

SHOP MANUAL

CASE/INTERNATIONAL

MODELS

2090	2290	2390	2590
2094	2294	2394	2594

IDENTIFICATION

Tractor model number and identification serial number are located on a plate on right fender of tractors not equipped with a cab, or on a plate on upper right of cab interior on tractors so equipped. Cab serial number is located on a plate on upper right of cab interior. Engine serial number is located on a plate on right rear of cylinder block. Transmission serial number is on right side of transmission housing. On models so equipped, front-wheel drive serial number is located on a plate on rear of front drive axle housing.

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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

	2090, 2094	2290, 2294	Models 2390, 2394	2590, 2594
GENERAL				
Engine Make	Own			
Engine Model	504BD	504BDT	504BDT	504BDT
Cylinders, No. of	6			
Bore	4-5/8 in. (117.5 mm)			
Stroke	5 in. (127 mm)			
Displacement	504 cu.in. (8.26 L)			
Compression Ratio	16.0:1	15.8:1	15.8:1	15.8:1
Main Bearings, No. of	7			
Cylinder Sleeves, Type	Wet			
Forward Speeds	8,12*	8,12*	12,24**	12,24**
*Models 2090 and 2290 with mechanical shift transmission have 8 forward speeds. Models 2090, 2290, 2094 and 2294 power shift tractors have 12 forward speeds.				
**Models 2394 and 2594 equipped with power shift High/Low unit have 24 forward speeds. All other power shift models have 12 forward speeds.				
TUNE-UP				
Firing Order	1-5-3-6-2-4			
Valve Tappet Gap, Warm—				
Intake	0.015 in. (0.381 mm)			
Exhaust	0.025 in. (0.635 mm)			
Compression at Cranking Speed	400 psi (2758 kPa)			
Injection Pump—				
Make	Robert Bosch			
Model	PES Multiple Plunger			
Timing	27° BTDC		25° BTDC	
Injection Nozzles—				
Make	Robert Bosch or American Bosch			
Opening Pressure,				
New	3950-4100 psi (27235-28270 kPa)			
Used	3400-3950 psi (23443-27235 kPa)			
Turbocharger—				
Make		Garret (AiResearch) T04B		
Engine Governed Speeds (Rpm)—				
Low Idle	725-775			
High Idle	2280-2320			
Rated Load	2100			
Battery Terminal Grounded	Negative			
CAPACITIES				
Cooling System	38 qts. (36 L)	38 qts. (36 L)	44 qts. (41.6 L)	44 qts. (41.6 L)
Crankcase (w/filters)	19 qts. (17.8 L)	23 qts. (22 L)	30 qts. (28.4 L)	30 qts. (28.4 L)
Transmission & Hydraulic System	100 qts. (94.6 L)	100 qts. (94.6 L)	128 qts. (121.1 L)	128 qts. (121.1 L)
Oil Type	Hy-Tran Plus			
Fuel Tank	65 gal. (246 L)	65 gal. (246 L)	85 gal. (322 L)	85 gal. (322 L)

Paragraphs 1-5

CASE/INTERNATIONAL

FRONT AXLE (TWO WHEEL DRIVE)

FRONT WHEEL BEARINGS

All Models

1. Refer to Fig. 1 for typical wheel hub and bearing assembly.

The tapered inner and outer roller bearings are not interchangeable. Clean and inspect bearing cups and cones and renew as necessary. Install inner seal (9) with lip facing spindle flange. Install outer seal (10) with lip facing away from bearing (11). Fill hub cavity and pack bearings with No. 2 lithium grease. Coat surface of seal lips with grease.

When adjusting wheel bearings, tighten nut (7) until drag on hub is felt, then back nut off ¼ turn or until next pin hole lines up. Bearings should have zero end play. Install cotter pin.

SPINDLES

All Models

2. R&R SPINDLES. To remove spindle, lift and support front of tractor and remove wheel. Disconnect tie rod ball joint from steering arm (3—Fig. 2). Remove bolt (1) and washer (2) from arm (3). Note index punch marks on arm and shaft indicating location of tapered splines for left or right steering arm, then remove steering arm. Support spindle and remove snap ring (4) and shims (5), then remove spindle (10) from axle extension (7).

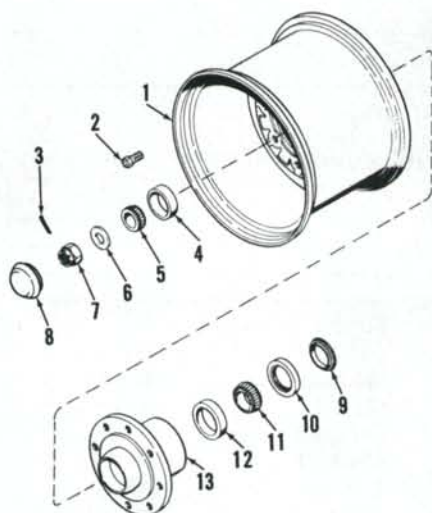


Fig. 1—Exploded view of wheel hub and bearing assembly used on all models.

- | | |
|-----------------|------------------|
| 1. Wheel | 8. Cap |
| 2. Bolt | 9. Seal (inner) |
| 3. Cotter pin | 10. Seal (outer) |
| 4. Bearing cup | 11. Bearing cone |
| 5. Bearing cone | 12. Bearing cup |
| 6. Washer | 13. Hub |
| 7. Nut | |

3. SPINDLE BUSHINGS. With spindles removed, spindle bushings (6 and 9—Fig. 2) can be removed using a suitable drift punch. New bushings are presized and should not require reaming if carefully installed. Press new bushings into axle ends until bushing flange seats against surface of axle ends.

Assembly by reversing disassembly procedure making sure punch marks on shaft and steering arm align. Tighten bolt (1) to 200-250 ft.-lbs. (271-339 N·m) torque. Lubricate through grease fitting (8) with No. 2 lithium grease. Tighten tie rod slotted nut to 100-125 ft.-lbs. (136-169 N·m) torque and install new cotter pin.

4. TIE RODS AND TOE-IN.

Disassembly of tie rod assembly is obvious after examination of unit and reference to Fig. 3. However, upon reassembly make sure clamp bolt (9) for left side drag link (3) is installed in same number hole as left side axle extension outer bolt; and that right side drag link bolt (11) is installed in one less number hole of drag link (2) than outer mount-

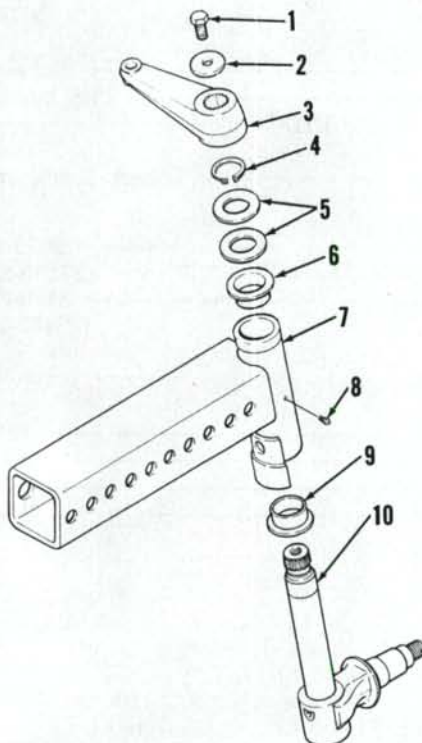


Fig. 2—Exploded view of steering spindle assembly typical of all models.

- | | |
|--------------------|--------------------|
| 1. Bolt | 7. Axle extension |
| 2. Washer | 8. Grease fitting |
| 3. Steering arm | 9. Bushing (lower) |
| 4. Snap ring | 10. Spindle |
| 5. Shims | |
| 6. Bushing (upper) | |

ing bolt of right axle extension. Tighten tie rod ball joint slotted nuts to 100-125 ft.-lbs. (136-169 N·m) torque. Install new cotter pins. Tighten drag link clamp bolt nuts to 45-54 ft.-lbs. (61-73 N·m) torque.

Front wheel toe-in must be 1/8 to 1/2 inch (3.2-12.7 mm). To adjust toe-in, remove clamp bolt (9—Fig. 3) on left drag link. Loosen jam nut (4), then turn drag link (3) in or out until desired toe-in is obtained. Install clamp bolt and tighten nut on clamp bolt to 45-54 ft.-lbs. (61-73 N·m) torque. Tighten jam nut (4) against drag link.

AXLE MAIN MEMBER AND PIVOT PIN

Models 2090 and 2290 (S/N prior to 9905953)

5. To remove axle main member, first raise and support tractor under engine side rails with suitable jack stands. Disconnect tie rods from steering arms, then refer to Fig. 3 and disconnect power steering cylinder (13) from axle main member and tie rod lug. Secure steering cylinder up and out of the way. Be careful not to damage hydraulic lines to cylinder.

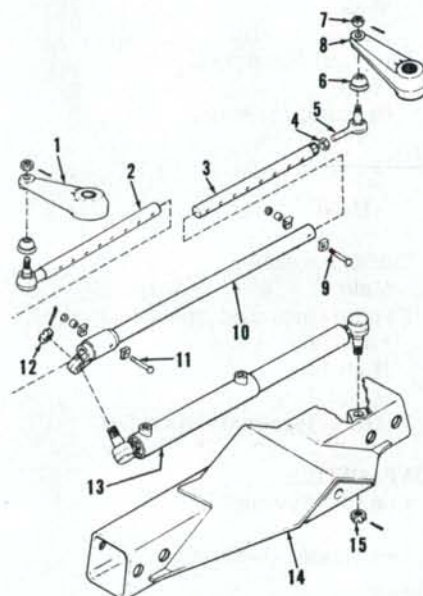


Fig. 3—Exploded view of steering tie rod, cylinder, and arms typical of all models. (Standard wheel base axle shown.)

- | | |
|------------------------|-----------------------|
| 1. Steering arm (R.H.) | 9. Clamp bolt (L.H.) |
| 2. Drag link (R.H.) | 10. Tie rod tube |
| 3. Drag link (L.H.) | 11. Clamp bolt (R.H.) |
| 4. Jam nut | 12. Slotted nut |
| 5. Ball joint | 13. Steering cylinder |
| 6. Dust cover | 14. Axle main member |
| 7. Slotted nut | 15. Slotted nut |
| 8. Steering arm (L.H.) | |

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Paragraph 6

Refer to Fig. 4, unpin and remove nut (10) from rear of pivot pin (4). Remove collar (11) and thrust washer (12). Remove bolt (17) from lock collar (14). Remove grease fitting (8) and install a slide hammer to pivot pin (4). Support axle main member with a rolling floor jack, then pull pivot pin out front of axle assembly. Catch thrust washers (12), lock collar (14) and shim washer (5) as pin (4) is withdrawn. Lower axle main member enough to clear front support and roll forward away from tractor.

Pin bushings (2 and 3—Fig. 4) can be removed using a suitable drift punch. Drive new bushings into front axle support until flush with axle support casting. Bushings are presized and should require no reaming if carefully installed.

When assembling, raise axle main member into position in axle support aligning pivot pin holes. Place retaining

ring (7—Fig. 4) and washer (6) onto pivot pin (4). Insert threaded end of pivot pin into axle support front bushing. Place shim thrust washer (5) between axle main member and axle support and slide pivot pin through washer and into axle main member front block. Install lock collar onto pin behind front block of axle member. Install bolt (17), washer (16) and lock tab (15) into lock collar (14) but do not tighten bolt at this time. Push pivot pin through rear of axle member and into rear of axle support.

Move axle main member as far forward as possible, withdraw pin and install as many shim washers (12) as possible between axle support and rear of axle main member. Move axle member rearward against washers, drive pivot pin rearward until a 1/8 inch (3.2 mm) gap exists between washer (6) and front of axle support as shown in Fig. 5. Tighten lock collar bolt (17) to 50 ft.-lbs.

(68 N·m) torque and bend lock tab (15—Fig. 4) over bolt head. Install collar (11) and pivot pin nut (10) on rear of pin and tighten nut against collar (11). Back nut off 1/4 turn or until cotter pin hole aligns and install cotter pin. Install grease fittings (8 and 9) and lubricate with No. 2 lithium grease.

All Other Models

6. To remove axle main member, first raise and support tractor under engine side rails with suitable jack stands. Refer to Fig. 3 and disconnect power steering cylinder (13) from axle main member and tie rod lug. Secure cylinder up and out of the way. Be careful not to damage hydraulic lines to cylinder.

Model 2390 and 2590 tractors with S/N prior to 9905953 are equipped with pivot pin lock collar (A—Fig. 6). All models with S/N 9905953 and above are equipped with axle main member with a keyway and Woodruff key (B) on pivot pin shaft (4).

On Models 2390 and 2590 (S/N prior to 9905953) remove bolt on lock collar (A). Loosen pinch bolt on shaft nut (8). Remove front snap ring (9) and grease fitting (10). Unscrew locknut (8), then remove front collar (7) and thrust washers (5 and 6). Remove rear snap ring (14), cup washer (15) and attach a slide hammer to front of pivot pin (4). Support axle main member with a rolling floor jack and pull pivot pin out front of axle and support. Catch split collars (16), shim washers (17 and 11) and lock collar (A) as pivot pin is withdrawn. Lower axle member enough to clear front support and roll forward away from tractor.

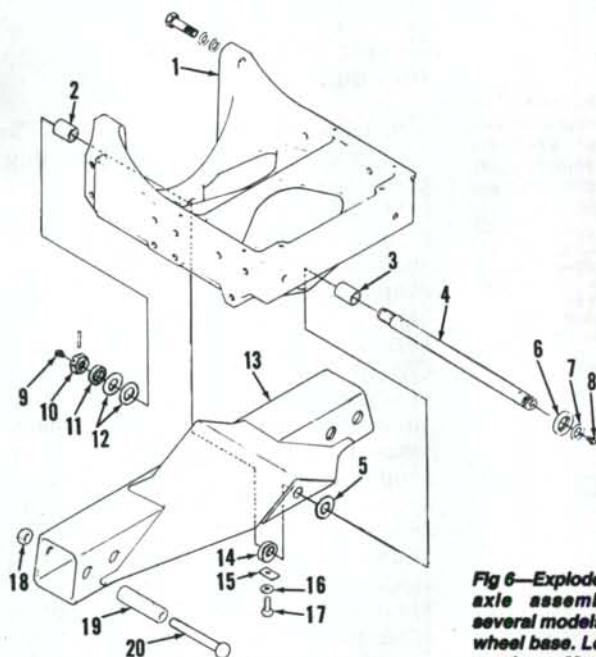


Fig. 4—Exploded view of front axle assembly used on Model 2090 and 2290 tractors (S/N prior to 9905953).

1. Front support
2. Rear bushing
3. Front bushing
4. Pivot pin
5. Shim washer
6. Collar
7. Snap ring
8. Grease fitting
9. Grease fitting
10. Pin nut
11. Collar
12. Thrust washers
13. Axle main member
14. Lock collar
15. Lock tab
16. Washer
17. Bolt
18. Nut
19. Spacer
20. Bolt

Fig. 6—Exploded view of front axle assembly used on several models with standard wheel base. Lock collar (A) is used on Models 2390 and 2590 prior to S/N 9905953. Refer to text.

1. Front support
2. Rear bushing
3. Front bushing
4. Pivot pin
5. Shim washer
6. Thrust washer
7. Collar
8. Shaft nut
9. Snap ring
10. Grease fitting
11. Shim washer
12. Axle main member (standard wheelbase)
13. Grease fitting
14. Snap ring
15. Cup washer
16. Split collars
17. Thrust washer
18. Nut
19. Spacer
20. Bolt

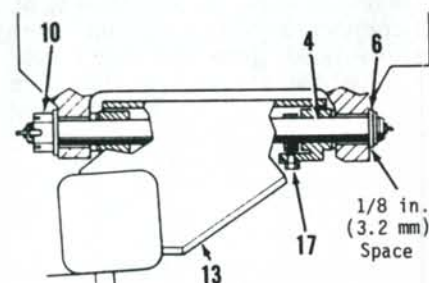
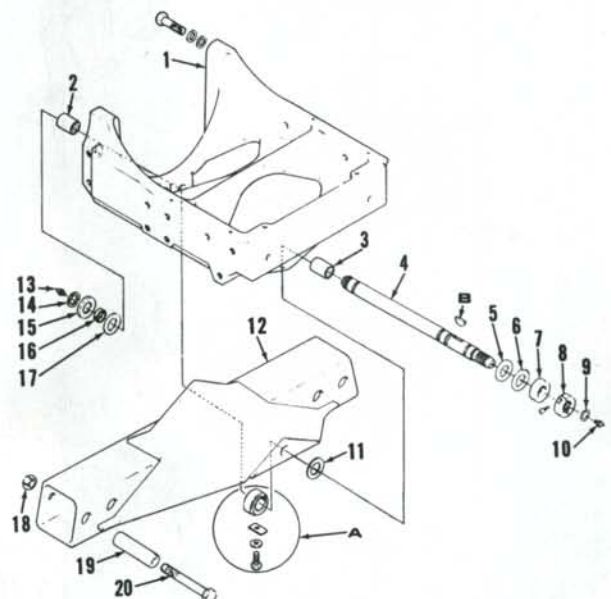


Fig. 5—Cross-sectional view showing pivot pin installation on Model 2090 and 2290 tractors (S/N prior to 9905953). Refer to legend in Fig. 4.

Paragraphs 7-9

On Models 2090, 2290, 2390 and 2590 (S/N 9905953 and above) and Models 2094, 2294, 2394 and 2594, remove front grease fitting (10—Fig. 6) and snap ring (9), loosen pinch bolt on shaft nut (8) and remove nut, then remove front collar (7) and thrust washer (6). Support axle main member with a rolling floor jack. Using a brass drift, bump pivot pin (4) rearward enough to allow removal of Woodruff key (B). Remove rear snap ring (14), cup washer (15), then using a slide hammer, pull pivot pin forward and out of axle and front support. Catch split collars (16) and thrust washers (11 and 17) as pivot pin is withdrawn.

Pin bushings (2 and 3—Fig. 6) can be removed using a suitable drift punch. Drive new bushings into front axle support until flush with axle support casting. Bushings are presized and should require no reaming if carefully installed.

Reinstall front axle on all models by reversing disassembly procedure.

EXTENDED WHEELBASE FRONT AXLE

Models 2390, 2590, 2094, 2294, 2394, and 2594 So Equipped

7. Models 2390, 2590, 2094, 2294, 2394 and 2594 tractors have an optionally available extended wheel base front axle which increases tractor wheelbase from 104 inches (264 cm) on standard units to 110 inches (279 cm) on Models 2094 and 2294 or 118 inches (300 cm) on Models 2390, 2590, 2394 and 2594. See Fig. 7. Removal of axle main member is similar to that of all model tractors outlined in paragraph 6 except the following: Tie rods and power steering cylinder pass through axle main member (12—Fig. 7); therefore hydraulic lines to steering cylinder must be disconnected for removal of axle. Cap or plug all hydraulic openings to prevent contamination of hydraulic system.

Reassemble by reversing disassembly procedure. Bleed power steering system as outlined in paragraph 25.

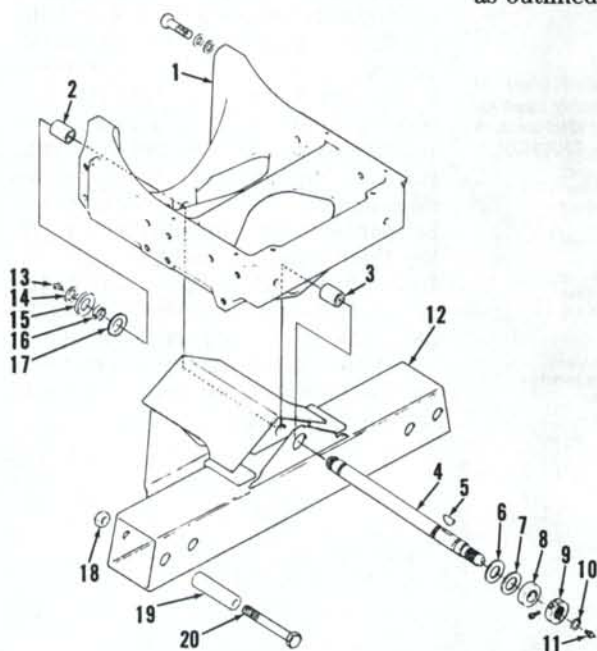


Fig. 7—Exploded view of extended wheelbase front axle main member assembly available on Models 2390, 2590, 2094, 2294, 2394 and 2594.

1. Front support
2. Rear bushing
3. Front bushing
4. Pivot pin
5. Woodruff key
6. Shim washer
7. Thrust washer
8. Collar
9. Shaft nut
10. Snap ring
11. Grease fitting
12. Axle main member
13. Grease fitting
14. Snap ring
15. Cup washer
16. Split collars
17. Shim washer
18. Nut
19. Spacer
20. Bolt

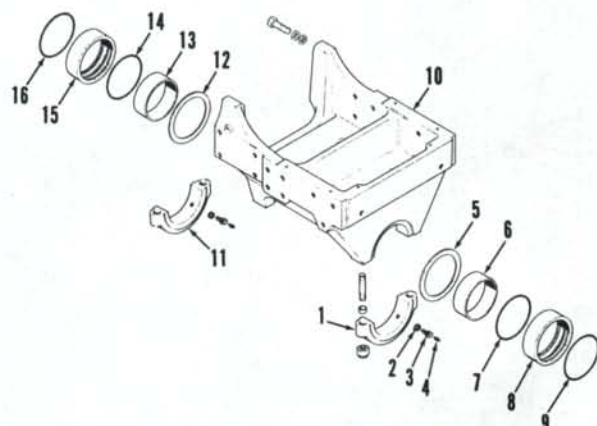


Fig. 8—Front support and component parts used on Models 2094 and 2294 equipped with Carraro front drive axle.

1. Support cap (front)
2. Washer
3. Bushing lock
4. Grease fitting
5. Thrust washer
6. Sleeve
7. "O" ring
8. Bushing
9. "O" ring
10. Front support
11. Support cap (rear)
12. Thrust washer
13. Sleeve
14. "O" ring
15. Bushing
16. "O" ring

CASE/INTERNATIONAL

FRONT SUPPORT

All Models

8. To remove front support (1—Figs. 4, 6 or 7), first disconnect headlight wiring then remove grille, hood and side panels. Remove radiator as outlined in paragraph 90. Remove front axle main member as outlined in paragraphs 6 or 7. Attach suitable hoist to front support, then unbolt and remove.

Assemble by reversing removal procedure. Tighten front support mounting bolts to 380-450 ft.-lbs. (515-610 N·m) torque.

FRONT-WHEEL DRIVE (CARRARO AXLE)

DRIVE AXLE ASSEMBLY AND SUPPORT

Models 2094 and 2294 So Equipped

9. REMOVE AND REINSTALL. To remove the front drive axle assembly, place transmission in PARK and securely block rear wheels. Unbolt and remove drive shaft shield and the front drive shaft assembly. Disconnect steering cylinder lines and cap or plug all openings. Loosen front wheel to hub nuts on both wheels. Install a side frame jack CAS-10500-1 or equivalent on each side of tractor. Raise front of tractor until wheels are off the ground. Remove wheel nuts and using a hoist, remove front wheels. Place a floor jack or special axle carrier CAS-10500-4 under front axle. Remove bearing lock (3—Fig. 8) and grease fitting (4) from bearing support caps (1 and 11), then unbolt and remove caps. Lower axle (floor jack) or raise tractor (axle carrier) and roll assembly forward from tractor. Remove bushings (8 and 15) with "O" rings (7, 9, 14 and 16), sleeves (6 and 13) and thrust washers (5 and 12).

To remove front support (10—Fig. 8), disconnect headlight wiring, then remove hood, grille and side panels. Remove radiator as outlined in paragraph 90. Attach a hoist to front support, then unbolt and remove.

Reinstall front support by reversing removal procedure. Tighten front support mounting bolts to a torque of 380-450 ft.-lbs. (515-610 N·m).

Inspect thrust washers (5 and 12—Fig. 8), sleeves (6 and 13) and bushings (8 and 15) for excessive wear or other damage and renew as necessary. Install

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Paragraphs 10-11

sleeves (6 and 13) on axle housing, then install thrust washers (5 and 12). Lubricate sleeves and install bushings (8 and 15) with new "O" rings. Reinstall axle assembly to front support (10). Install support caps (1 and 11), making certain the lube holes in bushings are aligned with holes in caps. Tighten support cap nuts to a torque of 400-480 ft.-lbs. (542-650 N·m). Install bushing locks (3) and grease fittings (4). Connect steering cylinder hoses and drive shaft. Tighten drive shaft bolts to a torque of 35-42 ft.-lbs. (48-57 N·m). Install drive shaft shield. Install front wheels and remove jacks. Tighten front wheel to hub nuts to 400-480 ft.-lbs. (542-650 N·m) torque.

WHEEL HUB AND PLANETARY

Models 2094 and 2294 So Equipped

10. R&R AND OVERHAUL. To remove the wheel hub and planetary, support axle housing and remove wheel and tire assembly. Rotate wheel hub until drain plug (8—Fig. 9) is at bottom, remove plug and drain oil. Unbolt and remove cover and carrier assembly (7). Drive out roll pins (9) and remove planetary pins (6) with "O" rings (5).

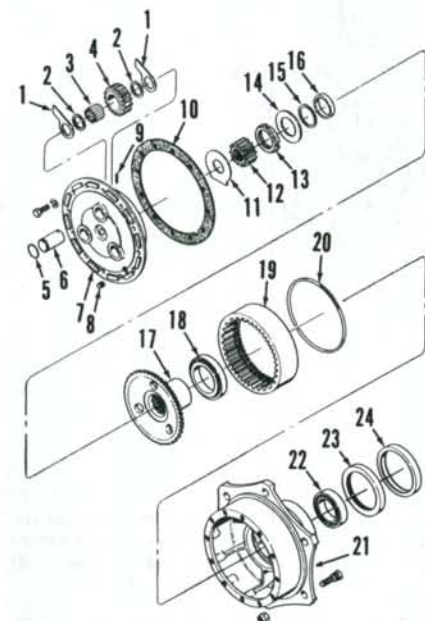


Fig. 9—Exploded view of wheel hub and planetary unit used on Carraro front drive axle.

- | | |
|--------------------|--------------------|
| 1. Thrust washers | 13. Locknut |
| 2. Spacers | 14. Thrust washer |
| 3. Bearing rollers | 15. Shim |
| 4. Planetary gear | 16. Ring |
| 5. "O" ring | 17. Gear hub |
| 6. Planetary pin | 18. Bearing |
| 7. Cover & carrier | 19. Ring gear |
| 8. Drain plug | 20. Retaining ring |
| 9. Roll pin | 21. Wheel hub |
| 10. Gasket | 22. Bearing |
| 11. Washer | 23. Oil seal |
| 12. Sun gear | 24. Dust seal |

Remove planetary gears (4) with thrust washers (1), spacers (2) and bearing rollers (3). Remove washer (11) from carrier and sun gear (12) from axle.

Using a spanner wrench, remove locknut (13), thrust washer (14) and shims (15). Measure total thickness of shim pack (15) and retain for reassembly. Attach a hoist to hub (21). Pull hub outward about one inch (25.4 mm), then push hub back into place. Remove centering ring (16) from the ring gear, then remove ring gear assembly. Carefully remove the wheel hub.

Remove cone of bearing (22), from stub shaft (17—Fig. 10) and cone of bearing (18—Fig. 9) from gear hub (17). Remove dust seal (24) and oil seal (23). If necessary, remove bearing cups from hub. Remove retaining ring (20) and lift gear hub (17) from ring gear (19).

Clean and inspect all parts and renew any showing excessive wear or other damage.

When reassembling, heat bearing cones to a temperature of 250° F (120° C) for aid in installation. Install hub (21) without oil seal (23) and dust seal (24). Install ring gear and gear hub assembly, centering ring (16), original shim pack (15), thrust washer (14) and locknut (13). Tighten locknut to a torque of 400-480 ft.-lbs. (542-650 N·m). Using a special fixture and torque wrench as shown in Fig. 11, check the torque needed to

rotate the hub. A torque of 35 in.-lbs. (4 N·m) will give the correct wheel bearing preload. Add or remove shims (15—Fig. 9) to obtain correct bearing preload. Shims are available in thicknesses of 0.004, 0.012 and 0.020 inch (0.1, 0.3 and 0.5 mm).

When correct bearing preload has been obtained, remove hub and install new oil seal (23) and dust seal (24). Reinstall hub assembly and tighten locknut (13) to a torque of 400-480 ft.-lbs. (542-650 N·m). Install sun gear (12) on axle shaft. Install thrust washer (11) in carrier (7), then install planetary gears (4) with bearing rollers (3), spacers (2) and thrust washers (1). Install new "O" rings (5) on planetary pins (6). Insert planetary pins and secure with roll pins (9). Use new gasket (10) and install cover and carrier assembly making certain that drain hole is aligned with cutout in wheel hub. Tighten retaining cap screws to a torque of 66-90 ft.-lbs. (89-122 N·m). Rotate hub until the filler (drain) hole is horizontal to center of hub. Fill hub with lubricant to filler plug opening. Capacity is 4.5 U.S. quarts (4.25 L). Use GL5 85/140 EP gear oil. Install filler plug.

Install wheel and tire assembly and lower tractor to ground. If necessary, repeat operation for opposite side.

STUB AXLE AND AXLE SHAFT

Models 2094 and 2294 So Equipped

11. REMOVE AND REINSTALL. To remove the stub axle (17—Fig. 10) and axle shaft (1), first remove wheel hub as outlined in paragraph 10. Then, remove the 12 stud nuts and lift off breather shield (19) and deflector (18). Remove the two dust plugs and install jack screws in stub axle. Tighten jack screws to separate stub axle from pivot housing (11). Remove stub axle, then remove dust seal (12), oil seal (13) and if necessary, bushing (14).

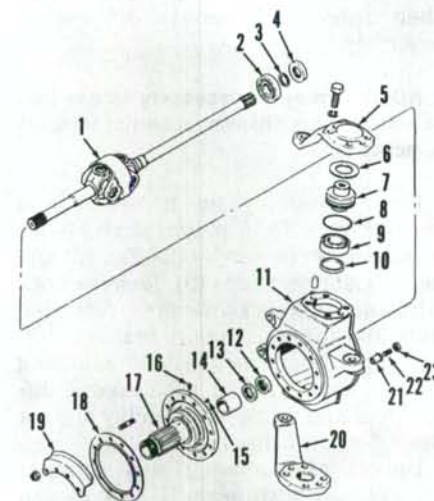


Fig. 10—Exploded view of pivot housing and components used on Carraro front drive axle. Items (6 through 10) are also used in bottom of pivot housing (11).

- | | |
|-------------------------|--------------------------|
| 1. "U" joint & axle | 12. Dust seal |
| 2. Ball bearing | 13. Oil seal |
| 3. Snap ring | 14. Bushing |
| 4. Oil seal | 15. Plug |
| 5. Steering arm (upper) | 16. Breather |
| 6. Shim | 17. Stub axle |
| 7. Pivot pin | 18. Deflector ring |
| 8. "O" ring | 19. Breather shield |
| 9. Bearing | 20. Steering arm (lower) |
| 10. Cup | 21. Stop |
| 11. Pivot housing | 22. Stud |
| | 23. Nut |

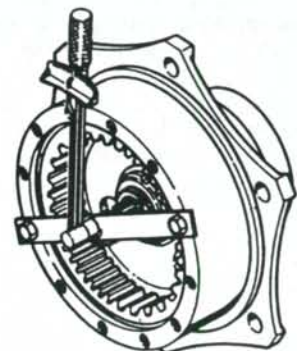


Fig. 11—Use special fixture and torque wrench to check wheel bearing preload. Refer to text.

Paragraphs 12-13

Remove upper and lower hole plugs at outer end of axle housing, then loosen locknuts and remove bearing locating screws. Withdraw axle shaft assembly. Remove snap ring (3) and bearing (2). Oil seal (4) can be pulled from axle housing, if desired. All parts for the double "U" joint axle shaft are available separately. Procedures for renewing "U" joint crosses and bearings are conventional.

When reassembling, install oil seal (4) with lip facing inward. Install bearing (2) and secure with snap ring (3). Lubricate oil seal (4) and carefully install axle shaft (1). Install and tighten upper and lower bearing locating screws. Then, install locknuts and tighten to a torque of 195 ft.-lbs. (264 N·m).

If removed, install new bushing (14) in stub axle. Install new oil seal (13), but DO NOT bottom in bore. Install dust seal (12) until flush with face of bore. Lubricate seals and install stub axle, deflector (18) and breather shield (19). Install stud nuts and tighten to a torque of 203 ft.-lbs. (275 N·m).

Reinstall wheel hub as outlined in paragraph 10.

PIVOT HOUSING

Models 2094 and 2294 So Equipped

12. REMOVE AND REINSTALL. To remove the pivot housing (11—Fig. 10), first remove wheel hub as in paragraph 10 and stub axle and axle shaft as in paragraph 11. Then, disconnect steering cylinder from upper steering arm (5) and tie rod from lower steering arm (20). Unbolt and remove lower steering arm (20) and lower shims (6). Attach a slide hammer to lower pivot pin (7) and remove pivot pin and bearing cone. Unbolt and remove upper steering arm (5) and upper shims (6). Using a slide hammer, remove upper pivot pin (7) and bearing cone. Lift off pivot housing (11). If necessary, use a slide hammer puller to remove bearing cups from axle housing.

Clean and inspect all parts and renew as necessary. Heat bearing cones to 250° F (120° C) for aid in installation. Allow to cool and install new "O" rings (8). If removed, install bearing cups in axle housing. Pack bearing cones with grease and put grease in cups (10) in axle housing. Install pivot housing and insert pivot pins and bearing cones. Use a plastic hammer and tap pivot pins into position. Install lower steering arm (20) without shims and tighten cap screws to a torque of 30 ft.-lbs. (40 N·m). Place all the shims (6) removed from upper and lower pivot pins plus another shim of 0.020 inch (0.5 mm) thickness on the

upper pivot pin. Install upper steering arm (5) and tighten cap screws to a torque of 30 ft.-lbs. (40 N·m). Using a feeler gage, measure the distance between upper steering arm and machined surface on pivot housing. Remove upper steering arm and all shims. Measure shim pack thickness. Subtract shims equal to the measured distance between steering arm and pivot housing from shim pack. Divide remaining shims by two. Place each shim pack half plus an additional 0.006-0.008 inch (0.15-0.20 mm) shim under each steering arm to provide 0.012-0.016 inch (0.3-0.4 mm) total bearing preload. Tighten upper and lower steering arm cap screws to a torque of 317 ft.-lbs. (430 N·m).

Complete balance of installation by reversing the removal procedure.

DIFFERENTIAL AND BEVEL DRIVE GEARS

Models 2094 and 2294 So Equipped

13. R&R AND OVERHAUL. To remove the differential assembly, first remove front drive axle assembly as outlined in paragraph 9. Then, remove wheel hubs and planetarys as in paragraph 10 and stub axles and axle shafts as in paragraph 11. Remove steering cylinders and tie rod. Remove drain plug and drain lubricant from axle housing. Attach a hoist to differential carrier, then unbolt and remove differential assembly.

NOTE: It may be necessary to use jack screws to force differential carrier from axle housing.

Place assembly on a bench and remove yoke from pinion shaft. Place matching marks on carrier (8—Fig. 12) and bearing support caps (9). Remove both adjusting ring locks. Remove retaining nuts and lift off support bracket (10), bearing support caps (9) and adjusting rings (1 and 17—Fig. 13). Remove differential and ring gear assembly and set aside for later disassembly.

Unbolt and remove seal retainer (3—Fig. 12) with seals (1 and 2) and gasket (4). Remove locknut (5), pull bevel pinion shaft out and catch bearing cone (6). Remove spacer (12), first shim (13), bearing cone (14) and second shim (13A) from bevel pinion shaft (15). Use a slide hammer puller and remove bearing cups (6 and 14).

If bevel pinion shaft (15), pinion bearings (6 and 14) or carrier (8) are renewed, pinion shaft protrusion must be set as follows: Install both pinion bearing cups. Install carrier bearing caps and

CASE/INTERNATIONAL

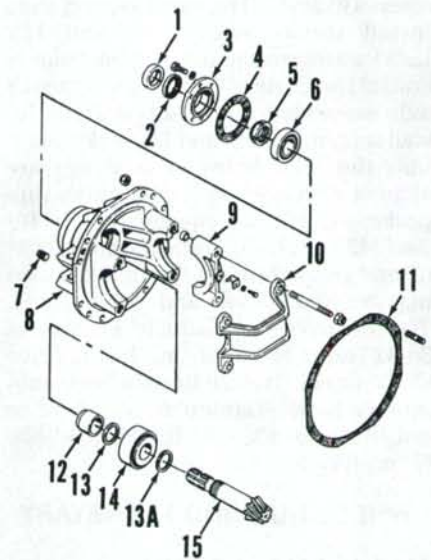


Fig. 12—View of bevel drive pinion and component parts removed from carrier (8).

- | | |
|-------------------------|--------------------------|
| 1. Dust seal | 9. Bearing support cap |
| 2. Oil seal | 10. Support bracket |
| 3. Seal retainer | 11. Gasket |
| 4. Gasket | 12. Spacer |
| 5. Nut | 13. Shim |
| 6. Taper roller bearing | 13A. Shim |
| 7. Drain plug | 14. Taper roller bearing |
| 8. Carrier | 15. Bevel drive pinion |

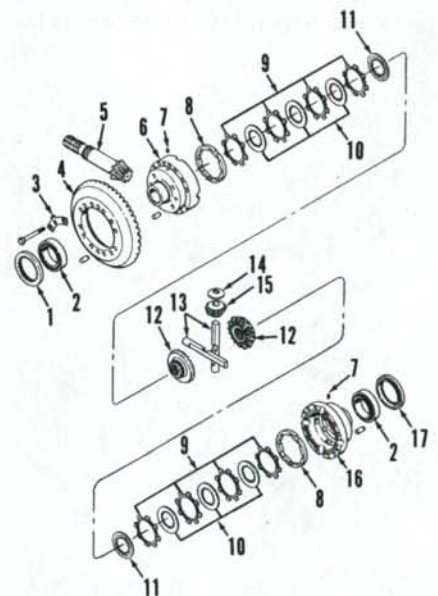


Fig. 13—Exploded view of late type Carraro limited slip front drive axle differential. On earlier type, discs (10), spacers (11) and side gears (12) had four tangs instead of 21 teeth.

- | | |
|----------------------------------|------------------------------------|
| 1. Adjusting ring | 10. Friction disc (internal teeth) |
| 2. Bearing cup & cone | 11. Spacer |
| 3. Lockplate | 12. Side gears |
| 4. Ring gear | 13. Side pins |
| 5. Bevel drive pinion | 14. Thrust washer |
| 6. Differential case half | 15. Differential pinions |
| 7. Set screw | 16. Differential case half |
| 8. Disc carrier ring | 17. Adjusting ring |
| 9. Friction disc (external tang) | |

tighten retaining nuts securely. Measure and record the bore diameter. This is

SERVICE MANUAL

Paragraph 14

dimension (D—Fig. 14). Install pinion bearing cones and using a fixture as shown in Fig. 14 or a bolt and washers, tighten nut to hold bearings tight in position. Place a 25 mm diameter rod having a cross hole drilled through it across bearing bore as shown in Fig. 14. Using a depth gage, measure from top of rod to face of inner bearing cone and record measurement. This is dimension (Y—Fig. 14). Subtract 25 mm (diameter of rod) from measurement of depth gage (Y). Add this to one-half the diameter of carrier bearing bore (D). This will be dimension (B). Then, subtract dimension etched on pinion shaft gear end from (B) if it is a minus (-) dimension or add if it is a plus (+) dimension (this dimension is in millimeters), for result. This dimension will be correct shim thickness to install between bearing cone (14—Fig. 12) and pinion shaft gear (15) for correct pinion shaft protrusion. Remove bearing cones from carrier.

Install the determined shim (13A) on pinion shaft. Heat bearing cone (14) to 250° F (120° C) and install on pinion shaft. Measure shim (13), removed during disassembly, and select a shim 0.5 mm thicker and install on pinion shaft. Install spacer (12) and insert pinion shaft into position in carrier. Heat bearing cone (6) to 250° F (120° C) and install on pinion shaft. Install a new locknut (5) and tighten to a torque of 100 ft.-lbs. (135 N · m). Using a dial indicator, measure pinion shaft end play. This measurement plus 0.05 mm is the correct shim thickness to be removed. Select and install correct shim (13), then tighten locknut to a torque of 442 ft.-lbs. (599 N · m). Using a torque wrench, measure amount of torque needed to rotate pinion shaft. A torque of 1.5-2.0 in.-lbs. (0.17-0.23 N · m) will be correct bearing preload. Install new oil seal (2) in seal retainer (3). DO NOT bottom seal in retainer. Install new dust seal (1) until flush with face of retainer. Lubricate seals and using new gasket (4), install retainer. Tighten cap screws to a torque of 60 ft.-lbs. (82 N · m).

Remove carrier bearings (2—Fig. 13). Place a match mark across both halves of differential case for aid in reassembly. Straighten lock plates (3), then unbolt and remove ring gear (4). Separate differential case halves (6 and 16). Remove friction discs (9 and 10), spacer (11) and side gear (12) and lift out cross pins (13) with differential pinions (15) and thrust washers (14). Then, remove second side gear (12), spacer (11) and friction discs (9 and 10). Remove set screws (7) and withdraw disc carrier rings (8).

Clean and inspect all parts and renew as necessary. Ring gear (4) and pinion shaft (5) are available only as a matched set and must be installed as such.

When reassembling, install disc carrier rings, aligning the set screw holes. Install set screws and tighten to a torque of 15 ft.-lbs. (20 N · m). Apply one or two drops of Loctite 290 in set screw holes after set screws are tightened. Measure thickness of each friction disc and renew any measuring less than 0.076 inch (1.77 mm). Measure total thickness of friction discs (9 and 10) for each side. Add correct spacer (11) to give a total thickness of 0.602-0.614 inch (15.3-15.6 mm) for each side. Apply a coating of grease to spacers and friction discs to hold them together on side gears during assembly. Install side gear with spacer and friction discs in each differential case half. Install cross pins with differential pinions and thrust washers on one case half, then install second case half, aligning match marks. If necessary, heat ring gear to a maximum of 400°-450° F (204°-232° C) and install over dowel pins. Install lockplates and cap screws and tighten cap screws to a torque of 88 ft.-lbs. (119 N · m). Bend lockplates up against cap screw heads. Heat carrier bearing cones (2) to 250° F (120° C) and install on differential case. Install bearing cups on cones and place differential in position in carrier. Install bearing support caps (9—Fig. 12) aligning match marks on carrier and caps. Install support bracket (10), install retaining nuts and tighten nuts lightly. Make certain there is some clearance between ring gear and pinion. Install bearing adjusting rings (1 and 17—Fig. 13) and turn them in against carrier bearings. Tighten retaining nuts on support bracket to 442 ft.-lbs. (599 N · m) torque.

Turn adjusting ring clockwise on ring gear side until ring gear contacts pinion shaft. Turn adjusting ring on opposite side clockwise until all clearance in the bearings is removed. Clearance is removed when the adjusting ring becomes difficult to turn. Attach a dial indicator to carrier and check ring gear

to pinion backlash which should be 0.006-0.010 inch (0.15-0.25 mm). To increase backlash, turn adjusting ring on ring gear side counterclockwise one notch and opposite ring clockwise one notch. If necessary, repeat procedure until backlash is correct. Adjustment is opposite to decrease backlash.

When backlash is correct, turn each adjusting ring clockwise one notch to preload carrier bearings. Install adjusting ring locks and tighten cap screws to a torque of 18 ft.-lbs. (25 N·m).

Use new gasket (11—Fig. 12) and install assembly in axle housing. Tighten retaining nuts to a torque of 144 ft.lbs. (195 N · m).

The balance of reassembly is the reverse of disassembly procedure. After installation, fill axle and differential housing to level plug opening. Capacity is 16 U. S. quarts (15 L). Use GL5 85/140 EP gear oil. Manufacturer recommends that oil in front drive axle be changed each 1000 hours of operation.

FRONT DRIVE SHAFT

Models 2094 and 2294 So Equipped

14. R&R AND OVERHAUL. To remove the front drive shaft, first unbolt and remove drive shaft shield (4—Fig. 15). Remove cap screws (14) and separate cross and bearing assemblies from front and rear yokes (5 and 1). Remove lube fittings (8 and 12). Remove cap screws (9 and 13) and separate cross and bearing assemblies (7 and 11) from drive shaft (10). Cross and bearing units (7 and 11) are serviced only as assemblies.

Reassemble and reinstall by reversing disassembly and removal procedures. Tighten cap screws (9 and 13) to a torque of 37-49 ft.-lbs. (50-66 N · m) and cap screws (14) to a torque of 35-42 ft.-lbs. (48-57 N · m).

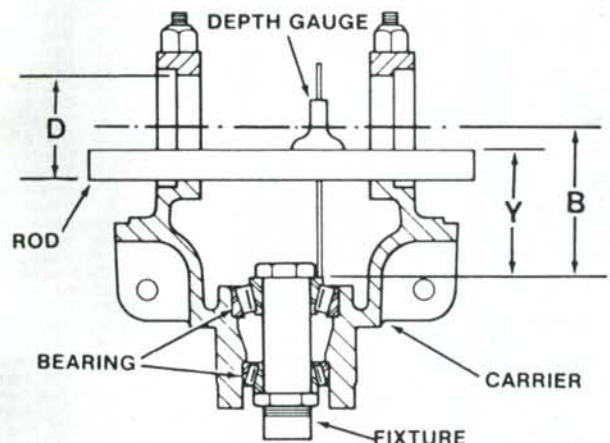


Fig. 14—Diagram showing method of securing pinion bearings in carrier to allow depth gage measurement to be taken. Refer to text.

Paragraph 15

TRANSFER GEARBOX

Models 2094 and 2294 So Equipped

15. R&R AND OVERHAUL GEAR-BOX. To remove the transfer gearbox, remove drain plug at bottom of gearbox and drain oil. Unbolt and remove drive shaft shield and front drive shaft. Remove nut (3—Fig. 15), washer (2) and yoke (1). Disconnect control cable from shift lever (9—Fig. 16). Place a floor jack under gearbox, remove mounting cap screws and lower gearbox from tractor.

Drive out groove pin (13) and remove shift lever (9). Unbolt and remove bottom cover (34) and gasket (35). Drive out roll pins (15) and remove shaft (14) and shift fork (11) and pads (12). Remove oil seal (10). Unbolt and remove rear cover (39) with "O" ring (38) and shims (36 and 37). Unbolt and remove seal retainer (31) and oil seal (32). Install washer and nut on output shaft (26). Attach a slide hammer puller and pull shaft out until bearing cup (30) is free of housing. Using a suitable puller, remove bearing cone (29). Remove output shaft assembly out through bottom opening. Remove snap ring (25) and carefully slide shift collar (23) from shaft.

NOTE: Hold a shop towel around shaft as collar is removed to catch detent balls (27) and springs (28).

Press shaft from gear (22), thrust washer (20) and bearing cone (19).

Remove nut (6) from idler shaft (2), then press shaft out of front bearing (7), rear bearing (4) and idler gear (3). Watch for ball (1) which may fall out of shaft. Remove bearing cups (5, 8 and 18) from housing, if necessary.

Clean and inspect all parts and renew any showing excessive wear or other damage. Bushing (21) is available only with output gear (22).

When reassembling, install bearing cups (5, 8 and 18), if removed. Install rear bearing cone (4) in cup (5) and place idler gear (3) with slot for ball (1) up, in position on rear bearing. Install idler shaft (2) and press into gear and bearing until ball hole is just above gear face. Place ball in position in idler shaft and press shaft fully into idler gear. Heat bearing cone (7) to 250° F (120° C) and install on idler shaft. Install a new nut (6) and tighten finger tight. Using a dial indicator, measure idler shaft end play. Correct end play is 0.001-0.004 inch (0.025-0.102 mm). Adjust nut to obtain correct end play, then lock nut in place by bending edge of nut into slot in shaft. Use grease to stick the three springs (28) and balls (27) in holes in shaft (26).

Tighten a worm drive hose clamp around the shaft to hold detent balls in position. Place shift collar (23) in position on shaft. Using a plastic hammer, drive shift collar into place over the detent balls and remove hose clamp. Install snap ring (25) in front of shift collar and place gear (22) and thrust washer (20) on rear of shaft. Heat bearing cone (19) to 250° F (120° C) and install on shaft. Install shaft assembly through bottom cover hole. Heat front bearing cone (29) to 250° F (120° C) and install on front of shaft. Install front bearing cup (30). Install new oil seal (32) in retainer (31) until seal is about 0.125 inch (3.175 mm) below face of retainer. Apply Loctite

504 gasket eliminator on front cover, lubricate lip of oil seal and install retainer. Tighten cap screws to a torque of 36 ft.-lbs. (49 N·m). Install rear cover (39), "O" ring (38) and original shims (36 and 37). Tighten cap screws to a torque of 36 ft.-lbs. (49 N·m). Use a dial indicator to measure output shaft end play. Correct end play is 0.003-0.005 inch (0.076-0.127 mm). Add or remove shims (36 and 37) as required to obtain correct end play. A 0.002 inch (0.05 mm) thick shim will change end play about 0.0015 inch (0.038 mm). A 0.005 inch (0.127 mm) thick shim will change end play about 0.004 inch (0.102 mm).

Fig. 15—Exploded view of drive shaft assembly used with Carraro front drive axle.

1. Rear yoke
2. Washer
3. Nut
4. Drive shaft shield
5. Front yoke
6. Lube fitting
7. Cross & bearing assy.
8. Lube fitting
9. Cap screw
10. Drive shaft
11. Cross & bearing assy.
12. Lube fitting
13. Cap screw
14. Cap screws

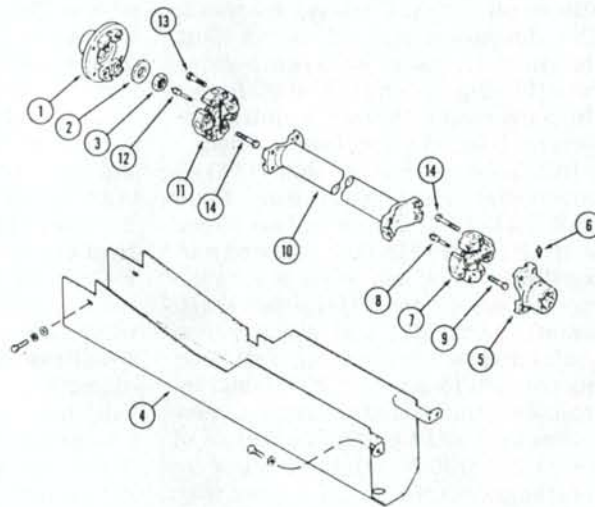
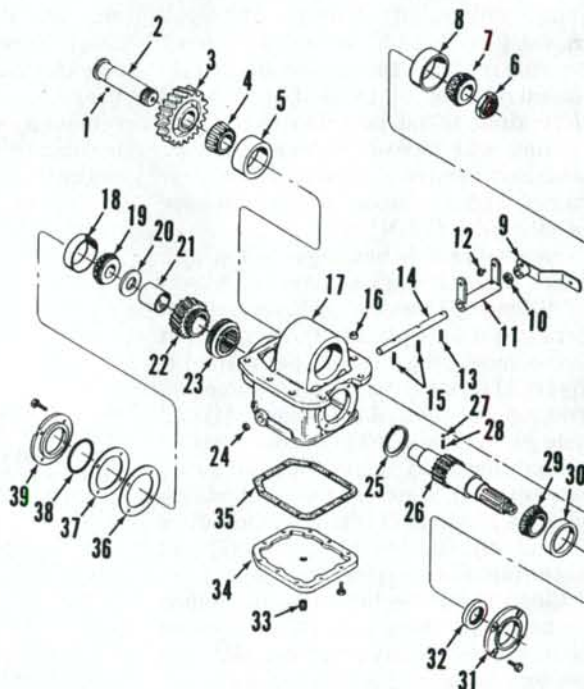


Fig. 16—Exploded view of transfer gearbox for front-wheel drive.

