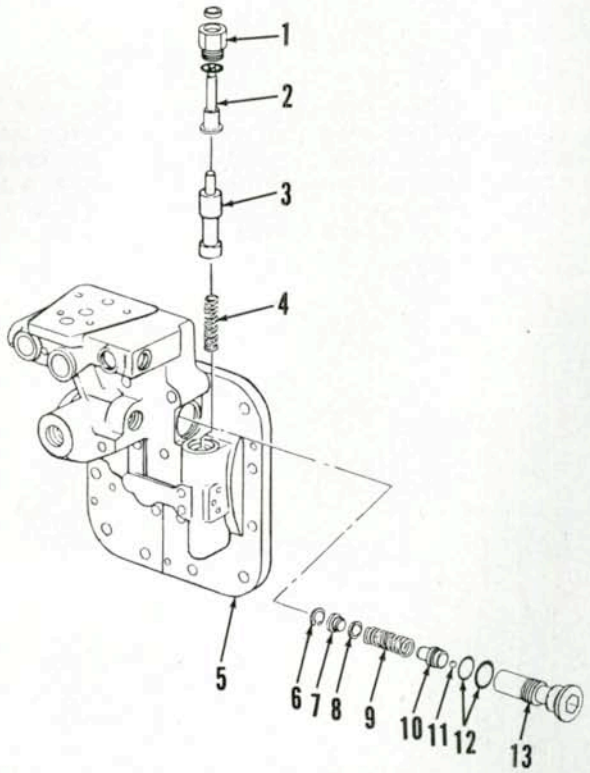


Fig. 307—System relief valve pressure setting may be adjusted by means of shims (8) between relief valve cap and spring.

1. Guide
2. Differential lock actuator rod
3. Differential lock valve
4. Spring
5. Pump adapter plate
6. Snap ring
7. Cap
8. Shim
9. Spring
10. Relief valve ball retainer
11. Ball
12. "O" rings
13. Relief valve body

PUMP FLOW TESTING

230. The oil flow of main pump and auxiliary pump is combined at the priority valve pack and is available to the remote valves. However, due to restrictions in remote valve circuit, the combined output of the pumps at rated engine speed exceeds the maximum flow capacity of a single remote outlet. Therefore, to check rated oil flow output of either or both hydraulic pumps, the pumps must first be isolated from each other as follows:

Disconnect auxiliary pump pressure line from the priority valve located under right-hand side of cab. If auxiliary pump oil flow is to be checked, connect pump pressure line to inlet of a suitable hydraulic flow meter. Direct outlet hose from flow meter into oil filler tube located in rear of lift cover. If only main pump oil flow is to be checked, connect a hose to auxiliary pump pressure line and secure open end of the hose in oil filler tube in lift cover.

CAUTION: There is no relief valve for the auxiliary pump when connected to flow meter in this manner. Be sure flow meter load valve is fully open before starting the engine, and adjust load valve carefully during flow test to prevent excessive pressure and possible damage to equipment.

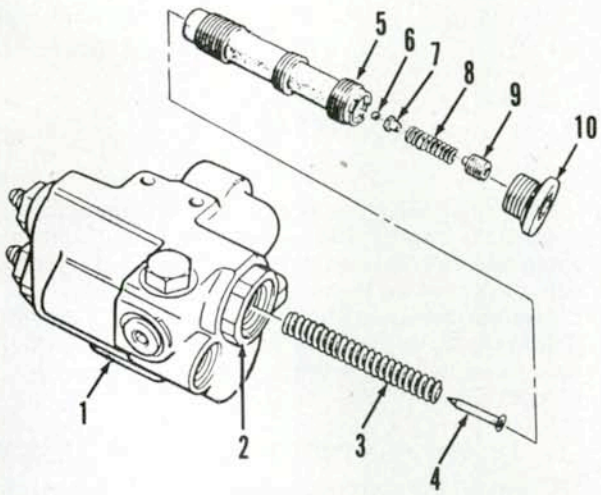


Fig. 308—The unload valve incorporates a pilot operated relief valve to protect remote control valves and auxiliary hydraulic pump from excessive pressure.

1. Priority valve
2. Unload valve sleeve
3. Spring
4. Filter screen
5. Unload valve spool
6. Relief valve ball
7. Ball retainer
8. Spring
9. Relief valve adjusting screw
10. Plug

If main pump oil flow is to be checked, connect inlet hose of a hydraulic flow meter to "Raise" coupler of No. 1 remote valve. Turn remote valve flow control knob to "Fast" flow rate. Connect flow meter outlet hose to either coupler of No. 2 remote valve and place control valve in "Float" position.

Oil temperature should be between 100°-140° F (40°-60° C). Operate engine at 2300 rpm on Model TW-5 and 2200 rpm on Models TW-15, TW-25 and TW-35. Pull No. 1 remote valve control lever rearward to "Raise" position to direct main pump flow to flow meter. Check oil flow at no load (pressure), then carefully close flow meter load valve and check flow at 2000 psi (13800 kPa). The pump flow under load should be within 20 percent of the flow at no load. If not, internal leakage within the system or a defective pump is indicated.

Rated flow capacity of the hydraulic pumps at 2500 psi (17240 kPa) with engine speed at 2300 rpm (TW-5) or 2200 rpm (TW-15, TW-25 and TW-35) is as follows:

Model TW-5

Main pump ..... 16 U.S. gpm (60 lpm)
Auxiliary pump ..... 9.3 U.S. gpm (35.3 lpm)

Models TW-15 and TW-25

Main pump ..... 15.3 U.S. gpm (58 lpm)
Auxiliary pump ..... 8.9 U.S. gpm (33.6 lpm)

Model TW-35

Main pump ..... 20 U.S. gpm (75 lpm)
Auxiliary pump ..... 8.9 U.S. gpm (33.6 lpm)

ADJUSTMENTS

NOTE: The adjustments outlined in following paragraphs 231 through 234 are those that can be made externally; internal adjustments are outlined in reassembly procedure in paragraphs outlining overhaul of system components. Inability to make system function properly by external adjustment will indicate need of system overhaul and/or internal adjustment.

231. DRAFT CONTROL LOWER LINK HANGER STOP. An adjustable eccentric stop (3—Fig. 310) is located on left side of rear axle center housing behind the lift link hanger (4). The stop limits rearward movement of hanger and twist of torsion bar (2). Forward movement of hanger is limited by a stop bolt (5) on torsion bar anchor (1).

With no load on the hanger, gap (A) between eccentric stop and hanger should be 0.330-0.340 inch (8.4-8.6 mm). To adjust, loosen cap screw and turn eccentric as necessary. Hold eccentric stop in place and tighten retaining cap screw to a torque of 55 ft.-lbs. (75 N·m). Adjust forward stop bolt (5) so that it is flush with front of hanger.

232. HYDRAULIC LIFT CONTROL LEVER LINKAGE. The lift control lever (L—Fig. 311) must provide full travel of control linkage without the lever con-

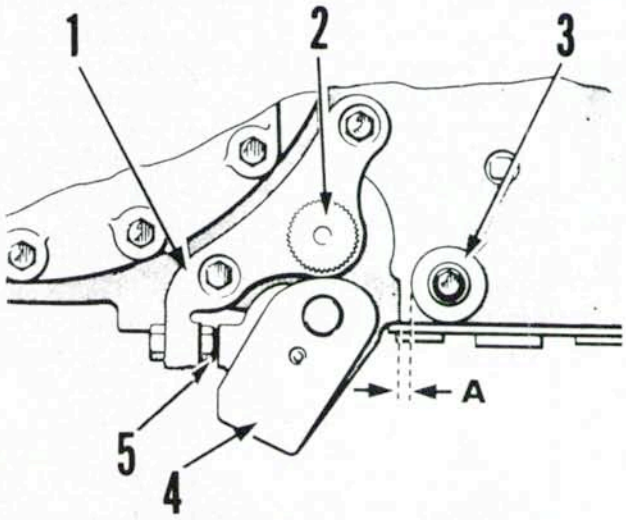


Fig. 310—View of draft control lower linkage stop adjustment points. Eccentric stop (3) on left side of rear axle center housing should be adjusted to provide a gap (A) of 0.330-0.340 inch (8.4-8.6 mm) between stop and lift link hanger (4).

1. Torsion bar anchor
2. Torsion bar
3. Eccentric stop
4. Lift link hanger, L.H.
5. Forward stop bolt

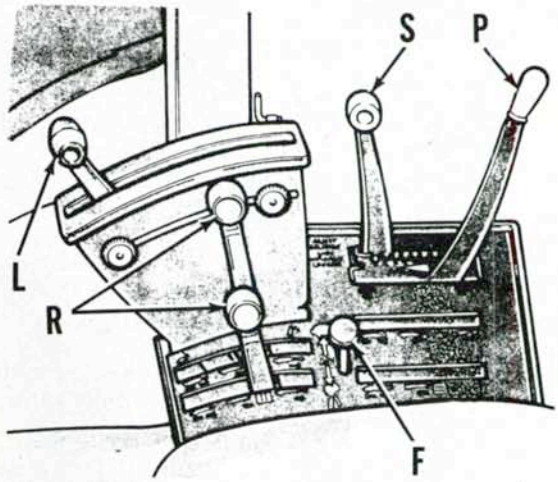


Fig. 311—View of operator's control console.

F. Variable flow control knob
L. Lift control lever
P. Pto control lever
R. Remote valve control levers
S. Selector (draft/position) control lever

tacting either end of slot in console. To adjust control lever, disconnect lift control rod (1—Fig. 312) at the cross shaft arm (4). Position the lift control lever so there is 1/8 to ¼ inch (3-6 mm) clearance between front of lever and lower end of slot in console. Rotate cross shaft (4—Fig. 312) fully clockwise, then adjust trunnion (2) on control rod so that trunnion will fit into hole of cross shaft while maintaining required clearance between control lever and console slot.

Reconnect linkage and check to be sure that control lever can be moved through full range of travel without contacting either end of slot in console.

233. POSITION CONTROL ADJUSTMENT. Place selector lever (S—Fig. 311) in position control (fully rearward). Start engine and move lift 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 (13-25 mm) away from front end of slot in console. If lift arms do not start to raise until after lever is more than 1 inch (25 mm) away from front end of slot in console, adjust position control pivot as follows:

Position the lift control lever so that front edge of lever is ½ to 1 inch (13-25 mm) from front end of slot in console. Loosen locknut (N1—Fig. 313) on position control adjustment pivot (P). Turn pivot until punch mark is positioned at 3 o'clock to provide starting point for adjustment. Start the engine and run at idle speed. Turn position control adjustment slowly clockwise until lift arms just begin to raise, then tighten locknut while holding adjustment pivot.

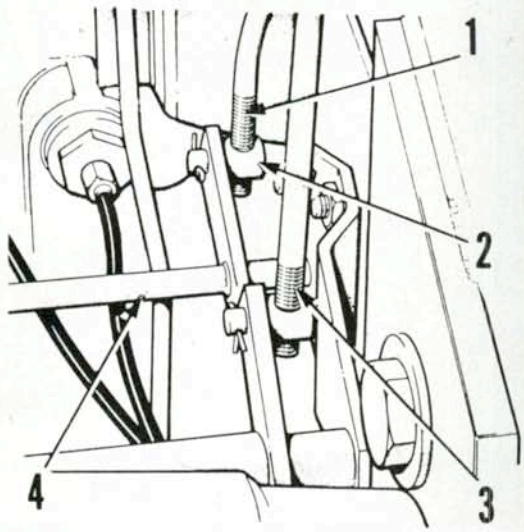


Fig. 312—Lift control linkage adjustment points.
1. Lift control rod
2. Trunnion
3. System selector rod
4. Cross shaft

Recheck position control adjustment as outlined above and readjust if necessary.

234. DRAFT CONTROL ADJUSTMENT. To check draft control adjustment, start engine and place selector lever (S—Fig. 311) in draft control position (fully forward). Move lift control lever (L) forward until lift arms are fully lowered, then slowly move lever rearward. The lift arms should start to raise when rear side of lever is ½ to 1 inch (13-25 mm) away from rear of slot in console. If lift arms do not start to raise with control lever in this position, adjust draft control as follows:

Loosen locknut (N2—Fig. 313) on draft control adjustment pivot (D) and turn pivot until punch mark is at 6 o'clock position to provide a starting point for adjustment. With engine running, position rear edge of lift control lever ½ to 1 inch (13-25 mm) from rear end of slot in console and slowly turn draft adjustment pivot clockwise until lift arms begin to raise. Tighten locknut while holding adjustment pivot.

Recheck draft control adjustment as outlined above and readjust if necessary.

HYDRAULIC PUMP

Main Hydraulic Pump

235. REMOVE AND REINSTALL. To remove main hydraulic pump and adapter plate from right side of rear axle housing, first drain oil from trans-

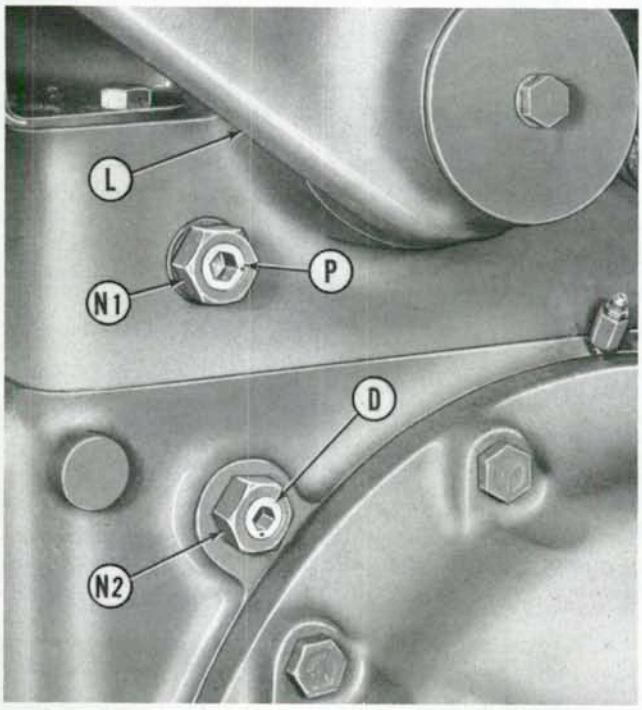


Fig. 313—View showing location of position control eccentric pin (P) and draft control eccentric pin (D) at right rear corner of lift cover and rear axle center housing.

mission and axle housings, approximately 20 U.S. gallons (76 liters). Remove access panel from floor on right side of cab. Remove cap screws retaining priority valve pack to top of pump adapter plate, then raise priority valve slightly and wire it to adjacent tractor component to hold it in place above adapter cover. Disconnect auxiliary pump intake tube (5—Fig. 315). Unbolt and remove intake filter and manifold (4). Remove return oil filter (2) to provide access to adapter plate retaining cap screws. Disconnect control linkage from variable flow control valve (1) on adapter plate. Disconnect wire from oil temperature sender unit if so equipped.