1. Ball
2. Shaft
3. Idler gear
4. Bearing cone
5. Bearing cup
6. Nut
7. Bearing cone
8. Bearing cup
9. Shift lever
10. Oil seal
11. Shift fork
12. Pad (2)
13. Groove pin
14. Shaft
15. Roll pins
16. Dowel ring
17. Housing
18. Bearing cup
19. Bearing cone
20. Thrust washer
21. Bushing
22. Output gear
23. Shift collar
24. Cup plug
25. Snap ring
26. Output shaft
27. Detent ball (3)
28. Detent spring (3)
29. Bearing cone
30. Bearing cup
31. Seal retainer
32. Oil seal
33. Drain plug
34. Bottom cover
35. Gasket
36. Shim, 0.002 in. (0.05 mm)
37. Shim, 0.005 in. (0.13 mm)
38. "O" ring
39. Rear cover



SERVICE MANUAL

Paragraphs 16-18

If necessary to renew cup plug (24), apply a light coat of Permatex No. 2 to plug and drive plug in until flush with outside of housing. Install a new oil seal (10) with lip to inside. Install shift pads (12) in shift fork (11), then install fork assembly and shaft (14) in housing. Secure with roll pins (15). Use new gasket (35) and install bottom cover (34). Tighten cap screws to a torque of 7 ft.-lbs. (10 N·m). Install shift lever (9) and secure with groove pin (13).

Apply Loctite 504 gasket eliminator on mounting surface of gearbox. Using a floor jack, raise gearbox into position. Install mounting cap screws and tighten to a torque of 106-127 ft.-lbs. (144-172 N·m). Connect control cable to shift lever. Install rear yoke (1—Fig. 15), washer (2) and nut (3). Tighten nut to a torque of 280-340 ft.-lbs. (379-461 N·m). Reinstall drive shaft and tighten cap screws to a torque of 35-42 ft.-lbs. (48-57 N·m). Install drive shaft shield. Fill transmission and transfer gearbox to correct level with Hy-Tran Plus fluid.

16. R&R AND OVERHAUL INPUT SHAFT. To remove the input shaft for the transfer gearbox, first split tractor between the torque tube and transmission case as outlined in paragraph 161. Drive a small chisel under edge of nut (5—Fig. 17) to unstake the nut from slots in shaft. Remove nut from input shaft. Remove the three cap screws (8) and remove input shaft assembly from torque tube.

Place housing in a press and press shaft from bearing cone (6) and housing (9). Remove seal rings (13), then press shaft from bearing cone (12). If necessary, use a suitable puller to remove bearing cups (7 and 11) from housing.

Clean and inspect all parts and renew any showing excessive wear or other damage.

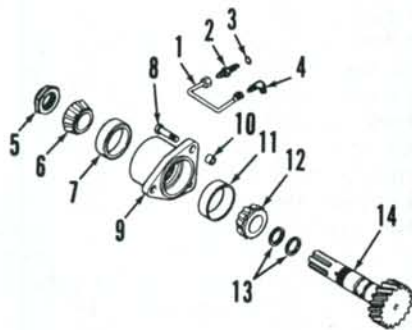


Fig. 17—Exploded view of transfer gearbox input shaft assembly which is located in the torque tube.

- | | |
|---------------------|--------------------|
| 1. Lubrication tube | 8. Cap screw (3) |
| 2. Straight fitting | 9. Housing |
| 3. "O" ring | 10. Dowel ring (3) |
| 4. Elbow fitting | 11. Bearing cup |
| 5. Nut | 12. Bearing cone |
| 6. Bearing cone | 13. Seal rings |
| 7. Bearing cup | 14. Input shaft |

When reassembling, press bearing cups into housing until bottomed. Heat bearing cone (12) to 250° F (120° C) and install on input shaft. Carefully install seal rings (13) in grooves on shaft, making certain that the hooked ends are engaged. Place shaft and bearing in housing. Heat bearing cone (6) to 250° F (120° C). Install new nut (5) and tighten nut until it is against bearing cone (6). Use a dial indicator and check input shaft end play. Correct end play is 0.001-0.004 inch (0.025-0.102 mm). Adjust nut as required to obtain correct end play. Then, stake edge of nut in slots in shaft.

Install input shaft assembly in the torque tube and tighten cap screws to a torque of 149-179 ft.-lbs. (201-243 N·m). Refer to paragraph 163 and reassemble tractor.

TIE ROD AND TOE-IN

Models With Carraro Front Drive Axle

17. Toe-in should be 0.0-0.060 inch (0.0-1.5 mm) and is adjusted by lengthening or shortening threaded tie rod ends equally. Tie rod ends are serviced as a complete unit only.

FRONT-WHEEL DRIVE (ZF AXLE)

DRIVE AXLE ASSEMBLY AND SUPPORT

Model 2294 So Equipped

18. REMOVE AND REINSTALL. To remove the front drive axle assembly, place transmission in PARK and securely block rear wheels. Unbolt and remove drive shaft shield and the front drive shaft assembly. Disconnect steering cylinder lines and cap or plug all openings. Loosen front wheel to hub nuts on both wheels. Install a side frame jack CAS-10500-1 or front split stand CAS-10749 on each side of tractor. Raise front of tractor until front wheels are off the ground. Remove wheel nuts and using a hoist, remove front wheels. Place a floor jack or special axle carrier CAS-10500-4 under front axle. Remove cap screw (5—Fig. 18), washer (4) and spacer (3). Then, remove pivot shaft (2) and thrust washers (6 and 9). Lower ax-

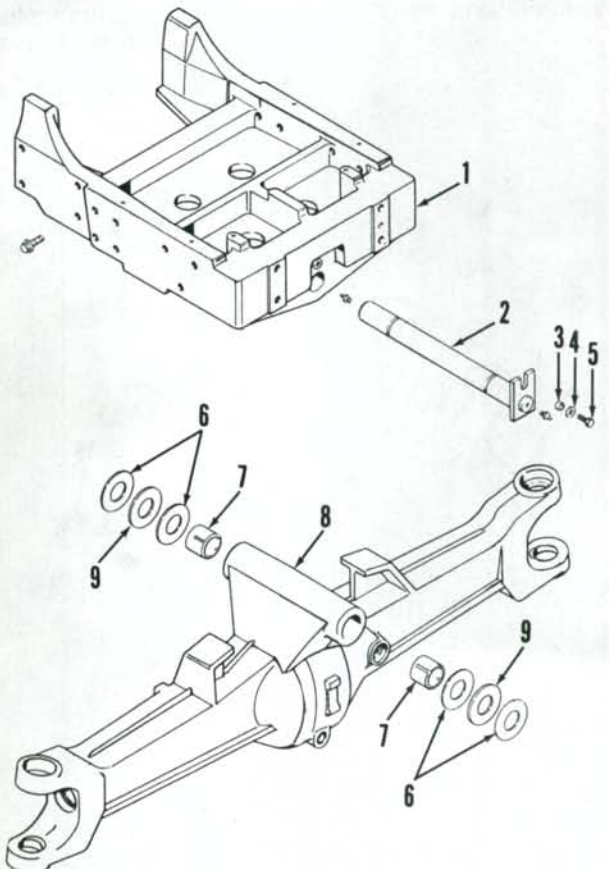


Fig. 18—Front support and axle housing used on Model 2294 equipped with ZF front drive axle.

1. Front support
2. Pivot pin
3. Spacer
4. Washer
5. Cap screw
6. Thrust washers (steel)
7. Bushings
8. Axle housing
9. Thrust washers (nylon)

Paragraph 19

le (floor jack) or raise tractor (axle carrier) and roll assembly forward from tractor. Inspect bushings (7) and renew as necessary. When installing new bushings, apply a coat of Loctite Anti-Seize to bore in axle housing. Freeze bushings in dry ice and carefully install flush to 1/16 inch (1.6 mm) below the face of axle housing.

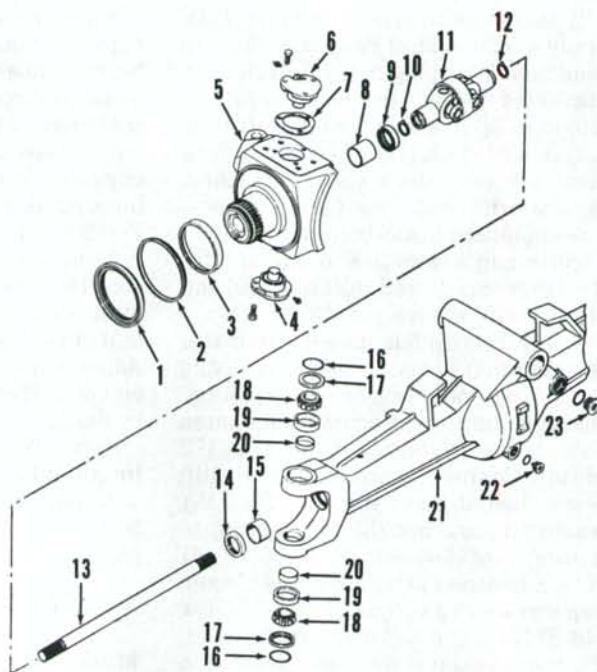
To remove front support (1—Fig. 18), disconnect headlight wiring, then remove hood, grille and side panels. Remove radiator as outlined in paragraph 90. Attach a hoist to front support, then unbolt and remove.

Reinstall front support by reversing the removal procedure. Tighten front support mounting bolts to a torque of 380-450 ft.-lbs. (515-610 N·m).

Inspect thrust washers (6 and 9) for excessive wear and renew as necessary. Reinstall axle assembly to front support. Make sure nylon thrust washer (9) is installed between steel thrust washers (6). Use as many additional steel washers as possible at rear side of axle housing (8) to shim axle housing forward. Secure pivot shaft (2) in place with spacer (3), washer (4) and cap screw (5), tightened to 93-112 ft.-lbs. (126-152 N·m) torque. Connect steering cylinder lines and reinstall drive shaft. Tighten drive shaft bolts and nuts to a torque of 45-54 ft.-lbs. (61-73 N·m). Install drive shaft shield. Install front wheels and remove jacks. Tighten front wheel to hub nuts to a torque of 400-480 ft.-lbs. (542-650 N·m).

Fig. 20—Exploded view of pivot housing and components used on ZF front drive axle.

1. Oil seal
2. Dust seal
3. Wear ring
4. Pivot pin (lower)
5. Pivot housing
6. Pivot pin (upper)
7. Shim
8. Sleeve bearing
9. Oil seal
10. Snap ring
11. "U" joint assy.
12. Snap ring
13. Axle shaft
14. Oil seal
15. Sleeve bearing
16. "O" ring
17. Seal cap
18. Bearing cone
19. Bearing cup
20. Cup plug
21. Axle housing
22. Drain plug
23. Fill & level plug



WHEEL HUB AND PLANETARY

Model 2294 So Equipped

19. R&R AND OVERHAUL. To remove the wheel hub and planetary, support axle housing and remove wheel and tire assembly. Rotate wheel hub until drain plug (9—Fig. 19) is at bottom, remove plug and drain oil. Remove the

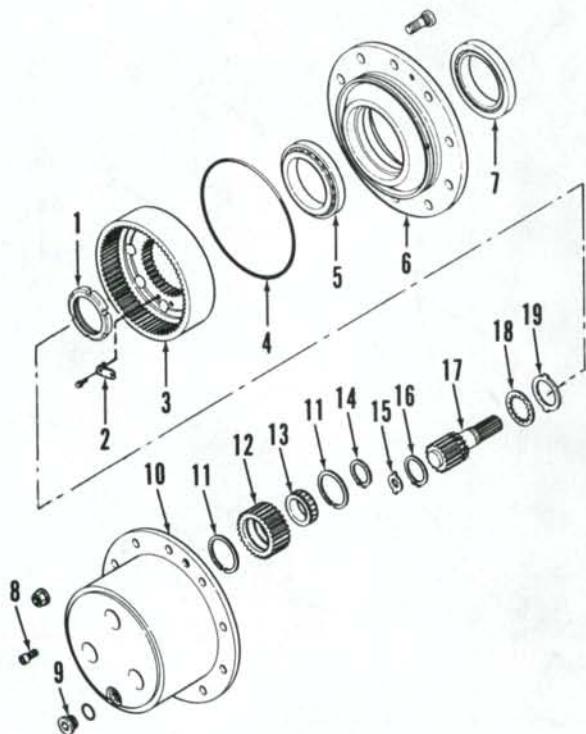
two socket head screws (8), then remove planetary carrier (10). Unbolt and remove lockplate (2). Using a spanner wrench CAS-1762 or equivalent, remove slotted nut (1). Remove ring gear (3), outer bearing cone (5), hub (6) and inner bearing cone (7). If necessary, remove bearing cups (5 and 7) and oil seal (1—Fig. 20) and dust seal (2) from hub. Sun gear (17—Fig. 19) is secured to axle shaft "U" joint (11—Fig. 20) with a snap ring (10). If necessary to remove sun gear, remove pivot housing (5) as outlined in paragraph 20. To remove the planetary gears (12—Fig. 19), remove snap rings (14) and slide gear and bearing assemblies from carrier (10). Remove tapered retaining ring (11) and slide bearing (13) from gear (12). Repeat operation for other two gears. Remove thrust washer (15) from center of carrier.

Clean and inspect all parts and renew any showing excessive wear or other damage. Remove snap ring (16) and check condition of splined thrust washer (18) and thrust washer (19). Renew as necessary and reassemble on sun gear. Reinstall bearings (13) in planetary gears (12) and install retaining ring (11) with wide side of ring towards bearing. Install gear assemblies and secure with snap rings (14).

To adjust end play of axle shaft and sun gear, make certain thrust washer (15) is removed from carrier (10). To determine dimension (A—Fig. 21) which is the distance from thrust washer seat to mounting flange of planetary carrier, install special tool CAS-1764 on thrust washer seat. The length of this tool

Fig. 19—Exploded view of wheel hub and planetary unit used on ZF front drive axle.

1. Slotted nut
2. Lockplate
3. Ring gear
4. "O" ring
5. Bearing cup & cone (outer)
6. Hub
7. Bearing cup & cone (inner)
8. Socket head screw
9. Drain plug
10. Planetary carrier
11. Retaining rings
12. Planetary gear
13. Roller bearing
14. Snap ring
15. Thrust washer
16. Snap ring
17. Sun gear & shaft
18. Splined thrust washer
19. Thrust washer



SERVICE MANUAL

Paragraph 20

(dimension B) is stamped in mm on tool. Place special tool CAS-1765 across mounting flange of planetary carrier. Using a depth gage through hole in tool CAS-1765, measure distance (C) to end of tool CAS-1764. Measure diameter of tool CAS-1765 (dimension D). Subtract dimension (D) from dimension (C) to obtain dimension (E). Add dimension (E) to dimension (B) to obtain dimension (A). Record this dimension. To determine dimension (F—Fig. 22) which is the distance from the end of the sun gear shaft to the face of the mounting flange of the planetary hub, push sun gear inward as far as possible. Assemble special tool legs CAS-1763 to tool CAS-1765 and hold against mounting flange of planetary hub. The length of this special tool assembly dimension (G) is stamped in mm on the legs. Using a depth gage through hole in tool CAS-1765, measure distance (H) to end of sun gear. Subtract dimension (H) from dimension (G) to obtain dimension (F). Then, subtract dimension (F) from dimension (A—Fig. 21) to obtain the total distance axle shaft and sun gear is free to travel. Correct end play of axle shaft and sun gear is 0.012-0.024 inch (0.3-0.6 mm). Subtract correct end play from the predetermined distance axle shaft and sun gear is free to travel to determine correct thickness of thrust washer (15—Fig. 19) to be installed. Thrust washers are available in thicknesses of 0.059, 0.067, 0.079, 0.087, 0.098 and 0.118 inch (1.5, 1.7, 2.0, 2.2, 2.5 and 3.0 mm).

When reassembling, install new wear ring (3—Fig. 20) and bearing cone (7—Fig. 19) on pivot housing. If removed, install bearing cups (5 and 7) in hub (6). Install new oil seal (1—Fig. 20) and dust seal (2) in hub. Lubricate seal and install hub and outer bearing cone (5—Fig. 19). Install ring gear (3) and slotted nut (1). Using a spanner wrench CAS-1762 tighten slotted nut until a rolling torque of 8.9-13.3 ft.-lbs. (12-18 N·m) with new bearings or 6.7-8.9 ft.-lbs. (9-12 N·m) with used bearings is required to rotate hub. Use special tool CAS-1768 to check rolling torque. When rolling torque is correct, secure with lockplate (2) and cap screws tightened to a torque of 70 ft.-lbs. (96 N·m). Install new "O" ring (4) on hub (6). Use grease to stick predetermined thrust washer (15) in place in carrier (10), then install carrier on hub. Install the two socket head cap screws (8) and tighten to a torque of 70 ft.-lbs. (96 N·m). Rotate hub until the filler (drain) hole is horizontal to center of hub. Fill hub with lubricant to filler plug opening. Capacity is 1.5 U.S. quarts (1.4 L). Use GL5 85/140 EP gear oil. Install plug (9). Install wheel and tire assembly and

tighten wheel to hub nuts to a torque of 400-480 ft.-lbs. (542-650 N·m). Lower tractor to the ground.

PIVOT HOUSING AND AXLE SHAFT

Model 2294 So Equipped

20. REMOVE AND REINSTALL. To remove the pivot housing (5—Fig. 20), first remove the wheel hub and planetary as outlined in paragraph 19. Remove snap ring (16—Fig. 19), splined thrust washer (18) and thrust washer (19) from sun gear (17). Disconnect tie rod end from arm on pivot housing. Unbolt upper and lower pivot pins (6 and 4—Fig. 20), then remove pivot pins with "O" rings (16), seal caps (17) and bearing cones (18). Keep shims (7) with upper pivot pin. Remove pivot housing (5), then withdraw sun gear, "U" joint and axle shaft assembly from axle housing. Drive out cup plugs (20) and remove bearing cups (19). Remove bearing cones (18), seal caps (17) and "O" rings (16) from pivot pins. Remove oil seals (9 and 14) and if necessary, remove sleeve bearings (8 and 15).

Loosen snap ring (10) in "U" joint and remove sun gear. Loosen snap ring (12) in "U" joint and remove axle shaft (13). Clean and inspect all parts and renew any showing excessive wear or other damage. "U" joint (11) is available only as a complete assembly. Reassemble sun

gear and axle shaft to "U" joint by reversing disassembly procedure.

If removed, install sleeve bearings (8 and 15). Install new oil seals (9 and 14) with lips of seals toward sleeve bearings. Install cup plugs (20) and bearing cups (19) in axle housing. Lubricate lips of seals (9 and 14), then insert axle shaft into axle housing. Make certain axle shaft splines engage splines in differential side gears. Install new "O" rings (16), seal caps (17) and bearing cones (18) on pivot pins and lubricate bearing cones with lithium grease. Carefully install pivot housing (5) over sun gear and axle housing. Install lower pivot pin assembly and tighten cap screws finger tight. Install upper pivot pin assembly with original shim (7) and cap screws tightened finger tight. Torque the bottom cap screws first, then the upper cap screws to 140 ft.-lbs. (190 N·m). Check swing resistance with a torque wrench which should be 16-21 ft.-lbs. (21-28 N·m) with new bearings or 8-10.5 ft.-lbs. (10.5-14 N·m) for used bearings. Adjust swing resistance by using alternate shim thickness. Shims are available in thicknesses of 0.024, 0.039, 0.055, 0.063, 0.071 and 0.079 inch (0.6, 1.0, 1.4, 1.6, 1.8 and 2.0 mm).

Install thrust washer (19—Fig. 19), splined thrust washer (18) and snap ring (16). Reinstall wheel hub and planetary as outlined in paragraph 19. Connect tie rod end to steering arm on pivot housing and tighten nut to 148 ft.-lbs. (200 N·m) torque.

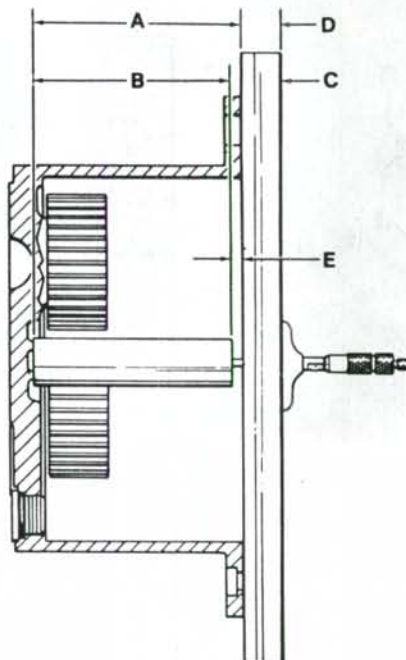


Fig. 21—View of special tools used to determine dimension (A) from mounting flange of planetary carrier to seat of thrust washer. Refer to text for procedures.

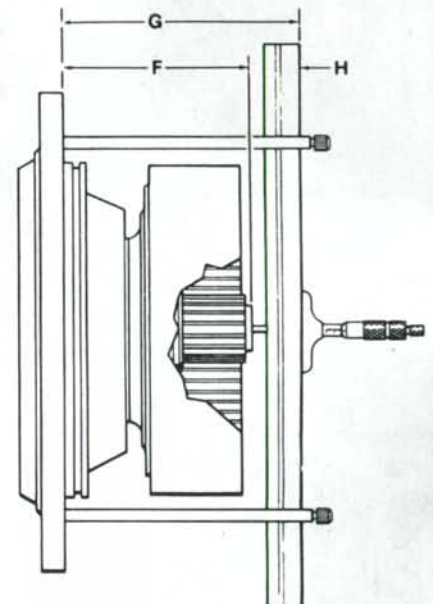


Fig. 22—View of special tools used to determine dimension (F) from flange of hub to end of sun gear shaft. Refer to text for procedures.

Paragraph 21

DIFFERENTIAL AND BEVEL DRIVE GEARS

Model 2294 So Equipped

21. R&R AND OVERHAUL. To remove the front differential assembly, place transmission in PARK and securely block rear wheels. Unbolt and remove drive shaft shield and front drive shaft assembly. Raise front of tractor and support each end of axle housing with jack stands. Unbolt and remove front wheels. Disconnect steering cylinder lines and cap or plug all openings. Disconnect tie rod ends from steering arms on pivot housings. Remove drain plug (22—Fig. 20) and drain oil from axle housing. Attach a hoist to planetary hub. Unbolt and remove upper and lower pivot pins (6 and 4) with bearing cones. Keep shim (7) with upper pivot pin. Remove planetary, pivot housing and axle shaft from each end of axle housing. Place a floor jack under differential assembly, remove differential cap screws and install a guide stud at each side of differential housing. Separate differential housing from axle housing and using the floor jack, remove assembly from tractor.

To disassemble, remove lock pins (16—Fig. 23) from adjusting nuts (9 and 15). Remove the adjusting nuts and bearing cups (10 and 14). Using a suitable puller, remove bearing cones (11 and 13). Remove cotter pins (21), then

pry off lockplates (26). Remove cap screws (22 and 25) and separate differential case halves (28 and 40). Remove differential pinions (34), cross pins (35) and thrust washers (33). Remove ring gear (27) and differential case half (28) assembly first, then remove differential case half (40) assembly. Remove side gear (36), thrust disc (37), friction discs (38) and friction plates (39) from differential case half (40). Remove side gear (32), thrust disc (31), friction discs (29) and friction plates (30) from differential case half (28). Ring gear (27) is secured to differential case half (28) by four sets of double spring pins (23 and 24). Use a press to remove case half from ring gear.

Remove nut (1), washer (2) and drive yoke (3) with seal cover (4). Drive bevel pinion shaft (20) out of bearing cone (6) and remove pinion with spacer (8) and bearing cone (19). Remove oil seal (5) and bearing cone (6) from differential housing (12). Using a press, remove bearing cone (19) and spacer (8) from bevel pinion shaft. Drive bearing cups (7 and 18) from differential housing, then remove shims (17).

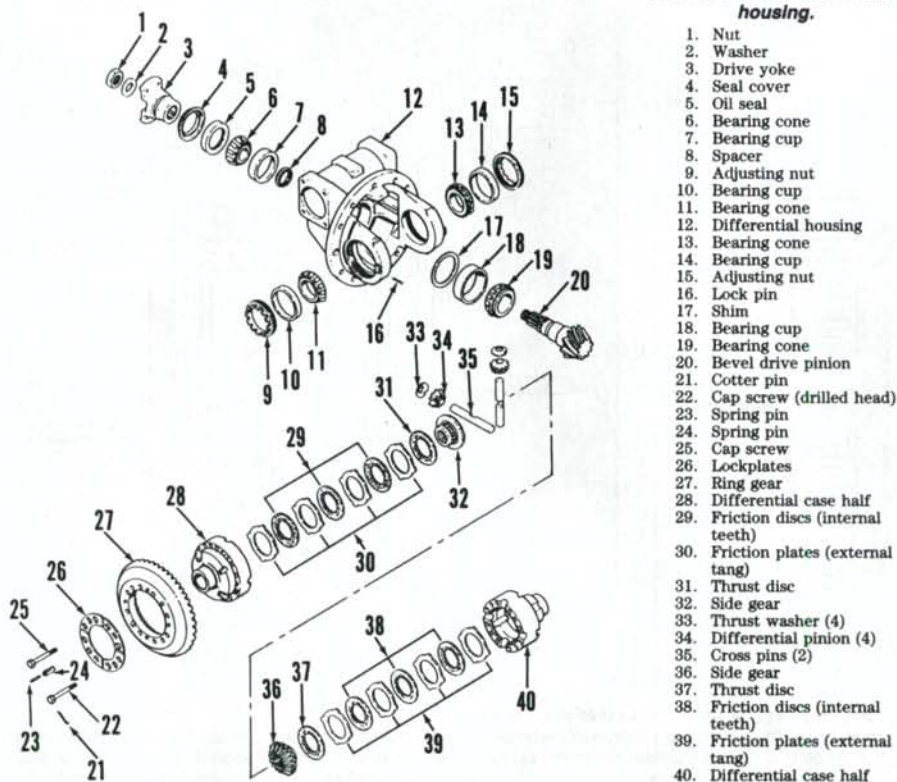
Clean and inspect all parts and renew any showing excessive wear or other damage. Bevel drive pinion (20) and ring gear (27) are available only as a matched

set as are the differential case halves (28 and 40).

To install and adjust bevel drive pinion position, proceed as follows: Install bearing cups (7 and 18) without shims (17) in differential housing (12). Install bearing cone (19) over rod end of special tool CAS-1770 and install in differential housing. Install bearing cone (6) on other half of special tool and install in housing. Tighten tool by hand until bearing cones are seated in bearing cups (all end play removed). Install pilot discs CAS-1771 in carrier bearing bores in differential housing. Insert special tool CAS-1765 through the pilot discs. Using a feeler gage, measure the distance between end of tool CAS-1770 and tool CAS-1765. Add this distance to the metric dimension stamped on tool CAS-1770, then add $\frac{1}{2}$ the diameter of tool CAS-1765. Subtract the metric dimension on end of bevel drive pinion from the previously determined sum to obtain thickness of shim (17) to be installed behind bearing cup (18). Shims are available in thicknesses of 0.004, 0.008, 0.012 and 0.020 inch (0.1, 0.2, 0.3 and 0.5 mm). Remove special tools and bearing cones, then remove bearing cup (18). Install the previously determined shim pack (17) and reinstall bearing cup (18). Heat bearing cone (19) to 250° F (120° C) and install on bevel drive pinion (20) until seated. Install drive pinion and bearing cone in differential housing and install new spacer (8). Heat bearing cone (6) to 250° F (120° C) and install on bevel drive pinion. Install new oil seal (5) with lip towards bearing cone (6). If bearing cover (4) is damaged, press old cover off and a new cover on drive yoke (3). Install drive yoke and washer (2) on bevel drive pinion. Apply Loctite to threads of nut (1), then install and tighten nut until a rolling torque of 1.5-2.2 ft.-lbs. (2.0-3.0 N·m) is required to rotate bevel drive pinion.

To reassemble the ring gear and differential, proceed as follows: If spring pins (23 and 24) have been removed or if new differential case is being installed, refer to Fig. 24 and install spring pins as shown. Install large spring pins (24—Fig. 23) until seated with slot in pins aligned with bolt circle. Then, install small spring pins (23) until flush with top of large pins with slots 180 degrees from slots in large pins. Heat ring gear (27) to 400°-450° F (204°-232° C) and install on differential case half. Double spring pins must enter the four smaller holes in ring gear. Place differential case half (28) on bench with open side upward. Install friction plates (30), friction discs (29), thrust disc (31) and side gear (32) in the case half. Then, install cross pins (35), differential pinions (34) and thrust washers (33) in the

Fig. 23—Exploded view of limited slip differential and bevel drive gears assembly used on 2F front drive axle. Note steering cylinder is removed from differential housing.



1. Nut
2. Washer
3. Drive yoke
4. Seal cover
5. Oil seal
6. Bearing cone
7. Bearing cup
8. Spacer
9. Adjusting nut
10. Bearing cup
11. Bearing cone
12. Differential housing
13. Bearing cone
14. Bearing cup
15. Adjusting nut
16. Lock pin
17. Shim
18. Bearing cup
19. Bearing cone
20. Bevel drive pinion
21. Cotter pin
22. Cap screw (drilled head)
23. Spring pin
24. Spring pin
25. Cap screw
26. Lockplates
27. Ring gear
28. Differential case half
29. Friction discs (internal teeth)
30. Friction plates (external tang)
31. Thrust disc
32. Side gear
33. Thrust washer (4)
34. Differential pinion (4)
35. Cross pins (2)
36. Side gear
37. Thrust disc
38. Friction discs (internal teeth)
39. Friction plates (external tang)
40. Differential case half

SERVICE MANUAL

Paragraphs 22-24

case half. Hold three of the differential pinions in place and using a dial indicator, check backlash between fourth pinion and side gear. Correct backlash is 0.008-0.012 inch (0.2-0.3 mm). Adjust backlash, if necessary, by selecting a thicker or thinner thrust disc (31). Thrust discs are available in thicknesses of 0.110, 0.114 and 0.118 inch (2.8, 2.9 and 3.0 mm). Install thrust disc with abrasive side towards friction plate. Repeat this procedure and adjust backlash using opposite half of differential (36 through 40).

Install differential case half (40) assembly in differential housing first, then install differential case half (28) assembly. Install cross pins (35), pinions (34) and thrust washers (33) and aligning part number on case halves, assemble differential. Install drilled head cap screws (22) on each side of spring pins and install cap screws (25) in remaining holes. Tighten cap screws to a torque of 110 ft.-lbs. (150 N·m). Install lockplates (26) and use a 19 mm socket to drive plates over cap screw heads. Install cotter pins (21) in drilled head cap screws (22).

Heat bearing cones (11 and 13) to 250° F (120° C) and install on differential case. Install bearing cups (10 and 14) and adjusting nuts (9 and 15). While maintaining some backlash between ring gear and bevel drive pinion, tighten adjusting nuts to remove all side play of differential. Then, tighten one adjusting nut two notches to obtain a preload of 2.2-2.9 ft.-lbs. (3.0-4.0 N·m). Check the metric backlash dimension on rim of ring gear which should be 0.20-0.28 mm. Loosen one adjusting nut and tighten the other adjusting nut one notch at a time to obtain correct backlash. Secure adjusting nuts with lock pins (16).

Clean mounting flanges of differential housing and axle housing with Loctite Safety Solvent. Apply Loctite Gasket



Fig. 24—Install double spring pins in differential case half as shown. Refer to text.

Eliminator to mounting flange of axle housing and install a guide stud at each side of housing opening. Slide differential assembly over guide studs and into position. Tighten cap screws and nuts to a torque of 185 ft.-lbs. (250 N·m).

Install new oil seals (14—Fig. 20) in each end of axle housing and carefully reinstall pivot housing and planetary assemblies by reversing disassembly procedures. Connect steering lines and tie rod ends and reinstall front drive shaft and shield. Install front wheels and lower tractor to ground. Fill front axle housing to level plug (23) opening with GL5 85/140 EP gear oil. Capacity is 9 U. S. quarts (8.5 L).

FRONT DRIVE SHAFT

Model 2294 With ZF Front Drive Axle

22. R&R AND OVERHAUL. To remove the front drive shaft first remove drive shaft shield (15—Fig. 25). Remove cap screws (7) and separate cross and bearing assemblies (6) from front and rear yokes (14 and 1). Remove lube fittings (4). Remove cap screws (5) and separate cross and bearing assemblies (6) from drive shaft (8) and

slip yoke (12). Unscrew cap (9) and remove slip yoke from drive shaft.

When reassembling, renew felt washer (10) and seal ring (11). Flanges on drive shaft and slip yoke (12) must be parallel. Cross and bearing units are serviced only as assemblies. The balance of reassembly is the reverse of disassembly procedure. Tighten cap screws (5 and 7) to a torque of 45-54 ft.-lbs. (61-73 N·m). Install drive shaft shield (15).

TRANSFER GEARBOX

Model 2294 So Equipped

23. The transfer gearbox and input shaft is the same as outlined in the Carraro front drive axle. For service information refer to paragraphs 15 and 16.

TIE RODS AND TOE-IN

Model 2294 With ZF Front Drive Axle

24. Toe-in should be 0-3/16 inch (0.0-4.763 mm) and is adjusted by turning the threaded studs between steering cylinder rod and tie rod ends. Both sides must be adjusted equally.

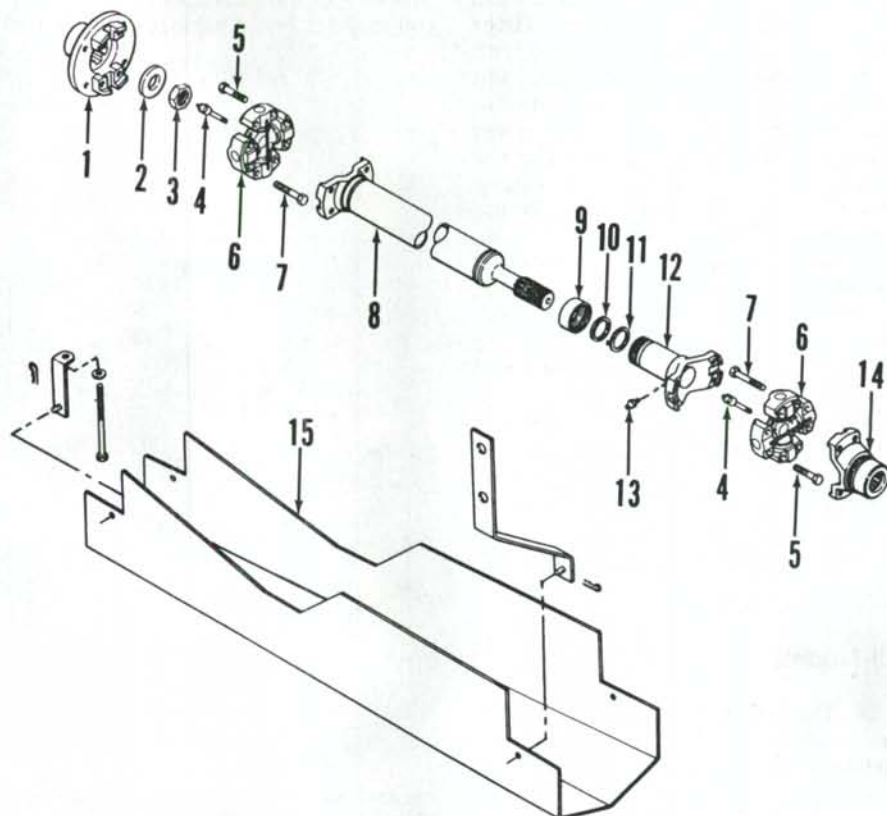


Fig. 25—Exploded view of front drive shaft assembly used with ZF front drive axle.

- | | | | |
|-----------------|--------------------|-----------------|------------------------|
| 1. Rear yoke | 5. Cap screws | 8. Drive shaft | 12. Slip yoke |
| 2. Washer | 6. Cross & bearing | 9. Cap | 13. Lube fitting |
| 3. Nut | assy. | 10. Felt washer | 14. Front drive yoke |
| 4. Lube fitting | 7. Cap screws | 11. Seal ring | 15. Drive shaft shield |

Paragraphs 25-27

POWER STEERING SYSTEM

All models are equipped with hydrostatic power steering using a Ross steering unit and an 8 gpm (30.3 L/min.) gear type hydraulic pump as the power source. One double acting cylinder (standard or ZF front drive axles) or two double acting cylinders (Carraro front drive axle) are used.

FLUID AND BLEEDING

All Models

25. The transmission and hydraulic system fluid is used in the power steering system. A dipstick located at the left rear of the tractor rear housing indicates fluid level. Use Hy-Tran Plus fluid in all models. Refer to CONDENSED SERVICE DATA tables for reservoir capacity and to HYDRAULIC SYSTEM SECTION for additional hydraulic system information.

Steering hydraulic circuit is combined with brake circuit and dual filter unit is located on right front side of transmission housing on Models 2090, 2290, 2094 and 2294 and at bottom front of transmission housing on Models 2390, 2590, 2394 and 2594. See Figs. 26 and 27 for exploded view of filter assemblies. Tractors are provided with a dash-mounted warning light, and filter elements should be renewed after first 20 hours of operation and when TRANS FILTER warning light flashes. Filters should be 10 to 12 micron rating. Relief valves (4—Fig. 26 and 27) should be tightened finger tight plus $\frac{1}{4}$ turn on all models. Wing nut (1—Fig. 27) should be tightened finger tight plus $\frac{1}{4}$ turn on Models 2390, 2590, 2394 and 2594. Filter cover bolts should be tightened to 35-42 ft.-lbs. (48-57 N · m) torque on all models.

To bleed the steering hydraulic system, run engine at half throttle and turn steering wheel from lock to lock several times until steering action is firm. Brake hydraulic system should also be bled as outlined in paragraph 185.

TROUBLESHOOTING

All Models

26. The following table lists some of the troubles which may occur in the operation of the power steering system.

1. No power steering or steers slowly.
 - a. Binding mechanical linkage.
 - b. Excessive load on front wheels and/or air pressure low in front tires.

- c. Steering cylinder piston seal faulty or cylinder damaged.
- d. Faulty power steering supply pump.
2. Will not steer manually.
 - a. Binding mechanical linkage.
 - b. Excessive load on front wheels and/or air pressure low in front tires.
 - c. Pumping element in hand pump faulty.
 - d. Faulty seal on steering cylinder or cylinder damaged.
3. Hard steering through complete cycle.
 - a. Low pressure from supply pump.
 - b. Internal or external leakage.
 - c. Faulty steering cylinder.
 - d. Binding mechanical linkage.
 - e. Excessive load on front wheels and/or air pressure low in front tires.
 - f. Cold hydraulic fluid.
4. Momentary hard or lumpy steering.
 - a. Air in power steering circuit.

SYSTEM OPERATING PRESSURE AND RELIEF VALVE

All Models

27. The power steering operating pressure is controlled by a relief valve contained in brake valve housing. Relief

pressure should be 2000-2250 psi (13790-15510 kPa) for all models.

To test steering relief pressure using a CAS-10280 flowmeter or equivalent, install outlet hose from flowmeter into transmission filler neck, then install a tee fitting between outlet hose on gear pump and pump. Install inlet hose of flowmeter to tee connector on pump. Close load valve on flowmeter, start and run tractor at 2000 rpm until hydraulic fluid reaches operating temperature of approximately 110° to 120° F (43°-49° C). Turn steering wheel to either left or right lock position and hold. Observe relief pressure on flowmeter pressure gage. If pressure is incorrect, adjustment is accomplished by loosening jam nut (14—Fig. 28) on power brake valve and turning steering pressure adjusting screw (15) as required. Turning adjusting screw clockwise will increase pressure. Turning screw counterclockwise will decrease pressure. When correct pressure is obtained, tighten locknut.

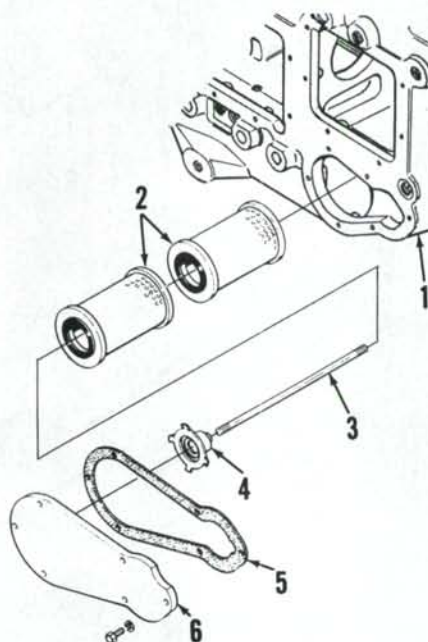


Fig. 26—Exploded view of hydraulic system filter assembly on Models 2090, 2290, 2094 and 2294 tractors.

- | | |
|-------------------------|-----------------|
| 1. Transmission housing | 4. Bypass valve |
| 2. Filter elements | 5. Gasket |
| 3. Rod | 6. Cover |

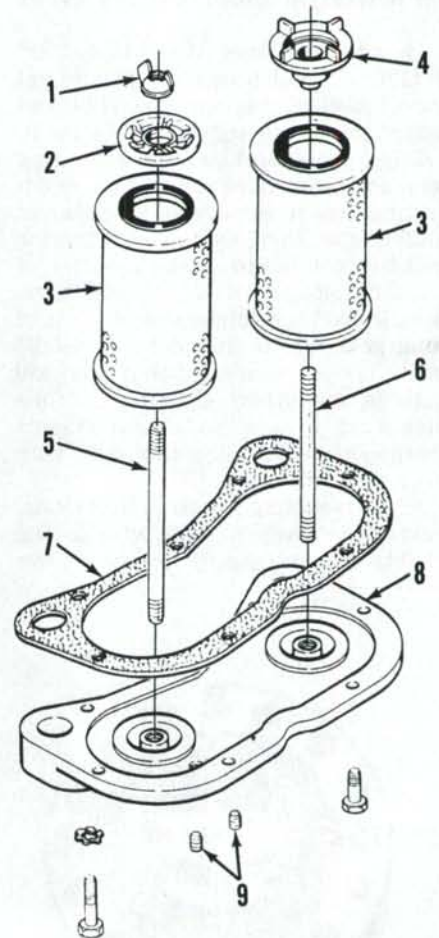


Fig. 27—Exploded view of hydraulic system filter assembly on Models 2390, 2590, 2394 and 2594 tractors.

- | | |
|-------------------|----------------|
| 1. Wing nut | 6. Stud |
| 2. Retainer | 7. Gasket |
| 3. Filter element | 8. Cover |
| 4. Stud | 9. Drain plugs |

SERVICE MANUAL

Paragraphs 28-31

OPERATIONAL TESTS

All Models

The following tests are valid only when the power steering is completely void of any air. If necessary bleed system as outlined in paragraph 25 before performing operational tests.

28. HAND PUMP. With power steering supply pump inoperative, (engine not running), attempt to steer manually in both directions.

NOTE: Manual steering with power steering supply inoperative will require high steering effort. If manual steering can be accomplished with supply pump inoperative, it can be assumed that the manual steering pump will operate satisfactorily with the supply pump operating.

29. STEERING WHEEL SLIP (CIRCUIT TEST). Steering wheel slip is the term used to describe the inability of the steering wheel to hold a given position without further steering movement. Wheel slip is generally due to leakage, either internal or external, or a faulty hand pump or steering cylinder. Some steering wheel slip, with hydraulic fluid at operating temperature, is normal and permissible. A maximum of one revolution per minute is acceptable.

To check for steering wheel slip, install outlet hose from a CAS-10280 flowmeter or equivalent into transmission filler neck, then install a tee fitting between outlet hose or line on gear pump and pump. Install inlet hose of flowmeter to tee connector on pump. Start and run engine at 2000 rpm until hydraulic fluid is at operating temperature of approximately 110°-120° F (43°-49° C). Close the load valve completely. With steering wheels straight ahead and neutral movement on steering wheel, neutral steering pressure should not be more than 450 psi (3103 kPa). If pressure is more than 450 psi (3103 kPa) refer to paragraph 34 for pressure adjustment of steering hand pump.

Shut off engine, then disconnect hydraulic hose (5—Fig. 29) on steering cylinder. Cap and plug hose and cylinder port. Close load valve on flowmeter, then start and run tractor at 1000 rpm. Turn steering wheel counterclockwise and hold tension on wheel while checking for external leakage at piston seal of cylinder.

Remove center cap and telescopic control cap from steering wheel and using a torque wrench, turn steering wheel counterclockwise to full lock and hold pressure. With engine running at 1000 rpm, steering slip should not ex-

ceed 1 rpm with 72 in.-lbs. (8.14 N·m) pressure on steering wheel. Repeat test with steering wheel in clockwise direction. If measured slippage is excessive, steering hand pump has abnormal internal leakage. Refer to paragraph 32 for service of steering hand pump.

30. STEERING CYLINDER TEST.

Reconnect hydraulic hose (5—Fig. 29) on steering cylinder. Start and run tractor at 1000 rpm until hydraulic fluid is at operating temperature of approximately 110° to 120° F (43°-49° C). Close load valve on flowmeter. Using a torque wrench, turn steering wheel to full lock either direction and hold pressure. With engine running at 1000 rpm, steering slip should not exceed 1 rpm more than that measured in paragraph 29 in either direction with 72 in.-lbs. (8.14 N·m)

pressure on steering wheel. If measured slippage is excessive, steering cylinder has more than normal internal leakage. Refer to paragraph 35, 37 or 38 for service of steering cylinder.

HYDRAULIC PUMP

All Models

31. The power source for hydrostatic steering system is an 8 gpm (30.3 L/min.) gear type pump. The pump is attached to a larger piston type pump which powers the main hydraulic system. Refer to paragraph 226 for testing, paragraph 238 for removal and installation and paragraph 245 for pump overhaul.

Fig. 28—Power brake housing showing steering relief valve on Models 2090, 2290, 2390 and 2590. Relief valve on other models is similar.

1. "O" ring
2. Seat
3. Ball
4. Washer
5. "O" ring
6. Guide
7. Spring (inner)
8. Spring (outer)
9. "O" ring
10. Piston
11. "O" ring
12. Retainer
13. Retaining ring
14. Locknut
15. Adjusting screw
16. Brake valve assy.

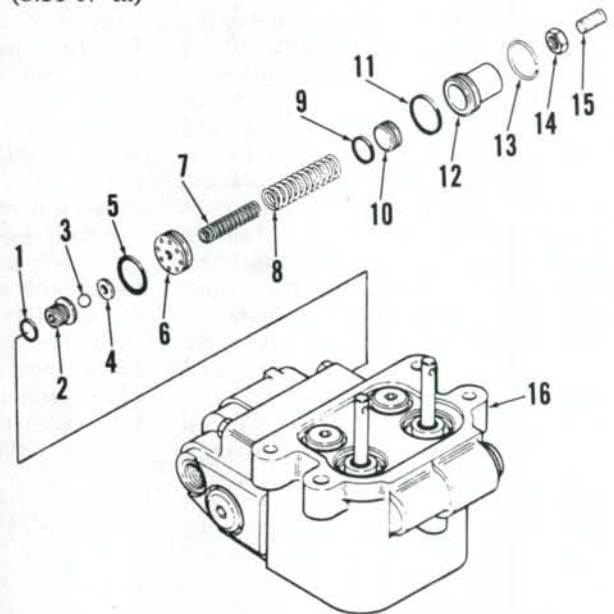
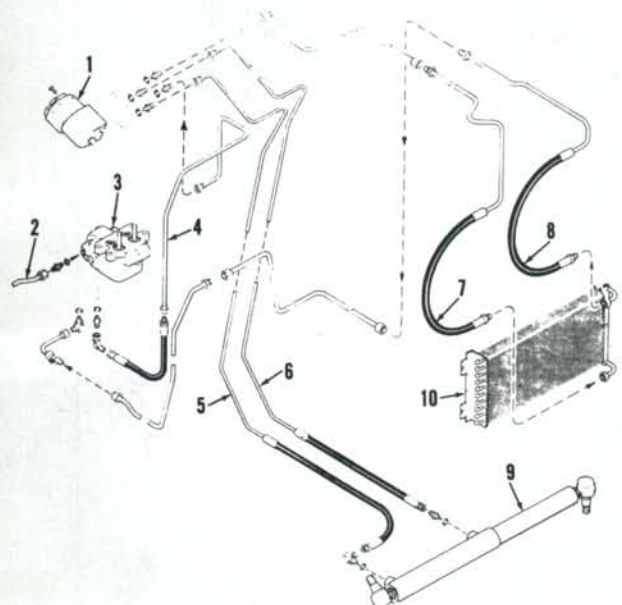


Fig. 29—Schematic view of typical steering hydraulic circuit. Steering relief valve is located in brake valve 3.

1. Manual pump
2. Supply line
3. Brake valve
4. Pressure line
5. Hose (R.H.)
6. Hose (L.H.)
7. Cooler inlet line
8. Cooler outlet line
9. Steering cylinder
10. Oil cooler



Paragraphs 32-33

HAND PUMP

All Models

32. REMOVE AND REINSTALL. To remove the steering hand pump, first remove the "E" rings and pin from the universal joint that connects the coupling to the steering pump. The coupling is located under the instrument panel. Disconnect the four hydraulic lines to the steering pump. Cap or plug all hydraulic openings to prevent contamination of the hydraulic system. Remove the three bolts securing steering pump to engine firewall, then remove pump.

Install steering pump by reversing removal procedure. Bleed system as outlined in paragraph 25.

33. OVERHAUL. To disassemble the removed hand pump refer to Fig. 30 and proceed as follows: Remove dirt seal, mounting plate and hydraulic fittings. Remove and discard outer shaft seal (39), then remove snap ring (38). Unbolt and remove cover (34), then remove seal ring (33), seal spacer (37) and inner shaft seal (36) from cover. Remove thrust washer (32), thrust needle bearing (31) and carefully withdraw input shaft assembly (items 18 through 30). Remove drive link (14) from valve spool (13), then remove seal ring (15) and washer (12) from valve sleeve (11) and withdraw valve spool (13) from pump body. Remove cap (1), remove locknut 2, then push adjusting screw (5) through pump plug and remove. Remove pump plug (3) and discard "O" ring (4).

Remove plug (7), discard "O" ring (8) and remove ball (9). Examine sleeve (11) in pump body for excessive wear, nicks or burrs. Do not remove sleeve from body. If renewal is necessary, complete body sleeve and spool assembly must be renewed.

To disassemble the rotor assembly (items 18 through 30) first withdraw commutator (19) from link (items 22 through 24). Remove and discard seal (18). Unbolt manifold (21), stand rotor assembly on shaft end, and lift off manifold. Check both sides of manifold for excessive wear, scratches or burrs. If renewal is necessary, manifold (21) and commutator (19) must be ordered as an assembly. Withdraw drive link (items 22 through 24) and using a magnet, remove spacer (25). Remove stator (26) from around rotor assembly to prevent rotor vanes (29) and springs (28) from falling out. Index vanes to rotor before removal to aid in reassembly.

Inspect rotor and stator for excessive wear, scratches or burrs. Rotor and stator must be ordered as a set if renewal is necessary.

Before reassembling, wash all parts in clean solvent and air dry. All parts, unless otherwise indicated, are installed dry. Install two ¼ inch NF studs into the input shaft (30) for aid in assembling. Place stator (26) onto the input shaft. Place rotor (27) in stator, then install vanes (29) into rotor.