On TW-5, TW-15 and TW-25 tractors, disconnect differential lock pedal linkage from differential lock valve (7—Fig. 315). On Model TW-35, disconnect differential lock pressure line. On all models, remove pto pressure line (6).

Remove pump adapter plate retaining cap screws and withdraw adapter plate with pump from axle center housing. Remove four cap screws retaining main pump to adapter plate and remove the pump.

When reinstalling pump, be sure to install new "O" rings between pump and adapter plate. Tighten pump retaining cap screws to a torque of 22 ft.-lbs. (30 N·m). Install pump and adapter plate with a new gasket and tighten retaining cap screws to a torque of 35 ft.-lbs. (47 N·m). Install inlet filter manifold with new "O" ring seals, making sure that both tubes enter the manifold. Tighten manifold retaining cap screws to a torque of 25 ft.-lbs. (34 N·m). Complete installation by reversing removal procedure.

236. OVERHAUL PUMP. With pump removed as outlined in paragraph 235, disassemble as follows: Unbolt and remove inlet manifold from pump. Remove pump drive gear retaining nut (2—Fig. 316), then use a suitable puller to remove gear (1) from pump shaft. Remove Woodruff key from shaft. Remove screws retaining front cover (7) and rear cover (12) to pump body. Lightly tap front end of pump drive shaft with a mallet to separate rear cover from pump body, then tap rear end of shafts to remove front cover. Keep components in order as removed. Remove pressure loading rings (5) and seal rings (4) from front and rear covers.

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; renew pump assembly if gear track wear exceeds 0.0025 inch (0.06 mm). Maximum runout across gear face to tooth edge is 0.001 inch (0.025 mm) and width of gears must be within 0.0002 inch (0.005 mm) of each other. Gear journals must be within 0.0005 inch (0.013 mm) of each other.

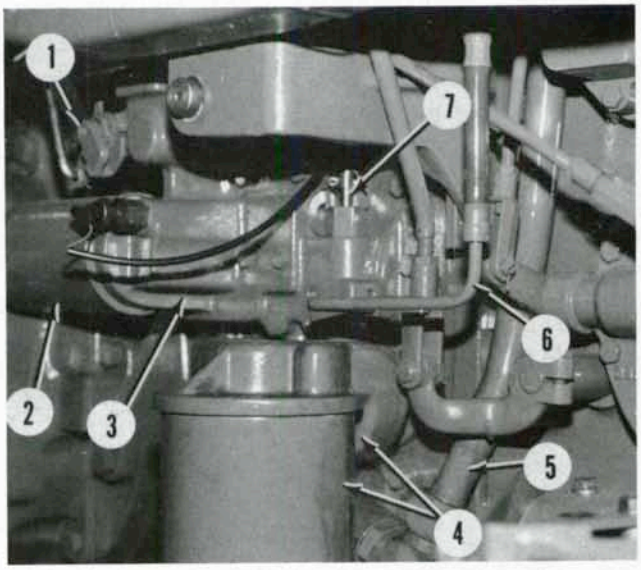


Fig. 315—Main hydraulic pump is mounted to backside of pump adapter plate (3) located on right-hand side of rear axle center housing. Differential lock valve (7) is not used on Model TW-35.

1. Variable flow valve linkage
2. Return oil filter
3. Pump adapter plate
4. Inlet filter & manifold
5. Auxiliary pump suction tube
6. Pto pressure line
7. Differential lock valve

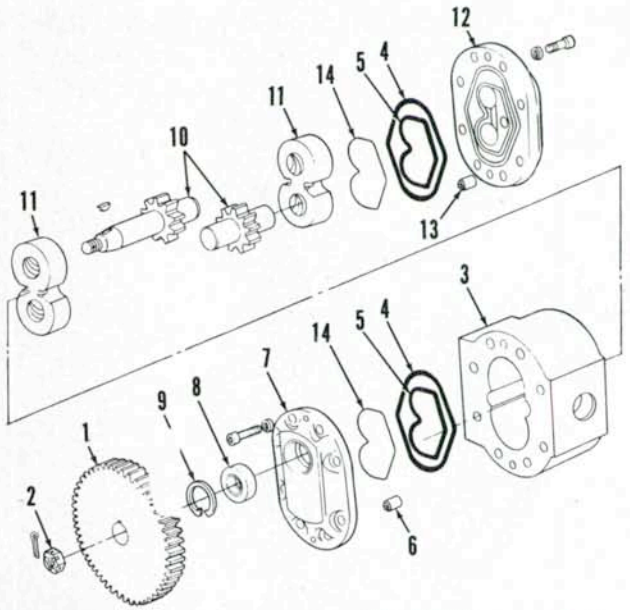


Fig. 316—Exploded view of main hydraulic pump. Seal ring (14) is used on TW-35 pump.

1. Drive gear
2. Slotted nut
3. Pump body
4. Seal rings
5. Pressure loading rings
6. Dowel
7. Front cover
8. Shaft seal
9. Snap ring
10. Pump gears
11. Bearings
12. Rear cover
13. Dowel
14. Seal ring

NOTE: If wear or scoring is extensive, it is usually more economical to renew pump assembly rather than attempt repairs.

When reassembling pump, lightly lubricate each component with a high temperature grease to protect pump from heat damage during initial start up. Install a new seal (8) in front cover, being careful not to damage cover bore. Pack cavity around shaft seal with high temperature grease. Place front and rear bearings over pump gears making sure that recess (2—Fig. 317) in each bearing is against gear faces and that relief grooves (1) will be on outlet side of pump. Install gears and bearings in pump body. Install new seal rings and pressure rings in front and rear covers, then install covers and tighten retaining cap screws evenly to a torque of 67 ft.-lbs. (91 N·m). Install Woodruff key, drive gear and retaining nut. Tighten nut to a torque of 48 ft.-lbs. (65 N·m) and install cotter pin.

Auxiliary Engine Mounted Pump

237. REMOVE AND REINSTALL. Thoroughly clean pump (4—Fig. 318) and surrounding area. Tag steering hydraulic hoses (2) to ensure correct reassembly, then disconnect hoses and plug all openings. Remove cap screws from steering line clamp (3) and move lines away from pump. Disconnect pump pressure line at rear of pump and remove bolt from clamp on pressure and inlet tube. Remove pump retaining cap screws, lift pump off tractor and pull free from inlet tube.

Prior to reinstalling pump, install a new "O" ring seal in pump inlet port. Be sure that end of inlet tube is smooth to prevent damage to "O" ring on installation. Pour hydraulic fluid into inlet port of pump and rotate gears to provide initial lubrication on start-up. Installation of pump is reverse of removal procedure.

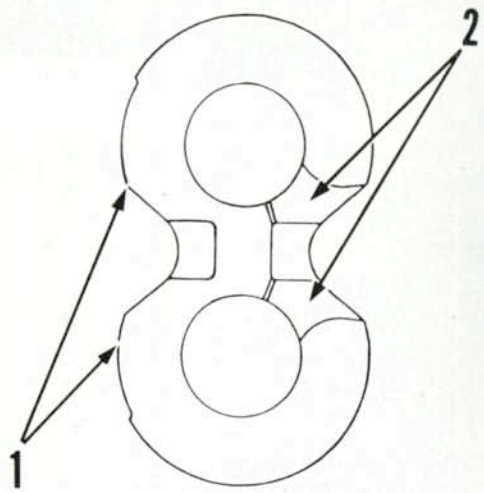


Fig. 317—Be sure that pump bearings are installed with relief grooves (1) on inlet side of pump and recess (2) in bearings against face of pump gears.

238. OVERHAUL PUMP. Prior to disassembly, scribe alignment marks on gear housing (12—Fig. 319), pump body (6) and end cover (4) to ensure correct reassembly. Remove pump inlet filter (1). Remove retaining ring (19) and plug (18) from gear housing (12). Hold the idler gear (23) in a vise, then remove drive gear retaining nut (16) and tab washer. Remove four retaining cap screws and separate gear housing and rear cover from pump body. Reinstall retaining nut on pump shaft, then tap end of shaft with a soft mallet to release drive gear (14) from shaft taper. Keep bearings (7) and gears (8) in order as removed.

To remove idler gear (23), first remove retaining ring (26) from gear housing. Bump the housing on a wood block to remove plug (25) from housing. If plug fails to fall out of housing, compressed air can be directed into bleed hole (2—Fig. 320) to force plug from housing. Remove idler shaft (22—Fig. 319), gear (23) and thrust washers (21).

Clean and inspect all parts. Minor burrs and score marks can be removed using "O" grade emery paper lubricated with kerosene. Check bearings for wear or scoring on the face and bores. Check pump body bores for gear track wear; renew pump assembly if gear track wear exceeds 0.004 inch (0.10 mm).

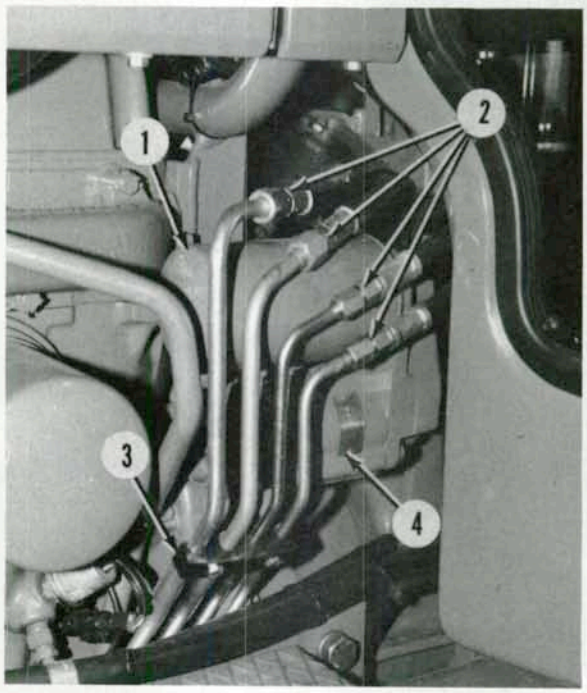


Fig. 318—Auxiliary hydraulic pump is mounted on left side of engine and driven by a gear on rear end of engine camshaft.

1. Oil filter
2. Power steering lines
3. Retaining clamp
4. Auxiliary hydraulic pump

Width of pump gears must be within 0.0002 inch (0.005 mm) of each other. Gear journals must be within 0.0005 inch (0.013 mm) of each other. Flatness of gear faces and bearings can be checked by applying blueing to bearing face and rotating against the gear. If blueing is not transferred evenly to gear face, renew gear and/or bearing. Renew seal ring (10), pressure loading ring (11), shaft oil seal (13) and all "O" ring seals.

NOTE: If wear or scoring of components is extensive, it is usually more economical to renew the pump assembly rather than attempt repairs.

Reassembly of pump is the reverse of disassembly procedure. If bearings (7) are being reused, they should be installed in their original positions. Be sure that recess (A—Fig. 321) on face of bearings is toward the gears and that relieved radius (R) is facing outlet side of pump body. Stuffer strip (9) must be positioned against pressure loading ring (11) on outlet side of pump. Lubricate all parts with hydraulic oil. Be sure that idler shaft plug (25—Fig. 319) is installed with slotted face toward the shaft. Tighten pump body retaining cap screws to a torque of 35 ft.-lbs. (47 N·m).

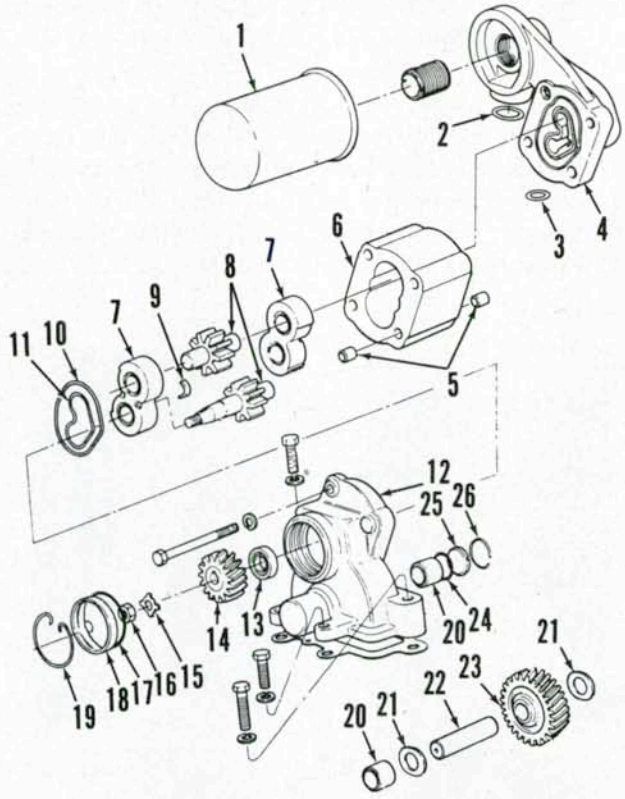


Fig. 319—Exploded view of auxiliary hydraulic pump assembly.

1. Oil filter
2. "O" ring
3. "O" ring
4. Rear cover
5. Dowels
6. Pump body
7. Bearings
8. Pump gears
9. Stuffer strip
10. Seal ring
11. Pressure loading ring
12. Front cover
13. Shaft seal
14. Drive gear
15. Lockwasher
16. Nut
17. "O" ring
18. Plug
19. Retaining ring
20. Bushings
21. Thrust washers
22. Idler shaft
23. Idler gear
24. "O" ring
25. Plug
26. Retaining ring

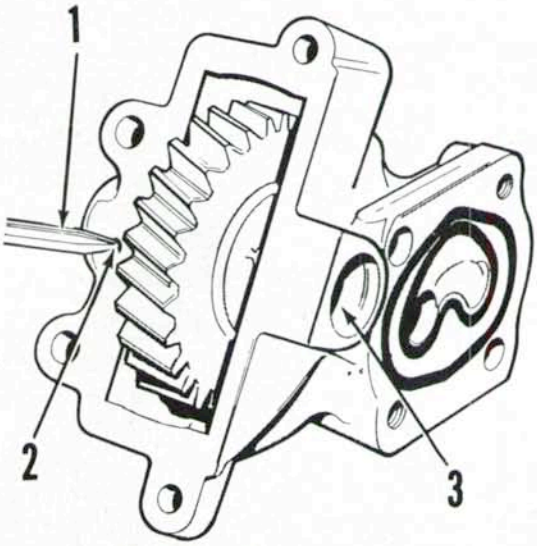


Fig. 320—If necessary, idler shaft plug (3) can be removed from housing by applying compressed air at bleed hole (1).