NOTE: If the same vanes are reused, be certain vanes are installed exactly as removed. The wear pattern on the edge of the vanes must all be rotating the same direction. If vanes are not correctly installed, wear pattern on the vane can be 180 degrees out of alignment.

Check free height of vane springs (28). If free height is less than 0.08-0.1 inch (2.032-2.540 mm) as shown in Fig. 31, renew vane spring. Install vane springs with arched back toward vane.

Check rotor and stator clearance as follows: Position lobe of rotor in valley of stator shown in Fig. 32. Center opposite lobe on crown of stator, then using a feeler gage, measure clearance between rotor tip and stator crown. If clearance exceeds 0.007 inch (0.178 mm), rotor and stator assembly must be renewed. Install spacer (25—Fig. 30), then install drive link with flat sides of pin (22 or 23) aligned with slot in rotor. Install manifold (21) flat side toward rotor-stator assembly. Place two worm-type hose clamps on input shaft assembly. One clamp spanning the input shaft and stator; the other clamp spanning the stator and manifold as shown in Fig. 33. This will ensure that the manifold and stator have a common center before cap screws are installed and tightened. Remove the two ¼ inch aligning studs, then install and tighten the seven manifold cap screws to 10-14 ft.-lbs. (14-19 N·m) torque. Install seal

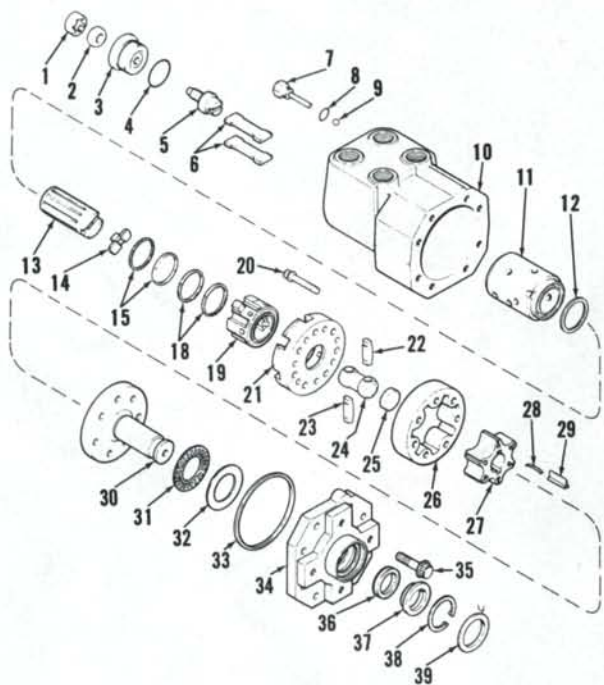


Fig. 30—Exploded view of Ross power steering hand pump.

1. Cap
2. Locknut
3. Pump plug
4. "O" ring
5. Adjusting screw
6. Torsion blades
7. Plug & pin
8. "O" ring
9. Ball
10. Pump body
11. Sleeve
12. Washer
13. Spool
14. Drive link
15. Seal assy.
18. Seal assy.
19. Commutator
20. Cap screw
21. Manifold
22. Pin
23. Pin
24. Drive link
25. Spacer
26. Stator
27. Rotor
28. Spring
29. Vane
30. Input shaft
31. Thrust bearing
32. Thrust washer
33. "O" ring
34. Cover
35. Cap screw
36. Seal
37. Spacer seal
38. Snap ring
39. Shaft seal



Fig. 31—Correct vane spring height is 0.080-0.100 inch (2.032-2.540 mm). Renew springs not meeting required height.

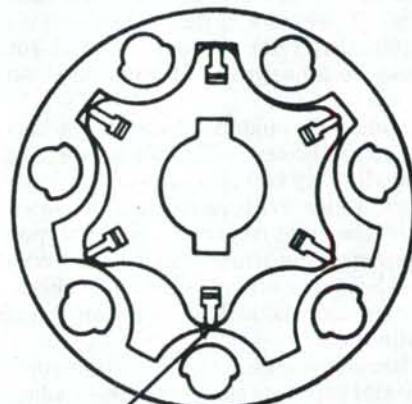


Fig. 32—With rotor positioned in stator as shown, clearance must not exceed 0.007 inch (0.178 mm). Refer to text.

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assembly (18—Fig. 30), Teflon side out, into open end of commutator (19). Align flat surfaces of drive link with slot in commutator and install commutator into manifold, seal toward drive link.

Install pump plug (3) with new "O" ring (4) into pump body and tighten to 40-50 ft.-lbs. (54-68 N·m) torque. Install adjusting screw (5) with new "O" ring through pump plug (3). Refer to Fig. 34 and install two torsion blades (6—Fig. 30) into valve spool (13).

NOTE: Identification marks on each blade must be toward outside when installed. Marks may be at opposite ends or both on one end as shown in Fig. 34. Install blades parallel with slot in valve spool and align top of blades flush with bottom surface of slot.

Hold adjusting screw in position and install spool assembly, flat end first, into pump body aligning the torsion blades in spool with slot in adjusting screw. Place drive link (14—Fig. 30) flat side down into slot in valve spool. Insert new seal (15) into valve sleeve, Teflon side outward. Carefully install input shaft assembly into pump body aligning drive link (14) with slot in commutator. When correctly installed, input shaft assembly will be approximately 1/8 inch below surface of pump body. Place thrust bearing (31) over shaft, then install original thrust washer, if undamaged, or new washer of equal thickness. Washers are available in thicknesses from 0.035 to 0.083 inch (0.89 to 2.11 mm) in 0.006 inch (0.15 mm) increments. Install pump cover (34) with new seal ring (33) and tighten cap screws to 10 ft.-lbs. (14 N·m) torque.

NOTE: Match outside shape of cover to pump body shape.

Using the CAS-1426 Seal Tool Kit or equivalent, install input shaft seal as follows: Clean input shaft and seal bore

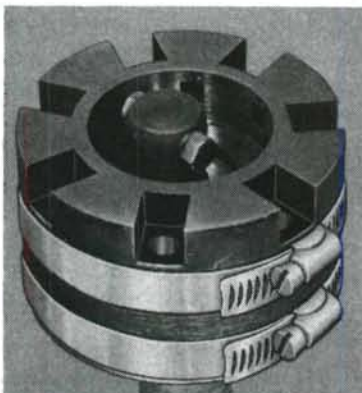


Fig. 33—View showing positioning of worm gear clamps to aid in assembly of input shaft assembly. Refer to text.

carefully. Place protective sleeve over input shaft; put compressor ring over input shaft and into upper seal bore. Lubricate seal (36) with petroleum jelly, place seal into compressor ring, lip side inward, and drive seal into pump body with seal driver. Driver will set correct seal depth.

Remove seal tools, install spacer (37), snap ring (38) flat side outward and protective seal (39) into pump body. Use seal driver to seat seal.

Install locknut (2) on adjusting screw (5) but do not tighten. Place check ball (9) into pump body. Do not allow it to fall out port in pump body. Install plug (7) with new "O" ring (8) with larger diameter toward plug, into pump body and tighten to 10-14 ft.-lbs. (14-19 N·m) torque. Install hydraulic fittings with new "O" rings into pump.

With hydraulic ports upward, pour hydraulic fluid into intake port and turn pump shaft until fluid appears at outlet port, then plug all ports. Install mounting plate so that the two grommets are at the top and the hydraulic fittings on pump will face left side of tractor. Install dirt seal on mounting plate.

34. To set centering pressure of hand pump, install a 3000 psi (21000 kPa) gage on each hydraulic steering cylinder line. Start and run tractor at 750 rpm until fluid is at operating temperature. Turn pump adjusting screw (5—Fig. 30) until pressure on both gages is the same, then tighten locknut (2) to 12-18 ft.-lbs. (16-24 N·m) torque. Bleed power steering system as outlined in paragraph 25.

STEERING CYLINDER

All Two Wheel Drive Models

35. R&R AND OVERHAUL. To remove steering cylinder, remove cotter pins on cylinder ball joint nuts. Disconnect hydraulic lines from cylinder and cap and plug all hydraulic openings. Remove ball joint nuts and remove cylinder from axle lug and tie rod.

36. With cylinder removed, move rod back and forth several times to clear fluid from cylinder. Refer to Fig. 35 and proceed as follows: Loosen jam nut (2) and unscrew ball joint (3) from cylinder head (1). Using a spanner wrench, remove cylinder head (1) from ported cylinder (10). Loosen jam nut (14) and unscrew ball joint (13) from rod (11). Remove gland assembly (items 5 through 9); then, withdraw rod (11) and piston assembly (items 22 through 27). Remove snap ring (15) and withdraw gland assembly (items 16 through 20). Remove retaining ring (21). Remove and

discard wear ring (22), "O" ring (23) and seal ring (24) from piston (25). On early cylinders, drive out pin (26) and slide piston off rod (11). Remove and discard "O" ring (27). All seals, "O" rings and back-up rings are now available for renewal. Clean all parts in a suitable solvent and inspect. Check ported cylinder (10) for scoring, grooves or out-of-roundness. Light scoring can be polished out by using a fine emery cloth and oil using a rotary motion while polishing. Heavy scoring, grooving or out-of-roundness will require renewal of cylinder. Check piston (25) for scoring or grooving. Polish out light scoring with fine emery cloth and oil using a rotary motion. Renew piston if heavily scored or grooved. Check rod (11) for straightness and renew as necessary.

Renew all "O" rings, seals and back-up rings upon assembly.

Reassemble steering cylinder as follows: Lubricate piston "O" ring (27) with petroleum jelly and install in inner groove of piston (25). Slide piston onto rod (11) pin side toward threaded end of rod, align holes in piston and rod, then press roll pin (26) through piston and rod until 1/4 inch (6.35 mm) of pin extends on each side of rod as shown in Fig. 36. Install seal ring (24—Fig. 35) in rear, outside groove of piston. Lubricate "O" ring (23) with petroleum jelly and install next to seal ring (24) on pin side of piston. Install wear ring (22) on piston in groove over pin. Place retaining ring (21) in the inside groove of ported cylinder (opposite of threaded end). Install rod and piston assembly into the ported cylinder with threaded end of rod at end of cylinder with retaining ring. Install rod seals (6 and 19) into

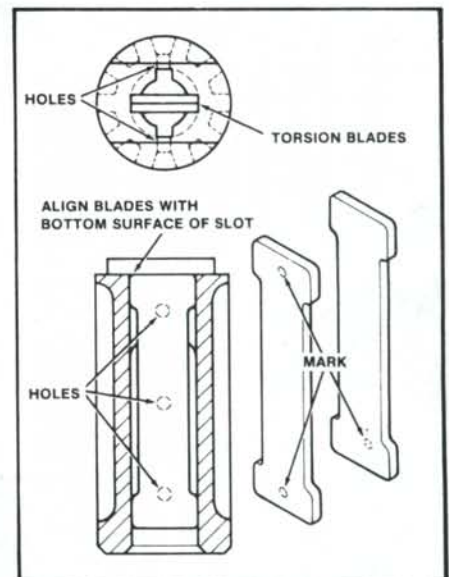
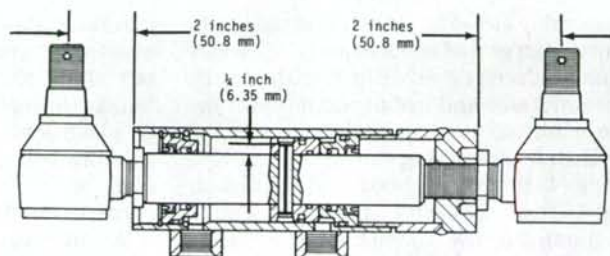


Fig. 34—Illustration showing correct installation of torsion blades in valve spool. Refer to text.

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small end of glands (7 and 20) with lip of seal toward small end of gland. Install wiper seals (5 and 18) into large end of glands (7 and 20) with lip of seal toward large end of gland. Using petroleum jelly, lubricate and install back-up rings (8 and 16) and "O" rings (9 and 17) onto outside groove of glands (7 and 20) with back-up rings toward large end of glands. Lubricate insides of glands and slide onto piston rod; small end of gland inward, at each end of ported cylinder. Install snap ring into groove at piston rod end of ported cylinder. Apply Loc-tite 242 or equivalent to threads on cylinder head (1) and tighten cylinder head into ported cylinder to 90-100 ft.-lbs. (122-136 N·m) torque. Screw ball

Fig. 36—Cross-sectional view of steering cylinder showing correct installation depth of piston pin and ball joints.



joints into rod and cylinder head until center of ball joint is 2 inches (50.8 mm) from end of cylinder as shown in Fig. 36. Tighten jam nuts (2 and 14—Fig. 35) to 30-40 ft.-lbs. (41-54 N·m) torque.

Install steering cylinder by reversing removal procedure. If necessary, loosen

ball joint jam nuts and turn ball joints to fit evenly and easily into axle and tie rod lugs. Tighten jam nuts to 30-40 ft.-lbs. (41-54 N·m) torque. Tighten ball joint nuts to 180-200 ft.-lbs. (244-271 N·m) torque and install cotter pins. Install hydraulic hoses and bleed power steering system as outlined in paragraph 25.

Models 2094 and 2294 With Carraro Front Drive Axle

37. R&R AND OVERHAUL. To remove either steering cylinder, identify and remove steering lines from cylinder. Immediately plug or cap all openings. Unbolt outer end from steering arm, then unpin inner end from axle housing. Lift out cylinder.

Clear cylinder of oil as necessary by moving piston rod through its complete stroke. Unscrew end cap (4—Fig. 37) and pull piston rod (1) and piston (7) out of cylinder tube (9). Remove retaining nut (8), piston assembly (7) and "O" ring (6). Slide end cap (4) off piston rod (1), then remove "O" ring (5) and seals (2 and 3).

Clean and inspect all parts and renew as necessary. Cylinder body must be smooth and free of score marks. Piston and piston rod must be free of nicks and burrs. Slight blemishes may be removed using fine emery cloth lubricated with kerosene, but all parts must be thoroughly cleaned before reassembly.

Reassemble by reversing disassembly procedure. Note chamfer side of piston must face toward end cap. Tighten nut (8) on piston rod to a torque of 60 ft.-lbs. (82 N·m). Lubricate all parts during reassembly.

Reinstall cylinder by reversing removal procedure. Repeat operation for other cylinder, if necessary. Bleed steering system as outlined in paragraph 25.

Model 2294 With ZF Front Drive Axle

38. The steering cylinder tube (14—Fig. 38) is housed in the front differential housing (12). To disassemble the cylinder, first disconnect tie rod ends (2) from steering arms and disconnect steering lines. Plug or cap line openings. Unbolt and remove steering stops (5) and spacer plates (6). Apply

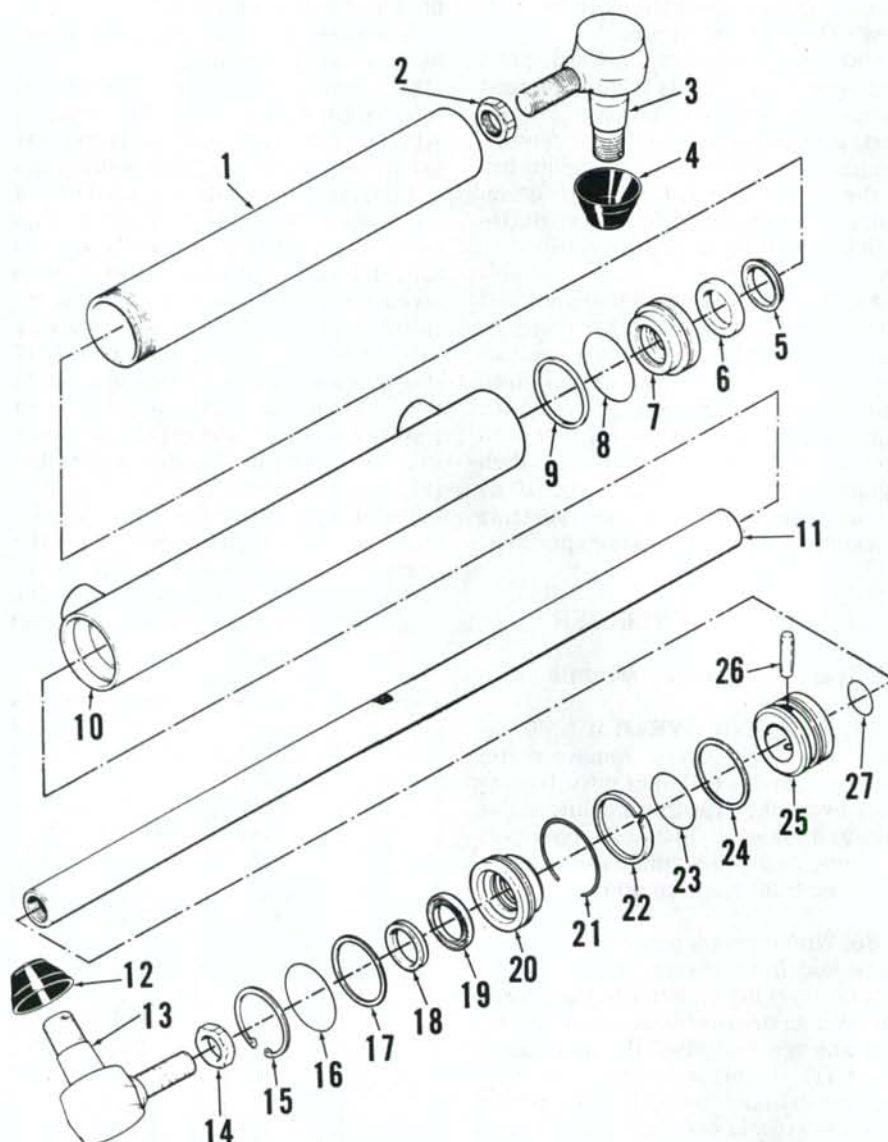


Fig. 35—Exploded view of early steering cylinder assembly used on two-wheel drive models. Piston and rod are integral on later cylinders.

- | | | | |
|---------------|-----------------|-------------------|---------------|
| 1. Tube | 8. Back-up ring | 15. Snap ring | 22. Wear ring |
| 2. Jam nut | 9. "O" ring | 16. Back-up ring | 23. "O" ring |
| 3. Ball joint | 10. Port tube | 17. "O" ring | 24. Seal ring |
| 4. Dust cover | 11. Rod | 18. Wiper | 25. Piston |
| 5. Wiper | 12. Dust cap | 19. Seal | 26. Pin |
| 6. Seal | 13. Ball joint | 20. Gland | 27. "O" ring |
| 7. Gland | 14. Jam nut | 21. Retainer ring | |

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heat as necessary to loosen Loctite, then unscrew tie rod studs (4) from cylinder rod (7). Unbolt and remove rod guides (11 and 30) and any shims (29) which are present. Remove "O" rings (13 and 15) from cylinder tube (14). Withdraw cylinder tube and rod assembly from differential housing (12). Slide piston and rod assembly from cylinder tube. Remove retaining ring (16), collar ring (18) and split ring (17). Move piston (21) on rod and remove split ring (24). Remove spacer (19) and "O" ring (20), then slide piston off the rod. Remove Teflon rings (26 and 28) and seal ring (27) from outside of piston and retaining ring (25), collar ring (23) and spacer (22) from end of piston. Remove scraper rings (9 and 32) and seal rings (10 and 31) from rod guides (11 and 30).

Clean and inspect all parts. Check cylinder tube, piston, rod and rod guides for cracks, scoring or other damage. Use all new "O" rings, seals and seal rings and lubricate with Hy-Tran Plus fluid during reassembly.

Reassemble cylinder by reversing disassembly procedure and adjust steering cylinder tube end play as follows: Install right rod guide (11) and tighten cap screws (8) to a torque of 140 ft.-lbs. (190 N·m). Push cylinder tube (14) inward until seated against rod guide (11). Using a depth gage measure distance cylinder tube protrudes out left side of differential housing. Then, measure cylinder depth bore in rod guide (30). The difference between the two measurements is the correct thickness of shim (29) to be installed to obtain zero

end play of cylinder tube. Shims are available in thicknesses from 0.039-0.071 inch (1.0-1.8 mm) in 0.002 inch (0.05 mm) increments. Install rod guide (30) with correct shim (29) and tighten cap screws (33) to a torque of 140 ft.-lbs. (190 N·m). Apply Loctite 242 to threads of tie rod studs (4) and tighten in cylinder rod to a torque of 260 ft.-lbs. (350 N·m). Install steering stops and spacer plates (5 and 6) and tighten bolts to 19-23 ft.-lbs. (26-31 N·m) torque. Connect steering lines and tie rod ends. Tighten nuts (1) to a torque of 148 ft.-lbs. (200 N·m) and install cotter pins.

Bleed power steering as outlined in paragraph 25 and adjust toe-in, if necessary, as outlined in paragraph 24.

OIL COOLER

All Models

39. An oil cooler (10—Fig. 29) is incorporated into the power steering system. Service of oil cooler involves only removal and installation or renewal of faulty units. Removal of oil cooler is obvious after removal of the radiator grille and hood and an examination of the unit. However, outlet and inlet hoses must be identified as they are removed from oil cooler pipes so oil circuits will be kept in the proper sequence.

STEERING COLUMN

All Models

40. Figure 39 shows steering column and adjustable parts. To remove steering column after manual pump is removed, proceed as follows: On telescopic column remove plug (20). Holding lock knob (22) remove nut (21), then remove lock knob. Remove nut (23) and using a suitable puller, remove steering wheel. Remove shroud from steering column. Disconnect battery and carefully remove all electrical switches and wiring from steering column panel. Disconnect tilt return spring (6), unbolt column pivot bearings (3 and 4) and remove column (2) by pushing on top of telescoping lock shaft (27). Remove roll pin securing inner shaft (33) to link (34). Remove internal snap ring and washer (29 and 30) from inside of outer shaft (25). Separate inner and outer shafts. Remove friction locks (31), lock keys (28) and stop pin (32) from inner shaft. Remove locknut (26) and lock shaft (27) from outer shaft. Press bushings (1 and 5) from column if necessary. Bushings are presized. Remainder of disassembly is obvious after examination.

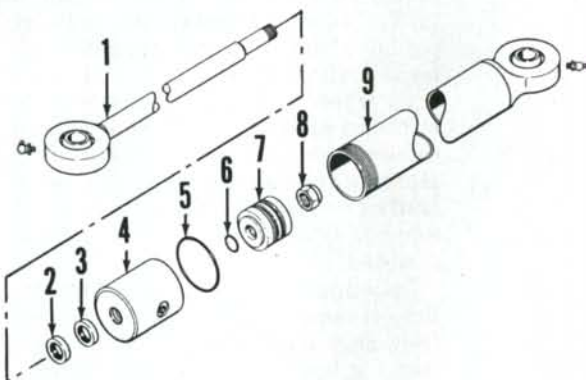


Fig. 37—Exploded view of typical steering cylinder used on models equipped with Carraro front drive axle. Two cylinders are used.

1. Piston rod
2. Wiper seal
3. Seal
4. Cap
5. "O" ring
6. Spacer plate
7. Piston
8. Nut
9. Cylinder tube

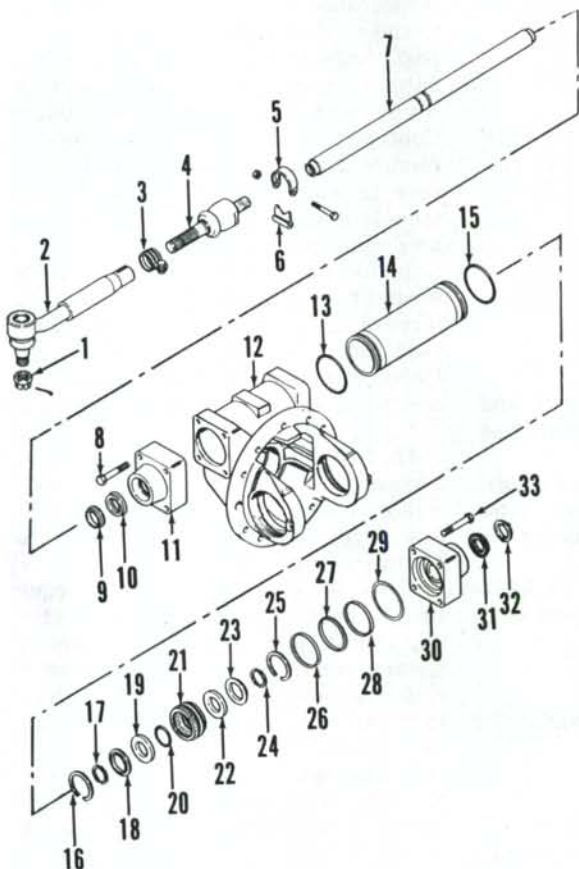


Fig. 38—Exploded view of steering cylinder used on Model 2294 equipped with ZF front drive axle. Cylinder tube (14) is located in front differential housing (12).

1. Nut
2. Tie rod end
3. Clamp
4. Tie rod stud
5. Stop plate
6. Spacer plate
7. Cylinder rod
8. Cap screw
9. Scraper ring
10. Seal ring
11. Rod guide
12. Differential housing
13. "O" ring
14. Cylinder tube
15. "O" ring
16. Retaining ring
17. Split ring
18. Collar ring
19. Spacer
20. "O" ring
21. Piston
22. Spacer
23. Collar ring
24. Split ring
25. Retaining ring
26. Teflon ring
27. Seal ring
28. Teflon ring
29. Shim
30. Rod guide
31. Seal ring
32. Scraper ring
33. Cap screw

Paragraphs 41-42

CASE/INTERNATIONAL

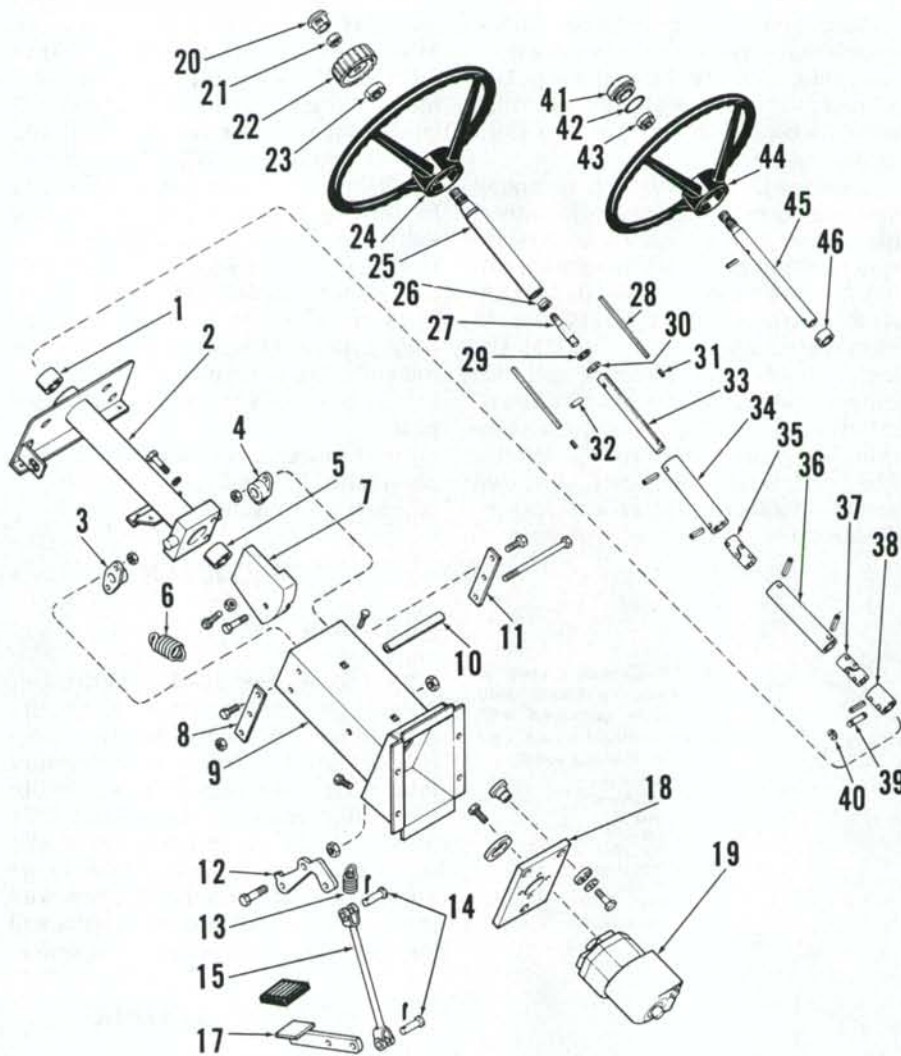


Fig. 39—Exploded view of steering shaft and column assembly.

- | | | | |
|------------------|------------|-----------------|---------------|
| 1. Bearing | 13. Spring | 25. Shaft cover | 36. Coupling |
| 2. Column | 14. Pins | 26. Nut | 37. "U" joint |
| 3. Pivot bearing | 15. Rod | 27. Shaft | 38. Coupling |
| 4. Pivot bearing | 16. Pedal | 28. Key | 39. Pin |
| 5. Bearing | 17. Plate | 29. Washer | 40. "E" ring |
| 6. Spring | 18. Pump | 30. Snap ring | 41. Plug |
| 7. Tilt quadrant | 19. Plug | 31. Lock | 42. Ring |
| 8. Brace | 20. Nut | 32. Pin | 43. Nut |
| 9. Support | 21. Knob | 33. Shaft | 44. Wheel |
| 10. Spacer | 22. Nut | 34. Coupling | 45. Shaft |
| 11. Brace | 23. Wheel | 35. "U" joint | 46. Bushing |
| 12. Latch | | | |

Removal procedure for stationary shaft (items 41 through 46) is similar to removal of telescoping shaft.

When reassembling telescoping shaft, lock keys (28) must align with slots in locknut (26). Tighten steering wheel nut (23 or 43) to 30-35 ft.-lbs. (41-48 N·m) torque. Tighten lock knob nut (21) on telescoping column to 14-15 ft.-lbs. (19-20 N·m) torque.

ENGINE AND COMPONENTS

All model tractors are equipped with engines having a bore and stroke of

4-5/8 x 5 inches (117.5x127.0 mm) and a displacement of 504 cubic inches (8.26 L).

Engines are of a six cylinder design, and are equipped with wet type sleeves. Dry type air filter is used in the air induction systems.

Models 2290, 2390, 2590, 2294, 2394 and 2594 engines are equipped with turbochargers.

R&R ENGINE ASSEMBLY

All Models

41. Remove front end weights, weight frame and adapters, if so equipped.

Disconnect headlight wiring, remove hood, side panels and radiator grille. Disconnect and remove cables from batteries and starting motor, then remove batteries and battery tray. Remove right side rail. Unbolt circuit breaker panel from oil pan and wire panel to side of engine. Disconnect tachometer drive cable. Shut off both suction and discharge valves on air conditioner compressor. Disconnect suction valve from compressor, cap suction port on compressor, move line back toward control center. Disconnect quick coupler on discharge line.

Disconnect two oil cooler lines. Disconnect necessary hydraulic lines from steering hand pump. Cap or plug hydraulic ports or openings. Drain cooling system, close heater supply valve and disconnect heater supply and return hoses. Shut off fuel supply at tank. Disconnect fuel return and supply lines from injection pump. Disconnect the throttle and stop control cables from injection pump. Disconnect all electrical connections to engine located under cab platform. Disconnect aspirator tube at muffler, then remove muffler and support brace. Remove left side rail. Drain oil pan if oil pan is to be removed.

Disconnect transmission oil cooler lines at radiator, remove radiator hoses from engine and disconnect hydraulic steering hoses from steering cylinder. Wedge wooden blocks between front axle and support to prevent tipping. Support engine with a suitable hoist. Support rear of tractor with suitable supports at torque tube. Place rolling floor jack under front axle support, remove cap screws securing front support to engine block and roll front wheels, front support and radiator as a unit away from engine.

On mechanical shift tractors, drain torque tube. On power shift tractors, remove drain plug from transmission case. Remove torque tube lower cover. Unbolt engine from torque tube and pull engine forward away from torque tube.

42. Install engine to torque tube by reversing removal procedure paying attention to the following: Apply Loctite 504 liquid gasket or equivalent to mounting surface of engine block. Install two 3/4 inch pilot studs to the torque tube housing. Rotate engine flywheel to align shaft splines with torque limiter splines (power shift tractors) or master clutch splines (mechanical shift tractors), then push engine until mounting surfaces contact.

Tighten 1/2 inch grade 5 bolts to 80-96 ft.-lbs. (109-130 N·m) torque and 1/2 inch grade 8 bolts to 110-132 ft.-lbs. (149-170 N·m) torque. Tighten 3/4 inch grade 8

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bolts to 380-456 ft.-lbs. (515-618 N·m) torque. Refer to Fig. 40 for identification and location of bolts. Tighten the front 5/8 inch side rail cap screws to a torque of 150-180 ft.-lbs. (203-244 N·m). Tighten the rear 3/4 inch side rail cap screws to 380-456 ft.-lbs. (515-618 N·m) torque after making sure the rear three screws on each side are coated with a good sealant, since they enter the torque tube.

The balance of installation is the reverse of removal procedure. Refer to paragraph 73 for diesel fuel system bleeding and paragraph 25 to bleed power steering system.

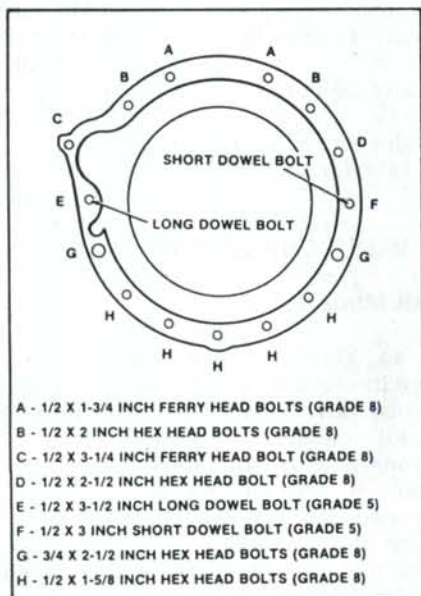


Fig. 40—View showing location and description of bolts used to secure torque tube to engine.

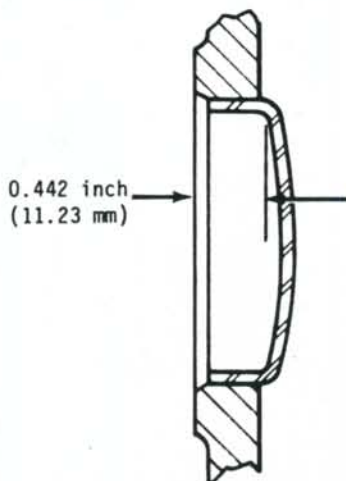


Fig. 41—Illustration showing correct installation depth of end expansion plugs in cylinder head.

CYLINDER HEADS

All Models

43. REMOVE AND REINSTALL. To remove any cylinder head, first drain cooling system and remove hood. Remove muffler, air filter assembly and breather tube. If so equipped, loosen clamp on intake elbow from turbocharger. Disconnect ether start tube (if so equipped) from intake manifold. Remove hood release mounting bracket, then remove intake manifold and gaskets. If so equipped, disconnect and remove turbocharger oil supply tube, exhaust elbow, seal ring and oil drain tube. Remove exhaust manifold heat shield and exhaust manifold with turbocharger, if so equipped. Remove exhaust manifold gaskets. Remove upper radiator hose and loosen water pump to manifold hose. Disconnect water temperature gage wire from sending unit and loosen rear clamp on cab heater hose. Remove water manifold and manifold gaskets. Remove fuel injectors and gaskets.

Remove rocker arm covers, rocker arms and push rods. Remove retaining bolts and lift cylinder head or heads from engine.

Check cylinder head for warpage using a straightedge and feeler gage. If measurement exceeds 0.005 inch (0.127

mm) in six positions, cylinder head must be machined or renewed. Renew cylinder head if head height is less than 4.080 inches (103.632 mm) after machining.

NOTE: After cylinder head is resurfaced, check the valve head recession specifications outlined in paragraph 45. Correct as necessary.

If expansion plugs are to be renewed, install end plugs to depth shown in Fig. 41, and install top plugs to depth shown in Fig. 42.

Head gaskets are equipped with an integral fire ring for each cylinder, which will compress to the necessary thickness required to seal each individual sleeve to cylinder head.

On all models, head gaskets have two smaller (guide) bolt holes for alignment purposes and aligning dowels are recommended for gasket installation as shown in Fig. 43. Dowels are available from Case as part No. CAS-1062A. Removal tong is Case part No. CAS-1061-2. Use tong to remove dowels after head is partially installed. Install gasket dry. Clean injector bores before installing head.

Install cylinder head bolts finger tight, then install intake manifolds, exhaust manifolds and water manifolds using new gaskets, tighten retaining cap screws finger tight and make sure heads are correctly aligned. Tighten cylinder head cap screws in three stages to 70, 140 and 210 ft.-lbs. (95, 190 and 285 N·m) using the sequence shown in Fig. 44.

When installing rocker arms, a clearance of 0.010-0.030 inch (0.254-0.762 mm) must be maintained at each end of the shaft. Clearance can be varied if necessary, by shifting rocker shaft brackets, or by adding or removing spacer washers. Adjust valve tappet gap as outlined in paragraph 44 after tractor is assembled.

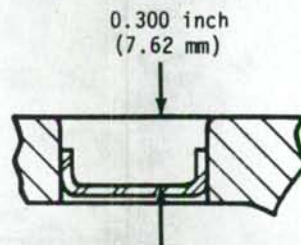
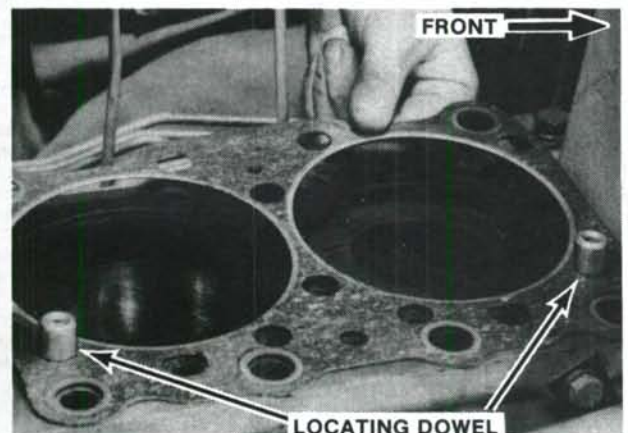


Fig. 42—Illustration showing correct installation depth of top expansion plugs in cylinder head.

Fig. 43—Install dowel guides in the positions shown to position head gasket.



Paragraphs 44-46

Other tightening torques are as follows:

Intake manifold	35-42 ft.-lbs. (48-57 N·m)
Exhaust manifold	25-30 ft.-lbs. (34-41 N·m)
Water manifold	35-42 ft.-lbs. (48-57 N·m)
Rocker arm brackets	40-45 ft.-lbs. (54-61 N·m)
Valve (rocker arm) covers	8-10 ft.-lbs. (11-14 N·m)

Complete the assembly by reversing the disassembly procedure. The manufacturer recommends that engine be operated under partial load for approximately one hour, then cylinder head retorqued following normal tightening sequence, to 210 ft.-lbs. (285 N·m).

44. VALVE (TAPPET) GAP ADJUSTMENT. The two position method of tappet gap adjustment is recommended. Turn crankshaft until No. 1 intake valve is closing and continue turning until TDC timing mark on crankshaft pulley is aligned with timing pointer as shown in Fig. 45. Adjust six valves indicated in upper section of Fig. 46.

Turn engine crankshaft one complete revolution until TDC timing mark on crankshaft pulley is aligned with timing pointer and adjust six valves indicated in lower section of Fig. 46.

Recommended hot tappet gap is 0.015 inch (0.381 mm) for intake valves and 0.025 inch (0.635 mm) for exhaust valves.

VALVES AND SEATS

All Models

45. Intake and exhaust valves on Model 504 BDT engines use hardened seat inserts. Model 504 BD, naturally

aspirated engine uses a hardened seat insert on exhaust valves, but seats intake valves directly into the cylinder head. A face angle of 44 degrees and seat angle of 45 degrees is recommended for all valves of Model 504 BD engine and exhaust valves of Model 504 BDT engines. A face angle of 29 degrees and seat angle of 30 degrees for intake valves is recommended on Model 504 BDT engines. All 30 degree intake valves are stamped with "30°" on valve, and also a part number, while 45 degree valves are plain.

Check valves against the following specifications:

INTAKE

Face angle	
504 BD	44°
504 BDT	29°
Seat angle	
504 BD	45°
504 BDT	30°
Stem diameter	0.402-0.403 inch (10.211-10.236 mm)
Stem to guide diametral clearance	0.0025 inch (0.0635 mm)

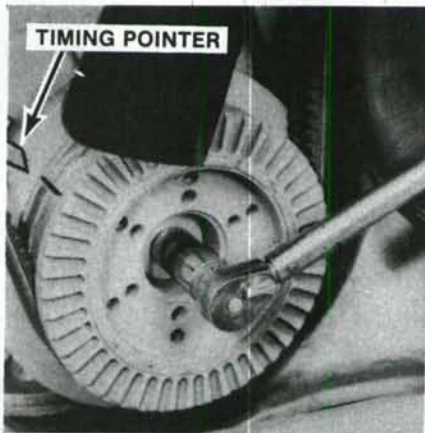


Fig. 45—To adjust valves, turn engine to TDC mark on crankshaft pulley as No. 1 Intake valve is closing.

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Seat width	0.0750-0.0975 inch (1.905-2.477 mm)
Valve run-out (max.)	0.002 inch (0.051 mm)
Valve tappet gap (warm)	0.015 inch (0.381 mm)
Valve recession from face of cylinder head	0.060 inch (1.524 mm)

EXHAUST

Face angle	44°
Seat angle	45°
Stem diameter	0.402-0.403 inch (10.211-10.236 mm)
Stem to guide diametral clearance	0.0025 inch (0.0635 mm)
Seat width	0.0775-0.1000 inch (1.969-2.540 mm)
Valve run-out (max.)	0.002 inch (0.051 mm)
Valve tappet gap (warm)	0.025 inch (0.635 mm)
Valve recession from face of cylinder head	0.060 inch (1.524 mm)

VALVE GUIDES AND SPRINGS

All Models

46. The semi-finished valve guides are interchangeable for intake and exhaust valves and are available only in a kit containing two guides. If ID of guide is worn to 0.4065 inch (10.325 mm) or larger, renew guide. Using a piloted arbor and working from top surface of cylinder head, press old guide out and new guide in until installed height (H—Fig. 47) measures 0.953 inch (24.206 mm). Ream guides after installation to a finished ID of 0.4045-0.4055 inch (10.274-10.300 mm).

Intake and exhaust valve springs are interchangeable and are available only in a kit which consists of four springs. Renew any spring that is cracked,

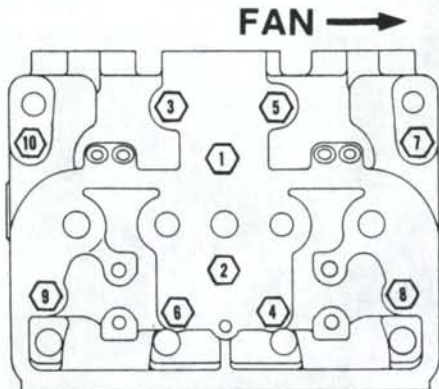
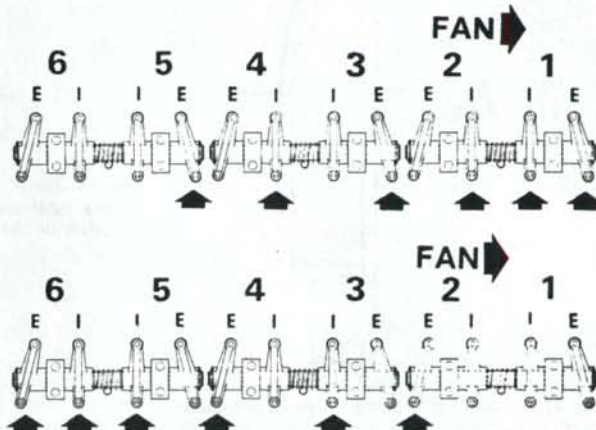


Fig. 44—Cap screw tightening sequence for cylinder heads. Torque in three stages to 70, 140 and 210 ft.-lbs. (95, 190 and 285 N·m).

Fig. 46—Upper view shows tappet gap adjusting chart with crankshaft at TDC position with No. 1 piston at end of compression stroke. Lower view is with engine rotated 360° to TDC position with No. 6. piston at end of compression stroke. Recommended gap is 0.015 inch (0.381 mm) for intake valves and 0.025 inch (0.635 mm) for exhaust valves with engine hot.



SERVICE MANUAL

discolored or does not meet the specifications which follow:

Free length 2.18 in.
(55.372 mm)

Test at
length 50-60 lbs. @ 1.94 in.
(225-269 N @ 49.2 mm)

Test at
length 153-167 lbs. @ 1.48 in.
(681-743 N @ 37.69 mm)

VALVE ROTATORS

All Models

47. Positive type valve rotators are used on both inlet and exhaust valves. No maintenance is required but each valve should be observed while engine is running to be sure the valve rotates a slight amount. Renew the rotator on any valve which fails to turn when engine is running. Renew rotator and keepers on any new valve installed.

ROCKER ARMS

All Models

48. Refer to Fig. 48 for an assembled view of rocker arm shaft and associated parts. Exhaust valve rocker arms are right hand and left hand units and are installed on shaft with valve contact ends closer together as shown.

Rocker shaft must be assembled with feed holes toward valve side of cylinder. Examine shaft for wear on pressure (bottom) side of shaft in rocker area and check rocker arms for excessive looseness on shaft. Also examine valve stem contact button on rocker arm. Renew rocker arms and/or shaft if wear is excessive. Install a new "O" ring on oil tube before installation. Side clearance of end (exhaust) rocker arms should be limited to 0.010-0.030 inch (0.254-0.762 mm) at each end during

shaft installation by adding or removing spacer washers behind snap ring. Tighten rocker arm stud nuts to 40-45 ft.-lbs. (54-61 N·m) during installation and adjust tappet gap as outlined in paragraph 44.

CAM FOLLOWERS

All Models

49. The mushroom type cam followers can be removed from below after first removing camshaft as outlined in paragraph 55.

The 0.8097-0.8102 inch (20.566-20.579 mm) diameter standard size followers have a normal clearance of 0.001-0.004 inch (0.0254-0.1016 mm) in cylinder block bores. If clearance is excessive, resize the bores to 0.815-0.8225 inch (20.866-20.891 mm) and install the 0.010 inch (0.254 mm) oversize followers provided in parts stocks.

TIMING GEAR COVER

All Models

50. To remove timing gear cover, drain engine oil and cooling system, disconnect headlight wiring; then remove



Fig. 48—Assembled view of rocker arm units showing components properly positioned. Recommended side clearance of 0.010-0.030 inch (0.254-0.762 mm) for each end rocker arm is adjusted by adding or removing shim washers.

hood, side panels and radiator grille. Remove air conditioning condenser and hose assembly from radiator support and carefully lay assembly aside with hoses connected. Disconnect transmission oil cooler lines at radiator. Cap or plug hydraulic openings to prevent contamination. Remove upper and lower radiator hoses. Remove radiator assembly. Remove fan and spacer. Unbolt and remove fuel pump drive gear cover (1—Fig. 49). Unbolt fuel pump drive gear (3) from fuel pump. Remove injection pump as outlined in paragraph 76. Remove alternator, A/C compressor belt and fan belts.

NOTE: Before timing gear cover can be removed, the front axle support must be separated from engine block and moved forward a minimum of 1-3/4 inches (44.45 mm).

Support tractor under torque tube with a suitable jack stand. One at a time, remove bolts securing front support to engine block and install longer bolts, approximately 4-1/2 inches (114.3 mm) long. Separate front support and roll away from engine block a minimum of 1-3/4 inches (44.45 mm). Remove A/C pulley and water pump pulley. Remove crankshaft pulley bolt and using a suitable puller with bolts, remove crankshaft pulley. Pry out front oil seal, remove bolts securing oil pan to timing gear cover then unbolt and carefully remove timing gear cover. Do not lose or damage the spring loaded thrust plunger in front end of camshaft when cover is removed.

Install cover and new gasket (7—Fig. 49) by reversing removal procedure. Tighten cover retaining bolts to a torque of 35-42 ft.-lbs. (48-57 N·m). Tighten crankshaft pulley cap screw (11) to 100-110 ft.-lbs. (136-149 N·m) torque. Tighten oil pan cap screws to 15-20 ft.-lbs. (20-27 N·m) torque. Tighten front support to engine block mounting bolts to 380-456 ft.-lbs. (515-618 N·m) torque.

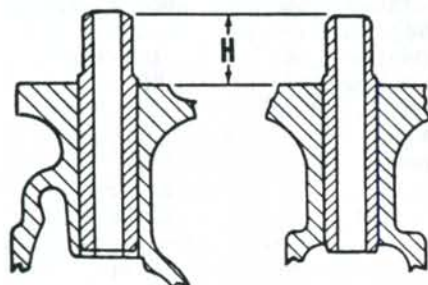
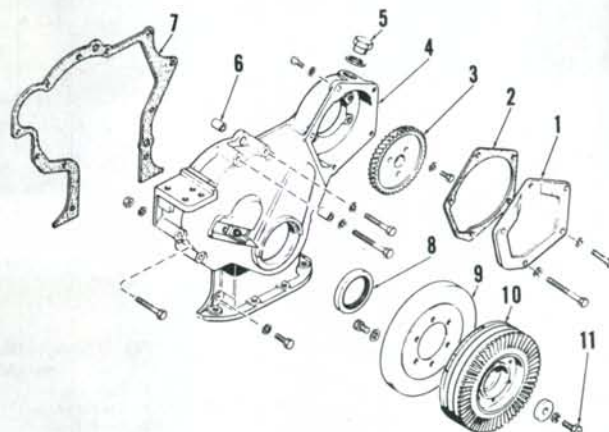


Fig. 47—Height (H) of installed valve guides should be 0.953 inch (24.206 mm). Guides must be reamed after installation.

Fig. 49—Exploded view of engine timing gear cover showing component parts.

1. Cover
2. Gasket
3. Pump gear
4. Cover
5. Timing hole plug
6. Dowel
7. Gasket
8. Oil seal
9. Viscous dampner
10. Crankshaft pulley
11. Cap screw



Paragraphs 51-55

TIMING GEARS

All Models

The timing gear train consists of the crankshaft gear, camshaft gear, idler drive gear, idler gear and injection pump drive gear. Engine oil pump mounts on front main bearing cap and drives through an idler gear from crankshaft gear, thus becoming a part of timing gear train. Refer to the appropriate following paragraphs for timing, inspection and overhaul data.

51. TIMING MARKS. The crankshaft gear and camshaft gear are provided with timing marks as shown in Fig. 50. Marks should be aligned as shown when units are installed. Idler gears are not timed, injection pump timing is accomplished during pump installation as outlined in paragraph 76.

52. CAMSHAFT GEAR. Although camshaft gear can be removed without withdrawing camshaft from engine block, the manufacturer recommends that shaft and gear be removed as a unit due to the difficulty of installing a new gear with camshaft in engine.

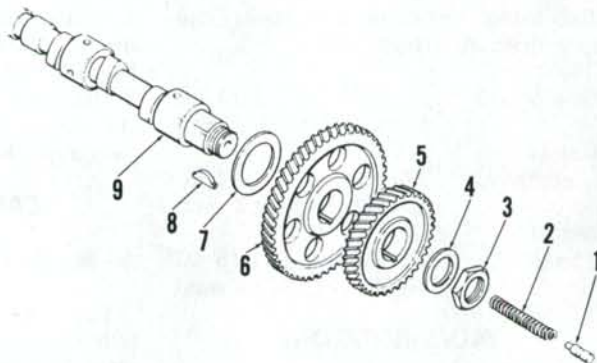
Before removing camshaft, check the backlash between camshaft and crankshaft gear at several points using a dial indicator. Backlash should be 0.004-0.011 inch (0.1016-0.2794 mm). Excessive backlash could be caused by gear wear, shaft wear or camshaft bushing wear; or by a combination of factors.

To remove the camshaft gear after removing camshaft as outlined in paragraph 55, straighten locking tab on locking washer, Fig. 51, remove retaining nut and press idler drive gear and camshaft gear from shaft. Check camshaft bushings ID and thrust washer while camshaft is out.

Install camshaft gears using heat to expand gears after first installing a new key and make sure the large hub of idler drive gear is toward camshaft gear and

Fig. 51—Exploded view of camshaft, timing gear and associated parts.

1. Plunger
2. Thrust spring
3. Nut
4. Lockwasher
5. Idler drive gear
6. Camshaft gear
7. Thrust washer
8. Woodruff key
9. Camshaft



timing marks are facing out. Install a new thrust washer if worn to less than 0.1215 inch (3.0861 mm). New thrust washer thickness is 0.1225-0.1275 inch (3.1115-3.2385 mm). Use a new retaining washer and tighten camshaft nut to a torque of 195-205 ft.-lbs. (264-278 N·m). Reinstall camshaft and gear unit as outlined in paragraph 55.

53. CRANKSHAFT GEAR. The crankshaft gear can be removed after removing the timing gear cover and timing idler gear. Use a suitable jaw type puller and a 5/8 inch stepped center to protect crankshaft threads. Renew the crankshaft key and heat new gear before installing. Be sure timing marks on crankshaft and camshaft gears are aligned as shown in Fig. 50 when installing gear.

54. IDLER GEARS. Idler drive gear is removed with camshaft gear as outlined in paragraph 52. Timing idler gear (4—Fig. 52) can be removed after removing timing gear cover as outlined in paragraph 50. It must be removed before removing camshaft as in paragraph 55 or crankshaft timing gear as in paragraph 53.

Timing idler gear (4) contains a bushing which is not renewable separately. Diametral clearance of the gear on the 1.7325-1.7330 inch (44.005-44.018 mm) shaft should not ex-

ceed 0.005 inch (0.127 mm). Renew shaft (3) if OD measures less than 1.732 inches (43.98 mm) and renew gear (4) if ID is larger than 1.740 inches (44.19 mm). End play of idler gear should not exceed 0.012 inch (0.305 mm). Renew inner thrust washer (5) if it is less than 0.061 inch (1.549 mm) thick and thrust plate (2) if end play is still excessive. Tighten idler shaft retaining cap screw (1) to a torque of 80-96 ft.-lbs. (109-130 N·m).

CAMSHAFT AND BEARINGS

All Models

The camshaft is carried in five renewable bushings. All camshaft journals are the same diameter, but have three different widths. End play is controlled by a spring loaded plunger in front end of camshaft and a thrust washer between camshaft gear and engine block. The front camshaft bushing provides metered lubrication for the timing gears, including injection pump idler gear. Intermediate bushings provide lubrication to rocker arms and valves, each bushing aligning with a drilling to one cylinder head.

55. REMOVE AND REINSTALL. To remove the camshaft and gear as a unit, first drain cooling system and remove timing gear cover as outlined in paragraph 50 and remove rocker arms as outlined in paragraph 48. Remove timing idler gear as in paragraph 54. Remove push rods and bend a short right-angle hook in a piece of welding rod for each cam follower; insert hooked end down through top of follower until it engages lube hole, then lift and secure the followers at the top of their travel. Remove tachometer drive using special tool No. CAS-1435 or equivalent puller. Carefully withdraw camshaft and gears as a unit from front of block after tachometer drive has been removed.

Remove camshaft gears as outlined in paragraph 52 if renewal is indicated. Refer to paragraph 56 for specification data on camshaft and bushings.

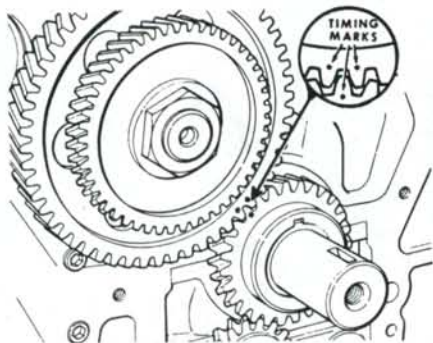


Fig. 50—Engine timing gear train showing timing marks.

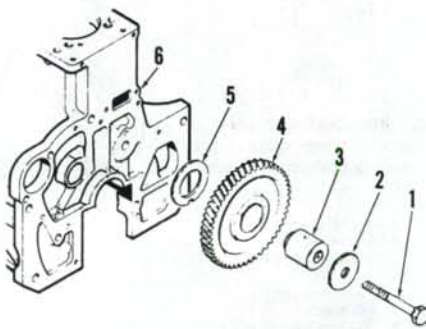


Fig. 52—Injection pump idler gear shown removed from engine block.

1. Cap screw
2. Thrust plate
3. Shaft (hub)
4. Gear
5. Thrust washer
6. Cylinder block

SERVICE MANUAL

When reinstalling camshaft, make sure timing marks are aligned as shown in Fig. 50. Complete the assembly by reversing the disassembly procedure. Adjust the valves as outlined in paragraph 44. Time the diesel injection pump as outlined in paragraph 75.

56. OVERHAUL. Desired camshaft journal clearance is 0.0014-0.0054 inch (0.0352-0.1372 mm), with a maximum permissible limit of 0.007 inch (0.178 mm). All camshaft journals should measure 2.246-2.247 inches (57.048-57.074 mm) and installed bushing ID should be 2.2484-2.2514 inches (57.109-57.186 mm). The precision, babbitt lined steel bushings are available only in complete sets of standard size bushings. Undersizes are not available.

To renew the camshaft bushings, first remove engine as in paragraph 41 and camshaft as in paragraph 55. Remove engine clutch, flywheel and the expansion plug at rear of camshaft bore. Use a bushing puller special tool No. CAS-1063 or equivalent remover/installer. The widest bushing (F—Fig. 53) is installed in front bore with hole (A) aligned in oil passage. The three intermediate bushings (I) are installed with the two large holes (A) aligned with drilled oil passages and rear bushing (R) with marked hole aligned with oil drilling. Holes (B) in bushings are against blank surfaces of block bores.

The camshaft thrust washer (7—Fig. 51) is 0.1225-0.1275 inch (3.1115-3.2385 mm) in thickness and controls the thrust applied by gear helix and pressure of thrust spring (2) and plunger (1). Thrust plunger spring has a free length of 3.625 inches (92.075 mm) and should test 45-55 lbs. (200-245 N) when compressed to a length of 2.750 inches (69.85 mm). Renew thrust washer if scored or otherwise damaged, or if worn to a thickness of less than 0.1205 inch (3.1 mm). Put Permatex No. 2 on rear cup plug and in-

stall to depth shown in Fig. 54. Install camshaft and gear unit as outlined in paragraph 52.

ROD AND PISTON UNITS

All Models

57. Connecting rod and piston units are removed from above after removing cylinder heads, oil pan and the connecting rod bearing caps.

When reinstalling rod and piston units, bearing cap should be away from camshaft, which will place the stamped cylinder numbers on camshaft side. Tighten the self-locking cap screws to a torque of 95-105 ft.-lbs. (129-142 N·m).

PISTONS, RINGS AND SLEEVES

All Models

58. Engines are equipped with pistons having two compression rings and one oil control ring. Fig. 55 shows cross-sectional view of ring types used.

Check the pistons, pins, rings and sleeves against the following specifications.

504 BD Engine

Piston Material Aluminum Alloy
Piston Diameter
Bottom of Skirt
(including
minimum) ... 4.6178-4.6198 inches
(117.292-117.343 mm)

Piston Skirt
Clearance 0.0052-0.0075 inch
(0.132-0.191 mm)
(max.) 0.0100 inch
(0.254 mm)

Sleeve Bore Diameter
(including
maximum) .. 4.6250-4.6283 inches
(117.475-117.559 mm)
Max. Out-of-Round 0.002 inch
(0.051 mm)

Max. Taper 0.002 inch
(0.051 mm)

Piston Pin
Diameter 1.6244-1.6246 inches
(41.260-41.625 mm)

Clearance in
Piston 0.0005-0.0009 inch
(0.0127-0.0229 mm)

Clearance In
Rod 0.0008-0.0014 inch
(0.0203-0.0352 mm)

Top Compression Ring—
Rectangular with Chrome Face
End Gap 0.015-0.025 inch
(0.381-0.635 mm)

(max.) 0.030 inch
(0.762 mm)

Side
Clearance 0.0035-0.0050 inch
(0.0889-0.127 mm)

(max.) 0.006 inch
(0.152 mm)

Intermediate Compression
Ring—
Square with Tapered Face
End Gap 0.013-0.023 inch
(0.330-0.584 mm)

(max.) 0.028 inch
(0.711 mm)

Side Clearance .. 0.003-0.005 inch
(0.076-0.127 mm)

(max.) 0.006 inch
(0.152 mm)

Oil Control Ring Two Piece
End Gap 0.016-0.026 inch
(0.406-0.660 mm)

(max.) 0.031 inch
(0.787 mm)

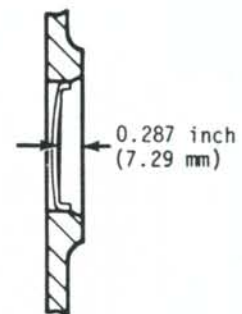


Fig. 54—Installed cam cup plug into engine block recessed at dimension shown.

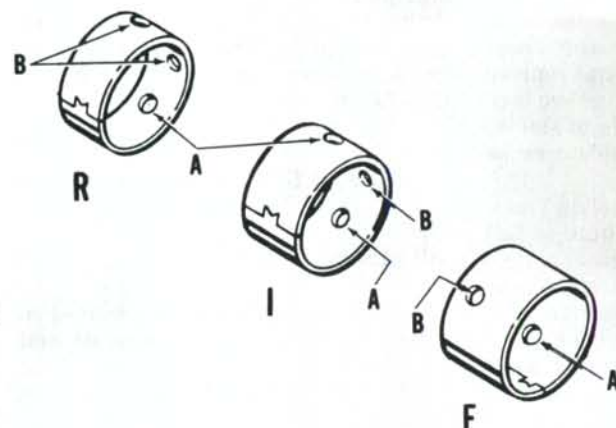


Fig. 53—Camshaft bushings are of same diameter but supplied in three widths. Widest bushing (F) is installed in front bore; narrowest bushing (R) in rear bore. Three intermediate bushings (I) are used. Holes (A) in bushings should align with oil passages in block bores; unmarked holes are installed to blank wall of bore.

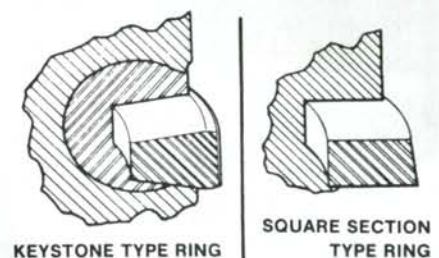


Fig. 55—Illustration of two types of compression rings. Refer to text for particular type ring used.

Paragraphs 59-63

Side Clearance . 0.0015-0.003 inch
(0.038-0.076 mm)
(max.) 0.0035 inch
(0.089 mm)

504 BDT Engine

Piston Material . . . Aluminum Alloy

Piston Diameter

Bottom of Skirt

(including

minimum) . . . 4.6178-4.6198 inches
(117.292-117.343 mm)

Piston Skirt

Clearance 0.0052-0.0075 inch
(0.132-0.191 mm)

(max.) 0.0100 inch
(0.254 mm)

Sleeve Bore

Diameter . . . 4.6250-4.6263 inches
(117.475-117.508 mm)

(max.) 4.6283 inches
(117.559 mm)

Max. Out-of-Round . . . 0.002 inch
(0.051 mm)

Max. Taper 0.002 inch
(0.051 mm)

Piston Pin (2290, 2294)

Diameter 1.6244-1.6246 inches
(41.260-41.265 mm)

Clearance in

Piston 0.0005-0.0009 inch
(0.0127-0.0229 mm)

Clearance in

Rod 0.0008-0.0014 inch
(0.0203-0.0352 mm)

Piston Pin (Other

504 BDT Engines)

Diameter 1.7994-1.7996 inches
(45.705-45.710 mm)

Clearance in

Piston 0.0005-0.0011 inch
(0.0127-0.0275 mm)

Clearance in

Rod 0.0008-0.0014 inch
(0.0203-0.0352 mm)

Top Compression

Ring—

Keystone with

Chrome Face

End Gap 0.015-0.025 inch
(0.381-0.635 mm)

(max.) 0.030 inch
(0.762 mm)

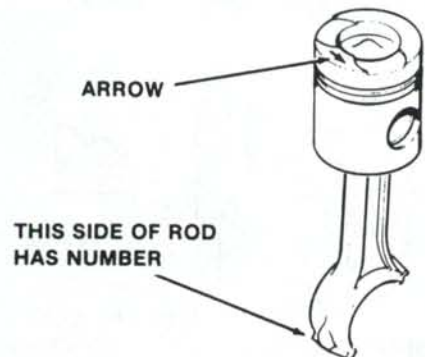


Fig. 56—View showing piston and connecting rod correctly installed.

Side Clearance . . . Not Measurable
Intermediate
Compression Ring —
Keystone with
Tapered Face

End Gap 0.015-0.025 inch
(0.381-0.635 mm)

(max.) 0.030 inch
(0.762 mm)

Side Clearance . . . Not Measurable

Oil Control Ring Two Piece

End Gap 0.016-0.026 inch
(0.406-0.660 mm)

(max.) 0.031 inch
(0.787 mm)

Side Clearance . 0.0015-0.003 inch
(0.038-0.076 mm)

(max.) 0.0035 inch
(0.089 mm)

CYLINDER SLEEVES

All Models

59. REFINISHING. If cylinder sleeves are to be reused, sleeve bore should be refinished using a 180-220 grit rigid hone or 180 grit silicone carbide double spiral brush. Move deglazing tool up and down in cylinder at the correct speed to provide an approximately 45 degree crosshatch pattern. Clean the finished sleeve thoroughly with a cloth dampened in warm detergent suds until a white cloth will remain clean when rubbed on the finished surface.

NOTE: Diesel fuel, oil or solvent will NOT remove abrasives from sleeves. Oil sleeves immediately after drying bore.

Recheck sleeve after honing. If out-of-round or taper exceeds specifications, or if maximum diameter exceeds specifications, renew sleeve.

60. REMOVE AND REINSTALL. The wet type cylinder sleeves can be removed with a suitable puller after removing rod and piston units as outlined in paragraph 57. Cover crankshaft to prevent dislodged particles from falling on crankshaft journals as sleeve is removed.

Thoroughly clean upper and lower grooves in cylinder block and remove and discard sealing rings. If sleeve is to be reinstalled, clean outside of sleeve. No attempt should be made to reuse sealing rings.

Install sleeve without sealing rings. Sleeve should enter block bore to full depth and turn freely by hand.

Install sealing rings on sleeve grooves, making sure rings are not twisted or cut. Lubricate with petroleum jelly or water soluble grease. Insert sleeves by hand and carefully press into place without turning sleeve. Sleeve protrusion must

CASE/INTERNATIONAL

be 0.000-0.006 inch (0.000-0.152 mm) above block. The use of a driver should not be necessary.

PISTON PINS AND BUSHINGS

All Models

61. The full floating piston pins are retained in piston bosses by snap rings and are available in standard size only.

Pin bushings in connecting rod should be removed with a press, and new bushing installed with a piloted arbor with oil hole in rod and bushing aligned. Bushing must be finish reamed or honed after installation. Refer to tables in paragraph 58 for specifications.

CONNECTING RODS AND BEARINGS

All Models

62. Connecting rod caps are retained by self-locking cap screws and rod and cap mating surfaces are grooved so that cap can be installed in correct position only.

Standard crankpin diameter is 2.748-2.749 inches (69.799-69.825 mm) for 504 BD engines on Models 2090 and 2094 and 504 BDT engines on Models 2290 and 2294. Standard crankpin diameter is 2.998-2.999 inches (76.149-76.175 mm) for 504 BDT engines on Models 2390, 2590, 2394 and 2594. Desired bearing clearance is 0.0011-0.0041 inch (0.028-0.104 mm) for all engines; Maximum allowable clearance is 0.0046 inch (0.117 mm). Regrind or renew crankshaft if out-of-round exceeds 0.0005 inch (0.0127 mm), or taper exceeds 0.0005 inch (0.0127 mm). Bearing liners are available in undersizes of 0.002, 0.010, 0.012, 0.020 and 0.030 inch (0.051, 0.254, 0.305, 0.508 and 0.762 mm) as well as standard. Connecting rod side clearance should be 0.007-0.016 inch (0.178-0.406 mm).

When reinstalling, bearing caps should be away from camshaft, which will place stamped cylinder numbers down and toward camshaft side as shown in Fig. 56. Tighten the selflocking cap screws to a torque of 95-105 ft.-lbs. (129-142 N·m).

CRANKSHAFT AND MAIN BEARINGS

All Models

63. The crankshaft is supported in seven main bearings. Crankshaft end play is controlled by bronze thrust washers on each side of fifth main bearing.

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Standard main bearing journal diameter is 2.998-2.999 inches (76.149-76.175 mm) for 504 BD engines on Models 2090 and 2094 and 504 BDT engines on Models 2290 and 2294. Standard main bearing journal diameter is 3.498-3.499 inches (88.849-88.875 mm) for 504 BDT engines on Models 2390, 2590, 2394 and 2594. On all models, main bearing caps are numbered 1 through 7 and caps must be reinstalled in correct position. Desired main bearing diametral clearance is 0.0016-0.0046 inch (0.041-0.117 mm) with a maximum allowable clearance of 0.005 inch (0.127 mm) for all engines. Upper and lower bearing shells are not interchangeable; be sure the half containing the oil hole is installed in block and that oil holes properly align.

Desired crankshaft end play is 0.003-0.015 inch (0.076-0.381 mm) for all engines. Maximum allowable crankshaft end play is 0.020 inch (0.508 mm) for all engines. Thrust bearing standard thickness is 0.184-0.186 inch (4.674-4.724 mm) for 504 BD engines on Models 2090 and 2094 and 504 BDT engines for Models 2290 and 2294. Thrust bearing standard thickness is 0.155-0.157 inch (3.937-3.988 mm) for 504 BDT engines on Models 2390, 2590, 2394 and 2594. Thrust washers of 0.006 inch (0.152 mm) oversize thickness are available for service in all engines.

Main bearing liners can be renewed after removing oil pan, oil pump and bearing caps.

Main bearing liners are available in undersizes of 0.002, 0.010, 0.020, 0.030 inch (0.051, 0.254, 0.508 and 0.762 mm) as well as standard. Main bearing cap screws are self-locking type and can be reused. When installing front mounted oil pump, check gear backlash as outlined in paragraph 52 when front bearing cap is installed. Tighten main bearing cap screws to a torque of 200-210 ft.-lbs. (271285 N·m).

CRANKSHAFT SEALS

All Models

64. FRONT. To renew the crankshaft front oil seal, disconnect headlight wiring, remove hood, side panels and radiator panel. Remove radiator as outlined in paragraph 90, and alternator

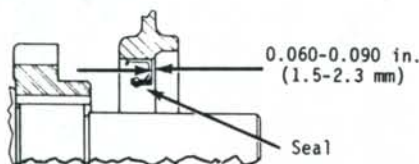


Fig. 57—Install front crankshaft seal to dimension shown.

belts. Remove crankshaft pulley bolt and using a suitable puller with bolts, remove crankshaft pulley. Pry crankshaft seal from front cover being careful not to damage seal surface in cover.

Install new seal, lip toward inside using special tool No. CAS-1109 or equivalent driver to depth shown in Fig. 57. Lubricate seal lip with petroleum jelly and reassemble tractor by reversing disassembly procedure.

65. REAR. To renew rear crankshaft seal, first split tractor between engine and torque tube as outlined in paragraph 41 and remove clutch or torque limiter and flywheel. Remove seal retainer cap screws and pry the retainer from its doweled position on cylinder block. Remove seal from retainer.

Press new seal squarely into retainer, lip toward engine. Coat both sides of retainer gasket from lower two holes to bottom of flange with nonhardening sealer such as Permatex No. 2 or equivalent. Use seal locating tool CAS-1087 or equivalent to correctly position seal in retainer. Seal depth can be increased to 0.03 inch (0.762 mm) if crankshaft surface is grooved. Lubricate seal lip with petroleum jelly and reinstall retainer, tightening retaining cap screws to a torque of 35-42 ft.-lbs. (48-57 N·m).

If seal flange on crankshaft is worn, a wear ring and seal kit can be installed over worn flange.

Install seal retainer plate on engine without seal installed. Heat wear ring to expand and install over crankshaft flange using special tool No. CAS-1087. Be certain chamfer on ID of wear ring goes on first. See Fig. 58. Allow wear ring to cool completely, lubricate seal and install in retainer and over crankshaft flange using the same tool, which will position seal to proper depth to ride on wear ring. Trim protruding ends of retainer gasket flush with gasket surface of cylinder block. Reinstall flywheel and tighten retaining bolts without hardened washers to 180-190 ft.-lbs. (244-258 N·m) torque or bolts with hardened washers to 230-250 ft.-lbs. (312-339 N·m) torque. Reinstall

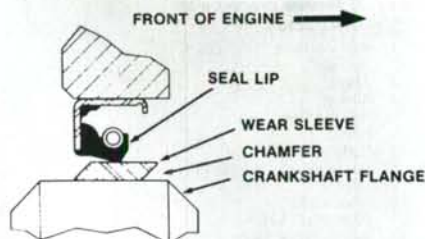


Fig. 58—Illustration showing correct installation of wear sleeve and rear crankshaft seal on worn crankshaft seal flange. Refer to text.

Paragraphs 64-67

torque limiter as outlined in paragraph 101 or master clutch as outlined in paragraph 100. Reassemble tractor by reversing disassembly procedure.

FLYWHEEL

All Models

66. To remove flywheel, first split tractor between engine and clutch housing as outlined in paragraph 41. Remove torque limiter or master clutch, then unbolt and remove flywheel.

On all models, flywheel ring gear is a shrink fit on front of flywheel and is installed with large beveled inner edge first. The manufacturer cautions against the use of a torch or open flame for heating gear. The recommended method is by heating ring in an oven or hot oil to a temperature of 400°-450° F (204°-232° C). Another suggested method is by using an electric heat gun.

Coat retaining cap screw threads with suitable thread sealant and tighten cap screws without hardened washers to 180-190 ft.-lbs. (244-258 N·m) torque and cap screws with hardened washers to 230-250 ft.-lbs. (312-339 N·m) torque.

OIL PAN

All Models

67. To remove oil pan, first drain oil pan and torque tube. Unbolt and remove torque tube front cover and seal. Unbolt and remove oil pan and gasket.

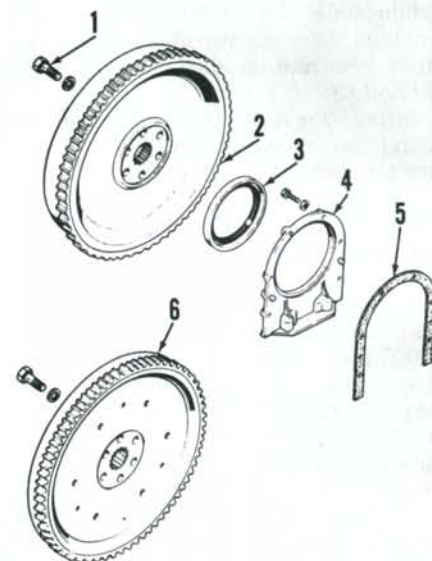


Fig. 59—Exploded view of flywheel and seal retainer.

1. Cap screw
2. Flywheel (torque limiter)
3. Oil seal
4. Seal retainer
5. Gasket
6. Flywheel (master clutch)

Paragraphs 68-69

While reinstallation of oil pan is the reverse of removal procedure, the following torque values and bolt positions should be observed. Using a new gasket, tighten oil pan hex head cap screws to 15-20 ft.-lbs. (20-27 N·m) torque. Install two new gasket tabs for torque tube cover in slots of oil pan with round corners toward front of engine. Install new torque tube front cover gasket, then install cover plate. Tighten the two inner ferry head cap screws on upper lip of cover plate to 15-20 ft.-lbs. (20-27 N·m) torque. Tighten the two outer ferry head cap screws to 35-42 ft.-lbs. (48-57 N·m) torque. Tighten the two hex head cap screws on outer ends of upper lip of cover to 35-42 ft.-lbs. (48-57 N·m) torque. Tighten the five hex head cap screws securing cover plate to torque tube to 110-132 ft.-lbs. (149-179 N·m) torque. Tighten oil pan and torque tube drain plugs to 29-31 ft.-lbs. (39-42 N·m) torque. Fill oil pan and torque tube to proper levels.

OIL PUMP AND RELIEF VALVE

All Models

68. R&R AND OVERHAUL. The engine oil pump is attached with front main bearing cap screws and is shim adjusted to provide recommended gear backlash of 0.006-0.011 inch (0.152-0.279 mm). With oil pan removed as outlined in paragraph 67, remove inlet tube, gallery pressure sensing tube (if so equipped), then unbolt and remove oil pump. Note number of shims upon removal.

Model 2090, 2290, 2094 and 2294 engines use a single large drive gear, while Model 2390, 2590, 2394 and 2594 engines were equipped with a small drive gear and an idler gear. See Figs. 60 and 61.

Install by reversing removal procedure using the removed shim pack. If parts are renewed which might affect drive gear backlash, install carefully and tighten mounting bolts finger tight; and turn engine over by hand and check for binding of drive gears. If binding occurs, install additional shims (6—Fig. 60 or 61) and recheck. Shims (6) are available in 0.005 inch (0.127 mm) thickness only. After front main bearing cap screws are properly tightened to a torque of 200-210 ft.-lbs. (271-285 N·m), install intake tube (1) and tighten compression nut to 90-100 ft.-lbs. (122-136 N·m) torque.

If backlash on Model 2390, 2590, 2394 or 2594 engine oil pump drive and idler gears exceeds 0.008 inch (0.203 mm) or gears are damaged, renew pump. Pump is available as an assembly only. All other parts are available separately. Remove pump cover and visually ex-

amine gears and body for wear or scoring. Radial clearance of gear teeth in housing bore should not exceed 0.009 inch (0.229 mm) on all pumps. Check clearance as shown in Fig. 62. Lay a piece of Plastigage over ends of gears and reinstall cover to check clearance, which should not exceed 0.008 inch (0.203 mm) on all pumps.

NOTE: DO NOT turn pump with Plastigage in place.

Refer to the following pump spring specifications and Figs. 60 and 61.

2090, 2290, 2094 and 2294 Engines Pressure Relief Valve Spring (4—Fig. 60)

Free length 2.0 inches
(50.8 mm)

Test at
length ... 23.8-25.6 lbs. @ 1.25 in.
(106-114 N @ 31.8 mm)

2390, 2590, 2394 and 2594 Engines Pressure Relief Valve Spring (4—Fig. 61)

Free length 2.874 inches
(72.3 mm)

Test at length 45-49 lbs. @ 1.89 in.
(200-221 N @ 48.0 mm)

Safety Relief Valve

Springs (2—Fig. 61)
Inner-Free length 3.106 inches
(78.89 mm)

Inner-Test at
length ... 33.6-37.2 lbs. @ 1.86 in.
(150-166 N @ 47.24 mm)

CASE/INTERNATIONAL

Outer-Free length ... 2.442 inches
(62.027 mm)

Outer-Test at
length ... 2.35-2.59 lbs. @ 1.20 in.
(10.5-11.5 N @ 30.48 mm)

When reinstalling pump cover, tighten retaining cap screws to a torque of 24-29 ft.-lbs. (33-39 N·m) torque. If body sleeve (7—Fig. 60 and 61) is renewed, be sure sleeve protrudes 0.175-0.200 inch (4.445-5.080 mm) above mounting face of pump. Idler shaft screw (11—Fig. 61) has left-hand threads and should be tightened to 40-45 ft.-lbs. (54-61 N·m) torque.

OIL PRESSURE REGULATOR

All Models

69. The oil pressure regulator valve is located in oil pump. See Figs. 60 and 61. Refer to paragraph 68 for regulator valve and spring specification. Filter bypass valve is located in oil filter manifold on all models.

Refer to Figs. 63 and 64 and the following specifications:

Filter Bypass Valve
Spring free length 2.81 inches
(71.37 mm)

Test at length .. 10.06 lbs. @ 1.4 in.
(45 N @ 35.56 mm)

Oil Pressure ... 40-65 psi @ 2100 rpm
(275-448 kPa @ 2100 rpm)

Fig. 60—Exploded view of oil pump used on Model 2090, 2290, 2094 and 2294 engines.

1. Suction tube
2. Compression nut
3. Plug
4. Spring
5. Relief valve
6. Shim
7. Body sleeve
8. Pump assy.

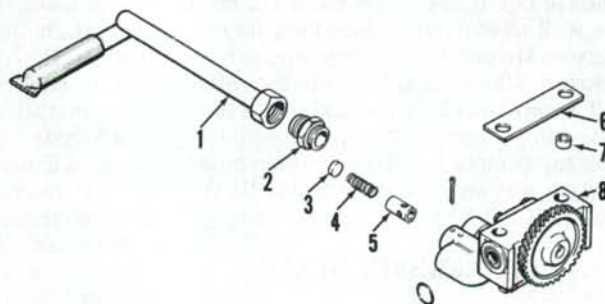
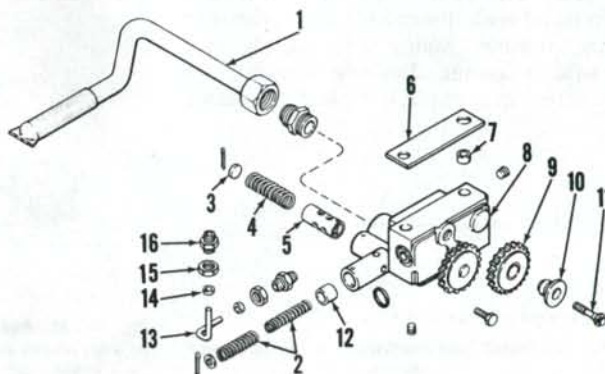


Fig. 61—Exploded view of oil pump used on Model 2390, 2590, 2394 and 2594 engines. Tube (13) senses pressure in oil gallery.

1. Suction tube
2. Springs
3. Plug
4. Spring
5. Relief valve
6. Shim
7. Body sleeve
8. Pump assy.
9. Idler gear
10. Idler shaft
11. Idler shaft screw
12. Safety relief valve
13. Sensing tube
14. Sleeve
15. Tube nut
16. Connector



SERVICE MANUAL

Paragraphs 70-72

OIL COOLER

Model 504 BDT Engines

70. The engine oil cooler is horizontally mounted to oil filter manifold (5—Fig. 64) located on right side of engine. Removal and disassembly of unit is obvious after examination of unit and reference to Fig. 64. Inspect oil bypass valve (6) for freeness in its bore.

Normal cleaning of oil cooler consists of blowing out water tubes with compressed air and flushing oil passages with a suitable cleaning solvent. Renew "O" rings and gaskets when reassembling.

DIESEL FUEL SYSTEM

All Models are equipped with a Robert Bosch Model PES multiple plunger injection pump. American Bosch or Robert Bosch multi-hole injector nozzles are used on all models.

FUEL FILTERS AND LINES

All Models

71. The manufacturer recommends the use of a good grade No. 2 diesel fuel having a Cetane rating of 40 or better be used for normal operation. For winter operation, Cetane rating should be 45-55 and fuel pour point should be at least 10° F (5° C) below lowest expected ambient temperature.

The fuel transfer pump is a constant volume, positive displacement type plunger pump which is mounted on side of injection pump and driven by a cam or injection pump camshaft. Refer to Fig. 65 for a schematic view of fuel system.

On all models a water trap and drain cock is located in bottom of main fuel tank. It is recommended that a small

quantity of fuel and any accumulated water be drained from the trap each day to prevent water accumulation.

72. **FUEL FILTERS.** Fuel filters are spin-on type (Fig. 66). Filters are available in a kit which consists of both units and both should be renewed each 500 hours or when noticeable power loss occurs.

To renew filters, first clean filter head, elements and surrounding area. Shut off fuel at fuel tank and remove drain plug from bottom of 1st stage filter. Use a clamp-type filter wrench which is supplied with tractor to remove filters. Remove and discard gasket located on

final filter mounting stud. Lightly oil gaskets on new units and on mounting stud, install new units and hand tighten $\frac{1}{2}$ to $\frac{3}{4}$ turn after contacting gasket surfaces. DO NOT overtighten. Bleed system as outlined in paragraph 73.

Fuel from tank comes directly to preliminary filter, which is part of transfer pump (Fig. 65). Service on this filter should be performed at the same interval as spin-on filters. Loosen locknut (Fig. 67), remove bowl and clean element with clean fuel, or renew if damaged or clogged. Clean and dry glass bowl with air or lint-free cloth, and renew gasket. Bleed system as outlined in paragraph 73.

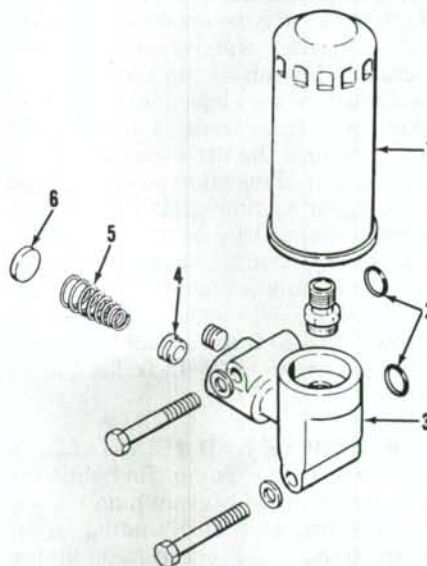


Fig. 63—Exploded view of single oil filter assembly.

- | | |
|-------------------|-----------------|
| 1. Filter element | 4. Relief valve |
| 2. "O" rings | 5. Spring |
| 3. Manifold | 6. Plug |

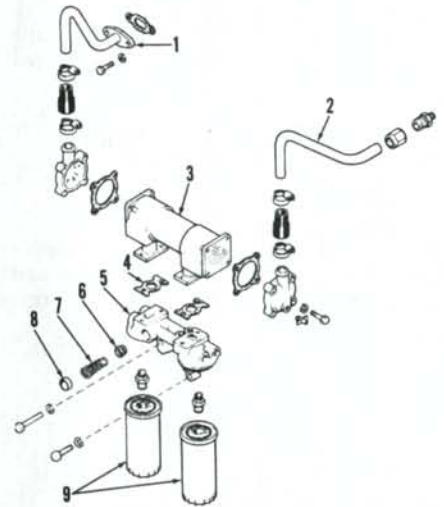


Fig. 64—Exploded view of dual oil filter assembly and heat exchanger assembly.

- | | |
|-------------------|-------------------|
| 1. Outlet tube | 6. Relief valve |
| 2. Inlet tube | 7. Spring |
| 3. Heat exchanger | 8. Plug |
| 4. Gasket | 9. Filter element |
| 5. Manifold | |

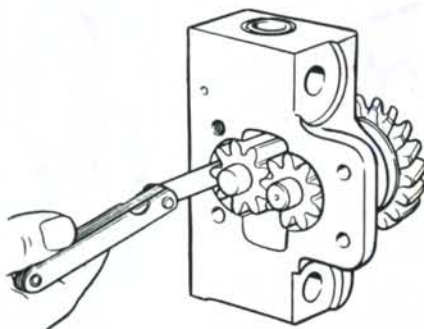


Fig. 62—Check radial clearance of pump as shown. Refer to paragraph 68 for specification.

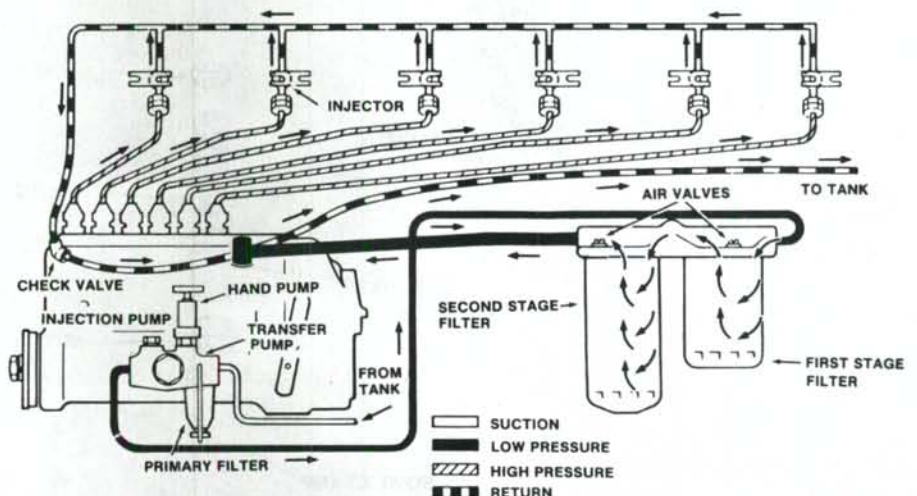


Fig. 65—Schematic view of fuel system and flow. Hand primer pump is located in transfer pump and fuel line from tank leads directly to transfer pump without passing through filter.

Paragraphs 73-77

BLEEDING

All Models

73. To bleed fuel system, be sure there is fuel in tank and that tank shut-off valve is open. Operate hand primer pump to fill preliminary filter bowl. Open bleed screw (6—Fig. 66) on top of first stage filter and actuate hand primer pump until air-free fuel flows through bleed screw opening. Close bleed screw (6) and open bleed screw (7), then continue pumping until air-free fuel appears. Close bleed screw (7) and actuate primer pump plunger several additional strokes to supply fuel to injection pump fuel gallery. Tighten hand primer pump plunger securely before attempting to start the tractor.

If necessary, fuel pressure may be checked at injection pump inlet fitting. Install a 0-50 psi (0-350 kPa) gage in fitting. Pressure should be 18-28 psi (124-193 kPa).

FUEL INJECTION PUMP

All Models

74. LUBRICATION. The fuel injection pump and enclosed governor are pressure lubricated by engine oil sup-

plied by an external oil line. Excess oil is returned to crankcase through injection pump drive housing.

75. TIMING. The recommended injection pump timing is given on a data decal on engine valve cover and is adjusted as follows: Turn crankshaft until No. 1 piston is coming up on compression stroke, then continue turning crankshaft until appropriate timing mark on crankshaft pulley is aligned with timing pointer as shown in Fig. 68. Remove timing hole plug and check timing marks on injection pump housing and drive gear hub as shown in Fig. 69. Marks should align, if they do not, loosen the four injection pump mounting flange nuts on rear of timing gear housing and rotate injection pump body in slotted holes.

If gear timing mark does not appear, No. 1 piston may be on exhaust stroke; turn crankshaft one complete turn and recheck. If pump timing marks cannot be aligned, remove injection pump drive gear cover from front of timing gear cover, remove the three cap screws retaining gear to injection pump hub and retime gear to timing idler gear until correct timing can be accomplished. Tighten injection pump gear retaining cap screws to a torque of 35-42 ft.-lbs. (48-57 N·m), 5/16 inch cover retaining screws to 17-20 ft.-lbs. (23-29 N·m) and 3/8 inch screws to 35-42 ft.-lbs. (48-57 N·m).

76. REMOVE AND REINSTALL. To remove injection pump, first shut off fuel and thoroughly clean pump, lines, connections and surrounding area. Align pump and crankshaft timing marks as outlined in paragraph 75 for convenience in reinstalling. Remove filter drain plug (1—Fig. 66) and drain filters. Disconnect throttle link and stop cable at pump. Disconnect and cap all

lines, not forgetting lube oil line between injection pump and engine block. Remove injection pump drive gear cover from front of timing gear cover. Remove the three cap screws securing pump drive gear to hub and lift out gear. Remove four mounting flange stud nuts and lift off injection pump and drive gear hub as a unit.

Install by reversing removal procedure. Tighten housing flange nuts finger tight only. Turn camshaft hub until pump timing marks align. Install gear with machined side next to hub flange and with mounting screw holes aligned. Install pump gear retaining cap screws and tighten to a torque of 35-42 ft.-lbs. (48-57 N·m). Recheck crankshaft timing marks, align injection pump timing marks; and tighten injection pump flange nuts to 35-42 ft.-lbs. (48-57 N·m). Complete installation by reversing removal procedure. Bleed system as outlined in paragraph 73 and adjust pump if necessary as in paragraph 77.

77. PUMP ADJUSTMENT. The diesel governor is an integral part of injection pump and, except for minor speed adjustments, governor service should be done at an authorized BOSCH Service Station.

Recommended diesel tractor governed speeds are as follows:

Slow Idle

All Models 725-775 rpm

High Idle (No Load)

All Models 2320 rpm

Rated (Loaded) Speed

All Models 2100 rpm

Governed high and low speeds are set on injection pump test stand and designed speeds are given on governor serial number plate.

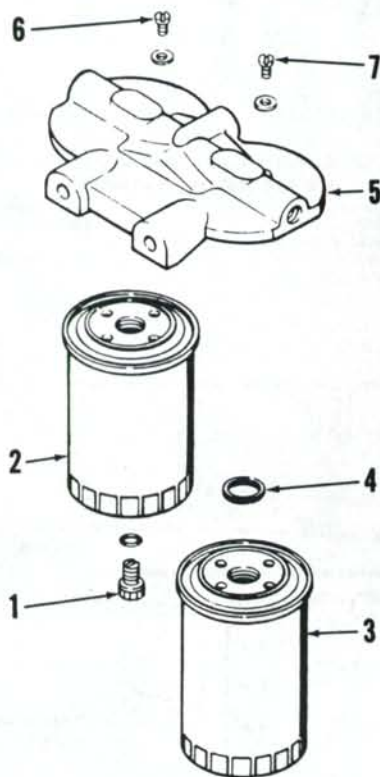


Fig. 66—Exploded view of dual filter and associated parts.

- | | |
|-----------------------|----------------|
| 1. Drain plug | 5. Filter head |
| 2. First stage filter | 6. Bleed screw |
| 3. Final filter | 7. Bleed screw |
| 4. Gasket | |

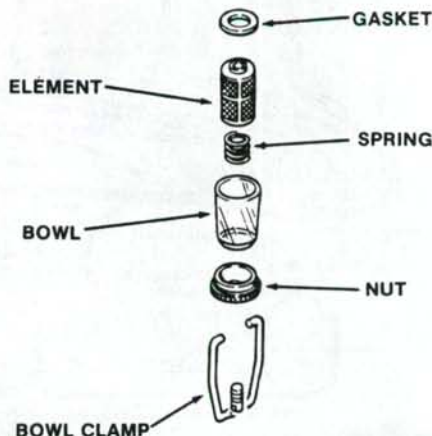


Fig. 67—Exploded view of preliminary filter on fuel injection pump.

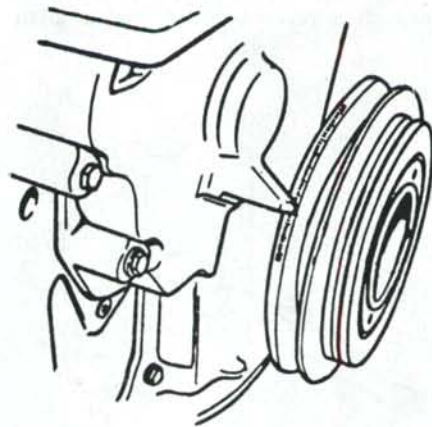


Fig. 68—To time the injection pump, align the indicated timing mark with timing pointer on gear cover. Refer to text.

SERVICE MANUAL

Paragraph 78

NOTE: The plate lists injection pump camshaft speed, which is $\frac{1}{2}$ crankshaft speed. For example, EEP/RSV 300-950 would mean that idle speed is 600 rpm crankshaft speed and rated speed is 1900 rpm. Tractor slow idle speed is normally set slightly higher than governor design speed.

To adjust governed speeds, first make sure that throttle linkage is correctly adjusted to fully open and close governor control lever (Fig. 70). Link should be connected to upper hole in arm.

To adjust slow idle speed, remove cap nut and turn low idle speed adjusting screw (Fig. 71) clockwise a slight amount to increase speed or counterclockwise to decrease speed. If tractor tends to "surge" or "hunt" at slow idle speed, remove cap nut (Fig. 72) and turn exposed supplementary idle adjusting screw clockwise not more than $\frac{1}{8}$ turn at a time until slow idle speed smooths out.

NOTE: Surge screw should NOT be backed out (counterclockwise) as this will aggravate surging problem.

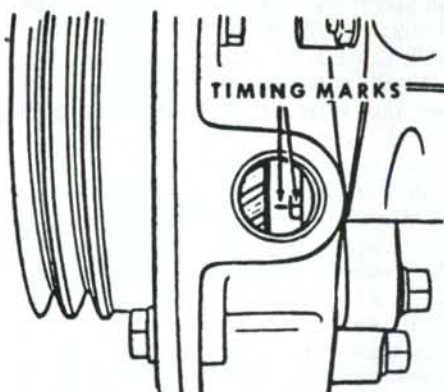


Fig. 69—With correct crankshaft timing mark aligned as shown in Fig. 68, remove plug from timing gear cover and align injection pump timing marks as shown.

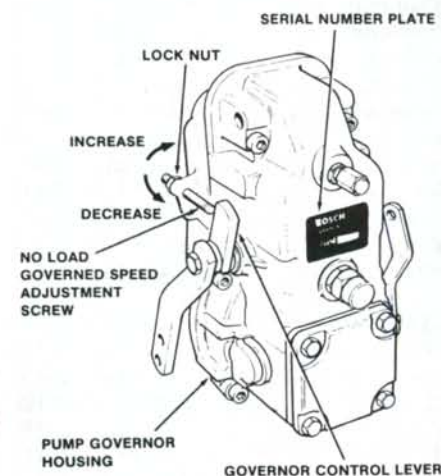


Fig. 70—Serial number plate on governor housing shows design speed of unit. Adjustment screw controls high idle speed.

Turning screw in too far will increase slow idle speed.

To adjust high idle speed, remove cap nut and turn no load governed speed adjustment screw (Fig. 70) counterclockwise to increase high idle speed or clockwise to decrease high idle speed.

Maximum fuel delivery on a turbocharged tractor pump should only be adjusted on a test stand, since turbocharger compensates for altitude changes and smoke level is not a dependable guide.

WARNING: Most fuel adjustments are sealed, and breaking the seals will void the warranty on models entitled to warranty coverage.

INJECTOR NOZZLES

All Models

All tractors use American Bosch or Robert Bosch injectors which are shown in exploded view Fig. 73.

78. TESTING AND LOCATING A FAULTY NOZZLE. If rough or uneven engine operation or misfiring indicates a faulty injector, defective unit can usually be located as follows:

With engine running at speed where malfunction is most noticeable (usually slow idle speed), loosen compression nut on high pressure line for each injector in turn, and listen for a change in engine performance. As in checking spark plugs, faulty unit is one which, when its line is loosened, least affects running of engine.

If a faulty nozzle is found and considerable time has elapsed since injectors have been serviced, it is recommended that all nozzles be removed and checked, or that new or reconditioned

units be installed. Refer to appropriate following paragraphs for removal and test procedures.

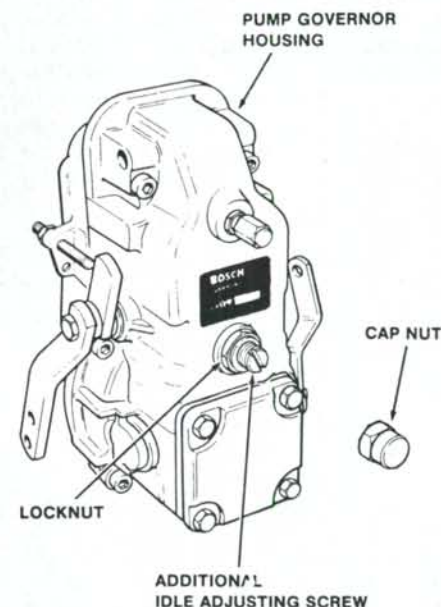


Fig. 72—If surging occurs, remove cap nut for access to supplementary idle adjusting screw.

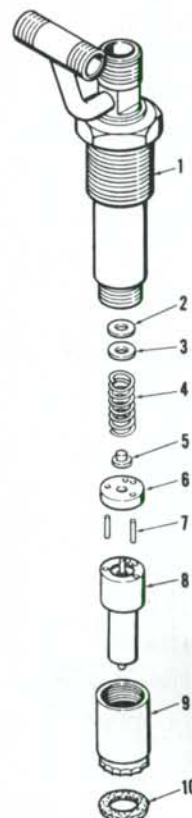


Fig. 73—Exploded view of American Bosch Injector. Robert Bosch Injector is similar.

1. Body
2. Shim, 0.062 inch (1.575 mm)
3. Shim, 0.002, 0.007, 0.010 & 0.025 inch (0.051, 0.178, 0.254 & 0.635 mm).
4. Spring
5. Spring seat
6. Valve stop
7. Dowel pins
8. Tip assy.
9. Cap nut
10. Gasket

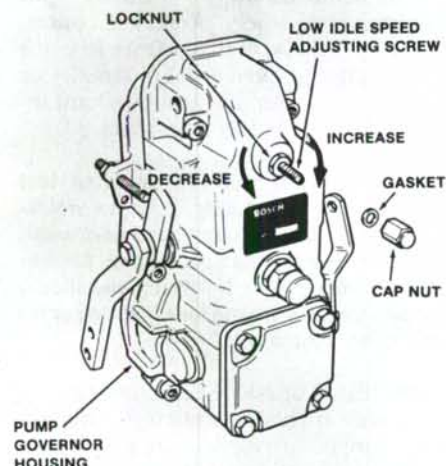


Fig. 71—Remove cap nut and adjust slow idle speed by turning idle adjust screw as shown to obtain correct idle speed.

Paragraphs 79-84

79. REMOVE AND REINSTALL.

Wash injector lines and surrounding area with clean diesel fuel or solvent to remove any dirt accumulation. Disconnect leak-off line nuts from each side of injector, then using a 11/16 inch crowsfoot wrench disconnect inlet fitting from injector using caution not to damage leak-off fitting. Use a 7/8 inch crowsfoot wrench and unscrew injector retaining nut, then remove injector by pulling upward and turning injector slightly. If gasket (10—Fig. 73) did not come out with injector, remove it from injector bore with a suitable tool or hooked wire. Gasket (10) must be renewed each time injector is removed.

Before installing injector, clean nozzle bore in cylinder head using special tool No. CAS-1411, or equivalent and blow out foreign material using compressed air.

When installing injector, place a new gasket (10) on injector, and if necessary, use a small amount of vaseline or light oil on gasket to retain it on injector. Install injector into cylinder head using a slight twisting motion and with leak-off fitting of injector toward valve cover. Partially install leak-off lines to each side of injector, then use a 3/8 inch wrench on flats of injector body and tighten injector retaining nut to 35-45 ft.-lbs. (48-61 N·m) torque. Install and hand tighten inlet line to injector, crank engine until fuel flows from inlet fitting then tighten inlet fitting to 18-22 ft.-lbs. (24-30 N·m) torque. Tighten leak-off line nuts to 35-45 in.-lbs. (4-5 N·m) torque. Start engine and check for leaks.

80. TESTING. A complete job of testing and adjusting an injector nozzle requires use of special test equipment such as test stand, special tool No. CAS-10091. See Fig. 74. Only clean, approved testing oil should be used in

tester tank. The nozzle should be tested for opening pressure, seat leakage, back leakage and spray pattern. When tested, nozzle should open with a sharp, popping or buzzing sound and cut off quickly at end of injection with a minimum of seat leakage and a controlled amount of back leakage. Check as outlined in the following paragraphs:

CAUTION: Fuel leaves nozzle tip with sufficient force to penetrate the skin. Keep hands away from nozzle tip when testing.