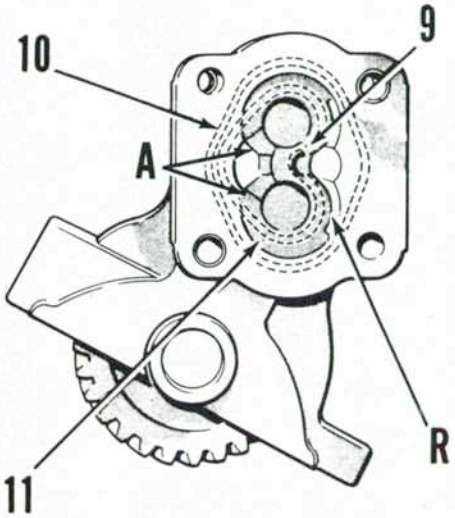


Fig. 321—When reassembling pump, be sure that recess (A) on bearings faces the gears and radius (R) is on outlet side of pump.

9. Stuffer strip
10. Outer sealing ring
11. Pressure loading ring

PUMP ADAPTER PLATE AND VALVE ASSEMBLIES

All Models

The pump adapter plate contains the differential lock valve (TW-5, TW-15 and TW-25 only), system relief valve and variable flow control valve. The adapter plate also serves as the mounting plate for main hydraulic pump.

239. R&R AND OVERHAUL. To remove adapter plate assembly, refer to hydraulic pump removal procedure outlined in paragraph 235. Refer to exploded view of pump adapter plate and hydraulic valves in Fig. 322 and to appropriate following paragraphs.

240. DIFFERENTIAL LOCK VALVE. On Model TW-35, the differential lock valve is not located in pump adapter plate. For service procedures covering TW-35 differential lock, refer to paragraph 169.

On Models TW-5, TW-15 and TW-25, proceed as follows: Unscrew valve rod guide (42—Fig. 322) and remove actuator rod (40), valve spool (39) and spring (38) from adapter plate (27). Clean and inspect all parts including valve bore in pump adapter housing. Renew worn or damaged parts. Be sure to install a new seal (43) in rod guide. Installation of valve is reverse of removal procedure.

241. SYSTEM PRESSURE RELIEF VALVE. To remove system relief valve, first remove differential lock valve (TW-5, TW-15 and TW-25) as outlined in paragraph 240. On all models, unscrew relief valve body (36—Fig. 322) from adapter plate.

To disassemble relief valve, push valve cap (28) in to compress valve spring (31) and remove snap ring (28). Be careful not to lose shims (30) or valve ball (33).

Inspect parts for wear or damage and renew as necessary. Relief valve opening pressure is adjusted by shims (30). If any parts of valve assembly are renewed, system relief pressure should be checked and adjusted as outlined in paragraph 228.

242. VARIABLE FLOW VALVE. To remove variable flow control valve (9—Fig. 322), drive roll pins (8 and 10) from each end of valve and remove arms (4 and 17). Remove shims (16) if so equipped. Unscrew gland nut (15) and remove spring washer (14), lever (13) and friction washer (12). Push valve out toward outside of adapter plate. Remove two back-up washers (6) and "O" rings (7) from valve. Inspect all parts for wear or damage and renew as necessary.

Reassemble using new "O" rings and back-up washers as follows: Install a new "O" ring (7) and back-up ring (6) on each end of valve with back-up rings at outside of "O" rings. Lubricate valve, then install valve (long end first) in bore with flow con-

1. Return oil filter
3. "O" rings
4. Variable flow valve arm
5. Override spring
6. Back-up washer
7. "O" ring
8. Roll pin
9. Variable flow valve
10. Roll pin
11. "O" ring
12. Thrust washer
13. Valve lever
14. Spring washer
15. Gland
16. Shim
17. Valve arm
18. Plug assy.
19. Roll pin
20. Plug
21. Connector
22. "O" ring
23. Spring
24. Flow control valve spool
25. Plug
26. "O" ring
27. Pump adapter plate
28. Snap ring
29. Spring seat
30. Shim
31. Relief valve spring
32. Ball retainer
33. Ball
34. "O" ring
35. "O" ring
36. Relief valve body
37. "O" rings
38. Spring
39. Differential lock valve spool
40. Valve actuator rod
41. "O" ring
42. Guide
43. Seal ring

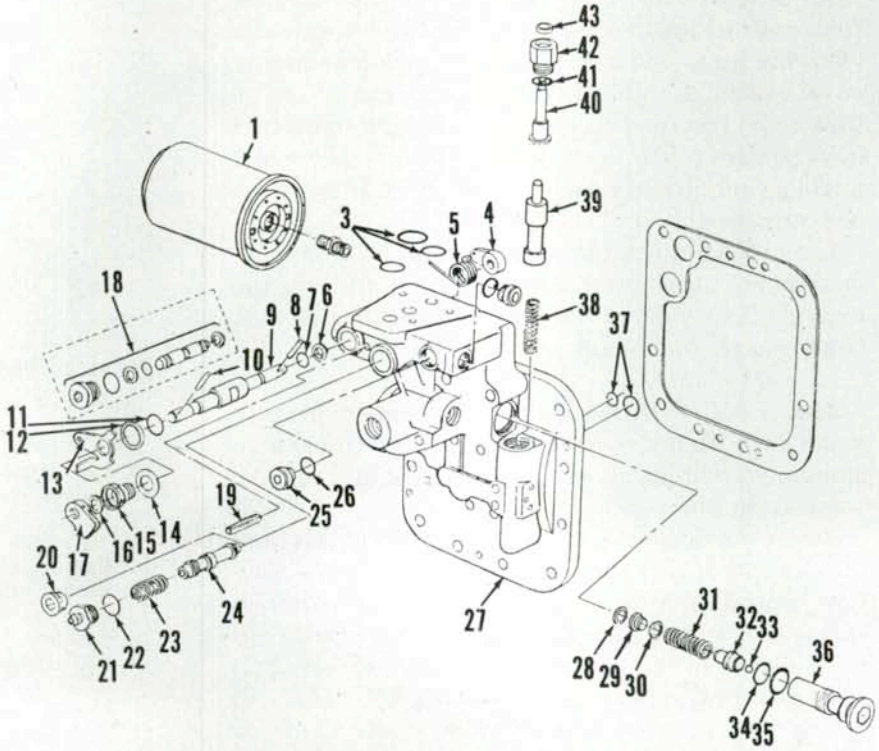


Fig. 322—Exploded view of hydraulic pump adapter plate and valve assemblies. Adapter plate (27) is serviced as a complete plate and valve assembly only; all other parts are available separately. Plug assembly (18) is used in place of variable flow valve (9) on tractors not equipped with hydraulic lift. Differential lock valve (39) is not used on Model TW-35.

trol notch up. Position friction washer (12) on adapter plate and hold in place with a small amount of grease. Place spring washer (14) and lever (13) on gland nut (15) with cupped side of spring washer toward the lever. Screw gland into adapter plate. Place shims (16), if used, and arm (17) onto shaft and secure with roll pin (10). Place override spring (5) and arm (4) on other end of shaft and secure with roll pin (8). Be sure override spring has approximately one turn of tension.

Check end play of variable flow control valve. If end play is not within range of 0.010-0.025 inch (0.25-0.64 mm), add or remove shims (15) as necessary. Be sure valve does not bind after reinstalling arm.

PRIORITY VALVE PACK ASSEMBLY

All Models

243. The priority valve pack assembly (21—Fig. 302) is mounted on top of pump adapter plate. The valve pack consists of flow control valve (24), unload valve (23) and check valve (22). These valves control flow of oil delivered to lift cylinder and remote valves.

The flow control valve meters flow of main hydraulic pump oil to lift cylinder and remote valves. The hydraulic lift has priority of main pump oil flow over the remote valves.

The unload valve receives bypassed main pump oil from flow control valve, combines it with oil flow from engine mounted auxiliary pump and directs this oil to the remote valves. If there is no demand at remote valves, the unload valve opens and allows oil flow to be returned to sump. The unload valve also incorporates a pilot operated relief valve to protect auxiliary pump and remote valve circuit from excessive pressure.

The unload check valve allows oil flow from auxiliary pump to pass to remote valves but prevents the return. Check valve also prevents main pump oil flow from entering auxiliary pump outlet line.

244. R&R AND OVERHAUL. To remove priority valve pack, first remove hydraulic tubes from valve assembly and plug all openings. Unbolt and remove valve from pump adapter plate.

Unscrew unload check valve plug (21—Fig. 324) and remove spacer (19), spring (18) and ball (17). Unscrew flow control valve restrictor fitting (22) and withdraw spring (24) and valve spool (25). Unscrew flow control valve sleeve (26) from housing. Remove plug (1) and withdraw unload valve spool (7), filter (13) and spring (14). Unscrew unload valve sleeve (3) from valve housing.

The unload valve spool incorporates a relief valve (items 8, 9, 10 and 11) to protect auxiliary pump and remote circuit. If it is necessary to remove relief valve, count the number of turns required to remove adjusting screw (11) so that screw can be reinstalled to original setting. Be careful not to damage lands of valve spool when removing and installing relief valve adjusting screw. A new valve spool includes the relief valve and is preset to specified pressure setting.

Inspect all parts for excessive wear, scratches or burrs. Minor imperfections may be removed with fine abrasive. Valve spools and sleeves should be renewed as matched assemblies. Be sure valve spools move freely in their sleeves. Renew all "O" rings and back-up rings.

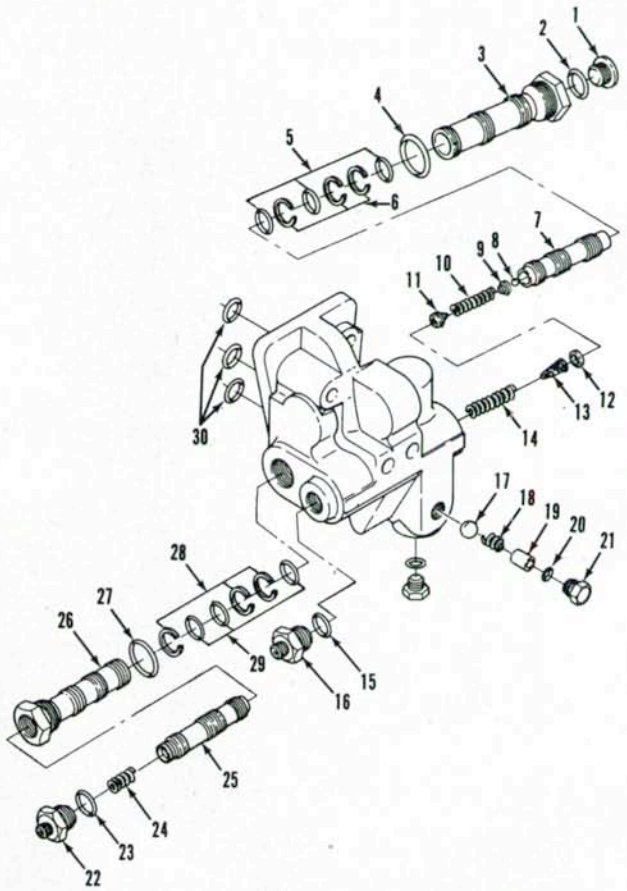


Fig. 324—Exploded view of priority valve assembly used on tractors manufactured April 1985 and after.

1. Plug
2. "O" ring
3. Unload valve sleeve
4. Seal
5. "O" rings
6. Back-up washers
7. Unload valve spool
8. Relief valve ball
9. Ball retainer
10. Relief valve spring
11. Adjusting screw
12. Washer
13. Filter screen
14. Spring
15. Seal
16. Restrictor fitting
17. Unload check valve ball
18. Spring
19. Spacer
20. "O" ring
21. Plug
22. Restrictor fitting
23. Seal
24. Spring
25. Flow control valve spool
26. Flow control sleeve
27. Seal
28. Back-up washers
29. "O" rings
30. "O" rings

NOTE: The unload valve sleeve and flow control valve sleeve are similar in appearance, but can be identified by the size of holes in section furthest from hexagon head. See Fig. 325.

When reassembling, coat all "O" rings with petroleum jelly. Flow control valve sleeve (larger holes) is installed in lower bore in valve body, and unload valve spool (smaller holes) is installed in upper bore. Tighten both valve sleeves to a torque of 75 ft.-lbs. (102 N·m). Tighten pilot restrictor fittings (16 and 22—Fig. 324) to a torque of 60 ft.-lbs. (82 N·m) and unload check valve plug (21) to 40 ft.-lbs. (54 N·m) torque.

Reinstall priority valve pack on pump adapter plate using new "O" ring seals. Tighten retaining cap screws to a torque of 32 ft.-lbs. (43 N·m).

LIFT COVER, CYLINDER AND CONTROL VALVE

245. R&R LIFT COVER, CYLINDER AND VALVE ASSEMBLY. It will be necessary to either remove cab or platform or tilt cab or platform forward to provide clearance for removal of lift cover. Refer to appropriate paragraph 266 through 269 for removal or tilting procedure.

Disconnect and remove remote valves with hydraulic tubes and attaching bracket from lift cover. Disconnect hydraulic line from lift assist cylinder if so equipped. Disconnect lift rods from lift arms. Disconnect pilot pressure tubes (5—Fig. 326), remote valve pressure tube (2) and return tube (6), lift pressure tube (4) and control linkage from lift cover, priority valve pack and pump adapter plate.

NOTE: If lift cylinder and control valve assembly is to be removed from lift cover, it is recommended that the four lift cylinder retaining cap screws (4—Fig. 333) be loosened prior to removing lift cover.