81. OPENING PRESSURE. Before conducting test, operate tester until fuel flows, then attach tester using correct adapter. Close valve to tester gage and pump tester lever a few quick strokes to be sure that nozzle is not plugged and that all five spray holes are open.

Open valve to tester gage and operate tester until fuel flows, then observe gage reading. Opening pressure should be 3400-3950 psi (23443-27235 kPa).

NOTE: If adjusting a new injector, or a used injector with a new spring (4—Fig. 73), opening pressure should be 3950-4100 psi (27235-28270 kPa).

If opening pressure is not as specified, disassemble injector as outlined in paragraph 84 and vary shims (3) as required. Shims are available in thicknesses of 0.002, 0.007, 0.010 and 0.025 inch (0.051, 0.178, 0.254 and 0.635 mm) and each 0.001 inch (0.0254 mm) of shim thickness will vary pressure about 55 psi (379 kPa).

NOTE: When testing all of the injectors in an engine there must not be more than 100 psi (689 kPa) difference between any of the injectors.

82. SPRAY PATTERN. Close the valve to tester gage and operate tester handle at approximately 60 strokes per minute. Five finely atomized conical sprays should be emitted from injector tip. If spray pattern is solid, streaky or irregular, disassemble and overhaul injector as outlined in paragraph 84.

NOTE: Injector will chatter when test stand is operated rapidly and is an indication of valve freedom and good seat width and interference angle conditions. Chatter will vary from injector to injector and should not be used as a criteria for accepting or rejecting an injector.

83. SEAT LEAKAGE. Point injector tip downward and operate tester rapidly to be sure nozzle valve is seated. Dry injector tip, then operate tester slowly to raise gage pressure to within 100 psi (689 kPa) of injector opening pressure

and maintain this pressure for 5 seconds. Observe injector tip and if nozzle is in good condition there should be no fuel accumulation in the 5 second period although a slight dampness is permissible. If fuel drips or a visible drop forms, renew injector or overhaul as outlined in paragraph 84.

84. OVERHAUL. Soak injector in a carbon removing solvent and clean outside of injector thoroughly. Clamp a 3/8 inch open end wrench in a vise to serve as a holding fixture, then place injector upright in wrench. Use a 15 mm box end wrench to remove cap nut (9—Fig. 73) and BE SURE that nozzle (8) does not turn with cap nut. If nozzle does turn with cap nut, dowels (7) and/or valve stop (6) will be damaged. Return injector to solvent if nozzle is stuck to cap nut.

With cap nut removed, nozzle (8), valve stop (6), spring seat (5), spring (4) and shims (2 and 3) can be removed from body (1). Note that two 0.062 inch (1.575 mm) thick shims (2) are used and the adjusting shims (3) must be between the two thick shims when reassembling. Shims (3) are available in thicknesses of 0.002, 0.007, 0.010 and 0.025 inch (0.051, 0.178, 0.254 and 0.635 mm).

Nozzle valve and body are a matched set and parts should never be intermixed. Keep parts for each injector separate and immerse in clean diesel fuel or solvent in a compartmented pan as injector is disassembled.

A brass wire brush can be used to clean exterior surfaces of body and nozzle. Clean nozzle spray orifices using 0.010 and 0.012 inch (0.254 and 0.305 mm) diameter cleaning wires. Each nozzle contains five 0.013 inch (0.330 mm) diameter spray orifices. Use compressed air to clean ducts in nozzle and a reverse flow of air through tip end of nozzle is recommended. Clean nozzle valve and ID of body. Clean nozzle valve seat area by using a brush and if necessary to remove varnish, use solvent and a felt cleaning pad. Make sure that nozzle valve slides freely in nozzle body. Renew any parts that are scratched, scored, eroded or show signs of any other damage. Pressure spring has a free length of 1.100 inches (27.9 mm) and should test 87.5 pounds (389 N) when compressed to a length of 1 inch (25.4 mm).

Reassemble injector as follows: Be sure parts are wet with diesel fuel and install one 0.062 inch (1.575 mm) thick shim in ID of body, then install adjusting shims and the remaining 0.062 inch (1.575 mm) thick shim. Install spring, then install spring seat with small diameter side toward spring. Align dowel pins in valve stop with dowel

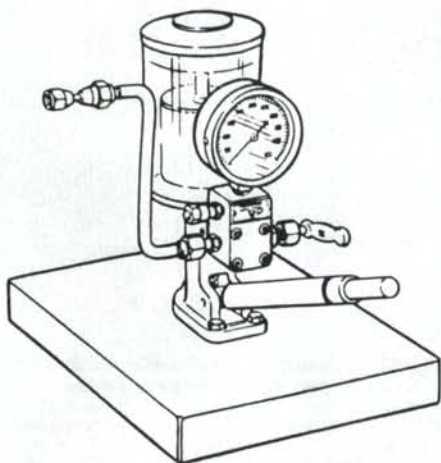


Fig. 74—CAS-10091 diesel fuel injection nozzle tester.

SERVICE MANUAL

Paragraphs 85-88

holes in body and install valve stop. Install nozzle assembly on valve stop, apply Lubriplate to shoulder only of nozzle, then install cap nut. Place injector in holding fixture and tighten cap nut to 30-35 ft.-lbs. (41-48 N·m) torque.

Recheck injector opening pressure, and if necessary, readjust opening pressure as outlined in paragraph 81.

TURBOCHARGER

Model 2290, 2390, 2590, 2294, 2394 and 2594 tractors are equipped with a Garrett (AIRsearch) Model T04B turbocharger. Refer to Fig. 75. The unit mounts on exhaust manifold and uses exhaust pressure to slightly compress the intake air.

OPERATION

Models So Equipped

85. Fig. 75 shows a schematic view of turbocharger unit. Exhaust manifold is split, three cylinders porting into each half, thus minimizing energy loss due to intermixing. Exhaust gas energy turns turbine wheel at a speed which may vary from a few thousand to 125,000 rpm, depending on engine speed and load. The compressor impeller supplies air to intake manifold at above normal atmospheric pressure. The additional air entering combustion chamber permits an increase in amount of fuel burned, and increased power output over an engine of comparable size not so equipped.

The use of engine exhaust to power the compressor increases engine flexibility, enabling it to perform with the economy of a small engine on light loads yet permitting substantial horsepower increase at full load. Horsepower loss because of altitude or atmospheric pressure changes is also largely eliminated. Turbine shaft bearings are floating sleeve type and unit is lubricated and cooled by a flow of engine oil under pressure.

In a naturally aspirated diesel engine (without turbocharger) an approximately equal volume of air enters cylinder at all loads, and only the amount of fuel is varied to compensate for power requirements. Turbocharging may supply up to three times normal amount of air under full load.

All diesel engines operate with an excess of air under light loads. In a naturally aspirated engine, most of the air is used at full load, and increasing amount of fuel results in a higher smoke level with little increase in power output. Turbocharging provides a variation of air delivery, and a turbocharged engine operates with an excess of air up to or beyond designed capacity of engine. When more fuel is provided, the turbocharger speed and air delivery increase, resulting in additional horsepower and heat with little change in smoke level. Smoke cannot, therefore, be used as an accurate guide to safe maximum fuel setting for a turbocharged engine. Refer to appropriate following paragraphs for inspection and renewal procedures.

86. PERIODIC INSPECTION. To inspect turbocharger unit, first remove muffler and hood. Stuff a clean rag into exhaust outlet elbow to prevent dirt entry, then thoroughly clean turbocharger, connections and surrounding area. Remove air cleaner, support elbow, clean-air inlet hose, exhaust elbow and connectors.

Visually inspect turbine wheel (exhaust end) for bent or broken blades. Inspect housing for carbon or other deposits. Inspect compressor impeller and housing for dirt or dust build-up and correct cause if evidence of dirt entry is found. Examine compressor impeller for damaged or broken blades.

Using a dial indicator, measure turbine shaft end play which should be 0.001-0.004 inch (0.0254-0.1016 mm). Excessive end play could indicate wear while absence of end play could indicate carbon build-up. Disconnect oil supply tube from top of shaft housing and

remove inlet fitting; then attach a dial indicator with plunger contacting turbine shaft through fitting opening. Apply equal pressure to both ends of turbine shaft and measure side clearance which should be 0.003-0.006 inch (0.0762-0.1524 mm). Turbocharger should be renewed or rebuilt if side play is not within limits specified.

R&R AND OVERHAUL

Models So Equipped

87. REMOVE AND REINSTALL. To remove turbocharger, first remove muffler and hood. Stuff a clean rag into exhaust outlet elbow to prevent dirt entry, then clean turbocharger, connections and surrounding area. Unbolt and remove exhaust outlet elbow and connector to turbocharger. Remove turbocharger oil supply and return lines. Loosen clean air hose clamps and move hoses away from turbocharger connections; then unbolt and remove the turbocharger and gasket from exhaust manifold center section.

Renew all gaskets and hose clamps; and hoses if their condition is questionable. Install turbocharger and tighten retaining nuts finger tight at this time. Install exhaust outlet elbow and connector, with retaining cap screws tightened finger tight. Align turbocharger and exhaust outlet elbow until connector will rotate 360 degrees without binding, then tighten retaining cap screws and nuts to a torque of 35-40 ft.-lbs. (48-54 N·m). Recheck to be sure connector remains free to turn, then complete assembly by reversing disassembly procedure.

Turbocharger **MUST** be primed after installation as follows: Pull engine stop control out so engine will not start. Energize starter and crank engine until oil pressure gage needle reaches GREEN zone. (Do not run starter continuously for more than 30 seconds.) Wait one minute, then start engine. Idle for 5 minutes at 1000 rpm to ensure complete turbocharger lubrication before loading engine.

88. OVERHAUL. Parts availability should be checked before overhaul is attempted. Mark across compressor housing (1—Fig. 76), center housing (13) and turbine housing (18) to aid alignment when assembling.

CAUTION: Do not rest weight of any parts on impeller or turbine blades. Weight of only the turbocharger unit is enough to damage the blades.

Remove lockplates and clamp plates from compressor housing (1) and remove

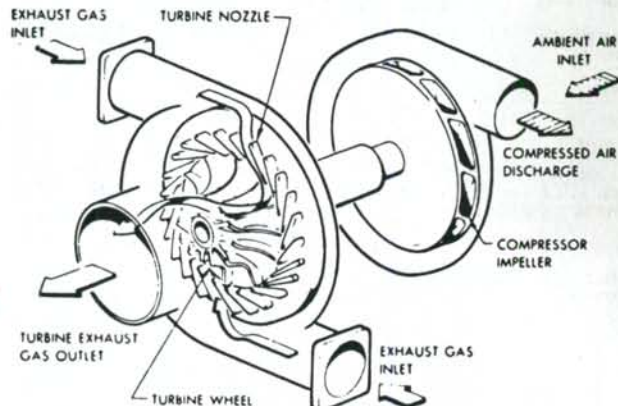


Fig. 75—Schematic view of turbocharger showing principles of operation.

Paragraph 88 Cont.

housing. Remove lockplates and clamp plates (6) from turbine housing (18) and remove housing. Hold turbine shaft from turning using appropriate type of holding fixture for turbine wheel (17) and remove locknut (2).

NOTE: Use a "T" handle or double universal socket to remove locknut in order to prevent bending turbine shaft.

Lift compressor impeller (3) off, then remove center housing from turbine shaft while holding shroud (15) onto center housing. Remove backplate (4), thrust bearing (9) and thrust collar (8). Carefully remove bearing retainers (11) from ends and withdraw bearings (12). Spring (5) is a factory controlled depth in backplate (4), so should not be disassembled or renewed separately. Renew only as an assembly with backplate.

CAUTION: Be careful not to damage bearings or surface of center housing when removing retainers.

The center two retainers do not have to be removed unless damaged or unseated. Always renew bearing retainers if removed from grooves in housing.

Clean all parts in a cleaning solution which is not harmful to aluminum. A stiff brush and plastic or wood scraper should be used after deposits have softened. When cleaning, use extreme

caution to prevent parts from being nicked, scratched or bent.

Inspect bearing bores in center housing (13—Fig. 76) for scored surfaces, out-of-round or excessive wear. Make certain bore in center housing is not grooved in area where seal (16) rides. Compressor impeller (3) must not show signs of rubbing with either the compressor housing (1) or backplate (4). Impeller should have 0.0002 inch (0.0051 mm) tight to 0.0004 inch (0.0102 mm) loose fit on turbine shaft. Make certain that impeller blades are not bent, chipped, cracked or eroded. Oil passages in thrust collar (8) must be clean and thrust faces must not be warped or scored. Ring groove shoulders must not have step wear. Clearance between thrust bearing (9) and groove in collar (8) must be 0.001-0.004 inch (0.025-0.102 mm) when checked at three locations. Inspect turbine shroud (15) for evidence of turbine wheel rubbing. Turbine wheel (17) should not show evidence of rubbing and vanes must not be bent, cracked, nicked or eroded. Turbine wheel shaft must not show signs of scoring, scratching or overheating. Shaft journal out-of-round must not exceed 0.0003 inch (0.0076 mm). Groove in shaft for seal ring (16) must not be stepped. If turbine shaft journals are damaged, undersized bearings of 0.005-0.010 inch (0.127 and 0.254 mm) may be ordered, and shaft reconditioned if so desired. Check shaft end play and radial clearance when assembling.

If bearing inner retainers (11) were removed, install new retainers. Oil bearings and install in center housing and install outer retainers. Position shroud (15)

on turbine shaft (17) and install seal ring (16) in groove. Apply a light, even coat of engine oil to shaft journals, compress seal ring (16) with a thin strong tool such as a dental pick and install center housing (13). Install new seal ring (7) in groove of thrust collar (8), then install thrust bearing so that smooth side of bearing (9) is toward seal ring (7) end of collar. Install thrust bearing and collar assembly over shaft, making certain that pins in center housing engage holes in thrust bearing. Install new rubber seal ring (10), make certain that spring (5) is positioned in backplate (4), then install backplate making certain that seal ring (7) is not damaged. Seal ring will less likely be broken if open end of ring is installed in bore of backplate first. Install lockplates (14) and screws, tightening screws to 75-90 in.-lbs. (9-10 N·m) torque. Install compressor impeller (3) and make certain that impeller is seated against thrust collar (8). Install locknut (2) to 18-20 in.-lbs. (2.0-2.3 N·m) torque, then use a "T" handle or double universal joint socket to turn locknut an additional 90 degrees in order to correctly preload turbine shaft.

CAUTION: If "T" handle or double universal joint socket is not used, shaft may be bent when tightening nut (2).

Install turbine housing (18) with clamp plates (6) next to housing, coat cap screws with a good antiseize compound, tighten screws to 100-130 in.-lbs. (11-15 N·m), then bend lockplates up around screw heads.

Check shaft end play and radial play at this point of assembly. If shaft end play exceeds 0.004 inch (0.102 mm), thrust collar (8) and/or thrust bearing (9) is worn excessively. End play of less than 0.001 inch (0.025 mm) indicates incomplete cleaning (carbon not all removed) or dirty assembly and unit should be disassembled and cleaned.

If turbine shaft radial play exceeds 0.006 inch (0.1524 mm), unit should be disassembled and bearings, shaft and/or center housing should be renewed, or shaft should be reconditioned and undersized bearings installed. Maximum permissible limits of all of these parts may result in radial play which is not acceptable.

Install compressor housing (1), but do not tighten until unit is installed, so perfect alignment can be made. Fill reservoir with engine oil and protect all openings of turbocharger until unit is installed on tractor. After intake hoses are all assembled, tighten clamp plates (6) to 110-130 in.-lbs. (12-15 N·m) torque to compressor housing (1), and complete assembly. Prime turbocharger as outlined in paragraph 87.

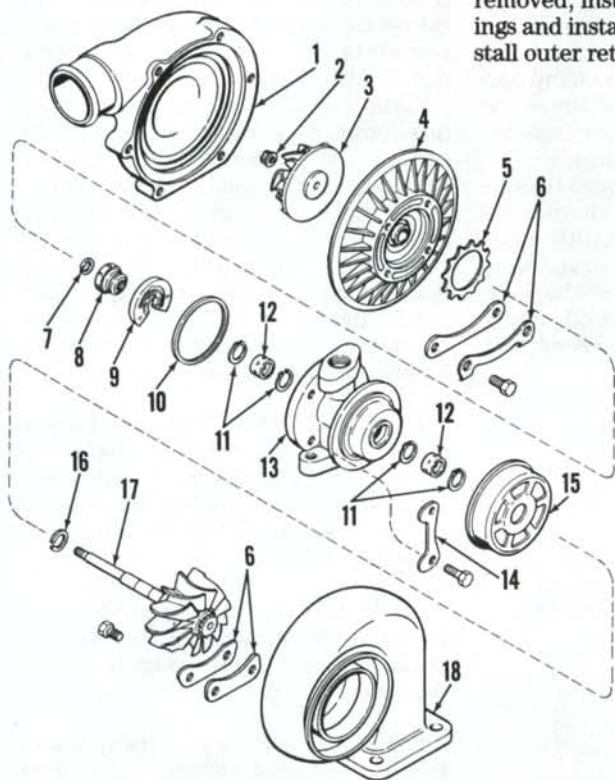


Fig. 76—Exploded view of AiResearch TO4B turbocharger assembly used on 2290, 2390, 2590, 2294, 2394 and 2594 series tractors.

1. Compressor housing
2. Locknut
3. Compressor impeller
4. Back plate
5. Spring
6. Clamp plate
7. Seal ring
8. Thrust collar
9. Thrust bearing
10. "O" ring
11. Bearing retainers (4)
12. Bearings (2)
13. Center housing
14. Lockplate
15. Shroud
16. Seal ring
17. Turbine shaft
18. Turbine housing

SERVICE MANUAL

Paragraphs 89-91

AIR CLEANER
SYSTEM

All Models

89. All models are equipped with a dry type air cleaner with a safety filter element (6—Fig. 77 and 78) which should be renewed each 1000 hours of operation. DO NOT attempt to clean safety element.

Large filter element (4—Figs. 77 and 78) can be cleaned by directing compressed air into inside of element. Air pressure must not exceed 100 psi (690 kPa). An element cleaning solution, Case part No. A40910 is available. Renew primary element after four cleanings.

Tractor is equipped with an air filter warning lamp on instrument cluster which indicates when primary filter element needs service.

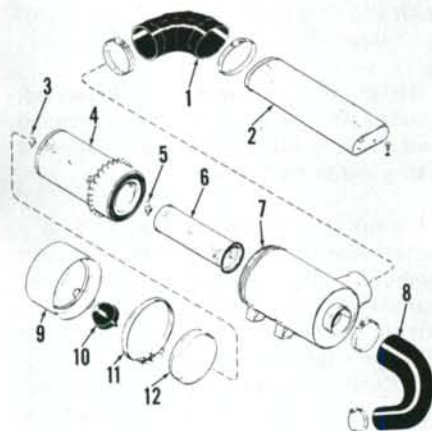


Fig. 77—Exploded view of typical air filter assembly used on Model 2090 and 2094 tractors.

- | | |
|--------------------|-------------------|
| 1. Intake hose | 7. Filter housing |
| 2. Intake tube | 8. Outlet hose |
| 3. Wing nut | 9. Cover |
| 4. Primary element | 10. Vacuum valve |
| 5. Wing nut | 11. Clamp |
| 6. Safety element | 12. Rubber cup |

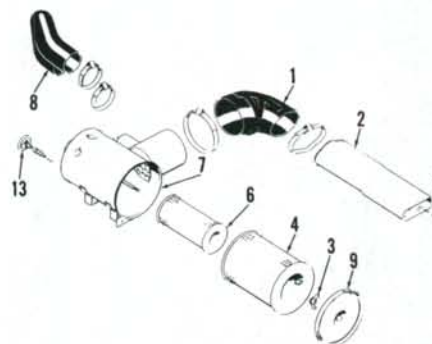


Fig. 78—Exploded view of typical air filter assembly used on Models 2290, 2390, 2590, 2294, 2394 and 2594 tractors.

- | | |
|--------------------|---------------------------|
| 1. Intake hose | 7. Filter housing |
| 2. Intake tube | 8. Outlet hose |
| 3. Wing nut | 9. Cover |
| 4. Primary element | 13. Restriction indicator |
| 6. Safety element | |

COOLING
SYSTEM

RADIATOR

All Models

90. To remove radiator, first disconnect headlight wiring, then remove

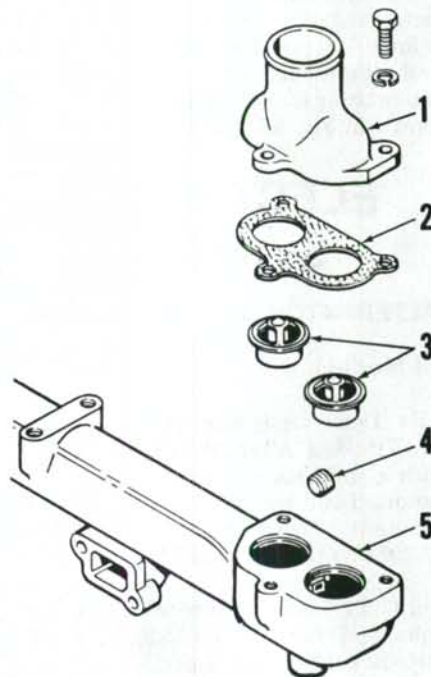


Fig. 79—Front end of water manifold showing thermostat housing.

- | | |
|----------------|-------------|
| 1. Cover | 4. Plug |
| 2. Gasket | 5. Manifold |
| 3. Thermostats | |

hood, side panels and grille. If so equipped, disconnect A/C receiver-dryer electrical connections, then remove A/C condenser and lay it on top of air cleaner assembly. If so equipped, disconnect ether starting aid. Drain radiator, disconnect oil cooler lines and disconnect upper and lower radiator hoses. Disconnect electrical connector, unbolt radiator supports, then using a suitable hoist, remove radiator assembly.

Install by reversing removal procedure.

A 10 psi (69 kPa) radiator cap is used on all models.

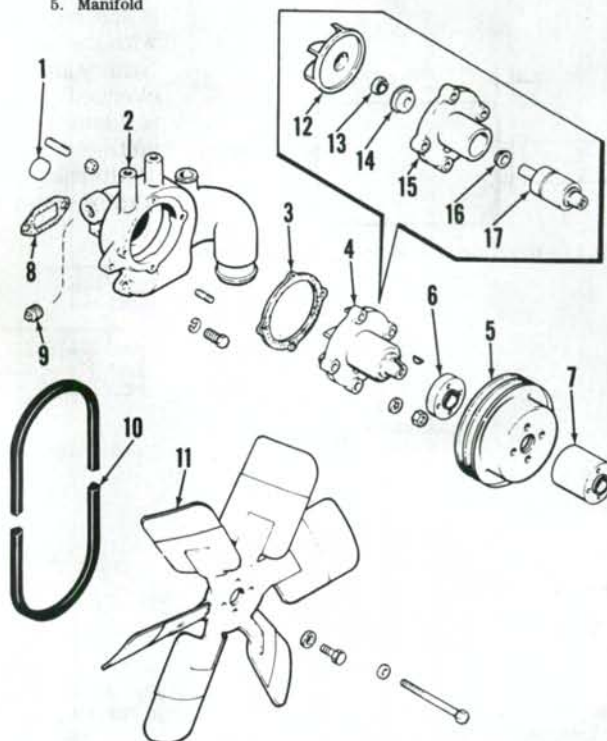
THERMOSTATS

91. The two thermostats are contained in a single housing as shown in Fig. 79. On all models thermostats should start to open at 175° F (79° C) and be fully open at 202° F (94° C). If thermostats do not fully open, the water will not be cut off complete to bypass hose, so water will continue to be routed back into engine.

To test for faulty thermostat, suspend a thermometer and thermostat in a container of water, heat water and observe the temperatures at which thermostat starts to open and where it becomes fully open.

Fig. 80—Exploded view of water pump assembly and associated parts.

- | |
|---------------------|
| 1. Cup plug |
| 2. Body |
| 3. Gasket |
| 4. Pump unit |
| 5. Pulley |
| 6. Pulley hub |
| 7. Spacer |
| 8. Gasket |
| 9. Plug |
| 10. Belt |
| 11. Fan |
| 12. Impeller |
| 13. Seal seat |
| 14. Seal |
| 15. Housing |
| 16. Slinger |
| 17. Shaft & bearing |



Paragraphs 92-95

WATER PUMP

All Models

92. REMOVE AND REINSTALL. To remove the water pump, first drain cooling system.

Loosen A/C compressor and remove A/C belt, if so equipped. Loosen alternator and remove fan belt, then unbolt and remove fan blades, spacer(s) and pulley. Remove the four stud nuts and pull pump from pump housing. Water pump and housing (4 and 2—Fig. 80) can be removed as a unit if pump is being removed for other work.

Install by reversing removal procedure. Tighten housing bolts, pump stud nuts and fan retaining bolts to a torque of 35-42 ft.-lbs. (48-57 N·m). Tighten fan belt to obtain ½ inch (12.7 mm) deflection measured midway between pulleys.

93. OVERHAUL. With water pump removed from body, remove impeller using a suitable puller. Do not pry against housing.

Remove seat (13—Fig. 80) from impeller and pry seal (14) from housing (15). Remove pulley hub (6) from pump shaft using jack screws. Press pump shaft and bearing (17) forward out of housing (15). Slinger (16) can now be removed from pump shaft, if necessary.

Clean and inspect all parts and renew as necessary. Pump housing (15) is not available separately and if renewal is required, the complete water pump assembly (4) must be renewed.

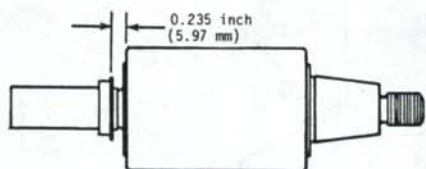


Fig. 81—When installing slinger, install to dimension shown.

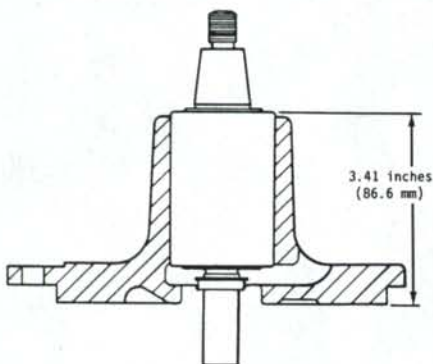


Fig. 82—When installing shaft and bearing assembly, install to dimension shown.

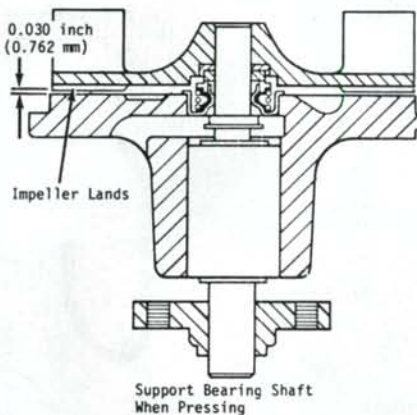


Fig. 83—Impeller is installed with 0.030 inch (0.762 mm) clearance between impeller and housing.

Reassemble water pump as follows: If installing a new slinger (16), install it on pump shaft to the dimension shown in Fig. 81 and note that shoulder of slinger is toward bearing. Press shaft and bearing assembly (17—Fig. 80) into housing (15) to the dimension shown in Fig. 82, then install Woodruff key, and pulley hub (6—Fig. 80) onto shaft. Install washer and tighten locknut to 45-50 ft.-lbs. (61-68 N·m) torque. Install new seal (14) into housing and press only on outer metal ring of seal. Install new seat (13) in impeller (12), then press impeller onto shaft until distance between impeller and housing is 0.030 inch (0.762 mm) as shown in Fig. 83.

ELECTRICAL SYSTEM

ALTERNATOR AND REGULATOR

All Models

94. Delco-Remy alternators are used on all models. Alternators are equipped with a solid state regulator internally mounted and has no provisions for adjustment. Delco numbers 1102921, 1102928 and 1102907 are 61 ampere cold output units; numbers 1102922, 1102930 and 1105173 are 72 ampere cold output units and number 1105540 is a 105 ampere cold output unit.

95. TESTING AND OVERHAUL. The only test which can be made without removal and disassembly of alternator is the regulator. If there is a problem with the battery not being charged, and battery and cable connectors have been checked and are good, check the regulator as follows: Attach an accurate voltmeter to output (battery) terminal of alternator, and ground the negative lead of meter to alternator case. Make

sure alternator has a good, clean ground to engine then start and run at approximately 1900 rpm, if reading is less than 13 volts, insert a small screwdriver into test hole (Fig. 84), making contact with tab on brush holder with tip of screwdriver and making sure shaft of screwdriver contacts side of hole in alternator case.

CAUTION: When inserting screwdriver in test hole, the tab is within ¾ inch (19 mm) of casting surface. Do not force screwdriver deeper than one inch (25.4 mm) into end frame.

If voltage increases to 13.2 volts or more, voltage regulator requires renewal.

To disassemble the alternator, first scribe matching marks (M—Fig. 85) on the two frame halves (5 and 16), then remove the four through-bolts. Pry frame apart with a screwdriver between stator frame (12) and drive end frame (5). Stator assembly (12) must remain with slip ring end frame (16) when unit is separated.

NOTE: When frames are separated, brushes will contact rotor shaft at bearing area. Brushes **MUST** be cleaned of lubricant if they are to be reused.

Clamp the iron rotor (13) in a protected vise, only tight enough to permit loosening of pulley nut (1). Rotor end frame can be separated after pulley and fan are removed. Check bearing surface of rotor shaft for visible wear or scoring. Examine slip ring surface for scoring or wear, and rotor winding for overheating or other damage. Check rotor for grounded, shorted or open circuits using an ohmmeter as follows:

Refer to Fig. 86 and touch the ohmmeter probes to points (1-2) and (1-3); a reading near zero will indicate a short

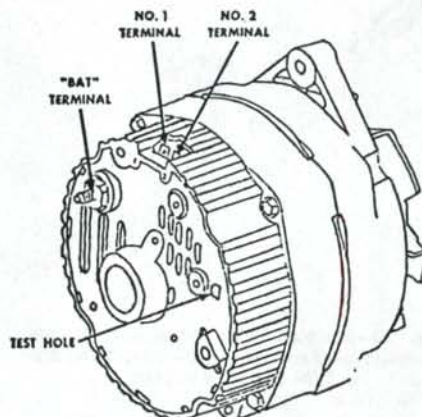


Fig. 84—View showing test hole on Delco-Remy alternator. Refer to text.

SERVICE MANUAL

circuit to ground. Touch ohmmeter probes to the slip rings (2-3); reading should be 2.7-3.0 ohms. A higher reading will indicate an open circuit and a lower reading will indicate an internal short. If windings are satisfactory, mount rotor in a lathe and check runout at slip rings using a dial indicator. Runout should not exceed 0.002 inch (0.051 mm). Slip ring surfaces can be trued if runout is excessive or if surfaces are scored. Finish with 400 grit or finer polishing cloth until scratches or machine marks are removed.

Before removing stator, brushes or diode trio, refer to Fig. 87 and check for grounds between points A to C and B to C with an ohmmeter, using the lowest range scale. Then reverse the lead connections. If both A to C readings or both B or C readings are the same, the brushes may be grounded because of defective insulating washer and sleeve at the two screws. If the screw assembly is not damaged or grounded, the regulator is defective.

To test the diode trio, first remove the stator. Then remove the diode trio, noting the insulator positions. With an ohmmeter, check between points A and D (Fig. 88) and then reverse the ohmmeter lead connections. If diode trio is good it will give one high and one low reading. If both readings are the same, the diode trio is defective. Repeat this test at points B and D and at C and D.

The rectifier bridge (Fig. 89) has a grounded heat sink (A) and an insulated heat sink (E) that is connected to the output terminal. Connect ohmmeter to the grounded heat sink (A) and to the ohmmeter lead connections. If both readings are the same, the rectifier bridge is defective. Repeat this test between points A and C, A and D, B and E, C and E, and D and E. Capacitor (11—Fig. 85) connects to the rectifier bridge and grounds to end frame and protects the diodes from voltage surges.

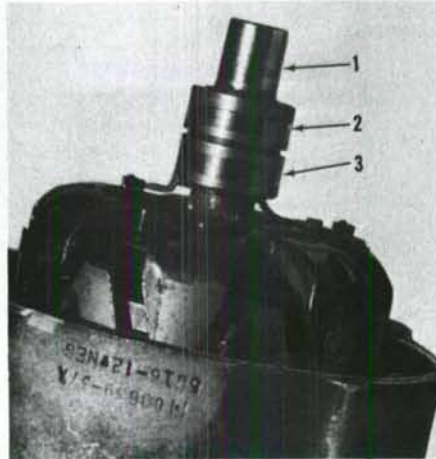


Fig. 86—Rotor showing test points when checking for grounds, shorts and opens.

Test the stator windings for grounded or open circuits as follows: Connect ohmmeter leads successively between each pair of leads. A high reading would indicate an open circuit.

NOTE: The three stator leads have a common connection in the center of the windings. Connect ohmmeter leads between each stator lead and stator frame. A very low reading would indicate a shorted circuit. A short circuit within the stator windings cannot be readily determined by test because of the low resistance of the windings. A shorted lead will probably be discolored and will have a strong odor.

Brushes and springs are available only as an assembly which includes brush holder (14—Fig. 85). If brushes are re-used, make sure all grease is removed

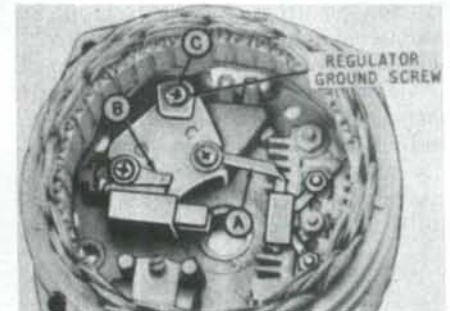


Fig. 87—Test points for brush holder. Refer to text.

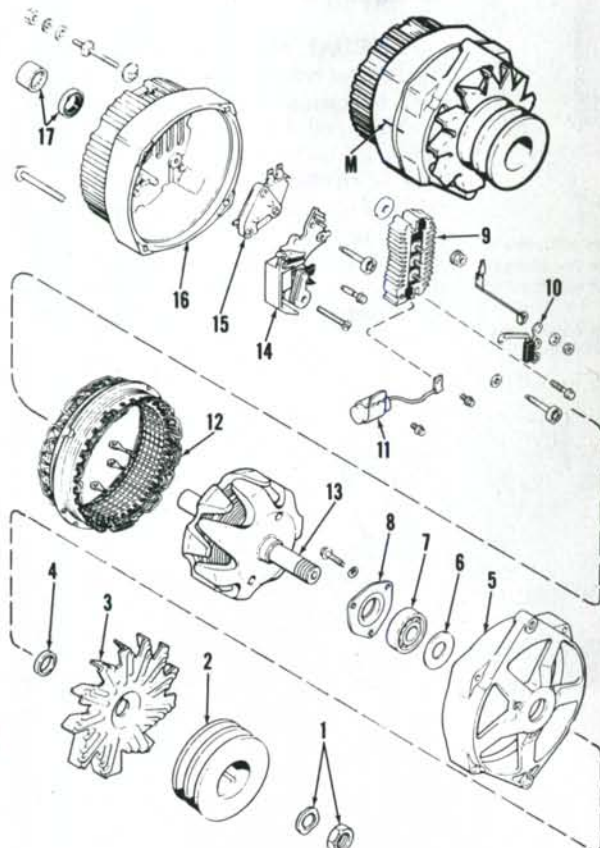


Fig. 85—Exploded view of "DELCOTRON" alternator used with internal mounted solid state regulator. Note matching marks (M) on end frames.

1. Nut & washer
2. Pulley
3. Fan
4. Spacer
5. Drive end frame
6. Grease slinger
7. Ball bearing
8. Bearing retainer
9. Bridge rectifier
10. Diode trio
11. Capacitor
12. Stator
13. Rotor
14. Brush holder
15. Solid state regulator
16. Slip ring end frame
17. Bearing & seal

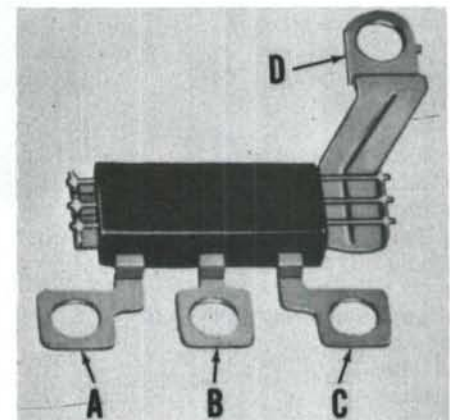


Fig. 88—Diode trio test points. Refer to text.

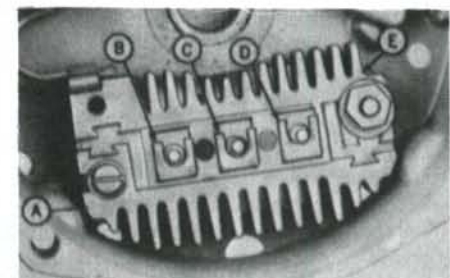


Fig. 89—Bridge rectifier test points. Refer to text.

Paragraphs 96-98

from surface of brushes before unit is reassembled. When reassembling, first install regulator and then brush holder, springs and brushes. Push brushes up against spring pressure and insert a short piece of straight wire through hole and through end frame to outside. Be sure that the two screws at points A and B (Fig. 87) have insulating washers and sleeves.

NOTE: A ground at these points will cause no output, or controlled output. Withdraw the wire under brushes only after alternator is assembled.

Remove and inspect ball bearing (7—Fig. 85). If bearing is in satisfactory condition, fill bearing $\frac{1}{4}$ full with Delco-Remy lubricant No. 1948791 and reinstall. Inspect needle bearing (17) in slip ring end frame. This bearing should be renewed if its lubricant supply is exhausted; no attempt should be made to relubricate and reuse the bearing. Press old bearing out toward inside and press new bearing in from outside until flush with outside of end frame. Saturate felt seal with SAE 20 oil and install seal.

Reassemble alternator by reversing disassembly procedure. Tighten pulley nut to a torque of 50 ft.-lbs. (58 N·m).

STARTING MOTOR

All Models

96. Delco-Remy and Nippondenso starting motors are used. Specifications are as follows:

Delco-Remy 1114704

No-Load Test

Volts	9
Min. Amperes*	140
Max. Amperes*	215
Min. Rpm	4000
Max. Rpm	7000

*Including solenoid.

Nippondenso 028000-7430

No-Load Test

Volts	11.7
Max. Amperes	130
Min. Rpm	3100

97. All starting motors are the solenoid shifted, positive engagement, overrunning clutch type.

The solenoid switch on starting motor not only closes the circuit between battery and starting motor but also shifts starter-drive pinion into mesh with flywheel ring gear, then energizes the field coils to turn the armature. The switch contains a high current-draw pull in winding which is shorted out when contact points are closed; and a low current-draw hold in coil which remains

active until key switch is released. An open circuit in the pull-in winding will prevent the solenoid from shifting the drive and actuating the motor. An open

circuit in hold-in winding (or a low battery) will cause solenoid to chatter.

Starter drive pinion clearance is not adjustable, however some clearance must be maintained between end of pinion and starter drive frame to ensure solid contact of the heavy-duty magnetic switch.

MASTER HYDRAULIC CLUTCH

(MECHANICAL SHIFT TRANSMISSION)

Models 2090 and 2290 tractors may be equipped with a mechanical shift transmission utilizing a hydraulically actuated master clutch bolted to the engine flywheel. Clutch is held in engaged position by hydraulic pressure until clutch pedal is depressed, shifting a spool in the master clutch valve. This directs hydraulic fluid flow from the clutch through ports in the clutch housing which releases pressure from the clutch piston. Belleville spring pressure then disengages the multi-disc clutch.

ADJUSTMENT

Models 2090 and 2290 So Equipped

98. **PEDAL AND LINKAGE.** Refer to Fig. 90 and remove clevis pin on clutch spool bellcrank. Adjust upper stop bolt on clutch pedal until centerline of pedal pad is 7.7 inches (195.6 mm) from cab floor. With clutch spool fully down into valve, align cable link with bellcrank, adjusting cable at lower mounting bracket if necessary, and install clevis pin and cotter pin. Push clutch pedal down until clutch spool has moved up

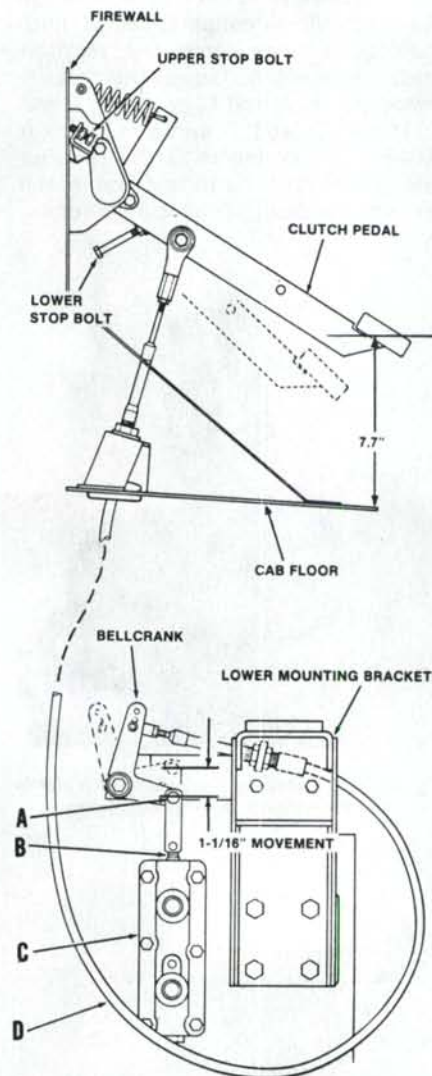
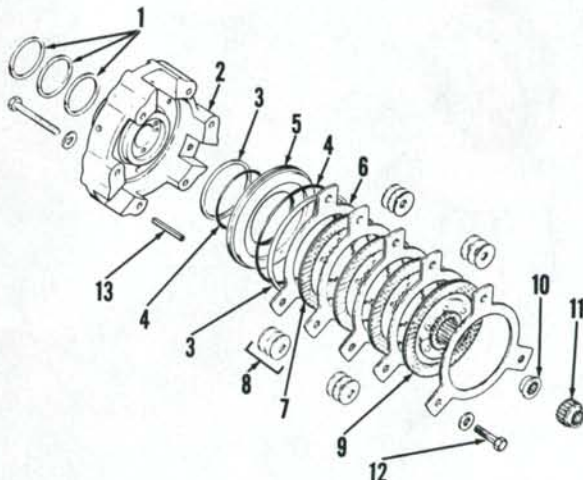


Fig. 90—Illustration showing points of adjustment for master clutch pedal and linkage for Models 2090 and 2290 tractors equipped with mechanical shift transmissions.

A. Clevis
B. Spool
C. Clutch valve
D. Cable

Fig. 91—Exploded view of master clutch assembly for 2090 and 2290 tractors equipped with mechanical shift transmissions.

1. Oil rings
2. Piston carrier
3. Seal ring
4. "O" ring
5. Piston
6. Plate
7. Disc
8. Belleville springs
9. Hub disc
10. Shaft bushing
11. Shaft sleeve
12. Bolt
13. Pin



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exactly 1-1/16 inches (27 mm). Holding clutch pedal in this position, adjust lower pedal stop bolt to contact firewall, then turn stop bolt 1/2 turn counterclockwise causing pedal to raise slightly, then tighten locknut on stop bolt.

NOTE: DO NOT allow clutch spool to move upward more than 1-1/16 inches (27 mm) or damage to clutch valve may occur.

R&R AND OVERHAUL

Models 2090 and 2290 So Equipped

99. To remove master clutch assembly, separate (split) tractor between engine and torque tube as outlined in paragraph 41.

With tractor split, unbolt and remove master clutch assembly from flywheel. Refer to Fig. 91. Remove the three bolts (12) and lift out clutch plates (6), friction discs (7) and Belleville springs (8) from piston carrier (2). Using compressed air in oil supply port of carrier, loosen and remove piston (5) from carrier. Remove oil rings (1) from carrier. Remove and discard "O" rings (4) and seal rings (3) from inside and outside groove of piston.

Check all parts for excessive wear or other damage and renew as necessary. Lubricate new "J" rings (4) with petroleum jelly and install in inner and outer grooves of piston. Lubricate seal rings (3) with petroleum jelly and install over "O" rings in inner and outer grooves of piston, then using a smooth wooden dowel or round plastic pen, seat seal rings into inner and outer grooves of piston. Lubricate inner and outer edges of piston and install, flat side inward, into piston carrier. Install first, a steel plate (6), then three Belleville washers over each of the three roll pins in the carrier. Refer to Fig. 92 and install the first Belleville washer concave side up, the second washer concave side down and the third concave side up. Lubricate friction disc with transmission oil and install on top of steel plate. Repeat installation procedure for remaining plates, discs and washers, except for the last hub disc (9—Fig. 91). Install hub disc with gear teeth toward inside, aligning the other discs with gear teeth. Install remaining Belleville washers as previously outlined and remaining steel plate, then install the three bolts and washers and tighten evenly until the last steel plate is 0.015-0.030 inch (0.381-0.762 mm) above piston carrier surface. Install three new oil rings (1) and reinstall clutch assembly onto flywheel making sure the three bolt heads of clutch assembly fit into bores of flywheel.

Tighten clutch mounting bolts to 110-132 ft.lbs. (149-179 N·m) torque.

Rejoin tractor halves by reversing split procedure. Adjust clutch pedal and linkage, if necessary, as outlined in paragraph 98.

MASTER CLUTCH VALVE

Models 2090 and 2290 So Equipped

100. **R&R AND OVERHAUL.** To remove master clutch valve, first disconnect pedal cable linkage from spool. Disconnect hydraulic lines. Cap or plug hydraulic openings. Unbolt and remove valve assembly from tractor. Remove and discard gasket. Refer to Fig. 93 and remove plug and pin assembly (items 6 through 12). Remove spool (3) from bottom of valve body (1). Remove snap ring (5) from spool. Pry spool seal (2) from valve body.

Inspect all parts for wear, nicks or burrs. If spool or bore in valve body are damaged, renew spool and body as an assembly. Check primary (7) and secondary (9) springs against following specifications:

Primary Spring (7)

Free Length 1.610 in.
(40.9 mm)
Load at Length .. 8.6-10.5 lbs. @ 1.2 in.
(38-47 N @ 30 mm)

Secondary Spring (9)

Free Length 0.760 in.
(19.3 mm)
Load at Length 1.2-1.5 lbs. @ 0.430 in.
(5.3-6.7 N @ 10.9 mm)

Lubricate parts with clean hydraulic oil and reassemble by reversing

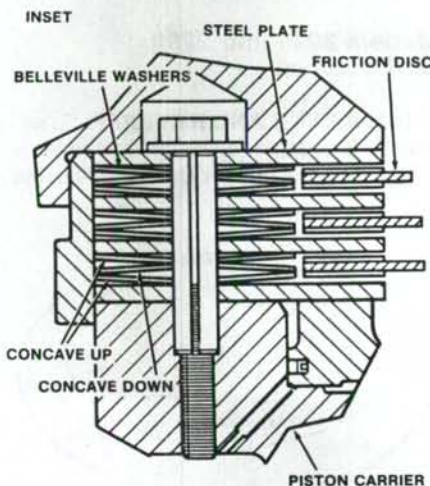


Fig. 92—Illustration showing correct assembly position of Belleville springs in master clutch. Refer to text.

disassembly procedure. Use new seal ring (2) and gasket upon assembly. Tighten plug (12) to 17-20 ft.-lbs. (23-27 N·m) torque. Tighten mounting bolts to 30-35 ft.-lbs. (41-47 N·m) torque. Bleed hydraulic system as outlined in paragraph 25. If necessary, adjust clutch pedal linkage as outlined in paragraph 98.

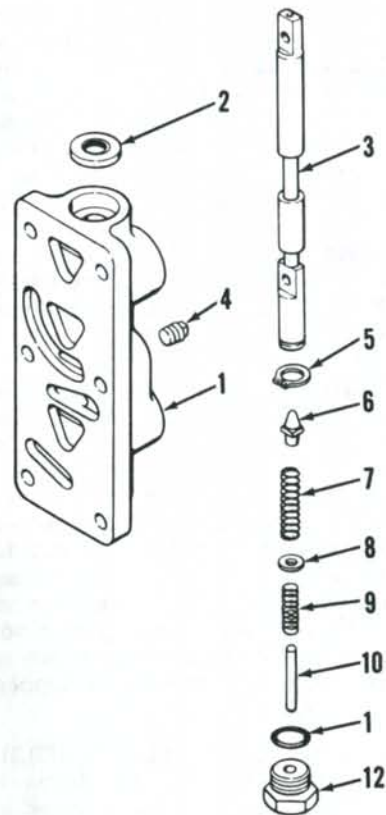


Fig. 93—Exploded view of master clutch valve assembly.

- | | |
|--------------------|--------------|
| 1. Valve body | 7. Spring |
| 2. Seal | 8. Washer |
| 3. Spool | 9. Spring |
| 4. Plug | 10. Pin |
| 5. Snap ring | 11. "O" ring |
| 6. Modulator point | 12. Plug |

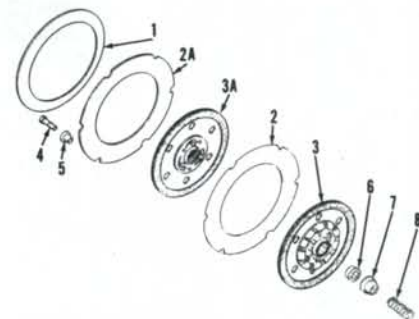


Fig. 94—Exploded view of torque limiter clutch used on Models 2090 and 2290 tractors so equipped and all 2390, 2590, 2094, 2294, 2394 and 2594 tractors.

- | | |
|--|-------------|
| 1. Belleville spring | 4. Bolt |
| 2. Plate | 5. Retainer |
| 2A. Plate (Models 2390, 2590, 2094, 2294, 2394 and 2594) | 6. Bushing |
| 3. Disc | 7. Sleeve |
| 3A. Disc (Models 2390, 2590, 2094, 2294, 2394 and 2594) | 8. Spring |

Paragraphs 101-104

TORQUE LIMITER CLUTCH

(Power Shift Transmission)

All Model 2390, 2590, 2094, 2294, 2394 and 2594 tractors and Model 2090 and 2290 tractors optionally equipped utilize a "slip type" torque limiter clutch bolted to engine flywheel. The Power Shift transmission on these models receives power through an input shaft from the torque limiter clutch.

Before overhauling torque limiter clutch, be sure problem is in that unit by performing the following stall test: With engine running approximately 1200 rpm, shift into 4th range, hold brakes and slowly release inching pedal. Engine should stall, unless torque limiter is slipping, which would allow hydraulic pump drive shaft to stop, thus losing the oil pressure to power shift. The torque limiter would then stop slipping since power shift clutch would slip. The pump would again be able to deliver pressure to power shift clutch and torque limiter would again slip, which would become a bucking action. If bucking does not occur, check for a power shift clutch or valve leakage as outlined in paragraphs 227 through 233.

101. TORQUE LIMITER CLUTCH. Tractor must first be split between engine and torque tube as outlined in paragraph 41, but do not remove front axle assembly. Drive wedge blocks between axle and front support to prevent sideways tipping.

Remove and inspect torque limiter steel plates, discs and Belleville spring. Figure 94 shows torque limiter with dual discs (3 and 3A) and two steel plates (2 and 2A) which were used on Models 2390, 2590, 2094, 2294, 2394 and 2594. Models 2090 and 2290 so equipped, were equipped with one disc and one plate.