Remove cap screws retaining lift cover to rear axle center housing. Attach a suitable lifting fixture (such as Ford tool No. 1302) to lift cover and use a hoist to raise and remove lift cover assembly as shown in Fig. 327.

When reinstalling lift cover, be sure that the roller (4—Fig. 327) on draft and position control guide enters the draft sensing yoke (3). Tighten cover retaining cap screws to a torque of 155 ft.-lbs. (210 N·m). Complete installation by reversing the removal procedure.

246. OVERHAUL CONTROL VALVE. With lift cover removed as outlined in paragraph 245, remove control valve assembly (2—Fig. 328) as follows: Remove oil pressure connecting sleeve (3), pilot pressure tube connecting sleeve (4) and lift assist pressure connecting sleeve (if so equipped) from lift cover. Remove four cap screws retaining lift cylinder to cover and remove cylinder and control valve as an as-

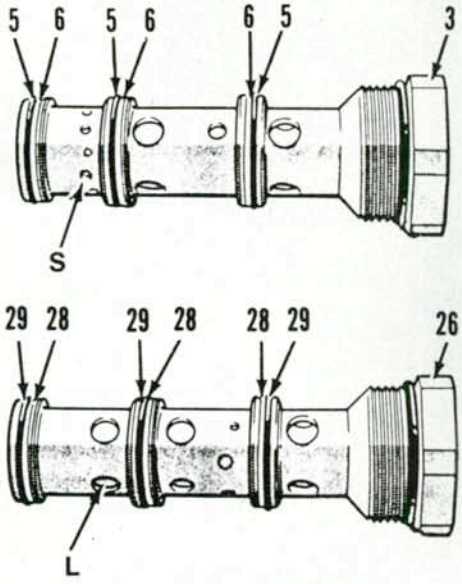


Fig. 325—Unload valve sleeve (3) and flow control valve sleeve (26) are similar in appearance. Unload valve sleeve has small holes (S) in end of sleeve, while flow control sleeve has large holes (L). Be sure "O" rings (5 and 29) and back-up washers (6 and 28) are installed correctly.

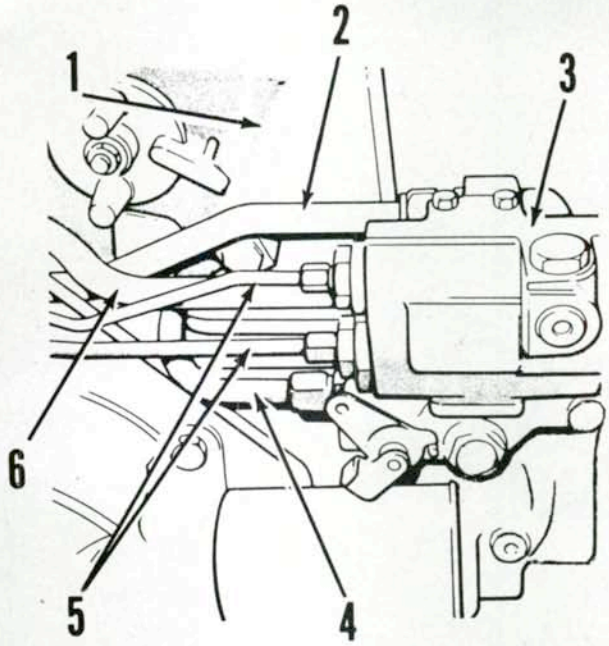


Fig. 326—Priority valve assembly (3) is mounted on top of pump adapter plate.

1. Lift cover
2. Remote valve pressure line
3. Priority valve pack
4. Lift pressure tube
5. Hydraulic lift and remote valve pilot lines
6. Remote valve return line

sembly. Unbolt and remove control valve block from lift cylinder.

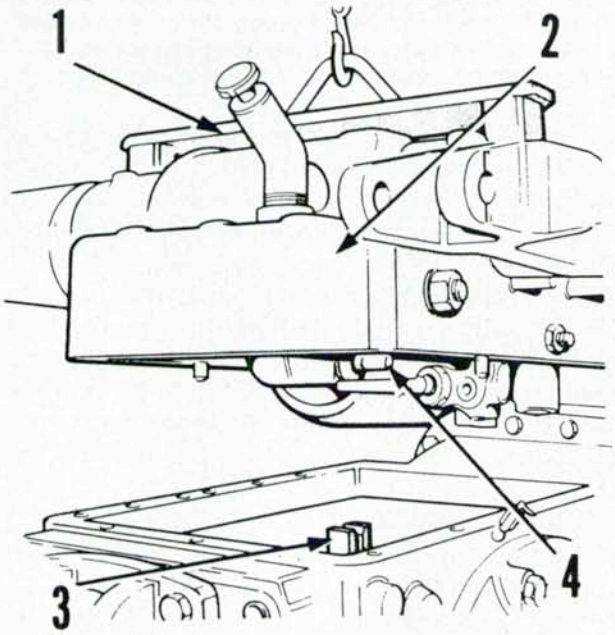


Fig. 327—Hydraulic lift cover removal and installation. Be sure that roller (4) engages draft sensing yoke (3) when reinstalling.

1. Lifting fixture, tool No. 1302
2. Lift cover
3. Draft sensing yoke
4. Roller

To disassemble valve, refer to Fig. 330 and proceed as follows: Unscrew plug (16) and remove poppet spring (18), ball seat (19), ball (20), drop valve poppet (21) and poppet actuator (22).

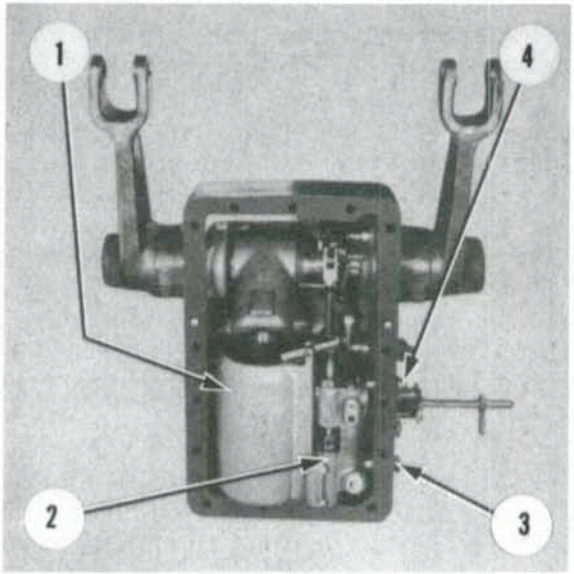
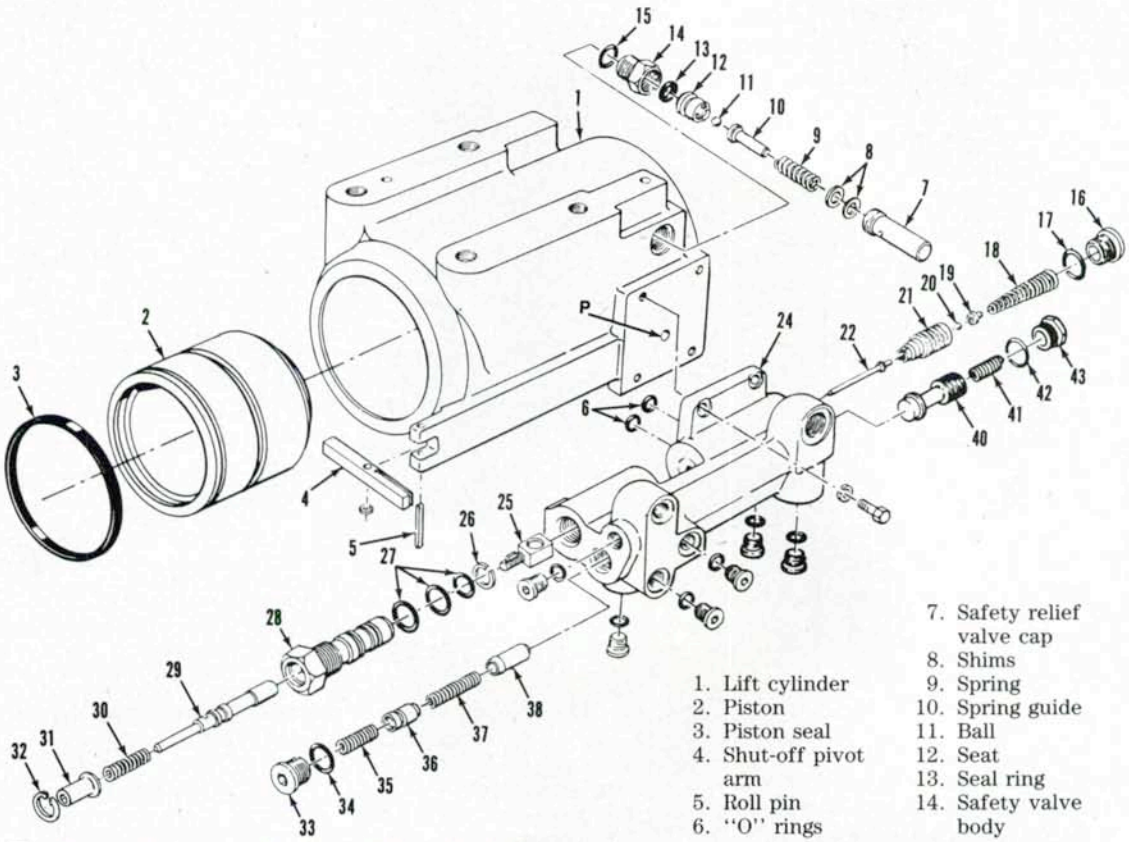


Fig. 328—Underside view of hydraulic lift cover showing lift cylinder (1), control valve assembly (2) and oil pressure connecting sleeves (3 and 4).



1. Lift cylinder
2. Piston
3. Piston seal
4. Shut-off pivot arm
5. Roll pin
6. "O" rings
7. Safety relief valve cap
8. Shims
9. Spring
10. Spring guide
11. Ball
12. Seat
13. Seal ring
14. Safety valve body
15. "O" ring
16. Plug
17. "O" ring
18. Spring
19. Ball seat
20. Drop poppet ball
21. Drop poppet valve
22. Actuator rod
24. Control valve housing
25. Control valve keeper
26. Back-up ring
27. "O" rings
28. Control valve sleeve
29. Lift control valve spool
30. Spring
31. Spring seat
32. Snap ring
33. Plug
34. "O" ring
35. Exhaust pressure valve spring
36. Exhaust pressure valve
37. Exhaust control valve spring
38. Exhaust control valve
40. Lift blocking spool
41. Spring type guide
42. "O" ring
43. Plug

Fig. 330—Exploded view of hydraulic lift cylinder and control valve assembly. Piston may be removed from cylinder by applying low pressure compressed air at fluid passage (P) in cylinder.

Unscrew plug (43) and remove spring (41) and lift blocking spool (40).

Unscrew control valve bushing (28) and remove bushing along with control valve (29), valve keeper (25), spring (30) and spring seat (31). Withdraw valve and keeper from bushing. Remove snap ring (32), spring seat and spring from bushing.

Unscrew plug (33) and remove exhaust valve pressure spring (35), exhaust pressure valve (36), valve control spring (37) and exhaust control valve (38).

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. Renew all "O" rings.

To reassemble valve, reverse disassembly procedure while observing the following special instructions. Be sure that exhaust pressure valve (36) is installed small end first; if valve is installed backward, the lift arms will not raise or lower. Tighten exhaust valve plug (33) to a torque of 65 ft.-lbs. (88 N·m). Tighten poppet valve plug (16) and lift blocking spool plug (43) to a torque of 90 ft.-lbs. (122 N·m). Tighten lift control valve bushing (28) to a torque of 135 ft.-lbs. (183 N·m).

After reassembly, adjust control valve keeper (25) as follows: Insert a 1/8 inch (3 mm) diameter pin or drill (D—Fig. 331) through hole in control valve (29) and bushing (28) to lock control valve in neutral position. Measure gap between keeper and drop poppet actuator (22) with a feeler gage (G). Turn keeper into or out of control valve spool to obtain a gap of 0.013-0.016 inch (0.3-0.4 mm), then remove drill bit.

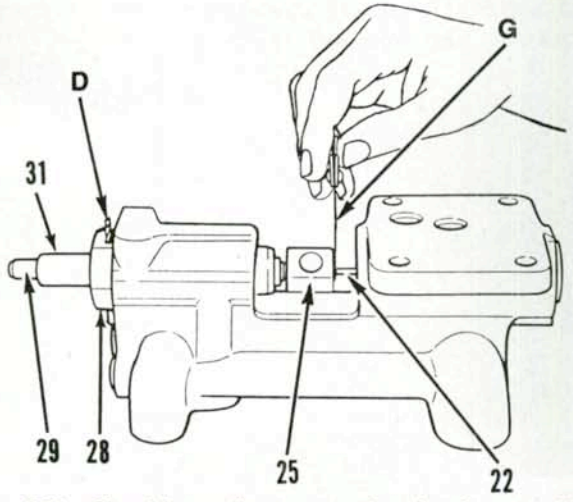


Fig. 331—Checking adjustment of valve keeper (25). Insert a 1/8 inch (3 mm) drill (D) or rod through valve spool (29) and bushing (28) to lock control valve in neutral position. Use a feeler gage (G) to measure clearance between keeper and actuator rod (22). Refer to text.

NOTE: If keeper threads into valve freely, either renew keeper or apply Loctite 262 Threadlocker or other suitable thread locking compound to threads of keeper. Be sure that threads of keeper and valve are clean before applying locking compound.

Assemble valve block to cylinder using new "O" rings. Tighten retaining screws to a torque of 22 ft.-lbs. (30 N·m).

247. OVERHAUL SAFETY VALVE. With lift cylinder and control valve assembly removed as outlined in paragraph 246, unscrew safety valve body (14—Fig. 330) from lift cylinder. Disassemble valve by unscrewing valve cap (7) from body.

When assembling valve use a new seal ring (13). If any parts other than seal ring are renewed, valve pressure setting must be checked using appropriate adapters and pressure test pump capable of maintaining 2800 psi (19300 kPa) pressure at 0.5 U.S. gpm (1.9 lpm) flow. If such test equipment is not available, renew complete valve assembly. Safety valve should open at 2650-2750 psi (18270-18960 kPa), and should not leak at below pop-off pressure. Vary shims (8) as required to obtain specified opening pressure.

248. LIFT CYLINDER AND PISTON. With lift cylinder and control valve assembly removed as outlined in paragraph 246, unbolt and remove control valve from lift cylinder. Remove pivot pin (5—Fig. 330), and pivot arm (4). Apply low pressure compressed air at fluid passage (P) in cylinder to force piston from cylinder.

CAUTION: A sudden blast of high pressure air will eject the piston at a dangerous speed.

Inspect piston (2) and cylinder bore for scoring or other damage and renew if necessary. Renew piston seal ring (3). Lubricate piston, seal and cylinder with hydraulic fluid, then install piston (closed end first) into cylinder.

249. OVERHAUL LIFT COVER. With lift cover removed as outlined in paragraph 245, remove lift cylinder and control valve from cover as outlined in paragraph 246.

250. CONTROL LINKAGE. To disassemble control linkage, remove snap ring (5—Fig. 333) from eccentric pin (7). Remove snap ring from control lever shaft (25) and remove pin from selector shaft (24), then remove the spring loaded actuator rod (58—Fig. 334) with control lever (65), position control arm (30) and draft/position control guide (51).

If necessary to disassemble spring loaded actuator rod, loosen locknut (N—Fig. 334) and unscrew hex

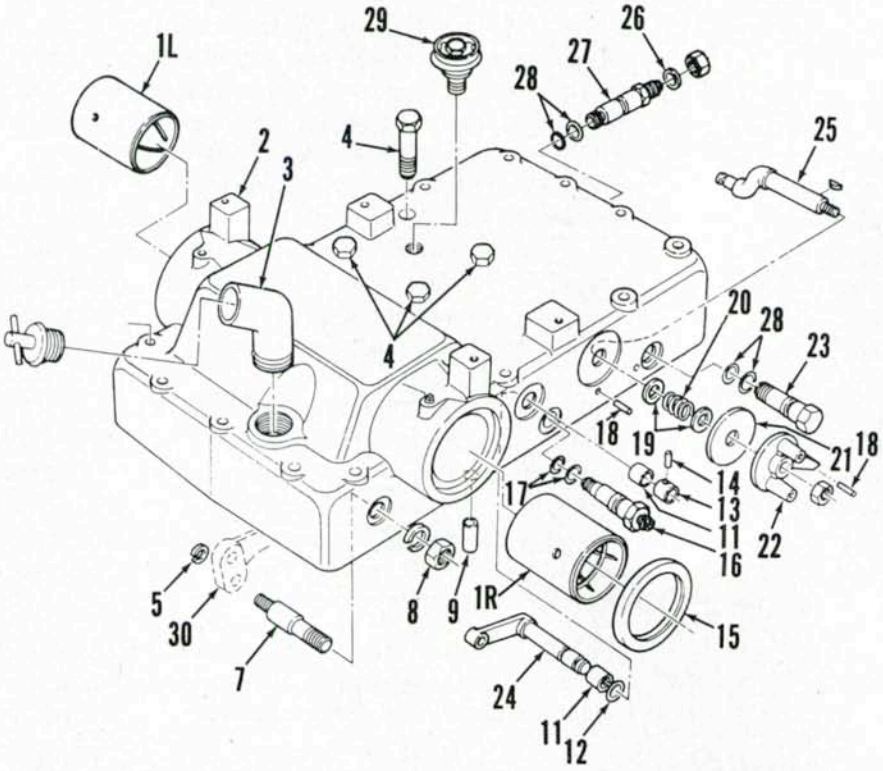
rod from yoke (57). Remove internal snap ring (59) from sleeve (63) and withdraw hex rod with spring (61) and bushings (60). Remove snap ring (62) from rod and remove spring and bushings.

To disassemble draft/position guide assembly, refer to Fig. 335. Drive out retaining pins (49) and remove the draft roller and pin (53) and the position control lever pin (52). Drive out pins retaining detent spring mounting pins (45), detent spring and spacer. Drive out pin (50) and remove yoke pin (56) and yoke (57) from guide (51).

To remove control lever shaft (25—Fig. 333), remove nut retaining control lever (22). Remove Woodruff key and friction disc (21), then withdraw shaft from inside of cover and remove the two flat washers (19) and spring (20) from shaft.

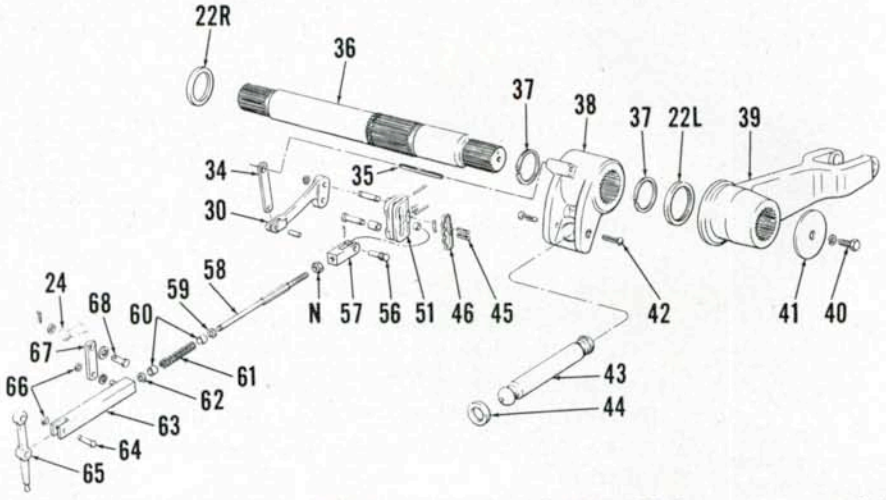
To remove selector lever shaft (24), drive retaining pin (14) out of hub (13) and shaft. Withdraw shaft from inside cover and remove spacers (11).

The position control eccentric pin (7) can be removed after removing nut (8) and lockwasher from outer end of pin.



1L. Lift shaft bushing, L.H.
1R. Lift shaft bushing, R.H.
2. Lift cover
3. Oil filler tube
4. Cap screws
5. Snap ring
7. Position control eccentric
8. Nut
9. Dowel pin
11. Spacers
12. "O" ring
13. Hub
14. Pin
15. Lift shaft seal
16. Pilot pressure sleeve
17. "O" rings
18. Pins
19. Washers
20. Friction disc spring
21. Friction disc
22. Control lever
23. Lift pressure sleeve
24. Selector shaft & arm
25. Lift control shaft & arm
26. Seal ring
27. Lift assist cylinder pressure sleeve
28. "O" rings
29. Breather
30. Position control arm

Fig. 333—Exploded view of hydraulic lift cover. Pressure sleeve (23) and pilot sleeve (16) thread into control valve body. Lift assist cylinder sleeve (27), if so equipped, threads into lift cylinder. Cap screws (4) retain lift cylinder to cover.



N. Locknut
22. Lift shaft seals
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. 334—Exploded view showing lift shaft and control linkage as removed from lift cover. Bumper ring (44) on piston rod (43) prevents rod from striking cylinder if lift arms are raised with piston in lowered position.

Reassemble linkage and install in lift cover by reversing disassembly procedure. Be sure to renew all seal rings. Note that length (L—Fig. 336) of the spring loaded actuator rod must be adjusted to 13.77-13.80 inches (349.6-350.4 mm) from center to center of pin holes. To adjust length, loosen locknut (N) and turn hex rod (58) in or out of yoke (57), then tighten locknut.

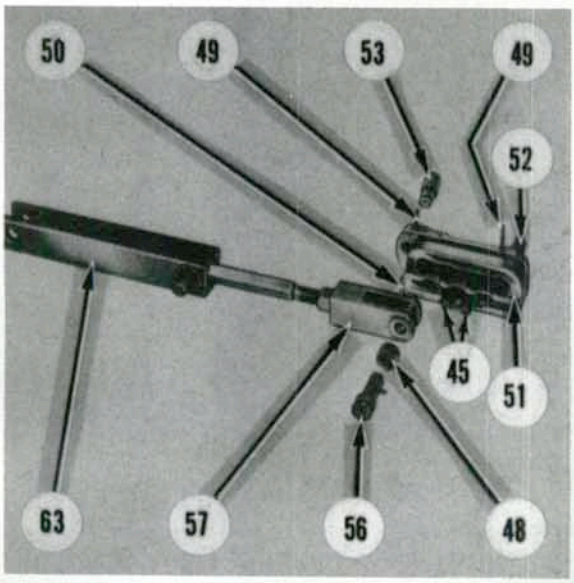


Fig. 335—Exploded view of draft/position control guide and detent mechanism. Head of pin (56) detents in notches formed in detent spring. Spring is mounted in split pins (45) which are retained in guide (51) by roll pins. Roller (53) engages yoke on draft control lever.

45. Split pins
48. Roller
49. Roll pins
50. Roll pin
51. Guide & detent spring
52. Position control pin
53. Draft control pin & roller
56. Yoke pin
57. Yoke
63. Actuator sleeve

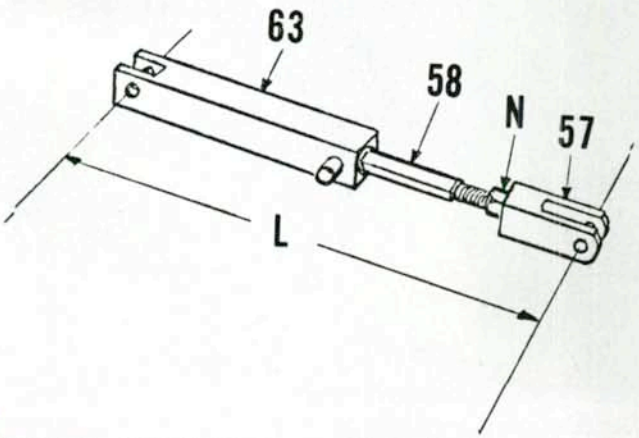


Fig. 336—Length (L) of assembled actuator rod must be adjusted to 13.77-13.80 inches (349.6-350.4 mm). To adjust, loosen locknut (N) and turn hex rod (58) in yoke (57).

251. LIFT SHAFT AND BUSHINGS. With control linkage removed as outlined in paragraph 250, remove cap screws (40—Fig. 334) from each end of lift shaft (36) and remove the lift arms (39). Note that lift shaft must be removed out left side of lift cover as inside diameter of right bushing is smaller than inside diameter of left bushing. Disengage snap rings (37) from their grooves and move snap rings and lift cylinder arm (38) to the right while bumping lift shaft to left side of cover until snap rings and lift arm can be removed from shaft, then withdraw shaft from cover.

The bushings (1L and 1R—Fig. 333) and shaft seals (15) can be removed from cover after removing lift shaft. Install new bushings with suitable driver, then install new seals with lip of seals inward.

NOTE: It is not necessary to remove lift shaft to renew seals. Remove seals by drilling a small hole in seal case, then thread a metal screw into hole and pull seal with a slide hammer. Install new seals over lift shaft and tap into place with a mallet.

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 lift arm retaining cap screws to a torque of 75 ft.-lbs. (102 N·m).

LOWER LINK HANGERS, TORSION BAR AND DRAFT CONTROL LINKAGE

252. TORSION BAR. To remove torsion bar (12—Fig. 337), first remove hitch lower link from left-hand lower link hanger (3). Remove cap screw (15) from right end of torsion bar. Unbolt and remove torsion bar anchor (11), then withdraw torsion bar from lift link hanger. If bar is broken or seized, remove snap ring (14) and flat washer (13) from right end of lower link hanger (3), then use suitable drift to drive torsion bar from right to left out of the hanger.

NOTE: Be careful not to chip, dent or scratch torsion bar as stress points may result, leading to torsion bar failure.

Install torsion bar by reversing the removal procedure. Be sure that alignment mark on torsion bar is aligned with marks on torsion bar anchor (11) and left hanger (3), and that index mark on right hanger (9) is aligned with mark on end of left hanger.

253. LOWER LINK HANGERS. To remove lower link hangers (3 and 9—Fig. 337), first drain oil from rear axle center housing. Remove hitch lower links from the hangers. Remove cap screw (15) and snap rings (10 and 14), then remove right hanger from end of left hanger.

To remove left hanger (3), remove lift cover as outlined in paragraph 245. Remove torsion bar anchor (11) and torsion bar (12). Loosen locknut (N) and remove set screw (S) from draft control arm (7). Pull left hanger out far enough to remove Woodruff key (4), then remove hanger from rear axle center housing.

Reverse the removal procedure to reinstall hangers.

254. DRAFT CONTROL LINKAGE. To service draft control linkage shown in Fig. 337, lift cover must first be removed as outlined in paragraph 245. 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 253 for removal of left lower link hanger (3).

When draft control linkage is reassembled and prior to installing lift cover, the link (16 and 17—Fig. 338) must be adjusted for proper length as follows: Loosen locknut on eccentric pin (19) and turn pin so eccentric is in up position. Measure distance (D) between center of dowel pin hole (H) in rear axle center housing to center of yoke in lever (18). If distance does not measure 5-5/8 inches (143 mm), back out eccentric pin until lever can be removed from pin. If measurement is less than 5-5/8 inches (143 mm), turn link rod (17) into link end (16). If measurement is more than 5-5/8 inches (143 mm), turn rod out of link end.

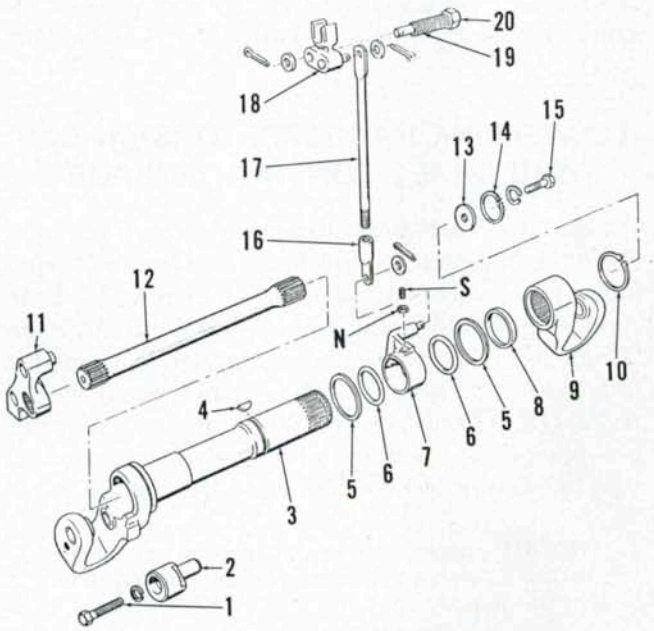


Fig. 337—Exploded view showing torsion bar, lower link hangers and draft control linkage. Refer to Fig. 338 for adjustment of draft control link (16 and 17).