Belleville spring (1) must be checked for free height with concave side down as shown in Fig. 95. Spring free height should be 0.482-0.494 inch (12.2-12.5 mm) on Models 2090 and 2290 or 0.451-0.463 inch (11.5-11.8 mm) on Models 2390, 2590, 2094, 2294, 2394 and 2594. Renew Belleville spring if measurement is less than 0.482 inch (12.2 mm) on Models 2090 and 2290 or 0.451 inch (11.5 mm) on all other models.

NOTE: If the discs (3 and 3A—Fig. 94) show signs of slipping or wear, renew all discs, plates and Belleville spring.

Clean removed parts and friction surface of flywheel of all dirt and grease. Fill pilot cavity in rear of crankshaft 2/3 full of Molylube No. 2.

NOTE: When dual discs are installed make sure rivet heads of discs are not lined up with each other so as to avoid contact. Sides of discs with springs must face away from each other.

When installing torque limiter, use a pilot shaft made from a planetary output shaft. Grind the front of output shaft down approximately 0.010 inch (0.254 mm) to 1.760 inches (44.7 mm) diameter before using.

On all models, retainers (5) must engage the half circle notches in plates. Tighten cap screws to 80-90 ft.-lbs. (108-122 N·m) in several steps in order to load Belleville spring evenly. Dish in Belleville spring must face outward. Install thrust control spring (8) in cavity in center of flywheel.

MECHANICAL SHIFT TRANSMISSION

Models 2090 and 2290 tractors may be equipped with a mechanically shifted eight speed gear type transmission consisting of a two speed range and four speed gear section. This provides eight forward speeds and four reverse.

Transmission gears are constant mesh type. Range gears are synchronized and can be shifted on-the-go. Reverse shifting requires tractor be stopped. Four speed gears require tractor be stopped for shifting.

LINKAGE ADJUSTMENT

Models 2090 and 2290 So Equipped

102. RANGE AND REVERSE. To adjust shift linkage for range and reverse gears, first disconnect the control cable

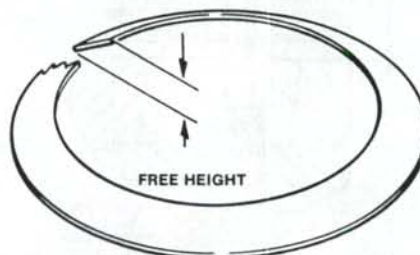


Fig. 95—Invert Belleville spring and measure dish as shown. Refer to text.

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yokes (8—Fig. 96). Place the range control lever (1) in neutral position. Align the reverse quadrant (3) and range quadrant (2) slots. Place the range and reverse shift levers (9 and 10) in neutral position (70 degrees above horizontal as shown in insert Fig. 96). Adjust position of cable yokes so that yoke holes align with shift lever holes. Install yoke pins and secure yokes.

103. FOUR SPEED TRANSMISSION. To adjust shift linkage on four speed transmission gears, first disconnect the control cable yokes (8—Fig. 97). Place the gear shift lever (1) in neutral position. Place the speed shift levers (9 and 10) in neutral position (20 degrees above horizontal as shown in insert A—Fig. 97). Adjust position of cable yokes (8) so that yoke holes align with shift lever holes. Install yoke pins and secure yokes.

104. NEUTRAL START SWITCH. To adjust the neutral start switches, place the four speed gear transmission in neutral, disconnect wiring and remove the two switches (Fig. 98). Remove the switch shims and place switches back into transmission without shims. Using an ohmmeter or suitable continuity light, turn switches in until light or meter shows continuity. Shift transmission through various gears and check to see if switch continuity breaks when

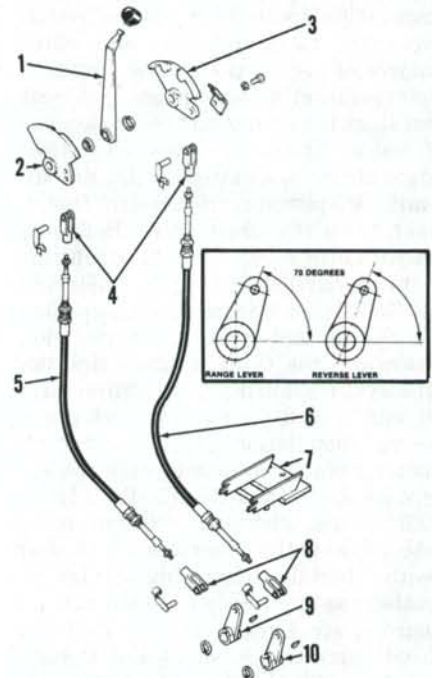


Fig. 96—Exploded view of high-low range and reverse shift linkage on Model 2090 and 2290 tractors so equipped.

- | | |
|---------------------|-------------------|
| 1. Shift lever | 6. Reverse cable |
| 2. Range quadrant | 7. Bracket |
| 3. Reverse quadrant | 8. Yoke |
| 4. Yokes | 9. Range lever |
| 5. Range cable | 10. Reverse lever |

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Paragraph 105

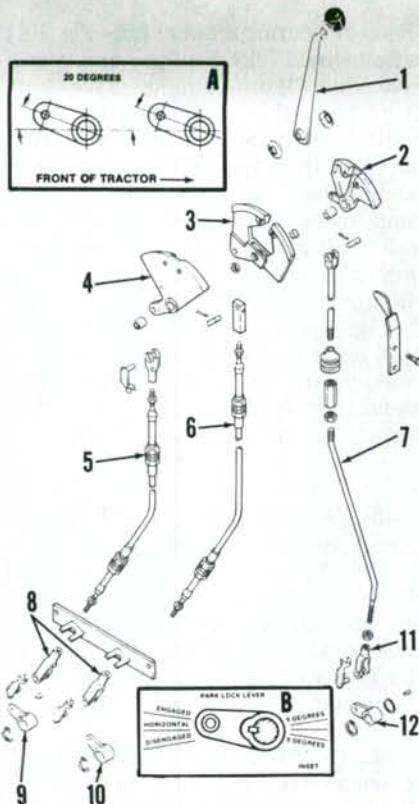


Fig. 97—Exploded view of four-speed shift linkage and park lock linkage on Model 2090 and 2290 tractors so equipped.

- | | |
|----------------------------|-----------------------------|
| 1. Shift lever | 7. Shift rod (park lock) |
| 2. Park lock quadrant | 8. Yokes |
| 3. 3rd & 4th gear quadrant | 9. Shift lever (1st & 2nd) |
| 4. 1st & 2nd gear quadrant | 10. Shift lever (3rd & 4th) |
| 5. Shift cable (1st & 2nd) | 11. Yokes |
| 6. Shift cable (3rd & 4th) | 12. Shift lever (park lock) |

transmission is in gear and continues when in neutral. Estimate number of shims needed to fill gap between switch and transmission to allow proper operation. Install shims with switch and recheck with meter or light. Readjust as necessary. Shims are available in thicknesses of 0.005 and 0.010 inch (0.127 and 0.254 mm). See Fig. 98.

RANGE SHIFT FORKS AND SHAFTS

Models 2090 and 2290 So Equipped

105. REMOVE AND REINSTALL. To remove shift forks and shift shafts for range transmission service or fork or shaft renewal, first drain transmission oil, then disconnect shift control cables from four speed transmission and park lock lever. Remove neutral start switch wiring. Remove rear side access cover and cable bracket. Disconnect range and reverse shift control cables, then remove front side access cover. Push the shift rail roll pin in until pin is complete-

ly in the shift rail. See Fig. 99. Using pliers, turn shift rail until flat area of rail is toward outside of transmission. Install a 5/16 inch NC bolt in rear threaded end of shift rail. Using pliers, pull on bolt

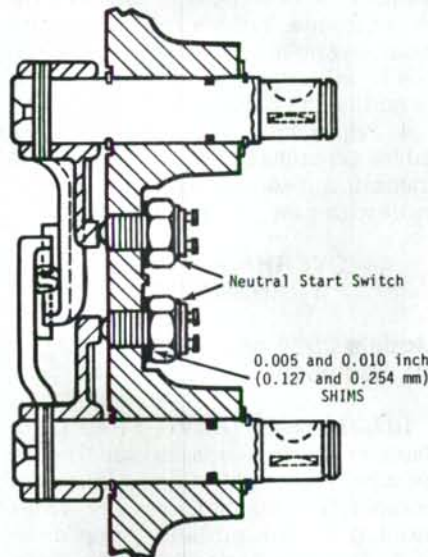


Fig. 98—Cross-sectional view showing neutral start switch shim placement and shim dimensions. Refer to text.

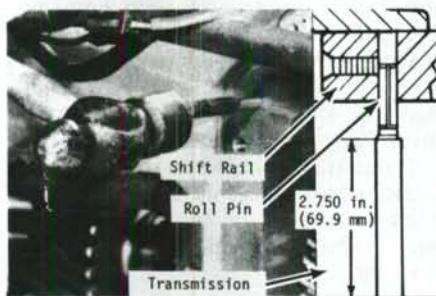
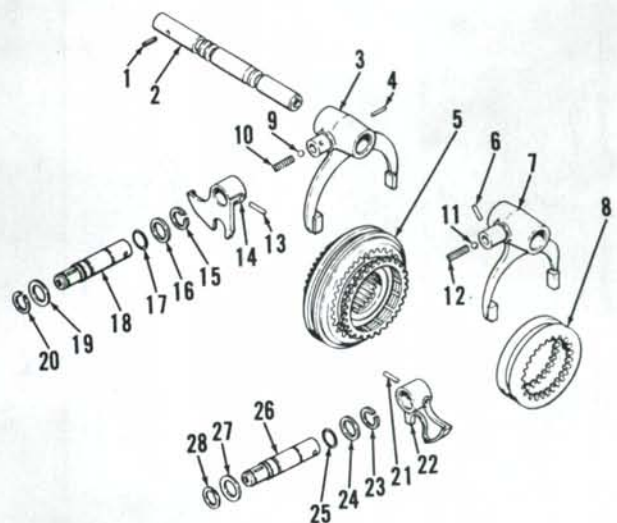


Fig. 99—View showing pin removal and installation procedure to range shift rail. When installing, drive pin into rail to depth shown. Refer to text.

Fig. 100—Exploded view of range shift rails, forks and related parts for Model 2090 and 2290 tractors equipped with mechanical shift transmission.

1. Roll pin
2. Shift rail
3. High-Low shift fork
4. Roll pin
5. Synchronizer assy.
6. Roll pin
7. Reverse shift fork
8. Shift collar (reverse)
9. Ball
10. Spring
11. Ball
12. Spring
13. Roll pin
14. Shift lever (inner)
15. Snap ring
16. Washer
17. "O" ring
18. Shifter shaft
19. Washer
20. Snap ring
21. Roll pin
22. Shift lever (inner)
23. Snap ring
24. Washer
25. "O" ring
26. Shifter shaft
27. Washer
28. Snap ring



rearward and move shift forks forward using a screwdriver. As shift rail is removed rearward, retain detent balls in shift forks. Remove shift rail out rear access side opening. Remove snap ring (28—Fig. 100) from reverse shift lever then remove shift lever from shaft. Remove inside snap ring (23) and washer (24) from shaft. Push top of range shift fork (3) inward and turn range shift lever fully clockwise. Push top of reverse shift fork (7) inward then slide reverse shift collar (8) fully toward front of transmission. Turn reverse shift shaft fully clockwise, then push shaft inward until inner shift lever is past reverse shift fork and inner range shift lever. Turn inner reverse shift lever fully upward and remove reverse shift fork through front side access opening. Turn range shift lever counterclockwise and remove range shift fork (3) through front side access opening.

Push reverse shift shaft into transmission and remove through front side access opening. To remove range shift shaft (18), remove snap ring (20), lever, washer (16) and inside snap ring (15), then push shaft into transmission and remove through front side access opening. Renew "O" rings (17 and 25) on shift shafts when reassembling.

Reassemble by reversing disassembly procedures noting the following: Remove roll pins (4 and 6) and springs (10 and 12) from shifting forks. Remove roll pin (1) from shift rail (2). After shift rail is in place, align pin hole with access hole in side of transmission and install roll pin into shift rail to depth shown in Fig. 99. With shift rail and shifting forks and levers installed, place detent balls and springs into shift forks and secure springs in place with roll pins (4 and 6). Adjust shift linkage as outlined in paragraphs 102, 103 and 104.

Paragraphs 106-109

TRACTOR SPLIT

106. To service the range or speed transmissions, tractor must be separated (split) between the torque tube and rear transmission frame as follows: First drain transmission and torque tube. Disconnect battery, remove cables from starter and remove battery tray. Remove side rails. Unbolt circuit breaker panel from oil pan and wire panel to side of engine. Disconnect brake valve tube, pto regulator hose and tube and the two brake valve hoses. Disconnect pto regulator valve tube from differential lock valve hose. Disconnect differential lock valve hose from axle differential lock tube. Disconnect shift control cables from range and speed transmission shift levers. Disconnect control cables from hitch and sensing control levers on hitch control valve. Disconnect control cable from pto regulator valve. Disconnect all necessary wiring harness connectors and ground wire from engine block. On the remote valve, disconnect control cables and if so equipped, remove flow control cables.

Loosen front cab or platform mount nuts on each side of tractor. Remove retaining rings from remote couplings, mark for identification when assembling, then push couplings out of frame. Disconnect transmission temperature sender wire from pto. Remove drawbar and drawbar mounting bracket from under tractor. Remove rear cab or platform mounting bolts on each side of tractor.

Support tractor under engine with splitting stand or suitable jackstands. Install rear splitting stand or support rear frame with rolling floor jack. Raise and support rear of cab or platform enough that it clears when transmission is moved toward the rear. Unbolt transmission from torque tube and roll transmission to the rear separating the tractor.

Assemble tractor by reversing disassembly procedure. Use Loctite 504 or equivalent sealant on transmission flange before uniting with torque tube. Tighten nuts securing transmission to torque tube to 400-450 ft.-lbs. (542-678 N·m) torque. Tighten cab or platform mounting bolts to 150-180 ft.-lbs. (203-244 N·m) torque. Adjust shift controls as outlined in paragraphs 102, 103 and 104. Adjust hitch control and sensing cables as outlined in paragraph 267. Fill transmission and torque tube to correct level with new Hy-Tran Plus fluid.

OVERHAUL RANGE TRANSMISSION

Models 2090 and 2290 So Equipped

107. RANGE DRIVE SHAFT. To disassemble range transmission, tractor must be separated (split) as outlined in paragraph 106. Remove the front bushing for the pto and pump drive shaft. Remove seal ring from range drive shaft. Remove front side and top transmission access covers. Disconnect lubrication tube and remove fitting from upper right on transmission housing, then pull out oil tube (26—Fig. 101) from bearing retainer (25) and transmission. Drive roll pin (1—Fig. 100) into range shift rail through access hole in side cover flange as shown in Fig. 99. Turn shift rail until flat area on rail is toward outside of transmission. Then push shift rail toward rear of transmission and remove shift rail from rear of transmission wall.

NOTE: As shift rail moves out of shift forks, detent balls (9 and 11—Fig. 100) will drop out.

Remove bearing retainer (25—Fig. 101) and oil shield (22). Pull pto and pump drive shaft (3) out of range drive shaft (2) until snap ring is visible on inside end of shaft, then remove snap ring from shaft end through top rear opening in transmission case. Remove pto and pump drive shaft from range drive shaft. Pull range drive shaft assembly from transmission.

Remove retaining rings (10 and 12—Fig. 101), then remove rear drive shaft bearing (11) from transmission. Disassembly of range drive shaft assembly is obvious after examination of unit and reference to Fig. 101.

108. REVERSE IDLER SHAFT. To remove reverse idler shaft and gear assembly, first drive roll pin (8—Fig. 101) into idler shaft until it bottoms in shaft. Push idler shaft (7) rearward removing thrust washer assemblies (4 and 9) and idler gear and bearing (5 and 6) as shaft is removed.

109. INTERMEDIATE SHAFT. To remove intermediate shaft, first remove oil shield (4—Fig. 102), remove range and reverse shift forks as outlined in paragraph 105. Remove rear side and top transmission access covers. Remove pto housing assembly from rear of transmission as outlined in paragraph 202. Remove rear pto drive shaft. Using an Allen wrench, remove the three screws (1—Fig. 102) securing the front end cap (2) and remove cap and shims (3).

If intermediate shaft is equipped with end cap and shims on rear end of shaft, remove cap and shims. See insert Fig. 102.

If intermediate shaft is equipped with a snap ring (26—Fig. 102) on rear end of shaft, proceed as follows: Refer to Fig. 103 and install spacer sleeve over first gear and between cluster gear and transmission case. Install end cap tool (Fig. 104) with a 0.125 inch (3.175 mm) shim pack on front end of intermediate shaft and tighten cap tool to 40 ft.-lbs. (54 N·m) torque. Install puller as shown in Fig. 104 and tighten nut against back side of puller plate until outer snap ring on front of bearing is tight against front of transmission, and end cap tool is tight against inner race of front bearing. Using a long punch, hit inner race of rear intermediate shaft bearing (29—Fig. 102) lightly until bearing is away from snap ring (26), then remove snap ring.

Install puller with nut and washer on outside of puller plate. Turn nut to pull intermediate shaft forward until front bearing is free from transmission case and shaft is clear of inner race of center bearing (19). Pull shaft out of transmis-

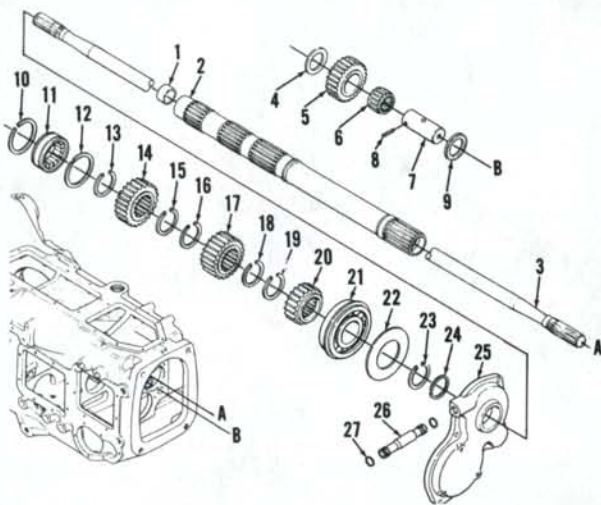


Fig. 101—Exploded view of drive shaft assembly on Model 2090 and 2290 tractors equipped with mechanical shift transmissions.

1. Bushing
2. Range drive shaft
3. Pto & pump shaft
4. Thrust bearing
5. Reverse idler
6. Needle bearing
7. Shaft
8. Roll pin
9. Thrust bearing
10. Retaining ring
11. Rear bearing
12. Retaining ring
13. Snap ring
14. Gear (high range drive)
15. Snap ring
16. Snap ring
17. Gear (low range drive)
18. Snap ring
19. Snap ring
20. Gear (reverse drive)
21. Front bearing
22. Oil shield
23. Snap ring
24. Seal ring
25. Bearing retainer
26. Oil tube
27. "O" ring

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Paragraphs 110-111

sion while removing gears, spacers and collars out top access opening.

110. Clean and inspect all parts for damage or excessive wear and renew as necessary. Check bearings for free smooth action and renew any bearing having a loose fit or rough action. Bearings may be heated to 250° F (120° C) for ease in assembling.

REASSEMBLY

111. INTERMEDIATE SHAFT. Assemble intermediate shaft as follows: If front shaft bearing (5—Fig. 102) was removed, install front thrust washer section of thrust bearing assembly (6) with flat side toward bearing. Heat and install front shaft bearing (5). If removed, install center bearing (19) in transmission. Install intermediate shaft

and bearing assembly into transmission enough to allow installation of intermediate shaft components in the following procedure. Install remainder of thrust bearing assembly (6) onto shaft with cup side of thrust washer toward front of transmission. Install reverse driven gear (7) flat side toward front. Place thrust bearing assembly (8) onto shaft with black side of bearing cup toward reverse gear. Install shift pinion hub (9) with recessed inside diameter toward front of transmission, then place shift collar (10) on hub (9). Place thrust bearing assembly (12) on shaft, black side against shift pinion hub, then install low range driven gear (13) with long side of hub toward rear of transmission. Install thrust bearing assembly (14), black side against low range gear. Place front synchronizer gear with flat side against low range gear. Place synchronizer (15)

onto shaft with recessed part of inner splines toward front of transmission. Install rear section of synchronizer gear with hub of gear against synchronizer. Install thrust bearing assembly (16) black side forward, high range driven gear (17) gear hub side forward and thrust bearing assembly (18) black side forward.

Push intermediate shaft through center bearing (19), then proceed to install drive gears and spacers in the following order: Install fourth drive gear spacer (20) which is 1-45/64 inches (43.3 mm) long, on intermediate shaft. Place fourth drive gear (21), spacer (22), cluster gear (23), small gear side rearward, spacer (24) and first drive gear (25) on shaft.

Install spacer sleeve into transmission over first gear and between cluster gear and transmission case as shown in Fig. 103. Install end cap tool with a 0.125 inch (3.175 mm) shim pack on front end of intermediate shaft and tighten cap to 40 ft.-lbs. (54 N·m) torque. Install puller assembly as shown in Fig. 104, tighten nut against back side of puller plate forcing intermediate shaft toward rear of transmission until outer snap ring on front bearing (5—Fig. 102) is tight against front of transmission and end cap tool is tight against inner race of front bearing.

Install rear bearing spacer (28), inner bearing snap ring (27), rear bearing (29) and outer bearing snap ring (30). Using a long punch, tap inner bearing race until seated against rear bearing spacer, then install rear shaft snap ring (26); or if so equipped, install rear end cap (see insert Fig. 102). Coat Allen screws with Loctite 271 or equivalent and tighten to 40 ft.-lbs. (54 N·m) torque.

Remove spacer sleeve and puller assembly. Install front end cap (2—Fig. 102) without shims and tighten Allen screws to 40 ft.-lbs. (54 N·m) torque to remove any clearance between gears and related parts on shaft. Remove end cap and using a depth micrometer, measure distance from face of front bearing to end of intermediate shaft as shown in Fig. 105. Add shims (3—Fig.

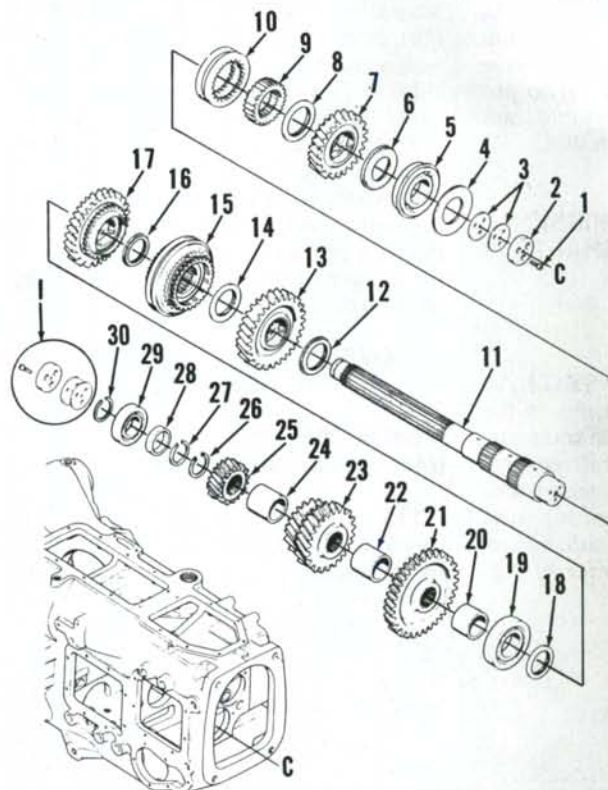


Fig. 102—Exploded view of intermediate shaft assembly on Model 2090 and 2290 tractors equipped with mechanical shift transmissions. Insert "I" shows rear shaft retaining plate for late model tractors.

1. Allen screw
2. Retaining plate
3. Shims, 0.005 & 0.007 inch (0.127 & 0.178 mm)
4. Oil shield
5. Front bearing
6. Thrust bearing
7. Reverse gear
8. Thrust bearing
9. Pinion hub
10. Shift collar
11. Intermediate shaft
12. Thrust bearing
13. Low range gear
14. Thrust bearing
15. Synchronized assy.
16. Thrust bearing
17. High range gear
18. Thrust bearing
19. Center bearing
20. Spacer, 1-45/64 inches (43.3 mm)
21. Gear (4th)
22. Spacer, 2-1/4 inches (57 mm)
23. Cluster gear (2nd & 3rd)
24. Spacer, 2-1/4 inches (57 mm)
25. Gear (1st)
26. Snap ring (early models)
27. Retaining ring
28. Bearing spacer
29. Rear bearing
30. Retaining ring

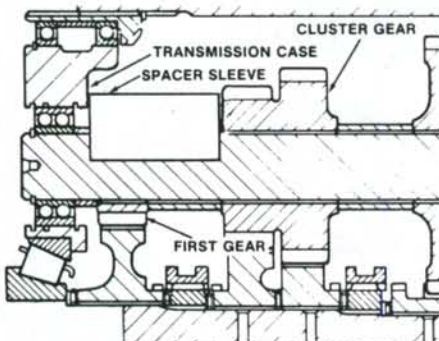


Fig. 103—Illustration showing installation of spacer sleeve on intermediate shaft for disassembly and assembly. Refer to text.

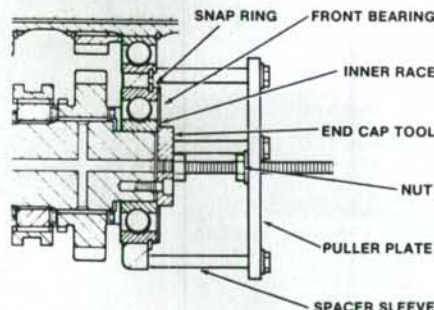


Fig. 104—Illustration showing installation of puller assembly for disassembly and assembly of intermediate shaft.



Fig. 105—View showing measurement of intermediate shaft recess from bearing face to determine shim pack. Refer to text.

Paragraphs 112-115

102) to measured dimension to obtain a clearance of 0.003 to 0.006 inch (0.076 to 0.152 mm) between face of front bearing and inside face of end cap, when end cap is reinstalled. Shims are available in thicknesses of 0.005 and 0.007 inch (0.127 and 0.178 mm). Coat Allen screws with Loctite 271 or equivalent and tighten screws to 40 ft.-lbs. (54 N·m) torque. Install oil shield (4) with bronze side toward bearing.

Install range shift forks and levers as outlined in paragraph 105. Install rear pto drive shaft then install pto housing assembly as outlined in paragraph 202.

112. REVERSE IDLER SHAFT.

Assemble reverse idler shaft as follows: Insert reverse idler shaft (7—Fig. 101) into front of transmission. Place thrust bearing assembly (9), black side toward rear of transmission. Install reverse idler gear (5) with needle bearing (6) onto shaft. Then install rear thrust bearing assembly (4), black side toward gear. Align pin hole in rear end of shaft with pin hole in transmission boss and install roll pin (8) until pin is flush with top surface of transmission boss.

113. RANGE DRIVE SHAFT. If measured inside diameter of drive shaft bushing (1—Fig. 101) exceeds 1.1385 inches (28.918 mm), renew bushing. Remove old bushing by splitting with a chisel. Use Loctite Primer and Loctite 271 sealant or equivalent on new bushing and install to depth shown in Fig. 106. Inside diameter of new bushing should be 1.1265-1.1285 inches (28.613-28.664 mm) after installation.

Heat and install front drive bearing (21—Fig. 101) with outer retaining ring facing away from the three gear spline end of shaft. Install snap ring (23) and seal ring (24). Install reverse drive gear (20) with long hub side against front bearing. Install snap ring (19), snap ring (18), low range gear (17), snap ring (16), snap ring (15), high range gear (14) and snap ring (13). Install rear drive shaft bearing (11) and bearing retaining rings (10 and 12) in transmission bore.

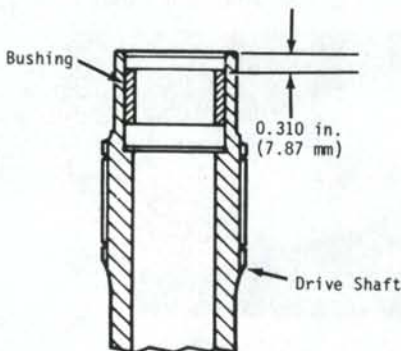


Fig. 106—Install rear pto and pump drive shaft bushing to depth shown.

Install drive shaft assembly into transmission until front bearing outer ring is against front of transmission. Slide pto and pump drive shaft (3) into drive shaft (2) enough to install snap ring on rear of pto and pump shaft. Then push pto and pump shaft in until spline end is in the coupling of the pto drive in rear of transmission. Install oil shield (22), bronze side against bearing. Install bearing retainer (25) and tighten bolts to 35-42 ft.-lbs. (48-57 N·m) torque. Use Loctite Primer and 242 sealant or equivalent on the three bearing retainer set screws and tighten screws to 12-15 ft.-lbs. (16.3-20.3 N·m) torque.

Install oil tube (26) with new "O" rings (27) and connect oil tube fitting and tube. Apply Loctite 504 or equivalent to transmission access opening flanges and install side and top access covers and tighten cover bolts to 35-42 ft.-lbs. (48-57 N·m) torque. Install new seal ring on range and reverse drive shaft, and install front bushing on pto and pump drive shaft. Reassemble tractor as outlined in paragraph 106.

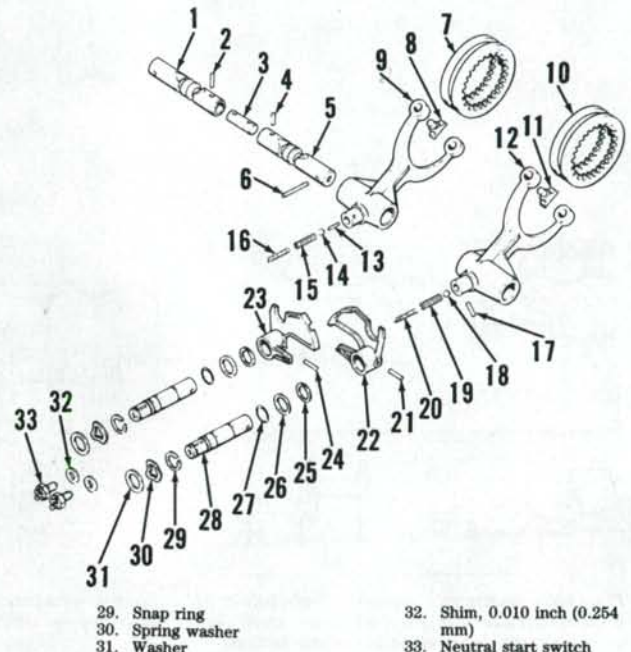
FOUR SPEED TRANSMISSION SHIFT FORKS AND SHAFTS

Models 2090 and 2290 (Mechanical Shift)

114. REMOVE AND REINSTALL. To remove shift forks or shift shafts for service or renewal, first drain transmission oil, then disconnect shift control cables from four speed transmission and park lock lever. Remove neutral start switch wiring. Remove rear side access cover and cable bracket. Refer to Fig.

Fig. 107—Exploded view of shift rail, forks and related parts on four-speed transmission of Model 2090 and 2290 tractors equipped with mechanical shift transmission.

1. Shift rail
2. Pin
3. Pin rail
4. Pin
5. Shift rail
6. Pin
7. Shift collar
8. Fork finger
9. Shift fork
10. Shift collar
11. Fork finger
12. Shift fork
13. Pin
14. Ball
15. Spring
16. Spring
17. Pin
18. Ball
19. Spring
20. Spring
21. Pin
22. Shift lever (inner)
23. Shift lever (inner)
24. Pin
25. Snap ring
26. Washer
27. "O" ring
28. Shift shaft
29. Snap ring
30. Spring washer
31. Washer
32. Shim, 0.010 inch (0.254 mm)
33. Neutral start switch



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107 and drive out detent pins (13 and 17) from both forks, then remove detent springs (15, 16, 19 and 20) and balls (14 and 18). Engage park lock, fully clockwise, then drive roll pin (6) out of shift rail (5) and shift rail bore in transmission. Remove pin (6). Disengage park lock, fully counterclockwise, put transmission in first gear by sliding rear shift fork rearward. Turn shift rail until roll pin (2) can be driven out of shift rail. Separate shift rail and push rear section (1) rearward out of shift fork (9), then remove shift fork. Remove shift fork (12) with shift rail (5) and connector bar (3) together. Remove rear section of shift rail (1) from bore in transmission.

To remove shifter shafts (items 21 through 31), hydraulic inlet screen (See Fig. 109) must be removed as outlined in paragraph 250. Remove outer shift levers from speed transmission. Remove snap ring (29—Fig. 107) from shift shaft (28). Remove flat washer (31) and wave washer (30). First remove shift shaft for third and fourth gear, then remove shift shaft for first and second gear. Renew "O" rings (27) on shift shafts when reassembling.

Reassemble by reversing disassembly procedure. Adjust shift linkage as outlined in paragraphs 103 and 104, and park lock linkage as outlined in paragraph 177.

OVERHAUL FOUR SPEED TRANSMISSION

Models 2090 and 2290 (Mechanical Shift)

115. COUNTERSHAFT. To service the four speed transmission countershaft, tractor must be separated (split)

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between torque tube and transmission as outlined in paragraph 106. Remove rear cab or platform mounts. With transmission suitably supported, remove wheels. Remove axle housings and final drive assemblies as outlined in paragraph 166. Remove pto housing assembly as outlined in paragraph 202. Remove brake assemblies as outlined in paragraph 192.

Disconnect differential lock oil fitting on right side of transmission then remove oil tube. Remove rear pto drive shaft. Disconnect hitch cable and remove oil tube from rear of transmission frame.

Support differential with wood blocks. Remove differential bearing carriers from both sides of transmission. Remove both differential bearing cones, shims and inner halves of brake cylinders from both sides of transmission. Attach a suitable chain or sling and hoist to differential assembly and remove from transmission.

Remove four speed transmission shift control cable bracket from top of transmission. Remove hitch cable upper mount bolts from top of rear transmission access cover, then remove cover. Remove front side transmission access cover.

Remove front bushing from pto shaft, pull shaft out approximately four inches, remove snap ring from rear of pto shaft, then withdraw pto shaft from input shaft.

Remove roll pins (13 and 17—Fig. 107) from both shifting forks. Remove detent balls and springs. Engage park lock and drive shift rail roll pin (6) out. Remove shift rail from rear of transmission. Remove shift forks.

Bend retainer nut (1—Fig. 108) lip from notch in countershaft and remove nut and thrust washer (2). Remove snap ring (6) from shaft. Using a brass drift, drive countershaft rearward approximately $\frac{1}{4}$ inch (6.35 mm) and install a suitable puller and remove front countershaft bearing cone (3). Push countershaft assembly rearward until out of park lock gear (8) and remove Woodruff key (7) (on models equipped with transmission S/N 10237494 and below) from countershaft. Push countershaft rearward while removing items (9 through 18) out top of access opening. Park lock gear cannot be removed until fourth, third and second gears are removed. Remove park lock gear (8) then remove remainder of items (19 through 23) out top of access opening and withdraw countershaft from rear of transmission.

Remove snap ring (5) from behind front bearing cup and drive out cup. Drive out rear bearing cup (25). Press rear bearing cone from countershaft.

116. Clean and inspect all parts for damage or excessive wear and renew as necessary. Check bearings for free smooth action and renew any bearing having a loose fit or rough action. Bearing (26—Fig. 108) may be heated to 250° F (120° C) for ease of assembly.

REASSEMBLY

117. COUNTERSHAFT. Assemble countershaft as follows: If rear pinion bearing cone (26—Fig. 108) was removed, heat and install bearing cone on countershaft with large side toward pinion gear. With countershaft standing vertical with pinion gear down assemble shaft components as follows: Install $\frac{1}{8}$ inch (3.18 mm) thick thrust washer from thrust bearing (23), then install needle bearing and cup washer, cup side down. Install first gear (22), hub gear end up. Install pinion shaft hub (19) with $\frac{1}{4}$ inch (6.35 mm) recessed spline side down, then install shift collar (20). Install thrust bearing (18), cup side down; second gear (17), hub gear end down. Install thrust bearing (16), cup side down, then third gear (15), hub gear end up.

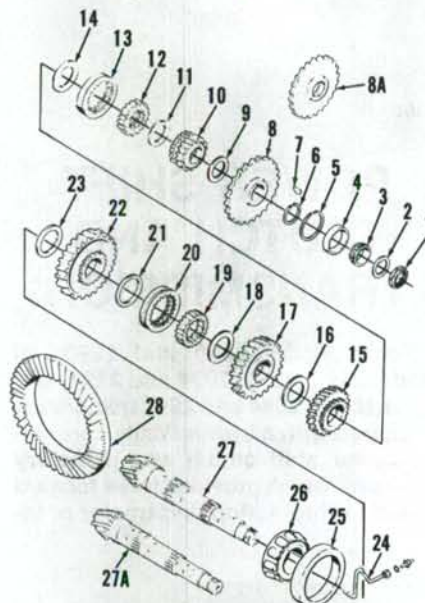


Fig. 108—Exploded view of four-speed gear countershaft used on all Model 2090 and 2290 tractors.

- | | |
|--|---|
| 1. Locknut | 14. Thrust washer |
| 2. Washer | 15. Gear (3rd driven) |
| 3. Bearing cone | 16. Thrust washer |
| 4. Bearing cup | 17. Gear (2nd driven) |
| 5. Snap ring | 18. Thrust washer |
| 6. Snap ring | 19. Hub (1st & 2nd) |
| 7. Woodruff key (transmission S/N 10237494 & before) | 20. Shift collar |
| 8. Park lock gear (transmission S/N 10237494 & before) | 21. Thrust washer |
| 9. Thrust washer | 22. Gear (1st driven) |
| 10. Gear (4th driven) | 23. Thrust washer |
| 11. Thrust washer | 24. Lube tube |
| 12. Hub (3rd & 4th) | 25. Bearing cup |
| 13. Shift collar | 26. Bearing cone |
| | 27. Pinion shaft (transmission S/N 10237494 & before) |
| | 27A. Pinion shaft (transmission after S/N 10237494) |
| | 28. Ring gear |

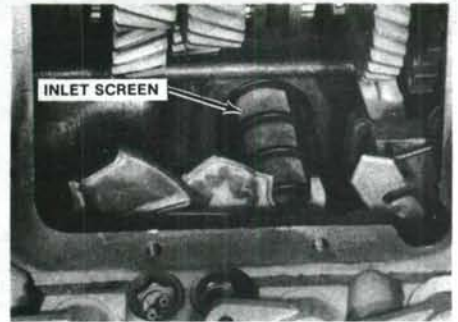


Fig. 109—Hydraulic inlet screen must be removed to remove shifter shafts.

Install thrust bearing (14), cup side up. Install pinion hub (12) with $\frac{1}{4}$ inch (6.35 mm) recessed spline side down, then install shift collar (13). Install thrust bearing (11) with $\frac{1}{8}$ inch (3.18 mm) thrust washer first and remainder of assembly, cup side down. Install fourth gear (10) with hub gear end down. Install thrust bearing (9) with cup side up. Install park lock gear (8) and key (7) (on models equipped with transmission S/N 10237494 and below) on shaft. Tap park lock gear with hammer to make sure there is no clearance between assembled parts. Install a shim type snap ring (6) and measure clearance between snap ring and park lock gear. Install appropriate thickness snap ring until 0.003-0.011 inch (0.076-0.279 mm) clearance is obtained. Snap rings (6) are available in thicknesses of 0.078, 0.088, 0.098, 0.108, 0.118, 0.128 and 0.138 inch (1.98, 2.24, 2.49, 2.74, 3.0, 3.25 and 3.5 mm). See Fig. 110 for cross-sectional view of assembled countershaft. Remove all parts from countershaft for assembly into transmission.

If front bearing cup was removed, install snap ring (5—Fig. 108) and press cup (4) into bore against snap ring. Install countershaft through rear of transmission case assembling parts in order outlined previously in this paragraph and shown in Fig. 110. Install a bar and bolt as shown in Fig. 111 to hold countershaft rigid and in correct position for installation of front bearing. Heat front bearing cone (3—Fig. 108) and install on front of countershaft, then install thrust washer (2) and retainer nut (1).

118. COUNTERSHAFT BEARING PRELOAD. Remove bar and bolt shown in Fig. 111. Tighten countershaft retainer nut, while rotating countershaft to remove clearance between countershaft bearing cones and cups. With transmission in neutral, measure rolling torque with a torque wrench. Tighten retainer nut until an additional 25-35 in.-lbs. (2.8-3.9 N·m) rolling torque for new bearings or 15-25 in.-lbs. (1.7-2.8 N·m) additional rolling torque for

Paragraphs 119-120

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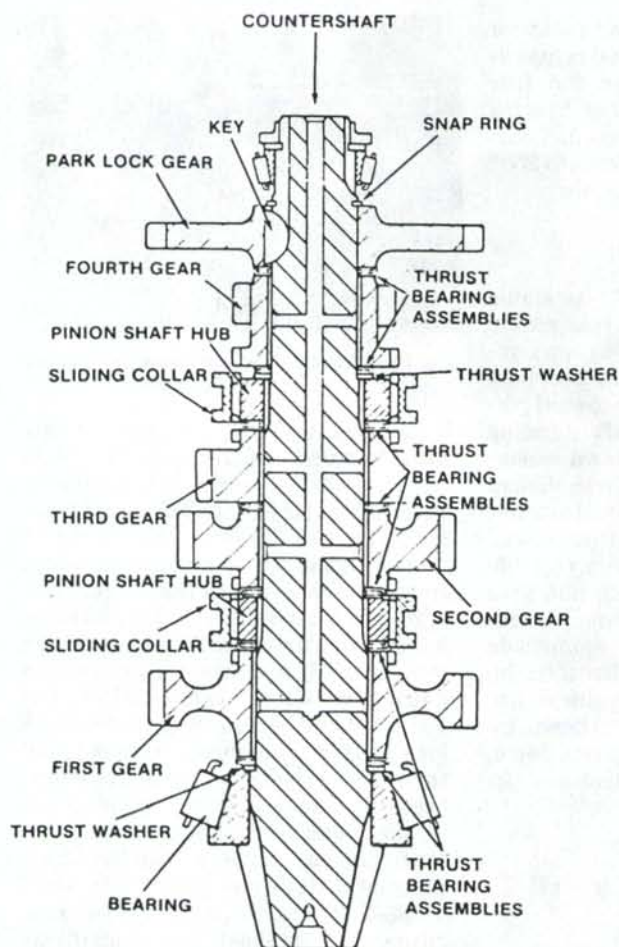


Fig. 110—Cross-sectional view of assembled countershaft and related parts.

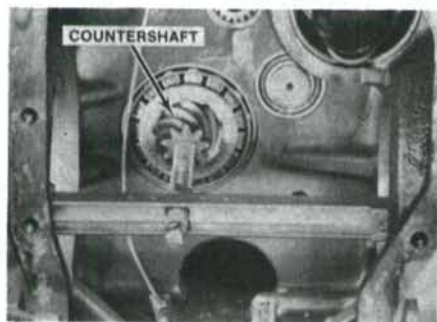


Fig. 111—With differential removed, install jackbolt and bar to support countershaft for reassembly.

original bearings is added to the original measurement. After correct preload is obtained, bend edge of retainer nut into groove in countershaft.

119. Reassemble tractor by reversing disassembly procedure. Adjust differential bearing preload and ring gear and pinion backlash as outlined in paragraph 170. Coat all mating surfaces of access covers, axle housings and transmission halves with Loctite 504 or equivalent prior to assembly. Fill transmission to proper level with new Hy-Tran Plus fluid. Bleed brakes as outlined in paragraph 185. Adjust hitch control and sensing cables as outlined in paragraph 267. Adjust shift linkage as outlined in paragraphs 102, 103 and 104.

POWER SHIFT CLUTCH AND TRANSMISSION

Some Model 2090 and 2290, all Model 2390, 2590, 2094 and 2294, and some Model 2394 and 2594 tractors are equipped with a hydraulically controlled power shift clutch and planetary drive unit which provides three forward speeds without stopping tractor or in-

terrupting power flow. Some Model 2394 and 2594 tractors are equipped with a power shift High/Low unit in front of the three-speed power shift resulting in six power shift speeds. The power shift transmission is coupled to a sliding gear transmission which can be shifted only when tractor is at a standstill. Reverse gears cannot be engaged while tractor is moving. The four-speed gearbox and three-speed power shift clutch provides a total of 12 forward and three reverse gear ranges. On Models 2394 and 2594 so equipped, the six-speed power shift and four-speed gearbox provides 24 forward and three reverse gear ranges. Reverse cannot be operated in fourth gear.

OPERATION

Power Shift Models 2090, 2290, 2390 and 2590

120. POWER TRAIN. The power shift clutch is a manually controlled, hydraulically actuated planetary gear unit shown in Fig. 112.

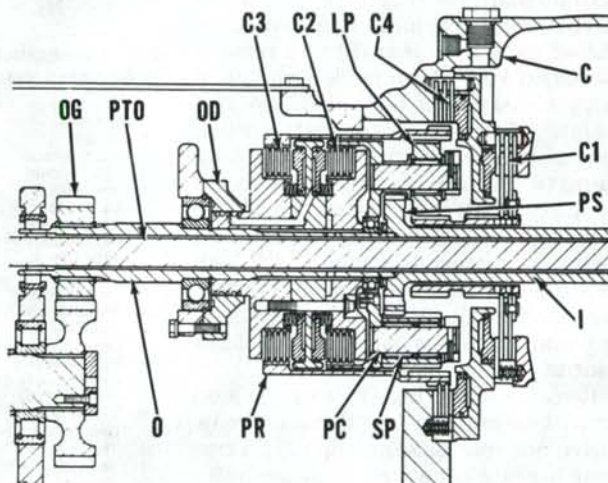
Control units consist of four clutches which are hydraulically actuated and released by spring pressure when hydraulic flow to clutch is blocked.

Power enters the clutch through input shaft (I—Fig. 112), which is splined to torque limiter disc (or discs) on flywheel. Input shaft is also primary sun gear (PS) in the clutch. Primary sun gear (PS) drives the three small planet pinions (SP) which in turn drive the large planet pinions (LP). The speed of output shaft (O) depends on which clutch units are engaged.

Power to pto clutch and hydraulic pumps is transmitted through two long shafts which pass through center of drive train. The front shaft is splined to flywheel by a drive sleeve. The two shafts couple at the hydraulic pump drive. Rear shaft drives pto clutch.

Fig. 112—Cross section of typical three-speed power shift clutch unit. Output shaft (O) is gear transmission input shaft.

- C. Carrier
- C1. Clutch 1
- C2. Clutch 2
- C3. Clutch 3
- C4. Clutch 4
- I. Input shaft
- LP. Large planet pinion
- O. Output shaft
- PC. Planet carrier
- PTO. Pto & pump drive shaft
- PR. Planetary ring gear
- PS. Planetary sun gear
- SP. Small planet pinion
- OD. Oil distributor
- OG. Output gear



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Utilization of input power depends on which clutch units are engaged; refer to Fig. 113 and the following:

CLUTCH C-1 (Fig. 114) when hydraulically engaged, couples the secondary sun gear (S) to carrier housing (C), making the sun gear a stationary drive member. Power is transmitted from input shaft (I) and small planet pinions (SP) to large planet pinions (LP), which walk round stationary sun gear (S) driving planet carrier (PC) in the same direction as input shaft but at a slower rate of speed. Clutch C-1 is hydraulically engaged in Low (1) and Intermediate (2) forward speeds. Clutch C-1 is the Starting Output clutch for forward loads and is provided with additional pressurized lubrication for smooth engagement and long life.

CLUTCH C-2 (Fig. 115) when hydraulically engaged, couples the planet carrier (PC) to output shaft (O). Output shaft thus delivers power to transmission at the same speed and in same direction as planet carrier turns. Clutch C-2 is hydraulically engaged in Low (1) and High (3) forward speeds and in Reverse.

CLUTCH C-3 (Fig. 116) when hydraulically engaged, couples the planetary ring gear (PR) to output shaft (O). Clutch C-3 is hydraulically engaged in Intermediate (2) and High (3) forward speeds.

CLUTCH C-4 (Fig. 117) when hydraulically engaged, couples the planetary ring gear (PR) to carrier housing (C), thus making the planetary ring gear the stationary drive member. Clutch C-4 is engaged in Reverse speed; Clutch C-2 is also engaged (Fig. 115) coupling planet carrier to output shaft. In reverse speed, power enters clutch

from input shaft and input sun gear driving small pinion which in turn drives the large pinion. The large pinion walks around the stationary planetary ring gear turning planet carrier at same speed as input shaft but in opposite direction.

NOTE: High (forward) speed is obtained by pressurizing Clutch C-2 (Fig. 115) and Clutch C-3 (Fig. 116), coupling both the Planet Carrier (PC) and Planetary Ring Gear (PR) to Output shaft (O).

It is a recognized feature of any planetary drive unit that when any two elements are locked together, planetary drive ceases to operate and becomes, in effect a solid drive member. In High (forward) speed the input shaft, planetary drive members and output shaft turn a single unit driving output shaft with crankshaft at crankshaft speed.

The transmission is designed to permit manual selection of any of the three forward speeds by moving a lever, without stopping tractor. To shift to reverse, it is necessary to depress the inching pedal and stop tractor before control lever can be moved to Reverse.

This prevents accidental overshifting into Reverse when downshifting in the forward gears. The inching pedal is also depressed to shift the mechanical range shift lever to any of the four speed ranges or to neutral. When inching pedal is depressed, power shift selector lever is automatically moved to "Low" position so that tractor always starts out in low when starting up after selecting the operating range.

121. CONTROL SYSTEM. The control valve consists of a manually actuated speed and direction selector valve which operates through hydraulically controlled shift (pilot) valves to direct hydraulic fluid under pressure to the appropriate clutch units. Also contained in the valve unit is a foot operated dump valve which interrupts hydraulic flow to clutch units and power flow to drive wheels; a reverse lockout spool which prevents accidental overshifting into reverse from a forward speed; a separate lubrication circuit; and retard, check and shuttle valves which monitor sequential flow to clutch units to control engagement rate.

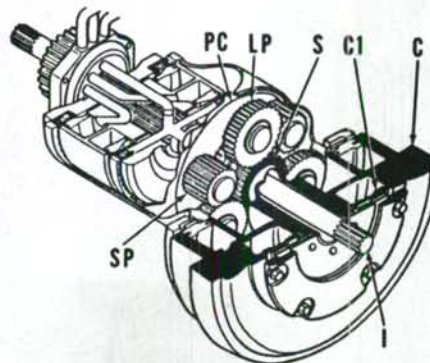


Fig. 114—With C-1 clutch engaged, secondary sun gear (S) is locked to carrier (C) as shown by black shading making secondary sun gear a stationary drive member.

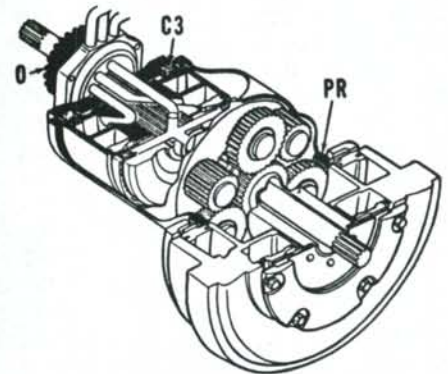


Fig. 116—With clutch C-3 engaged, output gear (O) is coupled to planetary ring gear (PR) (black shading), making planetary ring gear the output drive unit.