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

HYDRAULIC LIFT ASSIST CYLINDER

255. R&R AND OVERHAUL. Some tractors may be equipped with a lift assist cylinder which is mounted on rear axle housing and attached to hitch lift arm to increase lifting capacity of 3-point hitch.

To remove lift assist cylinder, fully lower the lift arms. Disconnect hydraulic line from cylinder and plug opening. Remove upper and lower attaching pins and remove cylinder.

To disassemble cylinder, remove socket headed plug from cylinder (2—Fig. 340). Withdraw piston from cylinder until piston rod retaining ring (4) is visible in opening in cylinder barrel, then use a small screwdriver or similar tool to pry retaining ring from groove in end of piston. The piston can now be pulled out of cylinder.

A seal kit is available for servicing the cylinder. If piston or cylinder is worn, scored or damaged, cylinder assembly should be renewed.

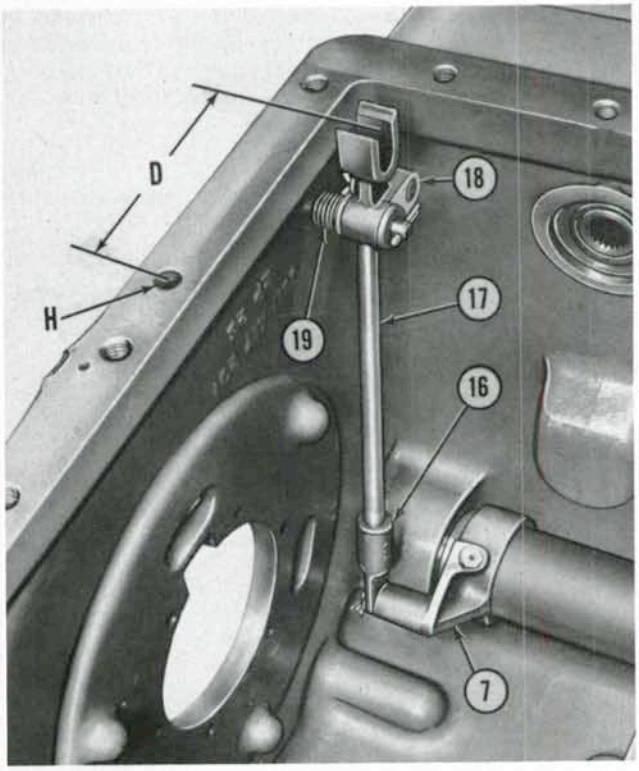


Fig. 338—With eccentric pin (19) in "up" position, adjust link (17) by turning link into or out of link end (16) so that distance (D) between center of dowel hole (H) in rear axle center housing to center of draft control lever yoke is 5-5/8 inches (143 mm).

To reassemble cylinder, install a new gland ring and wiper ring in end of cylinder. Install retaining ring into deeper groove (A) in end of piston as shown in Fig. 341. Lubricate piston with clean hydraulic oil, then carefully push piston into cylinder until retaining ring is aligned with opening in cylinder. Working through opening as in disassembly, roll the retaining ring into final assembly groove (B) in piston.

Reinstall cylinder and cycle hydraulic lift up and down several times to bleed all air from cylinder.

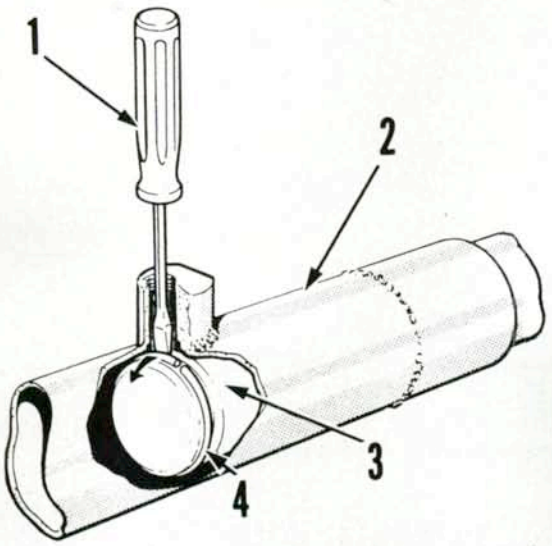


Fig. 340—To disassemble lift assist cylinder (2), insert a screwdriver (1) through cylinder port and pry retaining ring (4) off the piston (3).

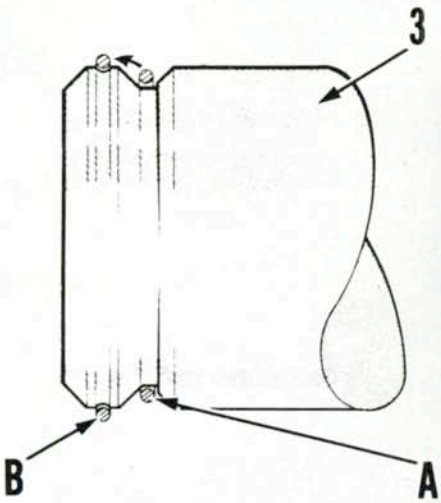


Fig. 341—When reassembling lift assist cylinder, install retaining ring in deeper groove (A) and push piston into cylinder. Then working through cylinder port, roll the retaining ring into assembly groove (B).

DE-LUXE REMOTE CONTROL VALVES AND COUPLERS

260. The De-luxe Remote Control Valves used on tractors produced in April 1985 and after are closed center type connected in parallel with hydraulic lift system. The hydraulic lift has priority on main hydraulic pump output over the remote valves. Oil flow from auxiliary hydraulic pump is available at all times for remote valve circuit.

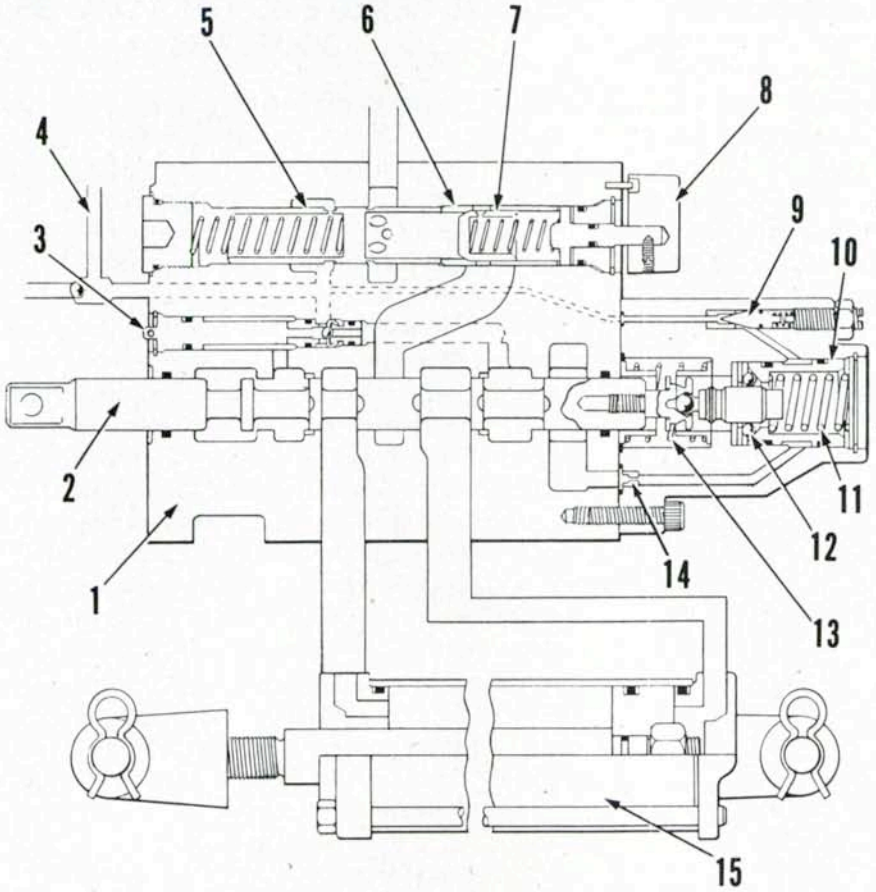
When a remote valve is actuated, pilot pressure is directed from the remote valve to the end of unload valve spool located in the priority valve pack. The pilot pressure moves the unload spool out of neutral position, which closes return to sump passage and combines the oil flow from main and auxiliary pumps to supply the remote circuit. When remote valves are not being used, pilot pressure to unload valve is cut-off and spring pressure returns the unload valve to neutral position. Oil flow from main and auxiliary pumps is then directed to sump.

Each remote valve spool has an adjustable flow control restrictor (6—Fig. 342), detent regulating valve (9) and shuttle check valve (3). Each spool may be individually adjusted for output flow and detent release pressure. A pilot operated relief valve is incorporated in the unload valve to protect remote circuit and auxiliary hydraulic pump from excessive pressure. Refer to paragraph 229 for relief valve pressure test procedure.

261. CHECK AND ADJUST REMOTE CONTROL VALVE DETENT PRESSURE. Connect a suitable hydraulic flow meter to "Raise" quick coupler of remote valve being checked, or install a 3000 psi (20000 kPa) pressure gage and load (shut-off) valve using a tee fitting as shown in Fig. 343 at "Raise" coupler. Oil return hose of testing equipment may be connected to "Lower" quick coupler or routed into filler tube.

Start the engine and set speed at 1700 rpm. With load valve on flow test equipment open, move control lever of remote valve being checked to "Raise" position. Slowly close load valve on flow test equipment while noting pressure gage reading. Remote valve lever should return to "Neutral" position when pressure reaches 2150-2350 psi (14825-16200 kPa). Detent pressure may also be checked in "Lower" position, if desired, in same manner by plugging test equipment into "Lower" quick coupler.

If control valve lever will not return to neutral within specified pressure range and valve spool is not binding, adjust detent pop-off pressure as follows: Loosen locknut on detent adjusting screw (1—Fig. 344) at rear of remote valve. Turn adjusting screw in to increase pressure setting, or turn screw out to decrease detent release pressure. Tighten locknut and recheck detent pressure.



1. Valve body
2. Valve spool
3. Shuttle check valve
4. Pilot pressure line
5. Flow control spool
6. Flow control restrictor
7. Load check valve
8. Flow control knob
9. Detent regulating valve
10. Detent spool
11. Detent spring
12. Detent balls
13. Centering spring
14. Orifice
15. Remote cylinder

Fig. 342—Cutaway view of single spool remote control valve assembly.

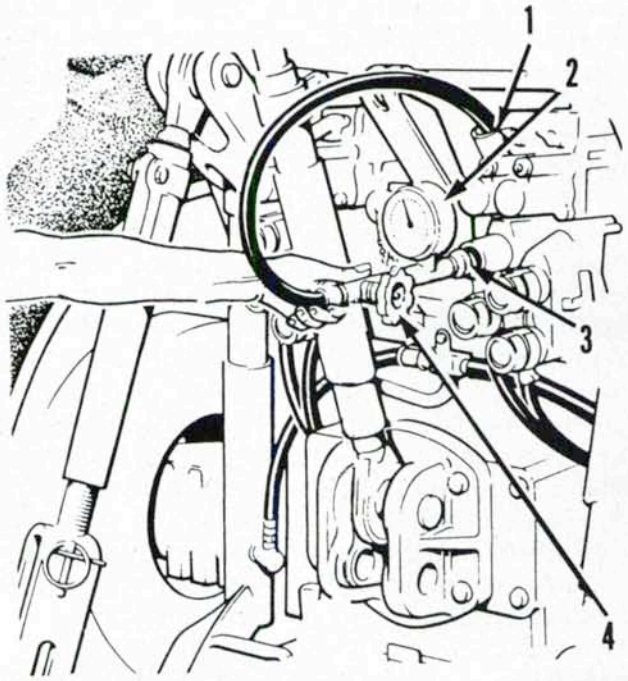


Fig. 343—To check and adjust remote valve detent pressure, connect a flow meter or a pressure gage (2) with a load valve (4) to remote coupler (3). Return oil can be directed into filler tube (1).

262. ADJUST REMOTE CONTROL VALVE LINKAGE. To adjust remote control valve linkage, place control valve in neutral position and disconnect control rod trunnion (2—Fig. 345) from valve spool. Loosen trunnion locknut and turn trunnion to adjust length of actuating rod (1) so that rear edge of control levers (L) is 2 inches (51 mm) from rear end of slots (A and B) in console.

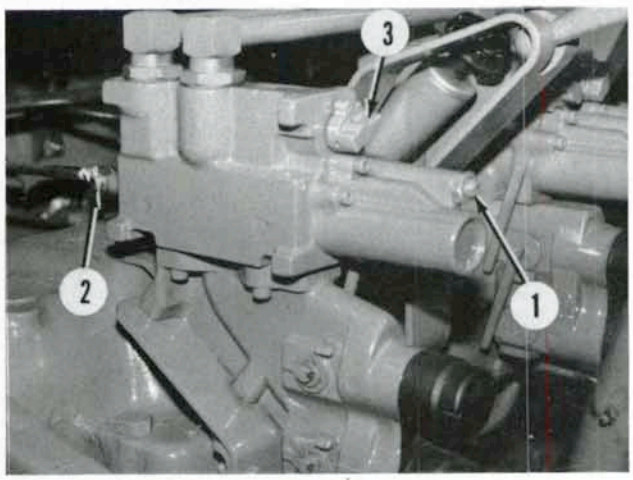


Fig. 344—Remote valve detent pressure is adjusted by turning adjusting screw (1).

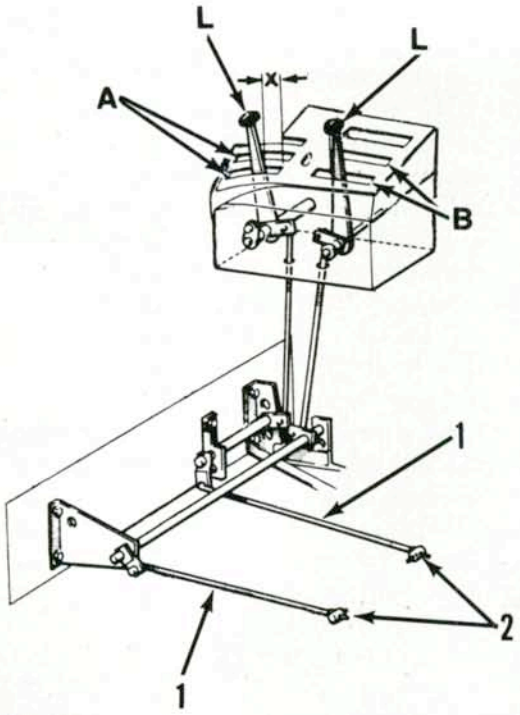


Fig. 345—With remote valves in neutral position, there should be 2 inches (50.8 mm) of clearance (X) between rear edge of control levers (L) and rear end of console slots (A and B). Adjustment is made at trunnions (2).

263. R&R REMOTE CONTROL VALVES. To remove remote control valve, first thoroughly clean valves and surrounding area. Disconnect control linkage from remote valve spool. Disconnect hydraulic tubes and plug all openings. Unbolt and remove remote valve and quick coupling assembly from mounting bracket.

To reinstall remote valve assembly, reverse the removal procedure. Tighten mounting cap screws to a torque of 24 ft.-lbs. (33 N·m).

264. OVERHAUL REMOTE VALVE UNIT. To disassemble valve, first unbolt and remove quick release coupling manifold from control valve body. Remove socket head screws retaining detent housing (25—Fig. 346) to valve body and remove detent assembly. Slide valve spool (19) with centering spring (20) out centering spring end of valve body. Compress centering spring and slide detent plunger (21) from slot in spring retainer. To remove centering spring, clamp control linkage end of spool in a vise and unscrew spring retainer coupling from end of spool. Note that thread locking compound is used on threads of retainer coupling and removal may be difficult.

Remove plug (1), spring (2) and flow control spool (3). Loosen set screw retaining flow control knob (10) and remove knob. Remove double spiral retaining ring (9), then withdraw flow restrictor control shaft

1. Plug
2. Spring
3. Flow control spool
4. Flow restrictor
5. Load check valve
6. Spring
7. Flow restrictor plug
8. Flow restrictor control shaft
9. Spring
10. Flow control knob
11. Back-up ring
12. "O" ring
13. Priority check valve
14. Snap ring
15. "O" rings
16. Shuttle check valve
17. "O" rings
18. Valve body
19. Valve spool
20. Centering spring
21. Detent spool
22. Adjusting screw
23. Spring
24. Detent regulating valve
25. Detent housing
26. Spacer
27. Detent balls
28. Back-up rings
29. "O" rings
30. Detent piston
31. Detent spring
32. End cover
33. Snap ring

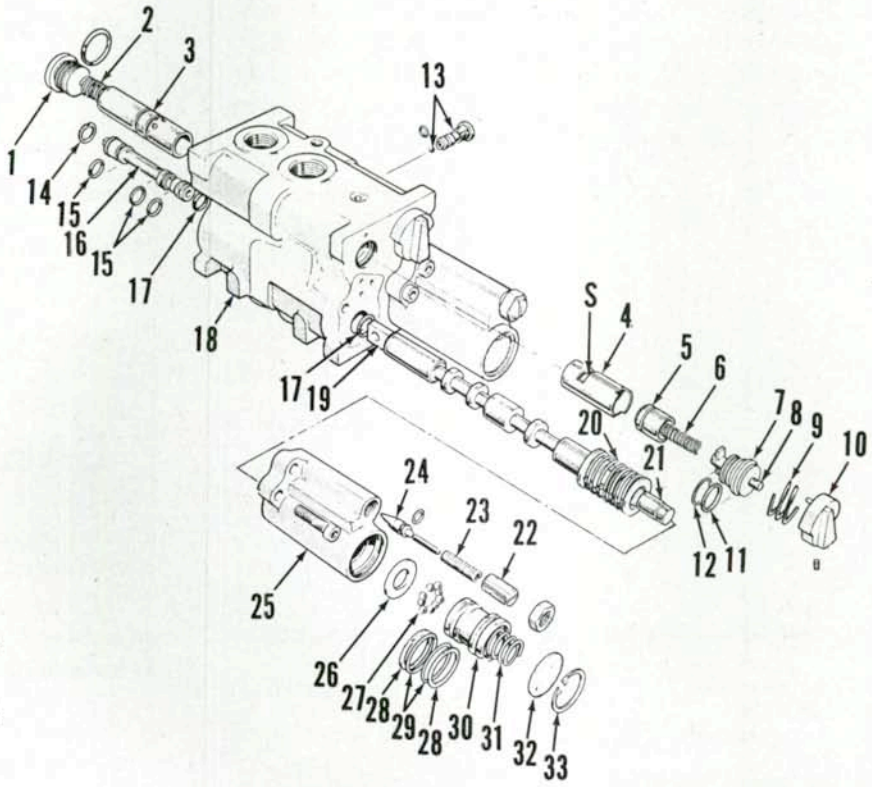


Fig. 346—Exploded view of double spool remote control valve assembly used on tractors built in April 1985 and after. Flow restrictor (4) must be installed with slot (S) positioned downward.

(8) and plug (7), spring (6), flow restrictor (4) and load check valve (5).

Remove retaining ring (14) securing shuttle check valve (16). Insert a small diameter rod through hole in end of shuttle valve to use as a handle and withdraw shuttle valve. On double spool valves, remove shuttle check valve seat and ball (13) from side of valve body.

To disassemble detent mechanism, depress end cap (32) to compress detent spring (31) and remove snap ring (33) retaining the end cap. Remove end cap, spring, detent piston (30), detent balls (27) and spacer (26). Remove detent regulating valve adjusting screw (22) and withdraw spring (23), rod and detent valve (24).

Inspect all parts for wear, scoring, burrs or other damage. Control valve spool and body are not available separately. Complete valve assembly must be renewed if spool and/or body are excessively worn or damaged. Renew all "O" ring seals and back-up rings.

Reassemble remote control valve by reversing disassembly procedure. Lubricate all components with clean hydraulic oil during assembly. If control valve centering spring was removed, apply a small amount of suitable thread locking compound, such as Loctite 262 Threadlocker to threads of spring retainer coupling.

Reinstall control valve and check and adjust detent pressure as outlined in paragraph 261.

265. OVERHAUL QUICK RELEASE COUPLING. To disassemble remote valve quick release couplers, remove rubber dust caps from couplers. Remove snap ring (4—Fig. 347), spring washer (3) and tab washer (2) from coupling lever shaft (1). Turn coupling lever to open position and withdraw it from coupler manifold. Unscrew sleeve (14) from manifold and withdraw coupler assembly. Remove actuator (6) from coupler. Push down on gland (9) and remove snap ring (8), then withdraw gland, sliding sleeve (10) and spring (11) from coupler.

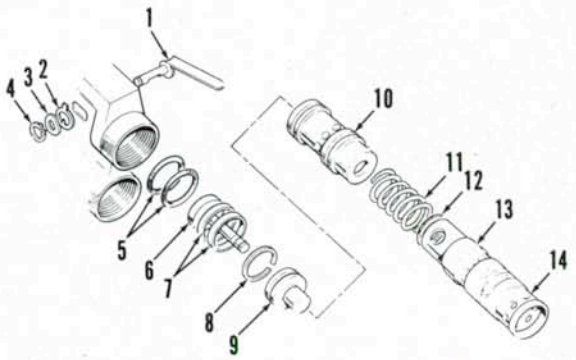


Fig. 347—Exploded view of remote valve quick coupler assembly.

1. Coupling lever
2. Tab washer
3. Spring washer
4. Snap ring
5. "O" rings
6. Actuator
7. Slipper seals
8. Snap ring
9. Gland
10. Sliding sleeve
11. Spring
12. Seal
13. Coupler
14. Sleeve

Inspect all parts for wear or damage and renew as necessary. Renew all seal rings. Lubricate all parts with clean hydraulic oil before installation.

To reassemble, install new seal (12) in coupler and assemble spring, sliding sleeve, gland and retaining ring. Insert actuator into gland. Install two new "O" rings (5) in coupler manifold grooves. Shape the slipper seals (7) as shown in Fig. 348, then install them in manifold grooves. The slipper seals should be stretched slightly before installing coupler to prevent damage to seals. A wedge shaped tool (S—Fig. 348) of suitable size may be inserted into bore of manifold to stretch the seals and fully seat them in manifold grooves. Lubricate coupler assembly, then carefully insert into manifold. Tighten sleeve to a torque of 60 ft.-lbs. (82 N·m). Install coupler handle, washers and snap ring.

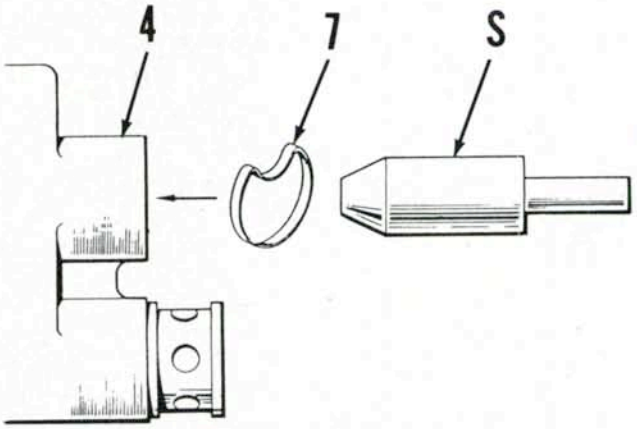


Fig. 348—Slipper seals (7) should be fully seated in coupler housing grooves using a wedge shaped tool (S) prior to installing coupler in housing.

CAB AND PLATFORM

The cab contains panels to provide access to components located beneath the cab. Removal of the cab is optional when performing major repairs requiring removal of transmission or rear axle center housing. Some mechanics prefer the additional working space provided when the cab is removed, while others prefer to work around the cab, leaving it attached to either the transmission housing or rear axle housing.

Early Model (Prior to November 1985) Safety Cab

266. REMOVE AND REINSTALL. The cab can be removed from the tractor without removing the hood and side panels. However, it is suggested that the sheet metal be removed to provide easier access to disconnect points beneath the hood.

Disconnect ground cable from battery. Disconnect pto control cable at left side of rear axle center housing and remove cable attaching bracket from hydraulic lift cover. Disconnect transmission handbrake control cable (if so equipped). If equipped with air conditioning, disconnect self-sealing couplings at rear of cab. It is not necessary to discharge the air conditioning system. Disconnect hydraulic lift system selector rod, hydraulic lift control rod, variable flow control rod, remote valve control rods and remote valve flow control cables at rear of tractor.

Disconnect differential lock pedal linkage from control valve under right side of cab. Disconnect brake lines from master cylinder on TW-5, TW-15 and TW-25 models. Disconnect lines from brake valve and differential lock valve on Model TW-35.

Remove bolt retaining front main wiring harness at front of cab and unplug harness connector (located behind power steering motor). Disconnect windshield washer pump wire from front main harness. Note that this wire is light green with a black stripe and connects to front main harness at top right rear corner of main fuel tank on tractors with an "A" or "B" prefixed serial number; while on tractors with a "C" prefixed serial number, this wire is gray with a yellow stripe and connects to front main harness in front of main connector. If equipped with Dual Power, disconnect Dual Power solenoid wire at plug connector located above transmission bellhousing.

Disconnect fuel shut-off cable, throttle cable and tachometer cable from fuel injection pump. Remove all clips retaining cables to engine. Close heater shut-off valves and disconnect heater hoses. Tag the four power steering hoses (1—Fig. 350) to ensure proper reassembly, then disconnect hoses and plug all openings. Disconnect clutch linkage (2) under left side of cab.

Remove gear shift lever boot, remove shift lever clamp bolts and pull shift levers from shift mechanism. Remove scuff plates from right and left side of cab. Pull floor mat back, remove front mounting bolt access plates from cab floor and remove cab front mounting bolts. Note that there may be shims located between cab front mounts and cab rails. Tag the shims so they can be reinstalled in their original location.

Remove the two bolts located midway along each side of the cab roof and attach eyebolts and a spreader bar as shown in Fig. 351. Be sure that eyebolts are fully threaded into cab roof, but do not overtighten as the cab roof could be damaged. Attach a suitable overhead hoist to spreader bar. Remove cab rear mounting bolts, then slowly raise cab clear of tractor.

IMPORTANT: Do not tilt cab rearward as cab rear mountings will be damaged.

Installation of cab is reverse of the removal procedure plus the following items: Be sure any shims located between cab rails and front mounts are in-

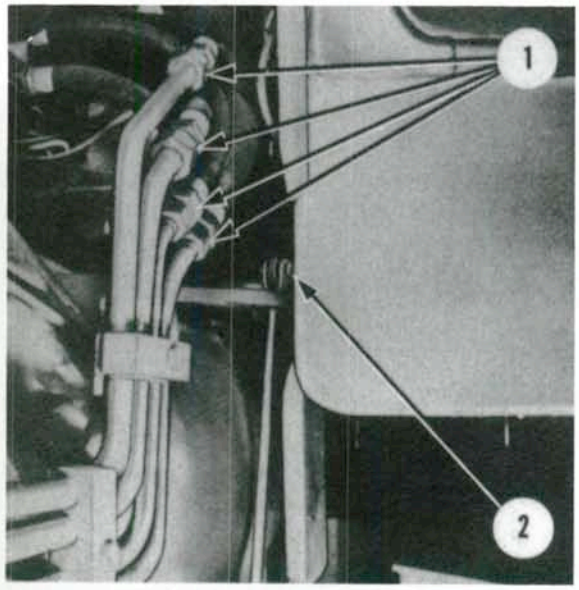


Fig. 350—When removing cab, tag power steering hoses (1) to ensure correct reassembly. Remove pin (2) to disconnect clutch linkage.