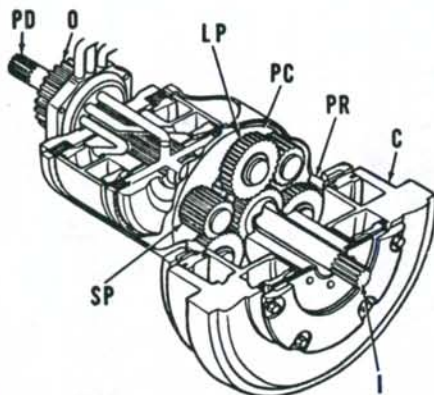


Fig. 113—Cutaway section of three-speed power shift clutch unit showing relative location of major component parts. Refer to Fig. 112 for parts identification. Output gear (O) and power drive shaft (PD) are not exactly as illustrated.

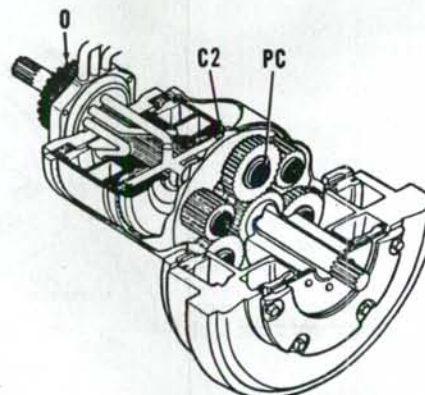


Fig. 115—With C-2 clutch engaged, planet carrier (PC) is coupled to output gear (O) as shown by black shading. Planet carrier thus becomes the output drive unit.

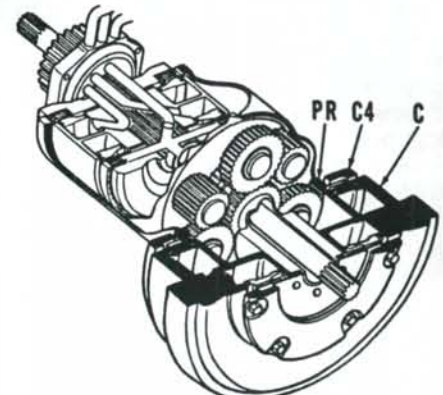


Fig. 117—With clutch C-4 engaged, planetary ring gear (PR) is coupled to carrier (C) making planetary ring gear a stationary drive member and causing planet carrier to turn in reverse direction.

Paragraphs 122-123

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Power to operate transmission system is provided by the main hydraulic system 23 gpm (88 L/min.) pump on Models 2090 and 2290 or 27 gpm (102 L/min.) pump on Models 2390 and 2590, through a pto and clutch flow divider valve while pressure lubrication is supplied by oil from the charging pump.

Refer to Figs. 118 and 119 for a pictorial schematic of the hydraulic system and power shift control valve.

Power Shift Models 2094, 2294, 2394 and 2594

122. POWER TRAIN. The power shift unit is an electric solenoid actuated and hydraulic operated planetary gear unit shown in Figs. 120 and 121.

Control units consist of four clutches on the three-speed and six clutches on the six-speed unit. Clutches (C-1, C-2, C-3 and C-4) operate the same as clutches outlined in paragraph 120. Clutches (C-5 and C-6—Fig. 121) are the High/Low unit. During operation, one of these clutches is always applied. Refer to Figs. 122 and 123 for charts showing which clutches are applied for each speed.

The input shaft is driven by the torque limiter discs on the flywheel. The output shaft speed and direction of rotation depends on which clutches are applied.

Power to the pto clutch and hydraulic pumps is transmitted through two long shafts which pass through center of the drive train. The front shaft is splined to the flywheel by a drive sleeve. The two shafts couple at the hydraulic pump drive. Rear shaft drives the pto clutch.

The power shift unit is designed to permit selection of any of the forward speeds by moving the power shift lever without stopping the tractor. To shift to reverse, it is necessary to depress the inching pedal, stop tractor and move reverse lockout lever, before the power shift lever can be moved to reverse position. This prevents accidental overshifting into reverse when downshifting in the forward gears. The inching pedal is also depressed to shift the mechanical range shift lever to any of the four speed ranges or to neutral or park. When inching pedal is depressed, power shift selector lever is automatically moved to first speed position so that tractor always starts out in lowest power shift speed after selecting a mechanical transmission gear. When mechanical (gear) transmission is in fourth gear, power shift cannot be shifted to reverse or if power shift is in reverse, gear transmission cannot be shifted to fourth gear.

123. CONTROL SYSTEM. The speed selector switch is mechanically operated

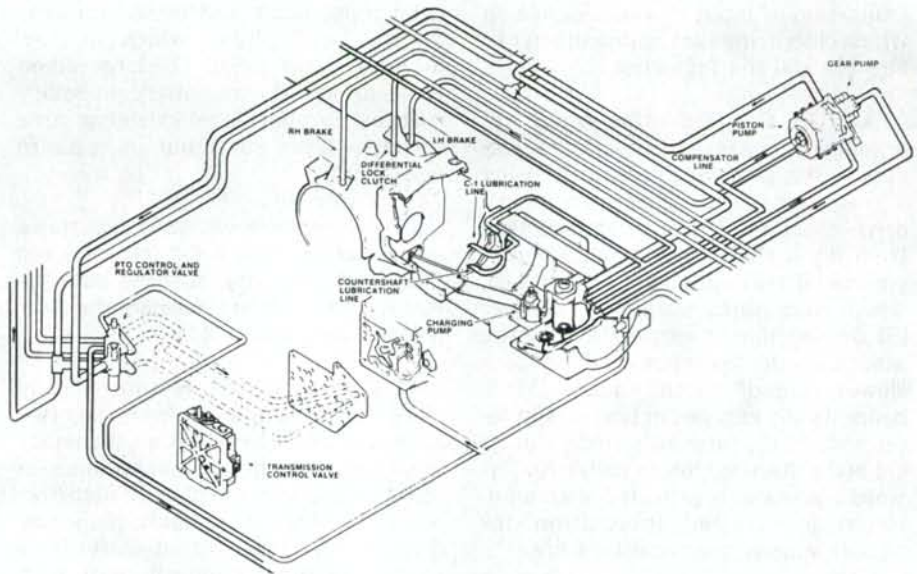


Fig. 118—Schematic illustration of hydraulic circuits to power shift unit on Model 2090 and 2290 tractors so equipped.

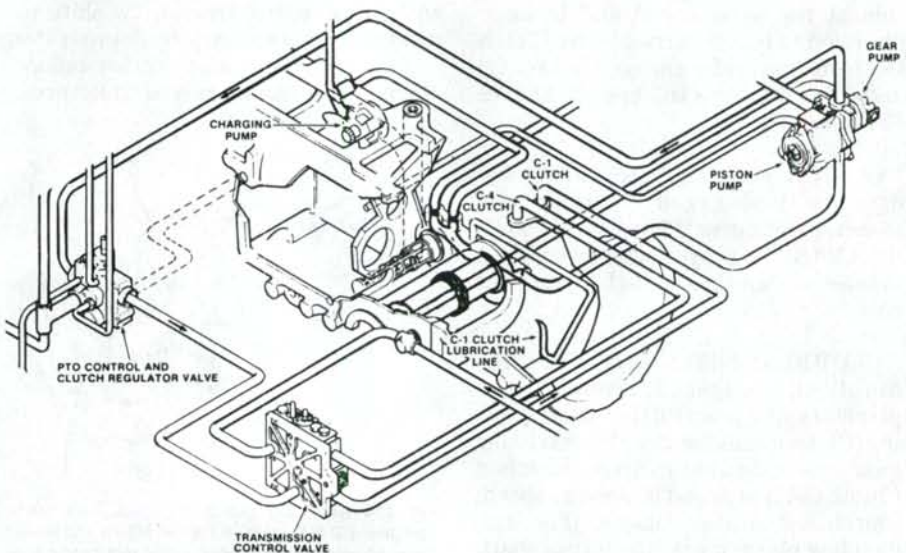
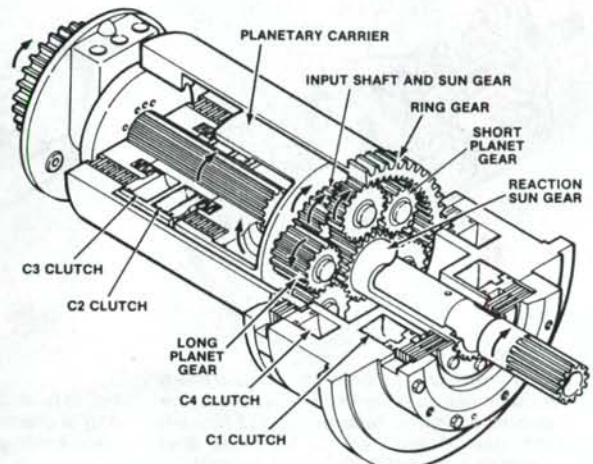


Fig. 119—Schematic illustration of hydraulic circuits to power shift unit on Model 2390 and 2590 tractors.

Fig. 120—Cutaway view of the three-speed power shift unit used on Models 2094, 2294, 2394 and 2594, showing relative location of major component parts.



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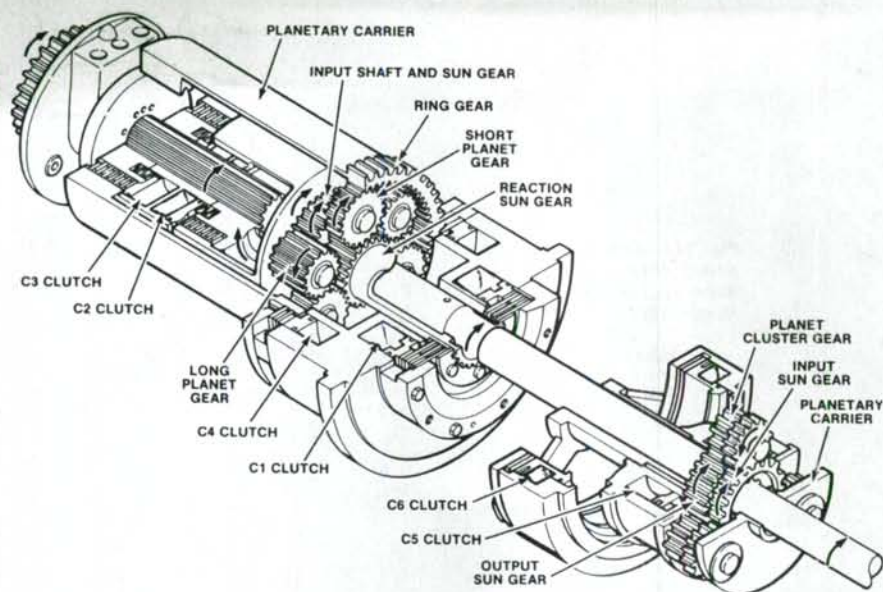


Fig. 121—Cutaway view of the six-speed power shift unit used on some Model 2394 and 2594 tractors.

POWER SHIFT HAND LEVER POSITION	APPLIED CLUTCHES			
	C1	C2	C3	C4
1 LOW	X	X		
2 INTERMEDIATE	X		X	
3 HIGH		X	X	
R REVERSE		X		X

Fig. 122—Chart identifying clutches applied for various speeds on three-speed power shift unit.

POWER SHIFT HAND LEVER POSITION	APPLIED CLUTCHES					
	C1	C2	C3	C4	C5	C6
1 FIRST	X	X				X
2 SECOND	X	X			X	
3 THIRD	X		X			X
4 FOURTH	X		X		X	
5 FIFTH		X	X			X
6 SIXTH		X	X		X	
R REVERSE		X		X		X

by the power shift control lever on the console. The switch position determines which clutches will engage or disengage. Each switch position completes circuitry to actuate two clutches on the three-speed power shift or three clutches on the six-speed power shift. Pressure switches, relays and solenoid valves are used in the control system.

The modulating spool in the control valve is mechanically moved with the inching pedal and is connected to the C-2 clutch. Partial depression of the inching pedal causes modulating spool

to be partially engaged. In this position, the main oil passage is blocked and oil flows through the 2 gpm orifice and is directed to both the C-2 clutch and the sump. The C-2 clutch won't engage until the modulating spool is completely engaged (inching pedal fully released). The modulating spool disengages when the inching pedal is completely depressed and clutch lube oil is directed

to the sump. When modulating spool is engaged, clutch lube oil is directed to the clutch friction plates for cooling.

Hydraulic power to operate the power shift system is provided by the main hydraulic system 23 gpm (88 L/min.) pump on Models 2094 and 2294 or 27 gpm (102 L/min.) pump on Models 2394 and 2594, through a flow divider-pressure regulator valve. The flow divider-pressure regulator valve controls oil pressure at 210 psi (1448 kPa) that is supplied to the power shift unit, pto and the differential lock.

ADJUSTMENT

Power Shift Models 2090, 2290, 2390 and 2590

124. LINKAGE ADJUSTMENT. To adjust the control linkage, refer to Figs. 124 and 125. Inching pedal should be 7.7 inches (195.6 mm) from center of pedal pad to cab floor as shown in Fig. 124. Adjust upper stop bolt to obtain correct distance. Push inching pedal down until clutch spool has moved up 1-1/16 inches (27 mm). Hold pedal in this position and adjust the lower stop bolt on pedal until it contacts firewall, then turn bolt 1/2 additional turn out causing pedal to lift slightly; tighten locknut. After pedal is adjusted, remove upper stop bolt.

Fig. 123—Chart showing which clutches are applied for each speed on six-speed power shift unit.

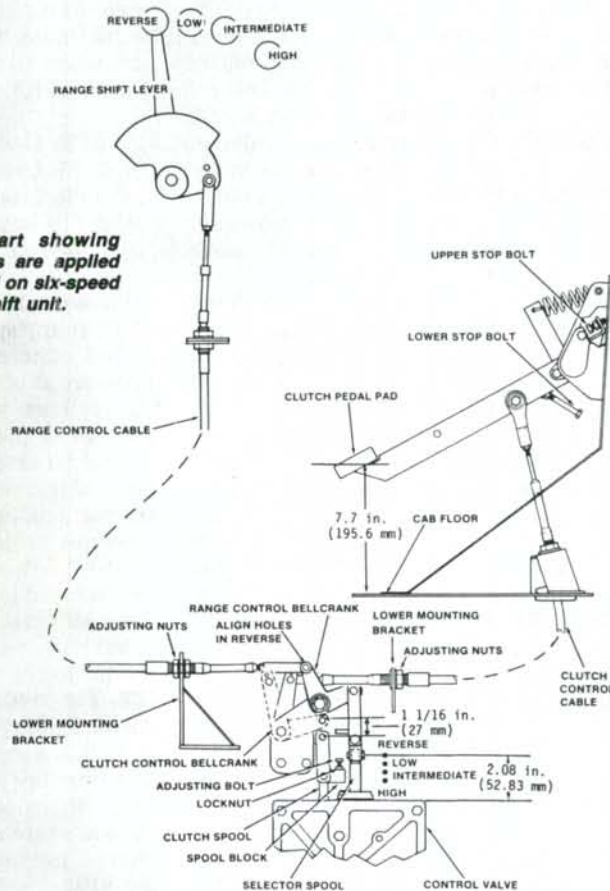


Fig. 124—Schematic view of inching pedal and power shift linkage, showing adjustment dimensions for Models 2090, 2290, 2390 and 2590.

Paragraphs 125-126

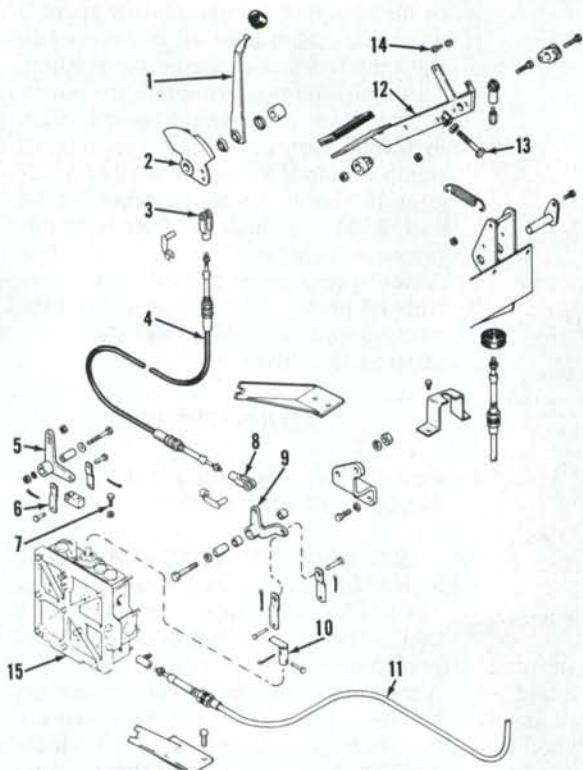


Fig. 125—Exploded view of power shift and inching pedal linkage adjustment points on Models 2090, 2290, 2390 and 2590.

1. Hand lever
2. Quadrant
3. Yoke
4. Cable
5. Bellcrank
6. Link
7. Adjustment bolt
8. Yoke
9. Bellcrank
10. Return lever
11. Cable
12. Inching pedal
13. Lower stop bolt
14. Upper stop bolt
15. Control valve

CAUTION: DO NOT allow clutch spool to travel upward more than 1-1/16 inches (27 mm).

Make sure clutch spool is completely down when pedal is in up position.

The power shift lever linkage adjustment should be made with hand lever in reverse position. Hole in control bellcrank should align with control cable yoke when selector spool is 2.08 inches (52.83 mm) from top of valve in reverse position. Adjust cable at lower mounting bracket if holes do not align. Move control lever to high position. Selector spool should completely move to high position, fully down.

With inching pedal completely pushed down, selector spool must return to low position. Adjust bolt on clutch spool block if selector spool does not return to low position.

125. PRESSURE TEST. Power shift clutch operating pressure should be 170-190 psi (1172-1210 kPa) at low engine idle and 180-200 psi (1241-1379 kPa) at high engine idle. Operating pressure is controlled by shims (13—Fig. 126 or 19—Fig. 127) located in pto control and flow divider valve body. Shims are available in thicknesses of 1/64 inch (0.397 mm) for 2090 and 2290 power shift model tractors and 0.0164 inch (0.42 mm) for all 2390 and 2590 model tractors. Add or remove shims as required to obtain correct pressure.

To check system pressure disconnect transmission pressure sensor from pto/flow divider and attach a 300 psi

(2100 kPa) gage in sensor port (See Figs. 128 and 129). Remove any of the marked port plugs (C-1, C-2, C-3 or C-4— Fig. 130) and install a 300 psi (2100 kPa) pressure gage. Start and run the engine. With transmission fluid at operating temperature and mechanical range transmission in neutral, move the selector lever to pressurize the selected clutch as follows:

- C-1 (To Low or Intermediate)
- C-2 (To Low, High or Reverse)
- C-3 (To Intermediate or High)
- C-4 (To Reverse, or depress inching pedal)

Pressure should remain relatively constant at any speed and should be equal for all clutches. A noticeable drop in pressure at idle speed or in a particular clutch port would probably indicate leakage in that clutch circuit.

Shut off engine and move test gage to lube oil test port (LO—Fig. 130), restart tractor engine and check lubrication pressure which should be 55-65 psi (379-448 kPa) with selector lever in any position and inching pedal released; and drop to zero pressure when inching pedal is depressed. Lubrication pressure is adjusted by adding or removing shims (27—Fig. 140) in pressure regulator valve. Adding or removing one 0.012 inch (0.31 mm) shim will change lubrication pressure approximately 5 psi (34.5 kPa). Shims of 0.027 inch (0.686 mm) thickness are also available, which will change pressure approximately 10 psi (69 kPa).

CASE/INTERNATIONAL

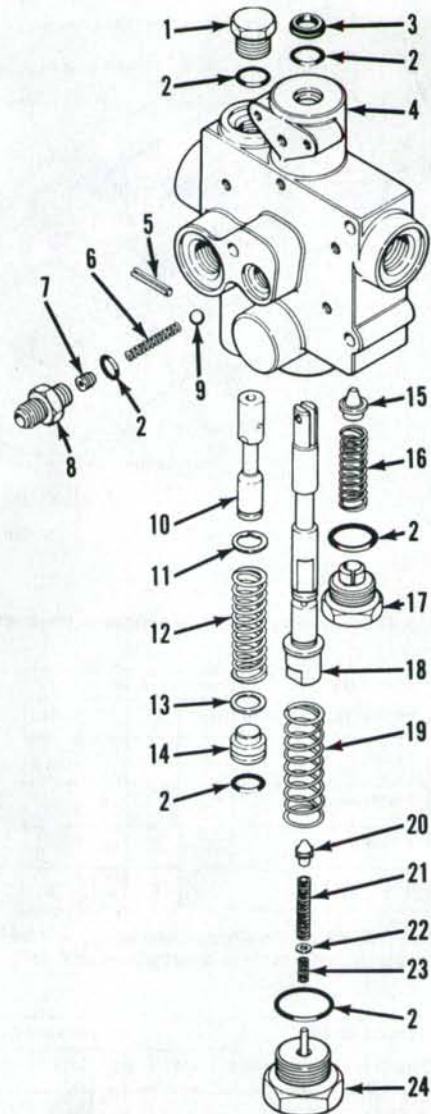


Fig. 126—Exploded view of flow divider and pto control valve for Model 2090 and 2290 tractors.

1. Plug
2. "O" ring
3. Wiper ring
4. Valve body
5. Roll pin
6. Spring
7. Set screw
8. Connector
9. Ball
10. Pressure regulator spool
11. Snap ring
12. Spring
13. Shim
14. Plug
15. Poppet
16. Spring
17. Plug
18. Pto control spool
19. Spring
20. Point
21. Spring
22. Washer
23. Spring
24. Plug

Operating circuit is also equipped with a relief valve (15—Fig. 126 or 13—Fig. 127) located in flow divider housing. Relief valve functions only as a surge relief valve upon sudden clutch engagement in power shift transmission and for cold oil starts. Relief valve should open at 240 psi (1655 kPa).

126. RETARD VALVE ADJUSTMENT. The transmission valve cover contains two adjustable, needle type retard valves, C-2 and C-3 retard (Fig. 131) which synchronize the shift se-

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quence when upshifting or downshifting between low and intermediate speeds. The need for adjustment is usually indicated by rough shifting when selector lever is moved. Checking and adjusting the valves requires the use of a special Clutch Monitor (No. CAS-1072) as shown and two pressure switches. To check and/or adjust the valves, proceed as follows:

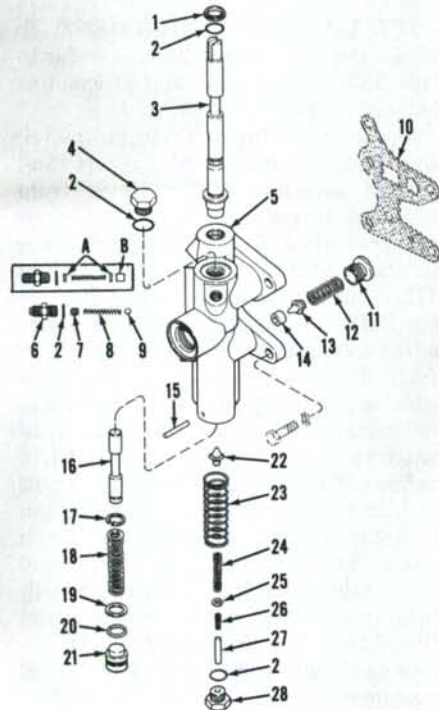


Fig. 127—Exploded view of flow divider and PTO control valve for Model 2390 and 2590 tractors. A in insert are detent washers; B is detent spool.

- | | |
|----------------------|-------------------------|
| 1. Wiper ring | 16. Pressure regulating |
| 2. "O" ring | spool |
| 3. Pto control spool | 17. Snap ring |
| 4. Plug | 18. Spring |
| 5. Valve body | 19. Shim |
| 6. Connector | 20. "O" ring |
| 7. Adjusting screw | 21. Plug |
| 8. Spring | 22. Point |
| 9. Ball | 23. Spring |
| 10. Gasket | 24. Spring |
| 11. Plug | 25. Washer |
| 12. Spring | 26. Spring |
| 13. Poppet | 27. Pin |
| 14. Seat | 28. Plug |
| 15. Roll pin | |



Fig. 128—View showing installation of a 300 psi (2100 kPa) gage in port where transmission pressure sensor was removed from Model 2090 and 2290 tractors.

Clean top of valve and remove plugs from C-2 and C-3 clutch pressure ports. Install the 170 psi (1172 kPa) pressure switch in C-3 port and the 50 psi (345

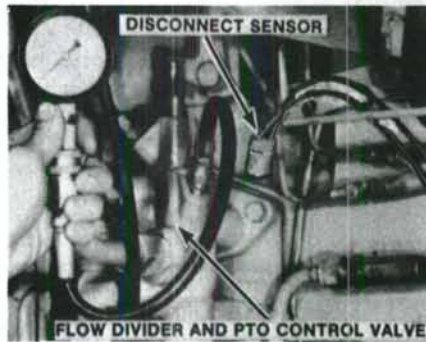


Fig. 129—View showing installation of a 300 psi (2100 kPa) gage in port where transmission pressure sensor was removed from Model 2390 and 2590 tractors.

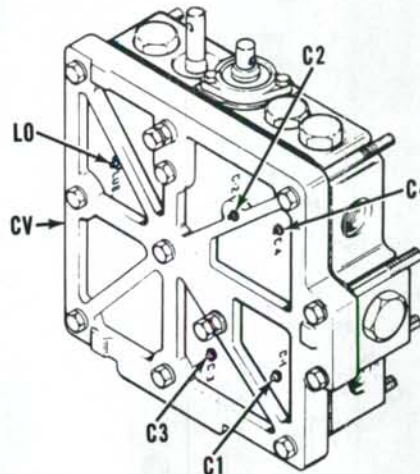


Fig. 130—View of control valve cover showing pressure test ports. LO. Lube oil test port CV. Control valve

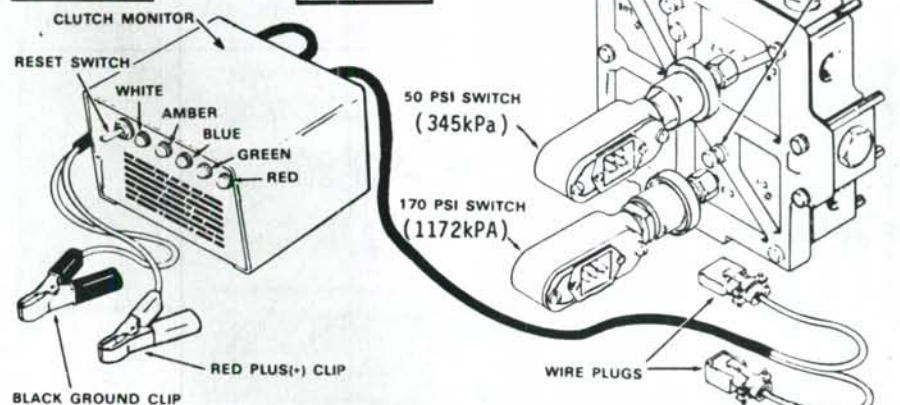
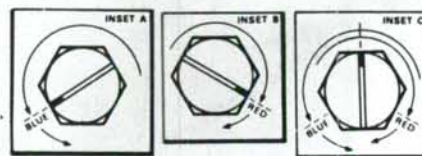


Fig. 131—A special clutch monitor CAS-1072 and pressure switches are required to correct adjust C-2 and C-3 retard valves. Refer to paragraph 126 for procedures.

Paragraph 126 Cont.

kPa) switch in C-2 port. Connect red alligator clip to battery positive and black clip to a suitable ground; while light indicates suitable power connections to monitor. Shift range lever to neutral and apply parking brake. Start and run engine at 1800 rpm; oil temperature must be 90°-100° F (32°-38° C) when making tests.

Move power shift lever to Low, then depress and release reset toggle switch; amber light indicates all conditions are satisfactory for proceeding with test. Move selector lever without hesitation from Low (1) to Intermediate (2) shift position:

If GREEN light comes on, C-2 retard valve is correctly adjusted.

If BLUE light comes on, flow is too fast from C-2 clutch; turn C-2 retard valve clockwise approximately 1/4 turn and recheck.

Repeat the test several times to be sure results are consistent. Correct setting of retard valve should be midway between the point when BLUE light first flashes (inset A) and the point where RED light first flashes (inset B) when several test settings are conducted. Inset C shows both extremes and midway point.

With C-2 clutch retard valve properly adjusted stop the tractor and reverse the position of the 50 psi (345 kPa) and 170 psi (1172 kPa) pressure switches. Place 170 psi (1172 kPa) switch in C-2 port and 50 psi (345 kPa) switch in C-3 port. Start the engine and repeat the test while downshifting from intermediate (2) shift position to Low (1) shift position and adjusting C-3 clutch retard valve. Indications and procedures are the same as given above except for shift direction and point of adjustment.

Paragraph 127

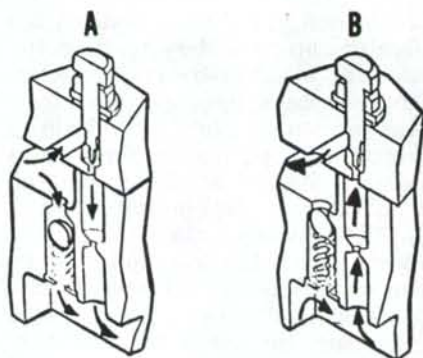


Fig. 132—Cross-sectional view of retard valve. Fluid entering clutch (A) flows by needle valve and through ball check valve. Return fluid (B) is blocked by the seated ball check and must flow through needle valve as shown.

The adjustable retard valves synchronize shift response by controlling the **RELEASE** of pressure from one clutch while allowing immediate engagement of another clutch. Incoming pressurized fluid to the clutch bypasses the retard valve as shown at (A—Fig. 132), while released fluid is routed through the needle valve by the seated check ball as shown at (B).

A retard valve which is open too wide will allow one clutch to release (and interrupt power flow) before the other clutch is engaged, resulting in interruption of power flow and a hesitation in forward travel. A retard valve which is closed too far will result in partial

engagement of two opposing clutches and a momentary partial lockup. Either condition will cause harsh, jerky shifting. No method other than the monitor shown in Fig. 131 has been found to ensure proper shift adjustment.

Power Shift Models 2094, 2294, 2394 and 2594

127. LINKAGE ADJUSTMENT. To adjust the power shift linkage, refer to Figs. 133, 134 and 135 and proceed as follows:

To adjust the inching (clutch) pedal, disconnect clutch cable clevis and reverse interlock cable clevis from bellcrank at control valve. Adjust upper stop bolt until distance between floor mat and clutch pedal is 6.8 inches (172.72 mm) measured as shown (Inset—Fig. 133). The clutch spool in the power shift valve must be in engaged position (fully down). Adjust clevis on clutch cable as necessary and connect clevis to bellcrank. Depress clutch pedal until clutch spool has moved up exactly 1-1/16 inches (27 mm). Adjust lower stop bolt with clutch pedal held in this position until stop bolt contacts brake and clutch cover. Tighten locknut on lower stop bolt. At this time, with pedal depressed, distance between floor mat and pedal should be 2.7 inches (68.58 mm) measured as shown in Fig. 133. After pedal is adjusted, remove upper stop bolt.

CAUTION: Do not allow clutch spool to travel upward more than 1-1/16 inches (27 mm) and make certain that clutch spool is completely down when pedal is in up position.

To adjust the reverse interlock cable, make certain that clutch cable is adjusted as previously outlined and proceed as follows: Depress clutch pedal and check to see that reverse interlock cable pulls power shift control lever to first speed position. If not, adjust clevis on reverse interlock cable as required.

Refer to (Inset A—Fig. 134) for three-speed power shift or (Inset (B) for six-speed power shift and adjust shift switch as follows: With switch lever positioned at 45 degrees for three-speed or 30 degrees for six-speed, connect ball rod assembly to switch lever and power shift range hand lever. Push power shift hand lever forward until the stop screw is against the cam surface of the interlock lever with interlock in clutch out position as shown in Fig. 134. Move power shift hand lever to reverse position. At this time, stop screw will move into the slot of interlock lever. Make certain that stop screw moves smoothly in the slot. If not, loosen switch mounting

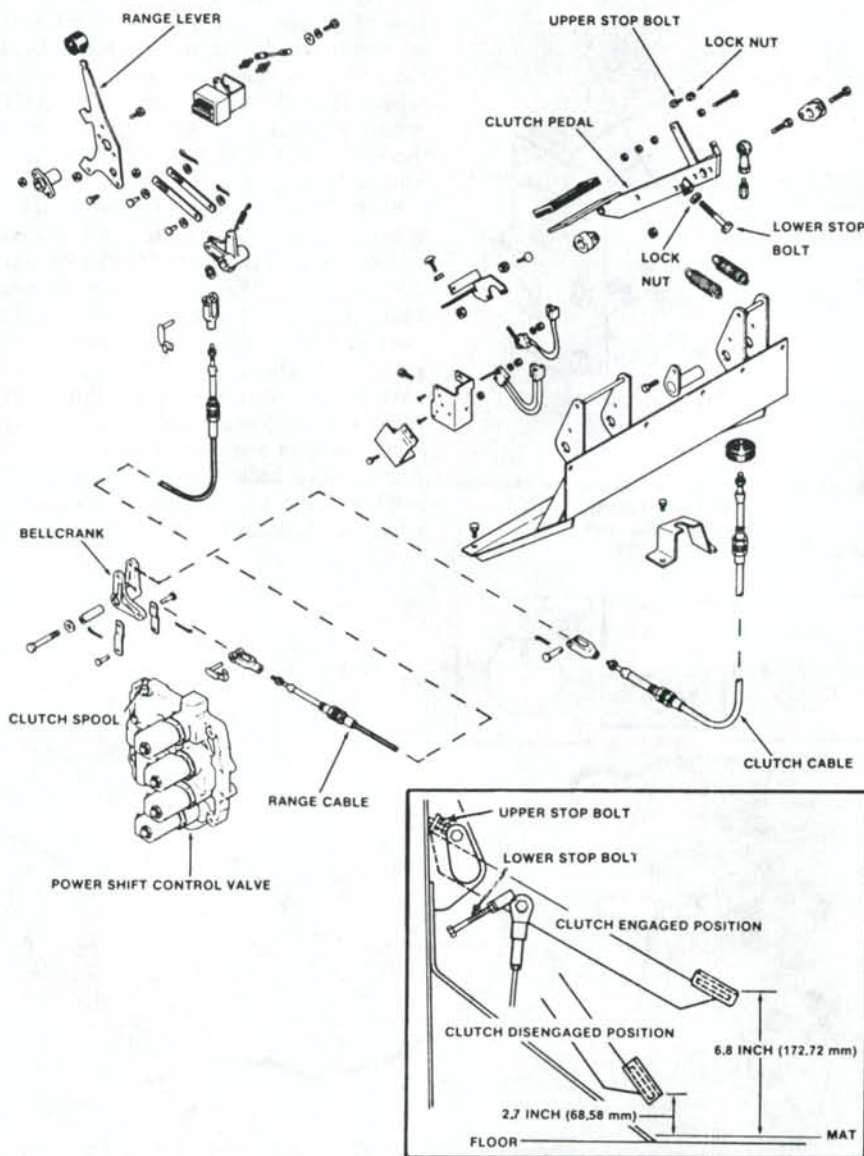


Fig. 133—Exploded view showing clutch control, shift lever and reverse interlock used on power shift Models 2094, 2294, 2394 and 2594. Inset shows pedal adjustments. Refer to text.

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Paragraph 128

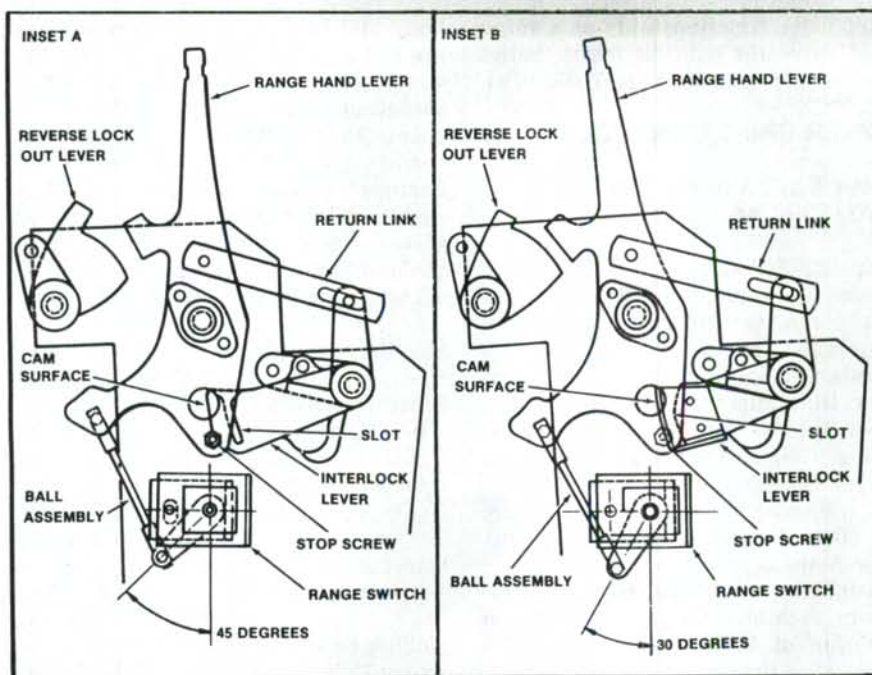


Fig. 134—Drawing showing power shift selector switch adjustment on Models 2094, 2294, 2394 and 2594. Inset A is for three-speed power shift and Inset B is for six-speed power shift.

screw and adjust switch position. Make sure that power shift control lever operation is smooth and positive in all forward and reverse ranges.

To adjust the two micro switches, refer to Fig. 135, remove switch cover and proceed as follows: Adjust the three wire C1/C4 swap switch by turning the lower switch adjusting bolt. Adjust the bolt until the C1/C4 switch actuates when clutch pedal is 2.9 inches (73.7 mm) above floor mat measured as shown in Fig. 135. Then, turn upper adjusting bolt until the two wire declutch switch actuates when clutch pedal is 5.3 inches (134.6 mm) above floor mat. Reinstall switch cover.

128. PRESSURE TEST. The manufacturer recommends that a Diagnostic Monitor CAS-1712 be used to test the power shift system. However, the system pressures can be checked with pressure gages. Power shift clutch operating pressure should be 210 psi (1448 kPa) at 2100 engine rpm. Operating pressure is controlled by shims (16—Fig. 136 or 23—Fig. 137) located in pto control and flow divider valve body. Shims are available in thicknesses of 1/64 inch (0.397 mm) and 3/32 inch (2.3 mm) for 2094 and 2294 power shift model tractors and 0.0164 inch (0.42 mm) and 3/32 inch (2.3 mm) for 2394 and 2594 tractors. Add or

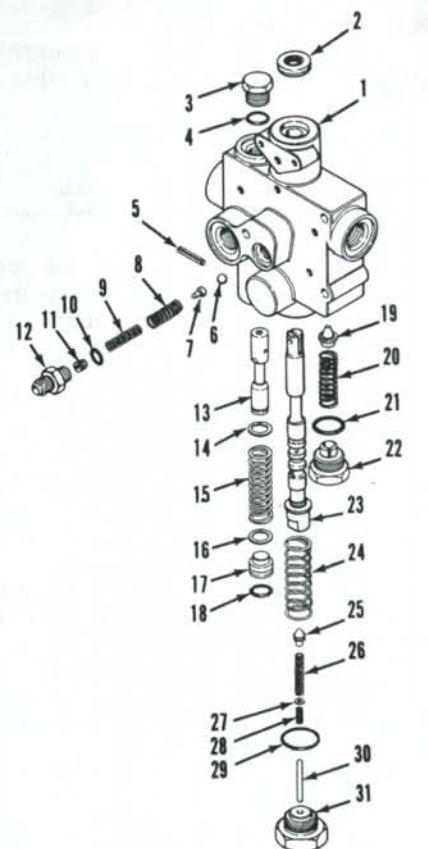


Fig. 136—Exploded view of flow divider and pto control valve for Model 2094 and 2294 tractors.

- | | |
|------------------------------|-----------------------|
| 1. Valve body | 16. Shim |
| 2. Oil seal | 17. Plug |
| 3. Plug | 18. "O" ring |
| 4. "O" ring | 19. Relief valve |
| 5. Roll pin | 20. Spring |
| 6. Detent ball | 21. "O" ring |
| 7. Guide pin | 22. Plug |
| 8. Spring (outer) | 23. Pto control spool |
| 9. Spring (inner) | 24. Spring |
| 10. "O" ring | 25. Modulator poppet |
| 11. Adjusting screw | 26. Primary spring |
| 12. Connector | 27. Washer |
| 13. Pressure regulator spool | 28. Secondary spring |
| 14. Snap ring | 29. "O" ring |
| 15. Spring | 30. Pin |
| | 31. Plug |

remove shims as required to obtain correct pressure.

To check system pressure, remove transmission pressure switch from pto control and flow divider valve and install a 600 psi (4137 kPa) test gage in the port. With engine operating at 2100 rpm and transmission fluid heated to at least 120° F (49° C), pressure should be 210 psi (1448 kPa).

To check clutch pressures, remove any of the marked port plugs P-1, P-2, P-3 or P-4 on right side of tractor or P-5 or P-6 on left side of tractor. With engine operating at 2100 rpm, transmission fluid at least 120° F (49° C) and gear transmission in neutral, move power shift lever to pressurize the selected clutch as follows:

Three-Speed Power Shift

- C-1 (To first or second)
- C-2 (To first, third or reverse)
- C-3 (To second or third)
- C-4 (To reverse)

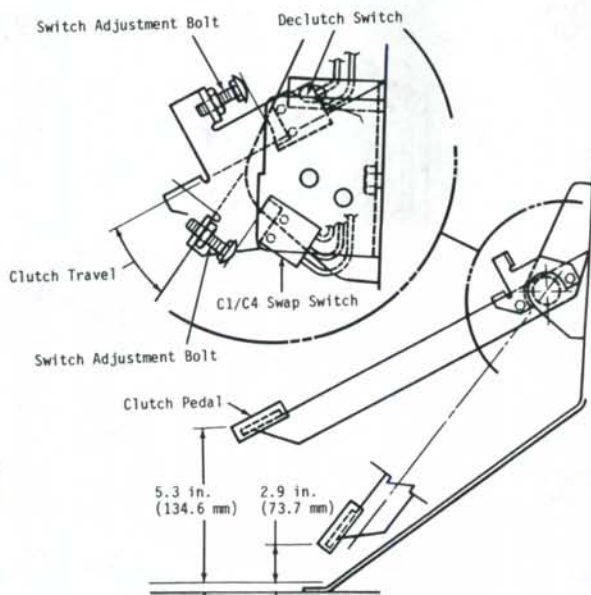


Fig. 135—View showing micro switch adjustment on power shift Models 2094, 2294, 2394 and 2594.

Paragraphs 129-131

Six-Speed Power Shift

- C-1 (To first, second, third or fourth)
- C-2 (To first, second, fifth, sixth or reverse)
- C-3 (To third, fourth, fifth or sixth)
- C-4 (To reverse)
- C-5 (To second, fourth or sixth)
- C-6 (To first, third, fifth or reverse)

Pressure should be equal for all clutches. A noticeable drop in pressure in a particular clutch port would probably indicate leakage in that clutch circuit.

Shut off engine and move test gage to the lube oil test port in power shift control valve. Steering return oil from the oil cooler flows through the modulating spool for clutch lubrication. Start engine and check lubrication pressure which should be 210 psi (1448 kPa) with selector lever in any position and inching pedal released. Pressure should drop to zero when inching pedal is depressed.

The system is also protected by a relief valve (19—Fig. 136 or 15—Fig. 137) located in the flow divider housing.

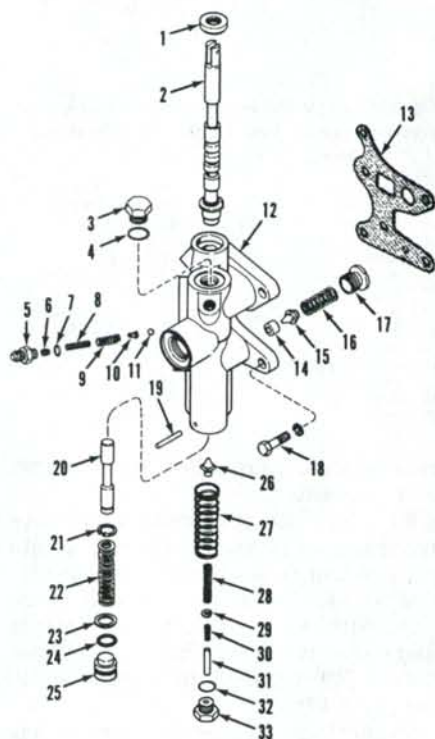


Fig. 137—Exploded view of flow divider and pto control valve for Model 2394 and 2594 tractors.

- | | |
|----------------------|------------------------------|
| 1. Oil seal | 18. Cap screw |
| 2. Pto control spool | 19. Roll pin |
| 3. Plug | 20. Pressure regulator spool |
| 4. "O" ring | 21. Snap ring |
| 5. Connector | 22. Spring |
| 6. Adjusting screw | 23. Shim |
| 7. "O" ring | 24. "O" ring |
| 8. Spring (inner) | 25. Plug |
| 9. Spring (outer) | 26. Modulator poppet |
| 10. Guide pin | 27. Spring |
| 11. Detent ball | 28. Primary spring |
| 12. Valve body | 29. Washer |
| 13. Gasket | 30. Secondary spring |
| 14. Seat | 31. Pin |
| 15. Relief valve | 32. "O" ring |
| 16. Spring | 33. Plug |

Relief valve functions only as a surge relief valve for cold oil starts. Relief valve should open at 240 psi (1655 kPa).

POWER SHIFT CONTROL VALVE

Power Shift Models 2090, 2290, 2390 and 2590

129. REMOVE AND REINSTALL. To remove the transmission control valve, first clean transmission valve and associated parts. Disconnect the necessary supply and clutch tubes from valve. Disconnect the linkage from the valve spools. Remove detent plug (1—Fig. 138), spring (3), spacer (4) and ball (6). Remove the ten cap screws (see Fig. 139) which attach valve housing and cover to transmission and lift off valve housing and cover as a unit.

Install by reversing removal procedure. Tighten retaining cap screws to a torque of 30-35 ft.-lbs. (40.7-47.5 N·m) using the sequence shown in Fig. 139. Adjust valve linkage if necessary as outlined in paragraph 124.

NOTE: DO NOT disturb C-2 and C-3 clutch retard valves (Fig. 131) unless absolutely necessary. Special tools are required for readjustment, as outlined in paragraph 126.

130. OVERHAUL. Refer to Fig. 140 for an exploded view of power shift control valve. Springs, spools and associated parts except for body, spring (33), modulator point (32), ball (12) and pin (37) are available individually. The valve

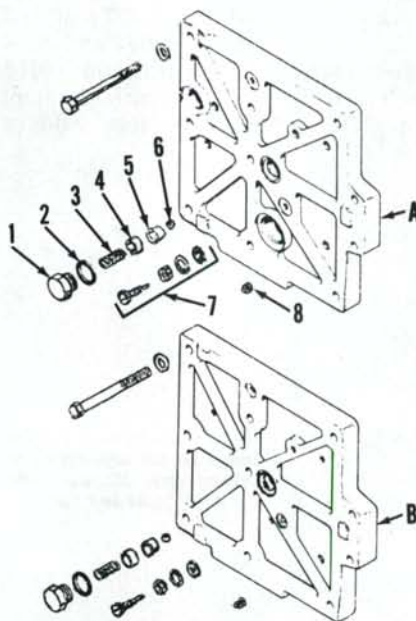


Fig. 138—View of Model 2090 and 2290 (A) and Model 2390 and 2590 (B) power shift control valve covers.

- | | |
|-------------|------------------------|
| 1. Plug | 5. Sleeve |
| 2. "O" ring | 6. Ball |
| 3. Spring | 7. Retard needle assy. |
| 4. Spacer | 8. Plug |

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body and previously mentioned parts are not serviced separately. A seal kit which contains all necessary "O" rings, gaskets and seals is available. Pilot valve spools (16, 24, 38 and 42—Fig. 140) and springs (15, 39 and 43) are interchangeable. C-4 spool spring (23) is slightly shorter than the other three. All valves should fit freely in body bores without binding or excessive looseness. Tightening torques are as follows:

- | | |
|--|-----------------------------------|
| Shuttle valve plug (1) .. | 13-15 ft.-lbs.
(17.6-20.3 N·m) |
| Pressure regulator plug (29) | 13-15 ft.-lbs.
(17.6-20.3 N·m) |
| Pilot valve plugs (13, 20, 41, 45) | 13-15 ft.-lbs.
(17.6-20.3 N·m) |
| Selector valve sleeve cap screws | 7-9 ft.-lbs.
(9.5-12.2 N·m) |
| Modulator spool plug (37) | 17-20 ft.-lbs.
(23-27 N·m) |
| Reducer bushing (52) .. | 22-25 ft.-lbs.
(30-34 N·m) |

Power Shift Models 2094, 2294, 2394 and 2594

131. REMOVE AND REINSTALL. To remove the power shift control valve (8—Fig. 141 or 142), remove nuts (5), lockwashers and solenoid cover (6). Clean control valve and surrounding area. Identify and disconnect electrical wires from solenoids and pressure switches. Disconnect hydraulic tubes as necessary and linkage from valve spool. Remove two cap screws (4) and install two 3/8 x 6 inch guide studs. Remove four studs (7) and balance of cap screws (4). Slide control valve from tractor. On

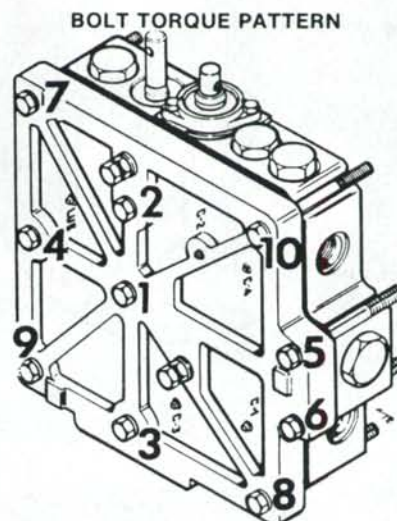


Fig. 139—When installing control valve, tighten cap screws to a torque of 30-35 ft.-lbs. (40.7-47.5 N·m) using sequence shown.

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Paragraphs 132-133

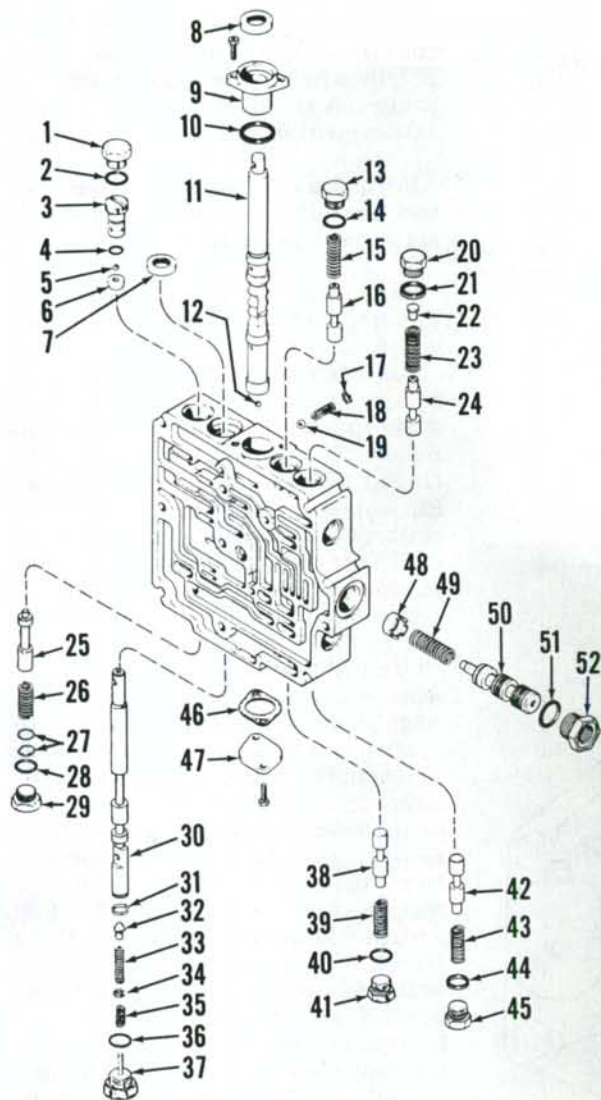


Fig. 140—Exploded view of power shift control valve showing component parts.