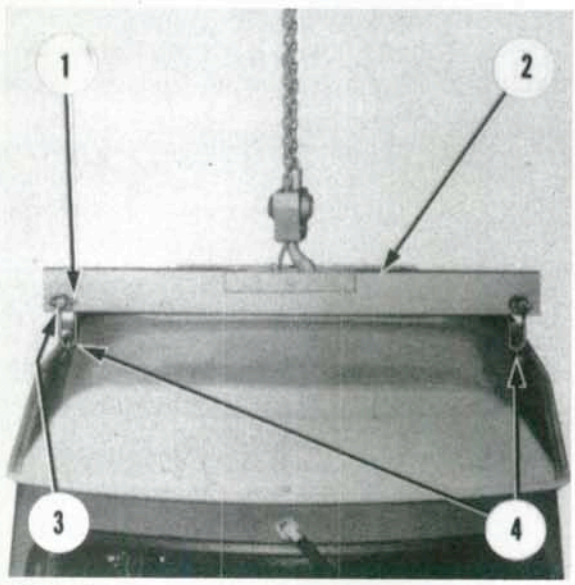


Fig. 351—Attach spreader bar (2) to threaded lifting points in top of cab using rings (3) and eyebolts (4).

stalled in their original location. Tighten cab front mounting bolts first to 200 ft.-lbs. (270 N·m) torque, then tighten rear mounting bolts to 280 ft.-lbs. (380 N·m) torque. Tighten cab rear mounting bracket to axle housing bolts to 200 ft.-lbs. (270 N·m) torque. Bleed air from brake system as outlined in paragraph 175 or 178. Adjust clutch free travel as outlined in paragraph 126. Adjust hydraulic system lift control lever and remote valve control linkage as outlined in HYDRAULIC SYSTEM section.

Platform

267. REMOVE AND REINSTALL. The platform can be removed from the tractor without removing the hood and side panels. However, it is suggested that the sheet metal be removed to provide easier access to disconnect points beneath the hood.

Disconnect battery ground cable. On tractors equipped with Dual Power, disconnect Dual Power solenoid wire at the plug connector located above transmission bellhousing. Disconnect wiring harness over transmission. Disconnect front main wiring harness at connector located at rear of power steering motor.

Disconnect throttle, fuel shut-off and tachometer cables from fuel injection pump and remove clips attaching cables to engine. Disconnect hydraulic brake lines at master cylinder (TW-5, TW-15 and TW-25) or brake valve (TW-35) and plug openings. Tag power steering hoses to ensure correct reassembly, then disconnect hoses from the tubes and plug all openings. Disconnect clutch linkage. Disconnect pto control cable at left side of rear axle center housing and remove cable retaining clip. Disconnect transmission handbrake control cable if so equipped.

Disconnect hydraulic system selector rod, hydraulic lift control rod, variable flow control rod, remote cylinder control rods and flow control cables at rear of tractor. Remove tail light and remote cylinder mounting brackets.

Remove the seat. Disconnect differential lock pedal from control valve and remove the pedal. Remove gear shift lever boot and floor mat. Remove clamp bolts from gear shift levers and remove the shift levers from shift mechanism.

Attach a hoist to platform using a spreader bar and chains. Remove mounting bolts from front and rear of platform. Slowly raise platform clear of the tractor.

Installation of platform is reverse of removal procedure. Tighten platform front mounting bolts to 200 ft.-lbs. (270 N·m) torque and rear mounting bolts to 40 ft.-lbs. (55 N·m) torque. Bleed air from brakes as outlined in paragraph 175 or 178. Adjust hydraulic system controls as outlined in HYDRAULIC SYSTEM section. Adjust clutch linkage as outlined in paragraph 126.

Late Model (November 1985 and After) Safety Cab

268. REMOVE AND REINSTALL. The cab can be removed from the tractor without removing the hood and side panels. However, it is suggested that the sheet metal be removed to provided easier access to disconnect points beneath the hood.

Disconnect fuel shut-off cable, throttle cable and tachometer cable from fuel injection pump. Remove clips attaching cables to engine. Close heater shut-off valves and disconnect heater hoses (2—Fig. 353) from valves. Disconnect battery ground cable. Disconnect main wiring harness and two auxiliary harnesses at connectors (1) located below power steering motor. Disconnect differential lock pedal linkage from control valve located under right side of cab (TW-5, TW-15 and TW-25). Disconnect hydraulic brake lines from master cylinder (TW-5, TW-15 and TW-25) or brake and differential lock valve (TW-35). Disconnect power brake and differential lock oil supply line (TW-35).

Tag the four hydrostatic steering hoses (1—Fig. 354) to ensure proper reassembly, then disconnect hoses from tubes and plug all openings. Remove rear shroud panels. Disconnect clutch linkage at cross-shaft lever.

If equipped with air conditioning, disconnect high and low pressure hoses at self-sealing couplings (1—Fig. 355) at rear of cab. It is not necessary to discharge the air conditioning system. Remove air conditioner drain hoses from cab support brackets.

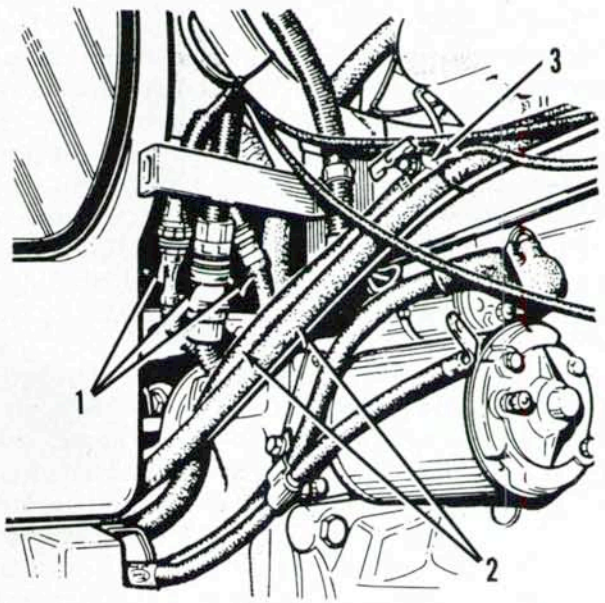


Fig. 353—Tractor main wiring harness connectors are located at right front side of cab.

1. Wiring harness connectors
2. Heater hoses
3. Heater rear shut-off valve

At rear of cab, disconnect remote control valve linkage (1—Fig. 356), hydraulic lift control rod (2), system selector rod (3) and variable flow control rod (4). Unbolt and remove support bracket from end of hydraulic lift control cross-shaft. Disconnect pto control rod at upper end of actuating rod. Disconnect cab ground strap from hydraulic lift cover.

Remove gear shift lever boot, remove clamp bolts from shift levers and remove levers from shift mechanism. Remove scuff plates from cab floor, then remove floor mat and pad from cab. Disconnect hand brake cable (if so equipped) from actuating lever and push cable out to underside of cab.

Remove two roof retaining bolts located midway along each side of cab. Attach a hoist using a spreader bar and eyebolts at the two center bolt holes (Fig. 357). Be sure spreader bar retaining bolts are fully screwed into cab, but do not overtighten as damage to cab roof may result. Remove cab front mounting nuts and studs. Remove cab rear mounting bolts and nuts, or cab mounting bracket to axle housing retaining bolts and nuts. Carefully raise cab clear of tractor.

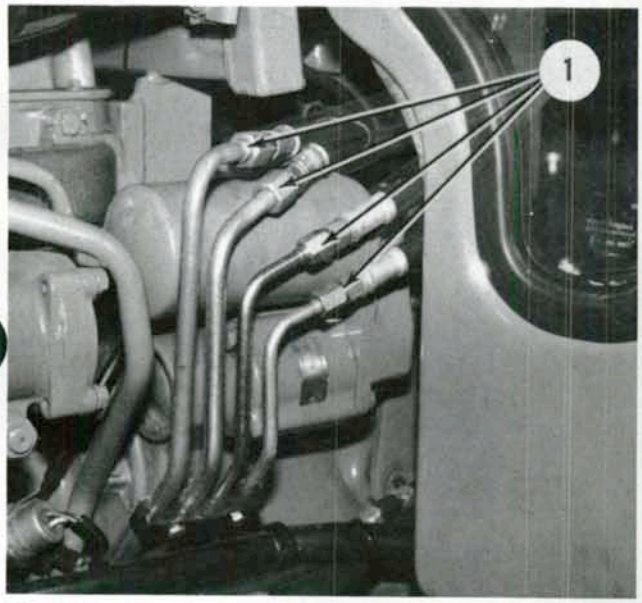


Fig. 354—Tag the four power steering lines (1) before disconnecting to ensure proper reassembly.

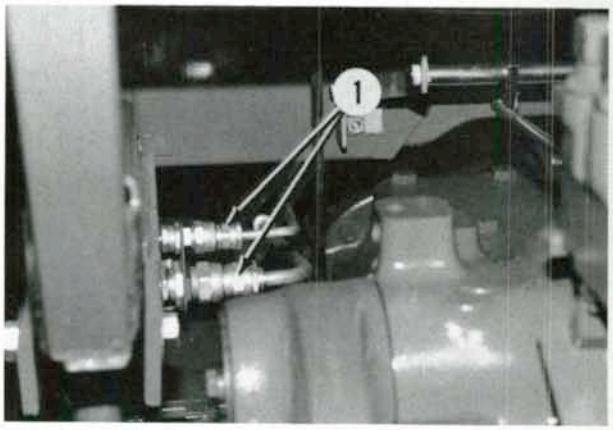


Fig. 355—Air conditioning system does not need to be discharged when disconnecting self-sealing couplers (1) located at rear of cab.

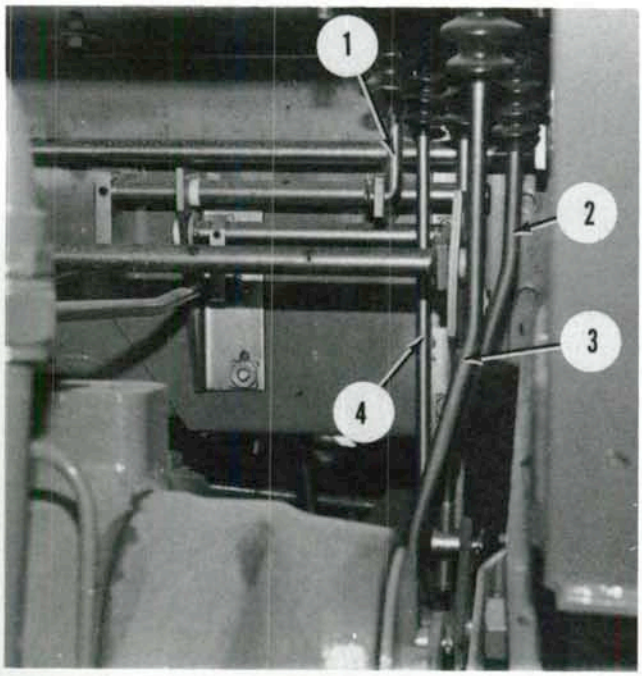


Fig. 356—View of hydraulic system control linkage located on right side of cab.

1. Remote valve control rod
2. Lift control rod
3. Hydraulic system selector rod
4. Variable flow control rod

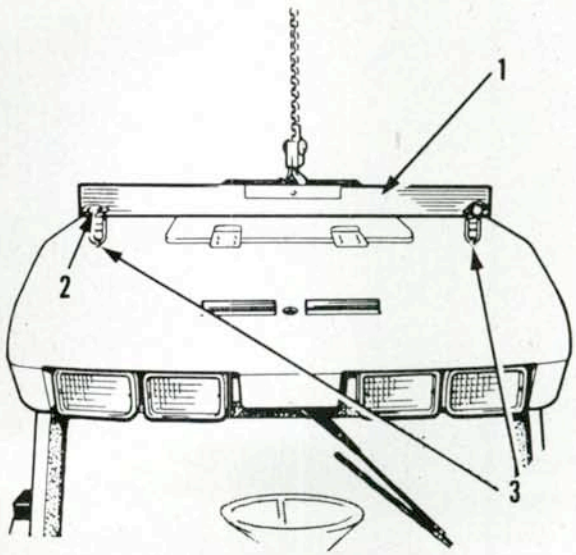


Fig. 357—To remove cab, remove two roof retaining bolts located midway along sides of cab and attach a spreader bar (1) using eyebolts (3) and rings (2) as shown.

IMPORTANT: Do not tilt cab rearward as cab rear mountings will be damaged.

Installation of cab is the reverse of removal procedure plus the following items: Tighten cab front mounting studs to 250 ft.-lbs. (340 N·m) torque. Lubricate threads of cab rear mounting bracket to axle housing bolts with oil prior to tightening. On tractors not equipped with hitch lift assist ram, tighten cab rear mounting bracket to rear axle bolts to 200 ft.-lbs. (270 N·m) torque. On tractors equipped with hitch lift assist ram, tighten cab rear mounting bracket to rear axle bolts to 250 ft.-lbs. (340 N·m) torque. Tighten cab rear mounting bracket bolts to 280 ft.-lbs. (380 N·m) torque. Bleed air from brake system as outlined in paragraph 175 or 178. Adjust hydraulic control linkage as outlined in HYDRAULIC SYSTEM section. Adjust clutch linkage as outlined in paragraph 126.

269. TILT CAB FORWARD. The cab may be tilted forward approximately three inches to provide clearance for removal of hydraulic lift cover. Do not tilt cab rearward as cab rear mountings will be damaged.

At rear of cab, disconnect remote valve, hydraulic lift control, system selector, variable flow control and pto control linkage. Unbolt and remove support bracket from end of hydraulic lift control cross-shaft. Disconnect cab ground strap from hydraulic lift cover. Disconnect differential lock pedal linkage from control valve under right side of cab (TW-5, TW-15 and TW-25).

Disconnect windshield washer tube from washer jet. Remove engine cowl top and side panels. Disconnect hydraulic brake lines from master cylinder (TW-5, TW-15 and TW-25) or brake and differential lock valve (TW-35).

Remove scuff plates from sides of cab floor. Lift front of cab mat and pad and remove cab front mounting stud access panels from floor of cab. Unscrew cab front mounting stud nuts until flush with end of studs. Remove cab rear support to rear axle mounting bolts. Use a suitable hoist or jack to lift rear of cab and insert wooden blocks between cab rear support and rear axle housings.

IMPORTANT: Rear of cab should not be raised higher than 3-1/2 inches. Lifting higher than this may break cab front windshield.

Lower cab into position on tractor and tighten front mounting stud nuts to 250 ft.-lbs. (340 N·m) torque. Lubricate threads of rear mounting bracket to axle housing bolts with oil, then tighten to 200 ft.-lbs. (270 N·m) torque (without lift assist ram) or 250 ft.-lbs. (340 N·m) torque (with lift assist ram). Bleed air from brake system as outlined in paragraph 175 or 178. Connect hydraulic control linkage and adjust, if necessary, as outlined in HYDRAULIC SYSTEM section.