1. Plug
2. "O" ring
3. Sleeve
4. "O" ring
5. Ball
6. Seat
7. Seal
8. Seal
9. Sleeve
10. "O" ring
11. Selector spool
12. Ball
13. Plug
14. "O" ring
15. Spring
16. Pilot spool
17. Retainer
18. Spring
19. Ball
20. Plug
21. "O" ring
22. Stop
23. Spring
24. Pilot spool
25. Pressure regulator plunger
26. Spring
27. Shims
28. "O" ring
29. Plug
30. Clutch control spool
31. Snap ring
32. Point
33. Spring
34. Washer
35. Spring
36. "O" ring
37. Pin & plug Assy.
38. Pilot spool
39. Spring
40. "O" ring
41. Plug
42. Pilot spool
43. Spring
44. "O" ring
45. Plug
46. Gasket
47. Cover
48. Sleeve
49. Spring
50. Reverse lock spool
51. "O" ring
52. Bushing

132. OVERHAUL. Refer to Fig. 147 for an exploded view of power shift control valve and to Fig. 148 for exploded view of solenoid valves. Disassembly and reassembly procedures are obvious after examination of units. Oil seal (1—Fig. 147) must be installed with lip toward inside. Tighten modulator spool plug (11) to a torque of 17-20 ft.-lbs. (23-27 N·m). When reassembling solenoids (3 and 15—Fig. 148), lubricate all "O" rings with petroleum jelly. Tighten tube assemblies (4 and 28) into valve bodies to a torque of 90-100 ft.-lbs. (122-135 N·m). Tighten coil retaining nuts (1 and 30) to a torque of 8-10 ft.-lbs. (10-13 N·m).

LUBRICATION RELIEF VALVE

All Power Shift Models

133. The lubrication relief valve (Fig. 149) is located on lower right of transmission housing near oil filter cover on 2090, 2290, 2094 and 2294 power shift model tractors. Model 2390, 2590, 2394 and 2594 tractors have relief valve located in lower right rear of inside of torque tube housing, and is accessible after a rear tractor split is performed. Valve should be checked if lubrication operating pressure cannot

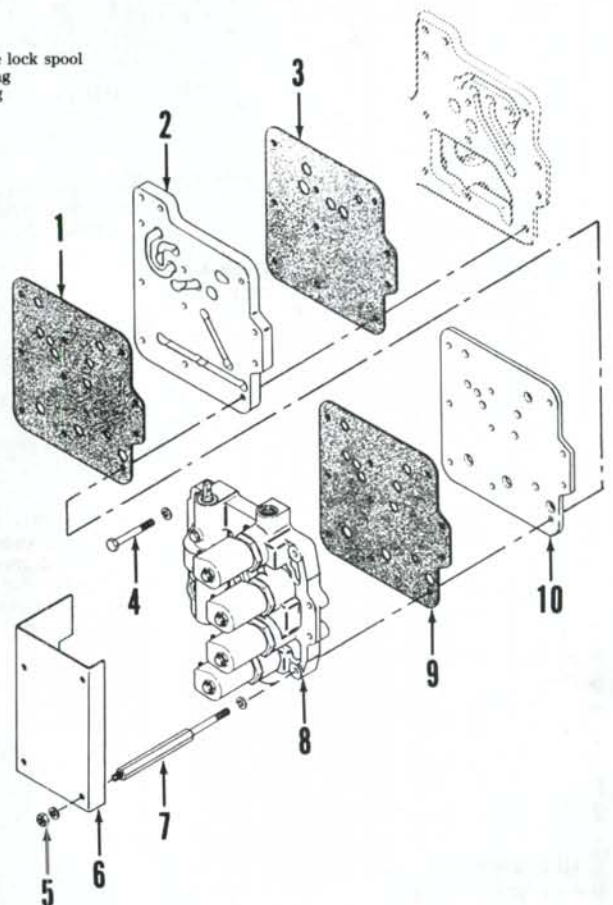
Models 2094 and 2294, remove outer gasket (9—Fig. 141), plate (10), center gasket (1), manifold (2) and inner gasket (3). On Models 2394 and 2594, remove outer gasket (9—Fig. 142), then unbolt and remove plate (10) and inner gasket (1).

On Models 2394 and 2594 equipped with six-speed power shift, clean valve (12) and surrounding area on left side of tractor. Identify and disconnect wires from solenoids and pressure switches. Disconnect hydraulic tube from valve, then unbolt and remove C-5 and C-6 valve (12) and gasket (11).

Reinstall valves by reversing the removal procedure, using new gaskets. Tighten cap screws (4—Fig. 141 or 142) and studs (7) to a torque of 30-35 ft.-lbs. (40-47 N·m) using tightening sequence shown in Fig. 143. Tighten cap screws (13—Fig. 142) to a torque of 17-20 ft.-lbs. (23-27 N·m) using tightening sequence shown in Fig. 144. Refer to Figs. 145 and 146 for views showing location of pressure switches, pressure check ports and solenoids.

Fig. 141—View of power shift control valve removed from Model 2094 or 2294.

1. Center gasket
2. Manifold
3. Inner gasket
4. Cap screw (10)
5. Nut (4)
6. Solenoid cover
7. Stud (4)
8. Control valve Assy.
9. Outer gasket
10. Plate



Paragraphs 134-135

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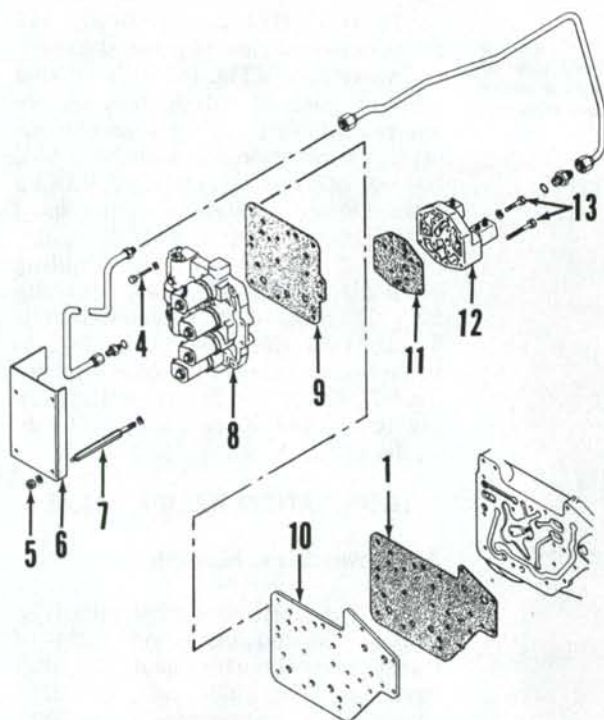


Fig. 142—View of power shift control valve removed from Model 2394 or 2594. C-5 and C-6 valve is used on six-speed power shift.

1. Inner gasket
4. Cap screw (10)
5. Nut (4)
6. Solenoid cover
7. Stud (4)
8. Control valve assy.
9. Outer gasket
10. Plate
11. Gasket
12. C-5 and C-6 valve assy.
13. Cap screws (12)

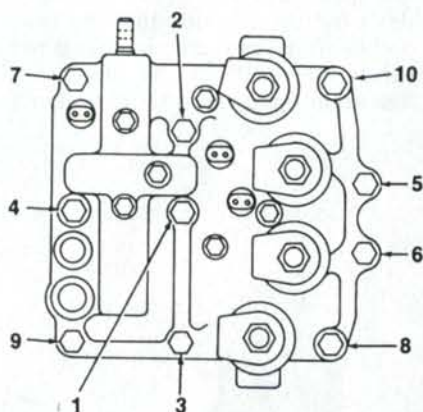


Fig. 143—View showing tightening sequence of power shift control retaining bolts on Models 2094, 2294, 2394 and 2594.

be obtained when tested as outlined in paragraph 125 or 128. All parts of relief valve except valve body are available individually.

OVERHAUL POWER SHIFT UNIT

To gain access to power shift unit, tractor must be split between torque tube and transmission housing on Models 2390, 2590, 2394 and 2594 or between engine and torque tube housing on Models 2090, 2290, 2094 and 2294.

Power Shift Models 2090, 2290, 2094 and 2294

134. TRACTOR SPLIT. To split tractor between torque tube housing and

engine, first remove cab from Model 2094 or 2294 as outlined in paragraph 277, then follow procedures outlined in paragraph 41, but do not remove front axle support or radiator.

NOTE: Cab does not have to be removed from Model 2094 or 2294 if output shaft is not going to be serviced.

Reconnect tractor as outlined in paragraph 42.

135. REMOVAL. With tractor split, remove flywheel baffle plate on Models 2094 and 2294, then on all models remove C-1 clutch lubrication tube (1—Fig. 150). Remove C-1 reaction plate (2), springs (3), sun gear (5) and clutch plates (4, 6, 7 and 8). Remove plugs for oil distribution tubes (15) located on top of torque tube, then remove oil distributor tubes. Unbolt and remove C-1 and C-4 piston carrier (16) and clutch plates and discs (22, 23 and 25). Remove C-4 clutch return springs (24). Align holes in planetary input gear with bearing carrier retainer screws (28) as shown in Fig. 151, then remove screws with a 3/16 inch Allen wrench. Remove drive sleeve from pto/pump drive shaft. Remove planetary carrier assembly from ring gear. Refer to Fig. 150 and remove thrust bearing assembly (38) and shaft locating snap ring (39). Using three 1/4-28 x 1-1/2 inch full thread bolts as jack screws, remove planetary carrier bearing and retainer (40 and 41). Remove pto/pump drive shaft. Loosen C-2 clutch hub bolts (56), then using a suitable puller, remove ring gear assembly (46 through 55) and (57 through 69).

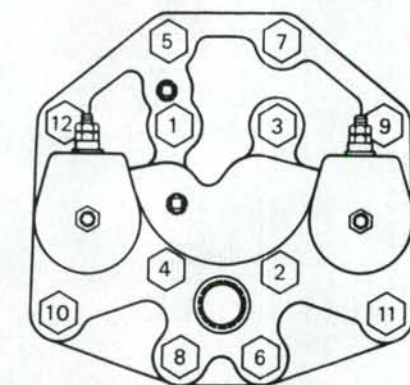


Fig. 144—View showing tightening sequence of C-5/C-6 valve retaining bolts on Models 2394 and 2594 equipped with six-speed power shift.

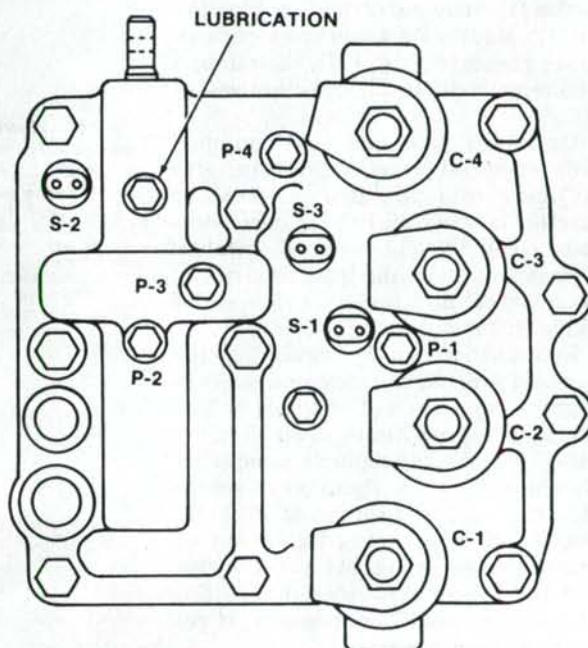


Fig. 145—View showing location of lubrication port, S-1, S-2 and S-3 pressure switches, P-1, P-2, P-3 and P-4 pressure check ports and C-1, C-2, C-3 and C-4 solenoids.

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Remove oil distributor (70) and bearing shield (73), then withdraw output shaft assembly (74 through 80).

136. OUTPUT SHAFT. Repair of output shaft assembly (items 74 through 80—Fig. 150) consists of inspection of gear (79), shaft splines and bearing (75). If renewal of bearing is necessary, heat new bearing to 250° F (120° C) and press on with snap ring side of bearing toward long splined end of output shaft.

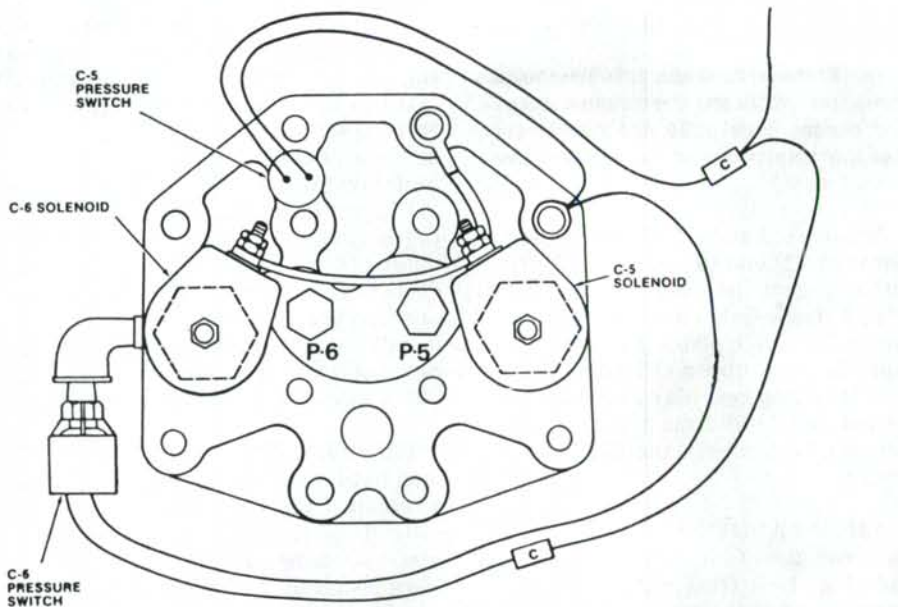


Fig. 146—View showing location of P-5 and P-6 pressure check ports, C-5 and C-6 pressure switches and C-5 and C-6 solenoids.

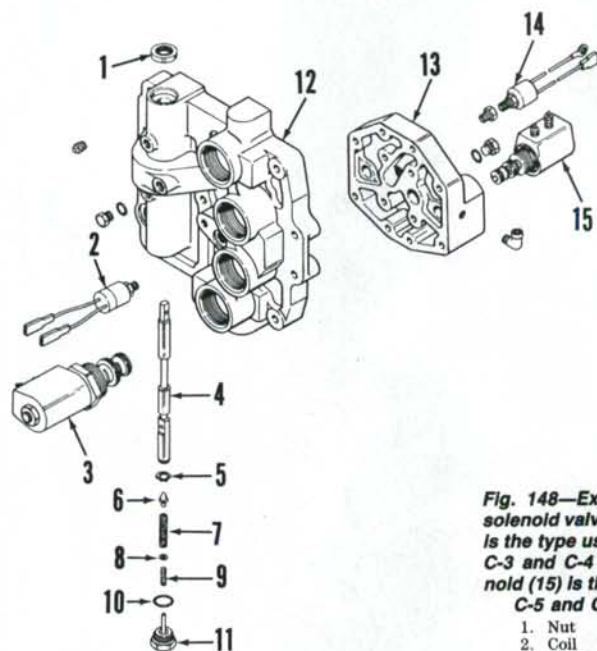


Fig. 147—Exploded view of power shift control valve used on Models 2094, 2294, 2394 and 2594. Items 13, 14 and 15 are used only on models equipped with six-speed power shift.

1. Oil seal
2. Pressure switch (3 used)
3. Solenoid valve (4 used)
4. Spool
5. Retaining ring
6. Modulator poppet
7. Primary spring
8. Washer
9. Secondary spring
10. "O" ring
11. Plug
12. Valve body
13. C-5/C-6 valve body
14. Pressure switch (2 used)
15. Solenoid valve (2 used)

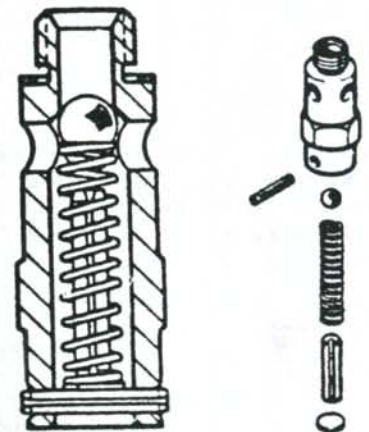


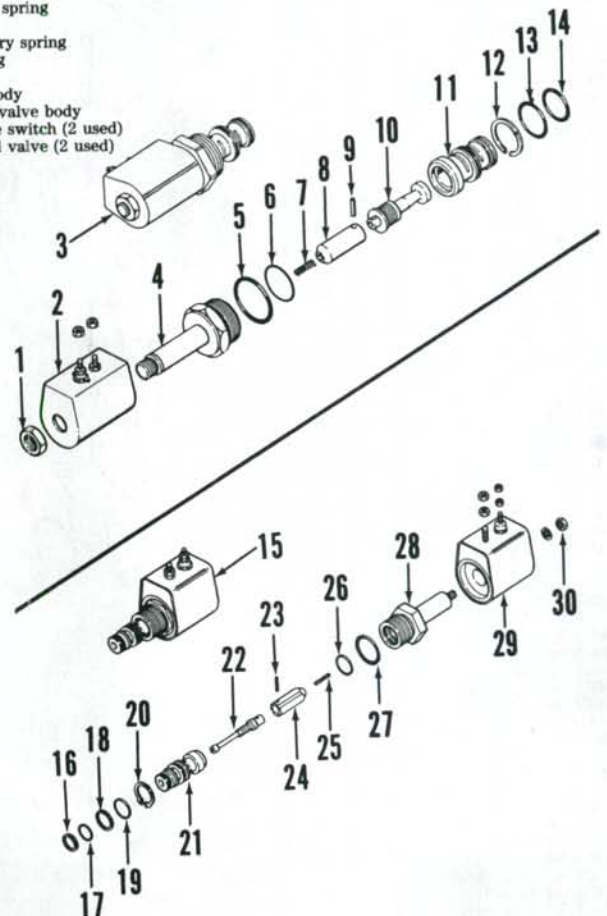
Fig. 149—Exploded and cross-sectional view of lubrication relief valve used on power shift models. Refer to text.

Fig. 148—Exploded view of solenoid valves. Solenoid (3) is the type used for C-1, C-2, C-3 and C-4 clutches. Solenoid (15) is the type used for C-5 and C-6 clutches.

1. Nut
2. Coil
3. Solenoid valve assy.
4. Tube
5. "O" ring
6. "O" ring
7. Spring
8. Plunger
9. Roll pin
10. Spool
11. Cage
12. Retaining ring
13. "O" ring
14. "O" ring
15. Solenoid valve assy.
16. Back-up ring
17. "O" ring
18. Back-up ring
19. "O" ring
20. Retaining ring
21. Cage
22. Spool
23. Roll pin
24. Plunger
25. Spring
26. "O" ring
27. "O" ring
28. Tube
29. Coil
30. Nut

Before removal of oil distributor (70), power shift valve must be removed as outlined in paragraph 129 or 131 and the three oil supply tubes (71) must be removed from oil distributor as shown in Fig. 152. Remove the three bolts (72—Fig. 150) securing oil distributor to torque tube.

NOTE: Bolts are accessible from back side of torque tube boss through opening in torque tube after control valve is removed from Models 2090 and 2290. On Models 2094 and 2294 with cab removed, remove transmission top front cover for access to the three bolts.



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If pto shaft bushing (77) inside diameter exceeds 1.1285 inches (28.6639 mm) on Models 2090 and 2290 or 1.2535 inches (31.8389 mm) on Models 2094 and 2294, renew bushing using Locquick Primer on outside surfaces, then Loctite 271 or equivalent on bushing and install new bushing to depth of 0.300 inch (7.62 mm) below flush with end of shaft. Install output gear (79) with recessed side of gear toward end of shaft.

137. RING GEAR, C-2 AND C-3 CLUTCH. To disassemble the ring gear, C-2 and C-3 clutch assembly, refer to Fig. 150. Unbolt and remove C-2 clutch hub (55), then remove C-2 clutch Belleville springs (53).

NOTE: Model 2090 and 2094 tractors use two Belleville springs on C-2 and C-3 clutches; Model 2290 and 2294 tractors use three Belleville springs on C-2 and C-3 clutches.

Remove C-2 clutch plates (54).

NOTE: Model 2090 and 2094 tractors use three steel plates and three friction discs on C-2 clutch; Model 2290 and 2294 tractors use four steel plates and four friction discs on C-2 clutch.

Remove C-2 and C-3 piston carrier (46 through 52) and (57 through 61), then lift ring gear (64), off C-3 clutch hub (68). Remove Belleville springs (62) and lower C-3 clutch plates (67) from clutch hub. Remove upper C-3 clutch plates (63) from ring gear (64) then remove internal ring (66) from ring gear (64). Remove button bearings (65) from ring gear.

138. C-2 AND C-3 PISTON CARRIER. Remove the four small "O" rings (46—Fig. 150) from carrier (47). Use compressed air to remove the C-2 and C-3 pistons (48 and 57) from carrier (47).

Remove inner and outer seals and "O" rings (items 49 through 52) and (58 through 61) from C-2 and C-3 pistons.

Lubricate new inner "O" rings (49 and 58) with petroleum jelly and install in both pistons. Lubricate new inner seal rings (50 and 59), install over inner "O" rings in pistons and seat seals using a smooth wooden dowel. Install outer "O" rings and seal rings (51, 52, 60 and 61) in both pistons in same manner. Lubricate edges of both pistons and install flat side inward into piston carrier. Lubricate the four new "O" rings (46) and install in carrier oil passages.

139. PLANETARY ASSEMBLY. To overhaul the removed planetary assembly (items 27 through 45—Fig. 150), drive pins (31) into planet gear shafts as shown in Fig. 153. This will allow planet shafts (29 and 30), gears (35 and 43), bearings (33, 34 and 44), thrust washers (32, 36 and 45) and spacers (42)

1. Lube tube
2. Reaction plate
3. Return springs
4. Disc (C-1)
5. Sun gear (C-1)
6. Disc (C-1)
7. Plate (C-1)
8. Disc (C-1)
9. Seal (outer)
10. "O" ring (outer)
11. Piston (C-1)
12. Seal (inner)
13. "O" ring (inner)
14. Pin
15. Oil tubes & "O" rings
16. Piston carrier (C-1 & C-4)
17. Seal (outer)
18. "O" ring (outer)
19. Seal (inner)
20. "O" ring (inner)
21. Piston (C-4)
22. Plate (C-4)
23. Disc (C-4)
24. Return springs
25. Plate (C-4)
26. Pin
27. Input shaft
28. Hex head screw
29. Pin (long planetary gear)
30. Pin (short planetary gear)
31. Roll pin
32. Race
33. Roller bearing
34. Roller bearing
35. Long planetary gear (24 teeth)
36. Race
37. Planetary carrier
38. Thrust washer, bearing & race
39. Snap ring
40. Ball bearing
41. Retainer
42. Spacer (short planetary gear)
43. Short planetary gear (36 teeth)
44. Roller bearing
45. Race
46. "O" ring
47. Carrier (C-2 & C-3)
48. Piston (C-2 & C-3)
49. "O" ring (inner)
50. Seal (inner)
51. "O" ring (outer)
52. Seal (outer)
53. Belleville springs
54. Plates & discs (C-2)
55. Hub (C-2)
56. Ferry head screw
57. Piston (C-2 & C-3)
58. "O" ring (inner)
59. Seal (inner)
60. "O" ring (outer)

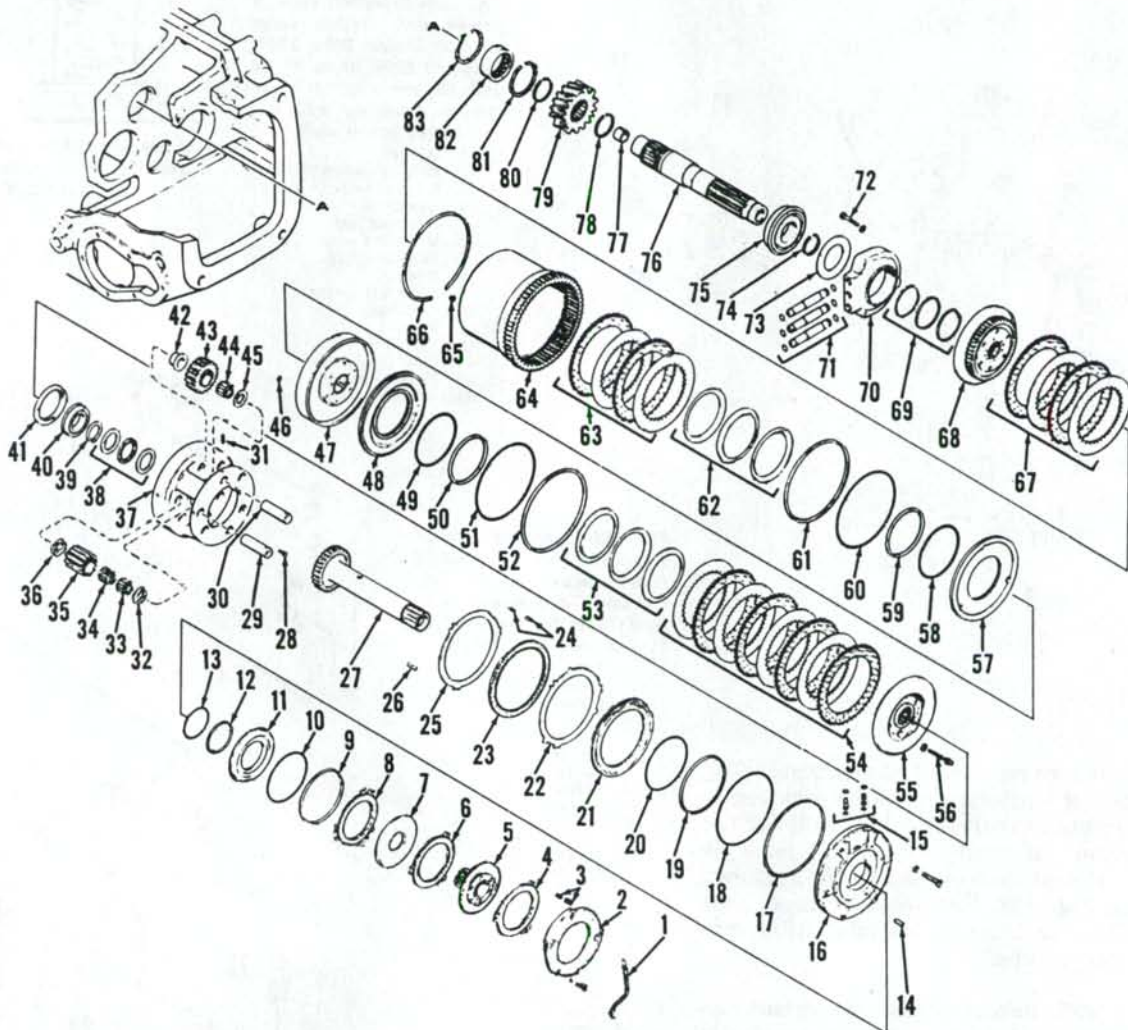


Fig. 150—Exploded view of power shift assembly for Models 2290 and 2294. Models 2090 and 2094 are similar.

- | | | | |
|--------------------------|---------------------------------------|------------------------|--------------------|
| 61. Seal (outer) | 67. Plates & discs (C-3) | 72. Bolt | 78. Snap ring |
| 62. Belleville springs | 68. Hub (C-3) | 73. Bearing shield | 79. Output gear |
| 63. Plates & discs (C-3) | 69. Oil rings | 74. Snap ring | 80. Snap ring |
| 64. Ring gear | 70. Oil distributor | 75. Ball bearing | 81. Snap ring |
| 65. Teflon button | 71. Oil distributor tubes & "O" rings | 76. Pinion drive shaft | 82. Roller bearing |
| 66. Snap ring | | 77. Bushing | 83. Snap ring |

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to be removed. Remove input shaft (27). Clean and inspect all parts and renew any that are questionable.

Reassembly by reversing disassembly procedure and observe the following: Needle bearings for the long planetary gears (35—Fig. 150) are different lengths; long bearings (34) are 1 inch (25.4 mm) for Model 2090 and 2094 tractors; 1-1/4 inches (31.75 mm) for Model 2290 and 2294 tractors. Short bearing (33) is 3/4 inch (19.05 mm) for Model 2090 and 2094 tractors and 1 inch (25.4 mm) for Model 2290 and 2294 tractors. Long planetary gears (35) must go in holes of carrier that are closest to outside of planetary shell. Short planetary gears (43) must go in holes next to inside of planetary shell. Thrust races (32, 36 and 45) are all 0.030-0.032 inch (0.762-0.813 mm) in thickness. Long needle bearing end of gear (35) must be toward inside splined end of planetary carrier. Install roll pins (31) into carrier until flush or recessed 1/32 inch (0.794 mm).

140. C-1 AND C-4 PISTON CARRIER. To renew seals and "O" rings in C-1 and C-4 clutch pistons (11 and 21—Fig. 150), follow procedure outlined in paragraph 138 and install into C-1 and C-4 clutch carrier (16) as described.

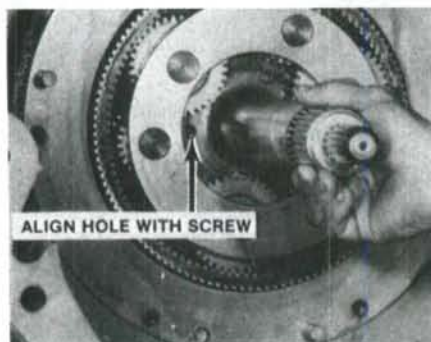


Fig. 151—Align hole in planetary input gear with hex head screw in bearing retainer. Refer to text.

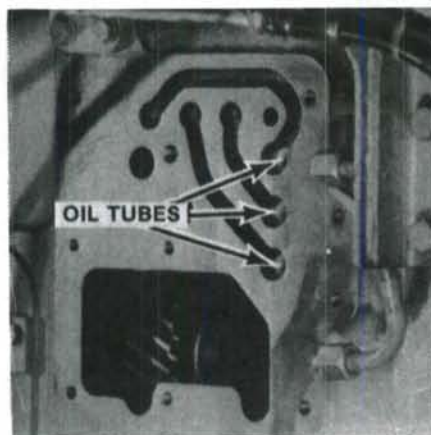


Fig. 152—View showing oil distributor tubes after removal of control valve.

141. REASSEMBLY. To reassemble the power shift clutch first, inspect output shaft rear bearing (82—Fig. 150) and renew if necessary. Install output shaft assembly (items 74 through 80) into transmission until bearing retaining ring on shaft bearing (75) seats against transmission case. Coat oil shield (73) with petroleum jelly, install into oil distributor (70) with brass side towards outside, then install oil distributor (70) with oil shield towards bearing. Oil shield must fit over bearing retainer and against bearing. Install carrier bolts and washers (72) from inside transmission case and tighten to 35-42 ft.-lbs. (48-57 N·m) torque.

Install oil distributor rings (69) on C-3 clutch hub (68) making certain hook ends are engaged. Clean threaded holes in C-3 clutch hub, then use Loctite Primer NF in threaded holes. Inspect all friction and steel plates (63 and 67) for wear or warpage and renew as necessary.

Lubricate all discs and plates with clean Hy-Tran Plus fluid. Install one friction disc, one steel plate, one friction disc and one steel plate over clutch hub (68—Fig. 150). Install clutch retaining ring (66) and button bearings (65) into ring gear (64).

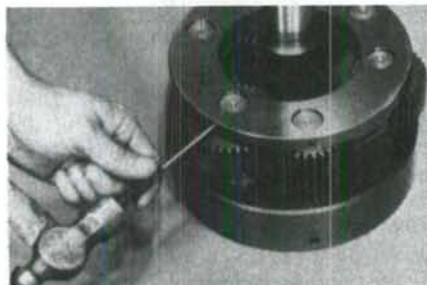


Fig. 153—Drive planetary gear shaft pins into shafts for removal of gears and shafts. Refer to text.

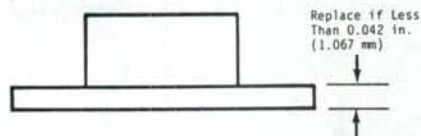


Fig. 154—Renew Teflon buttons in ring gear if worn beyond dimension shown.

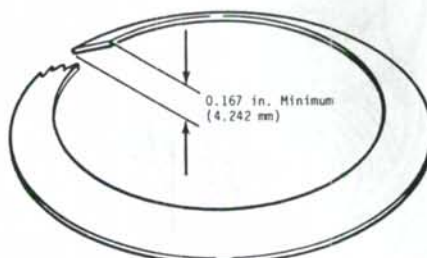


Fig. 155—Renew Belleville springs if free height is less than dimension shown.

Paragraphs 140-141

NOTE: Renew button bearings if head thickness is less than 0.042 inch (1.067 mm) as shown in Fig. 154.

Install ring gear (gear teeth up) on C-3 clutch hub engaging friction disc outside teeth in ring gear. Install remaining discs and plates alternating one friction disc and one steel plate on all models.

Check Belleville springs (62—Fig. 150) for wear, rounded corners or scratches and renew as necessary. If free height is less than 0.167 inch (4.242 mm) as shown in Fig. 155, renew Belleville spring.

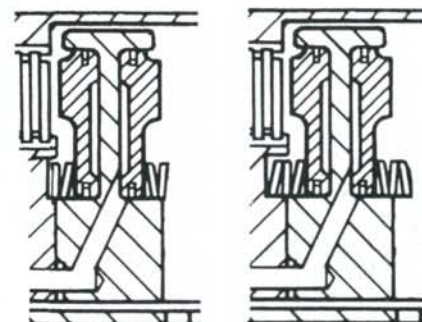
Install Belleville springs (62—Fig. 150) into recessed area of C-3 clutch hub (68). On Model 2090 and 2094 tractors, put first spring with inside diameter higher than outside diameter, and second spring with inside diameter contacting high inside diameter of first spring. See Fig. 156. On Model 2290 and 2294 tractors, put first spring with outside diameter higher than inside diameter, second spring outside diameter contacting outside diameter of first spring and third spring inside diameter contacting inside diameter of second spring. See Fig. 156.

Install a 3/8 inch NC x 7 inch stud into bolt hole of C-3 clutch hub which aligns with timing mark as shown in Fig. 157. Use Locquick Primer T and Loctite Epoxy 601 or equivalent on surfaces between C-3 clutch hub and C-2 and C-3 piston carrier assembly (47—Fig. 150).

NOTE: Do not allow Epoxy to enter pressure or lube ports of these parts.

Install C-2 and C-3 piston carrier assembly into ring gear, "O" ring side inward, aligning timing marks on piston carrier with stud in clutch hub.

Install Belleville springs (53) into piston carrier recesses. On Model 2090 and 2094 tractors, install first spring with inside diameter higher than out-



2090 AND 2094 TRACTORS
TWO BELLEVILLE SPRINGS

2290 AND 2294 TRACTORS
THREE BELLEVILLE SPRINGS

Fig. 156—Cross section showing correct installation position of C-3 clutch Belleville springs. Refer to text.

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side diameter, then second spring with inside diameter contacting inside diameter of first spring. On Model 2290 and 2294 tractors, install first spring with inside diameter higher than outside diameter, then second spring with inside diameter contacting inside diameter of first spring and third spring with outside diameter contacting outside diameter of second spring. See Fig. 156.

C-2 clutch hub (55—Fig. 150) has a timing mark on inside face which must be transferred to outside face. Use a dab of paint, or other suitable means, to make a visibly clear mark. Install discs and plates (54) starting with a friction disc and then steel plate, alternating discs and plates, until a total of six plates for Model 2090 or 2094 tractor or eight plates for Model 2290 or 2294 tractor are installed. Install three clutch plate holders (Fig. 158) to aid assembly. Refer to Fig. 159 and install clutch and hub package, using two 3/8 inch (9.53 mm) rods as a handle as shown. Be sure timing mark on hub is aligned with stud in C-3 clutch hub. Use Locquick Primer and Loctite 601 or equivalent sealant on surface of C-2 clutch hub surfaces.

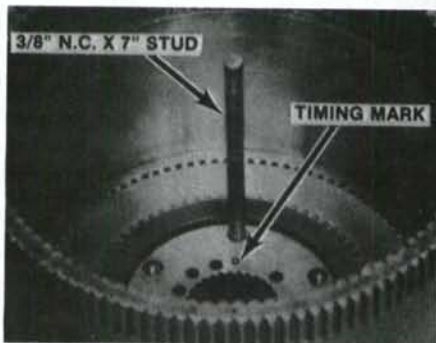


Fig. 157—View of ring gear showing installation of stud aligning with timing mark on C-3 clutch hub.

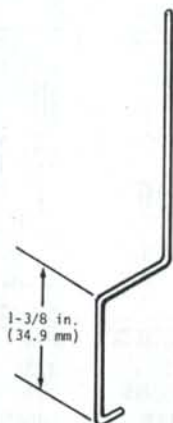


Fig. 158—Illustration of clutch plate holder showing correct dimension of bend for Models 2090 and 2094, to aid installation. On Models 2290 and 2294, use clutch plate holders CAS-1083.

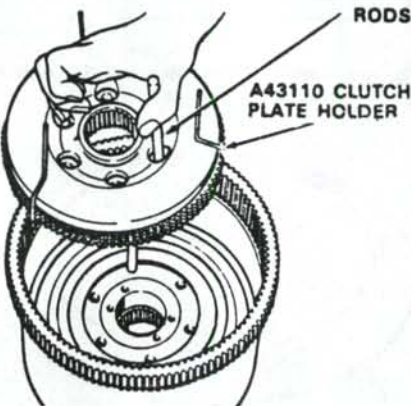


Fig. 159—Align mark on C-2 clutch hub with stud when installing assembly.

NOTE: Do not allow sealant to enter pressure or lube ports on hub.

To be certain C-2 clutch hub is correctly seated, measure gap between C-2 clutch hub and C-2 piston. Gap must be 3/8 inch (9.53 mm) or clutch hub could be held up on Belleville springs or C-2 clutch plates are not flat on hub.

Use a pilot shaft to align assembly as shown in Fig. 160, use Locquick and Loctite sealant or equivalent on cap screws (56—Fig. 150), install hardened washers under cap screws and tighten cap screws only tight enough to feel Belleville springs starting to compress. Final tightening must be done after ring gear assembly is installed on transmission mainshaft. Remove clutch plate holder tools and pilot shaft. Lubricate oil distributor rings (69—Fig. 150) on ring gear assembly, install pto shaft into output shaft, then install ring gear assembly into torque tube. Tighten C-2 clutch hub cap screws (previously installed) evenly to 45-50 ft.-lbs. (61-68 N·m) on Models 2090 and 2290 or 110-120 ft.-lbs. (149-163 N·m) on Models 2094 and 2294. Install bearing retainer (41), recessed area toward outside. Heat planetary carrier bearing (40) to 250° F (120° C) and install on output shaft with retaining ring on bearing toward inside, then install snap ring (39), sharp edge toward outside. On Models 2090 and 2290 install thrust washers and needle bearing (38) with 0.092-0.095 inch (2.337-2.413 mm) thick washer against planetary shaft bearing, then needle bearing and 0.030-0.032 inch (0.762-0.813 mm) washer. On Models 2094 and 2294, install the 0.092-0.095 inch (2.337-2.413 mm) thick washer against planetary shaft bearing, then install the one-piece needle bearing and race with needles facing the thick washer.

To install planetary assembly on all models, first install a 1/4 x 5 inch stud

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into one of the bearing retainer holes (41—Fig. 150). Install the planetary assembly into ring gear assembly aligning bolt holes in planetary shell with guide stud. Turn ring gear to engage C-2 clutch friction plates. Pull ring gear forward and when faces of short planet gears are flush with, or 1/8 inch (3.18 mm) below ring gear face, all clutch plates will be properly engaged. Put Loctite Primer and Loctite 290 or equivalent on threads of new socket head (Jaycock) cap screws (28), then remove guide stud and install and tighten cap screws to 10-14 ft.-lbs. (14.6-19 N·m) torque. Install drive shaft sleeve on pto shaft.

To reinstall C-1 and C-4 piston carrier (16—Fig. 150), renew any worn or damaged parts (items 2 through 26). Install seals and "O" rings of C-1 and C-4 pistons (11 and 21) as outlined for C-2 and C-3 pistons in paragraph 138, then install pistons into carrier (16). Install clutch reaction pins (26) into torque tube clutch housing. Lubricate inner and outer return springs (24) with petroleum jelly and install in recesses of clutch housing. Install C-4 steel clutch plate (25) aligning tabs with pins (26).

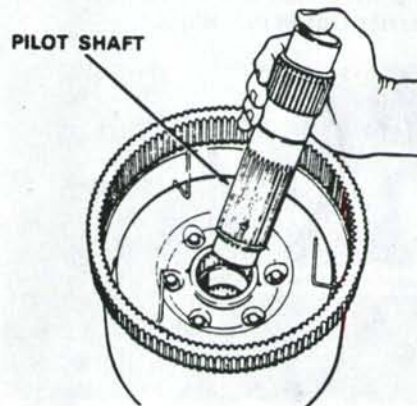


Fig. 160—Use pilot shaft to align assembly before cap screws are tightened.

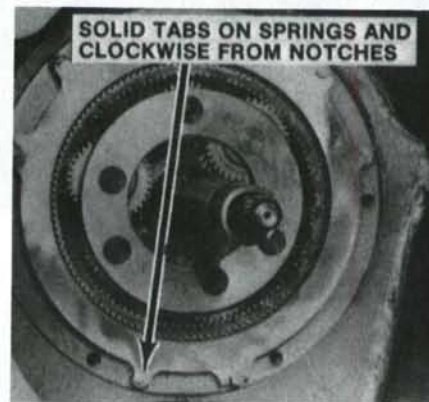


Fig. 161—Installing C-4 steel clutch plate with notches on pins and tabs aligning with return springs.

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Install C-4 friction disc (23). On Model 2290 and 2294 tractors, install another C-4 steel plate so that tabs align with pins (26), then install another friction disc. On all models, install clutch plate (22), with solid tabs, so that notches align with pins (26) and solid tabs cover return springs as shown in Fig. 161.

Install C-1 and C-4 piston carrier (16—Fig. 150) with oil tube holes up, making certain dowel pins (26) in housing enter holes in carrier. Install bolts with new hardened washers and tighten to 35-42 ft.-lbs. (48-57 N·m) on Models 2090 and 2290 or 80-96 ft.-lbs. (108-130 N·m) on Models 2094 and 2294.

Install C-1 friction plate (8—Fig. 150) on piston carrier with notched tabs on pins (14) and solid tabs clockwise from notches. Install C-1 steel plate (7), friction disc (6), without solid tabs, aligning notches on pins. Install sun gear (5), engaging splines with solid disc (7) and short planetary gears, then install friction disc (4) aligning notches on pins. Lubricate inner and outer return springs (3) with petroleum jelly and install in holes of C-1 reaction plate (2). Install bolts with new hardened washers, except for bolt which secures lube tube (1). Install lube tube and clamp and bolt, then tighten all reaction plate bolts to 35-42 ft.-lbs. (45-57 N·m) torque.

NOTE: Tip of lube tube (1) must be as near to gap between planetary input shaft and sun gear as possible without touching.

Install C-1 and C-4 oil distributor tubes (15) with new "O" rings. End of tube with smallest diameter must be down. Tighten plugs for oil tubes in top of clutch housing to 13-15 ft.-lbs. (18-20 N·m) torque.

Install the three oil distributor tubes (71) with new "O" rings. End of tubes with smallest diameter go into torque tube and engage oil distributor carrier. See Fig. 162.

Reinstall control valve as outlined in paragraph 129 or 131. Rejoin tractor by reversing split procedure.

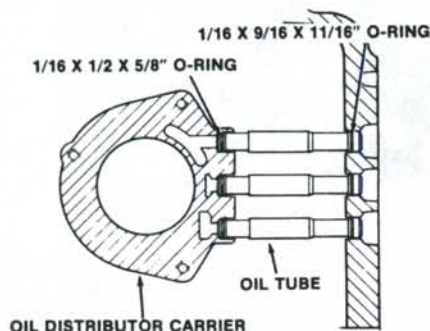


Fig. 162—View showing installation of oil distributor tubes and "O" rings for Model 2090, 2290, 2094 and 2294 tractors. Refer to text.

OVERHAUL POWER SHIFT

Model 2390, 2590, 2394 and 2594

142. TRACTOR SPLIT. Split tractor between transmission and torque tube as follows: First disconnect headlight wiring and remove engine hood and side panels. Disconnect batteries and remove batteries and battery tray. Drain transmission and torque tube oil. Disconnect four speed transmission shift control cables and remove cables from mounting brackets. Disconnect cables from power shift selector bellcrank on Models 2390 and 2590 and cable from inching spool bellcrank on all models. Disconnect bellcrank clevises from selector and inching spool, then remove bellcrank bracket. Disconnect park brake rod. Disconnect power shift solenoid wires and pressure switch wires on Models 2394 and 2594, then on all models, disconnect neutral start switch connectors. Disconnect control cables from hitch valve at rear of tractor. Disconnect all hydraulic tubes from pto clutch regulator valve, disconnect electrical connectors from transmission pressure switch, then unbolt and remove pto clutch regulator valve and gasket. Remove the two outside lower caps from control valve and install two studs in their places. This will aid in removing control valve and manifold plate. Remove control valve assembly. Remove manifold plate, and remove the five oil distributor tubes from transmission by threading a 1/2 inch NC cap screw into tube and pull on cap screw to remove tube (refer to Fig. 163). Remove studs from manifold flange. Disconnect lube tube from torque tube. Loosen nuts on both sides of front cab or platform mounts. Disconnect both left and right brake lines on tractor rear. Disconnect all necessary wiring connectors to rear of tractor. Disconnect the three hydraulic tubes and clamps on left side of tractor shown in Fig. 164. Disconnect inlet tube from remote valves. Disconnect C-1 lube tube from side of

transmission housing. Disconnect differential lock tube from hose, electrical connector from pump pressure sensor and inlet tube from gear pump. Remove remote valve return tube from side of torque tube. Remove C-1 and pto lube manifolds from side of torque tube and inlet tube for gear pump. Remove inlet tube for piston pump. Disconnect electrical terminal from pto temperature sender. Place suitable support stands under rear of cab or platform, lift cab or platform enough so that transmission will clear when rear of tractor is separated and rolled rearward. Support tractor under torque tube with suitable jackstands or support fixtures, and place rolling floor jack or rolling support fixture under rear housing. Unbolt transmission from torque tube and roll rear section rearward, separating tractor and being certain all hydraulic lines and electrical wiring are clear.

Install new gasket on torque tube housing and reconnect tractor by reversing removal procedures and tighten transmission to torque tube cap screws to 150-180 ft.-lbs. (203-244 N·m) torque.

NOTE: Engine may have to be rotated to align input shaft splines to torque limiter and pto shaft splines to flywheel.

Tighten cab or platform mounting nuts to 150-180 ft.-lbs. (203-244 N·m) torque. Install new "O" rings on oil distributor tubes, (see Fig. 163), lubricate generously and install tubes until they bottom in transmission. Install power shift manifold plate, using new gaskets, and control valve and tighten cap screws in sequence shown in Fig. 139 or 143 to 30-35 ft.-lbs. (41-48 N·m) torque. Use new gasket and install pto clutch regulator valve and tighten cap screws to 30-35 ft.-lbs. (41-48 N·m) torque. Adjust power shift selector linkage and inching pedal linkage as outlined in paragraph 124 or 127. Adjust four-speed range shift linkage as outlined in paragraph 154. Adjust park lock rod as outlined in paragraph 180. Adjust hitch valve linkage as outlined in

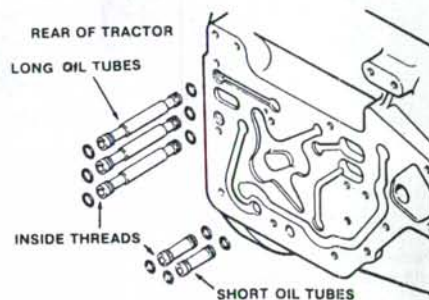


Fig. 163—View showing five oil distributor tubes and "O" rings for Models 2390, 2590, 2394 and 2594 tractors. Refer to text.

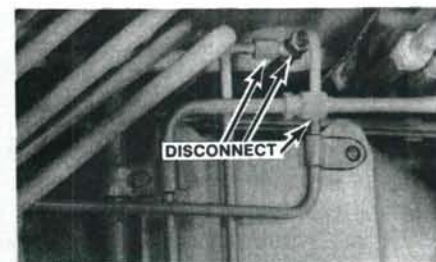


Fig. 164—View of left side of tractor showing three hydraulic tubes to be disconnected for tractor split on Model 2390, 2590, 2394 and 2594 tractors.

Paragraphs 143-145

paragraph 267. Adjust pto valve spool as outlined in paragraph 194 or 195. Fill transmission and torque tube to correct level with new Hy-Tran Plus oil.

SPECIAL NOTE: The following paragraphs will cover procedures for the three-speed power shift unit used on Models 2390, 2590, 2394 and 2594. For information covering the six-speed power shift used on some Model 2394 and 2594 tractors, use this section plus the two-speed (High/Low) unit in paragraph 152.

143. REMOVAL. Split tractor between torque tube and transmission as outlined in paragraph 142. If power shift is to be overhauled, but not removed for gear transmission repair, it is not necessary to remove carrier assembly (70—Fig. 165) from transmission housing. If power shift carrier must be removed, the following steps must be

taken to preserve countershaft (bevel pinion shaft) bearing preload and rolling torque:

Remove outer retaining nut and lockwasher (43 and 42—Fig. 184) from under carrier assembly. Make a continuous mark on inner retainer nut (41) and countershaft (16). Count the number of turns required to remove nut and make a record of it so preload can be duplicated at the time of reassembly.

NOTE: Failure to observe the above steps will necessitate removal of rear axles and differential to obtain correct pinion preload. Make sure that alignment marks on retainer nut and pinion shaft are matched exactly and exact number of turns are used on retainer nut when reassembled.

CAUTION: Small cap screw in power shift carrier must be removed from shift rail before carrier is removed from transmission housing.

144. C-1 AND C-4 CLUTCHES. To disassemble C-1 and C-4 clutches, remove C-1 clutch lube oil line (1—Fig. 165) and cap screws retaining C-1 reaction plate (2). Remove reaction plate and springs (3), then remove sun gear and clutch plates (items 4 through 8). Remove cap screws to C-1 and C-4 piston carrier (16), then remove carrier, clutch return springs (24) and C-4 clutch plates (22, 23 and 25). Use compressed air in piston carrier oil tube holes to remove C-1 piston (items 9 through 13) and C-4 piston (items 17 through 21).

145. PLANETARY REMOVAL. To remove planetary assembly from ring gear, align holes in planetary input gear with carrier retainer screws (28) as shown in Fig. 151, and remove screws with a 3/16 inch Allen wrench, then withdraw planetary assembly from ring gear. After planetary is out, remove needle thrust bearing and washers (38—Fig.

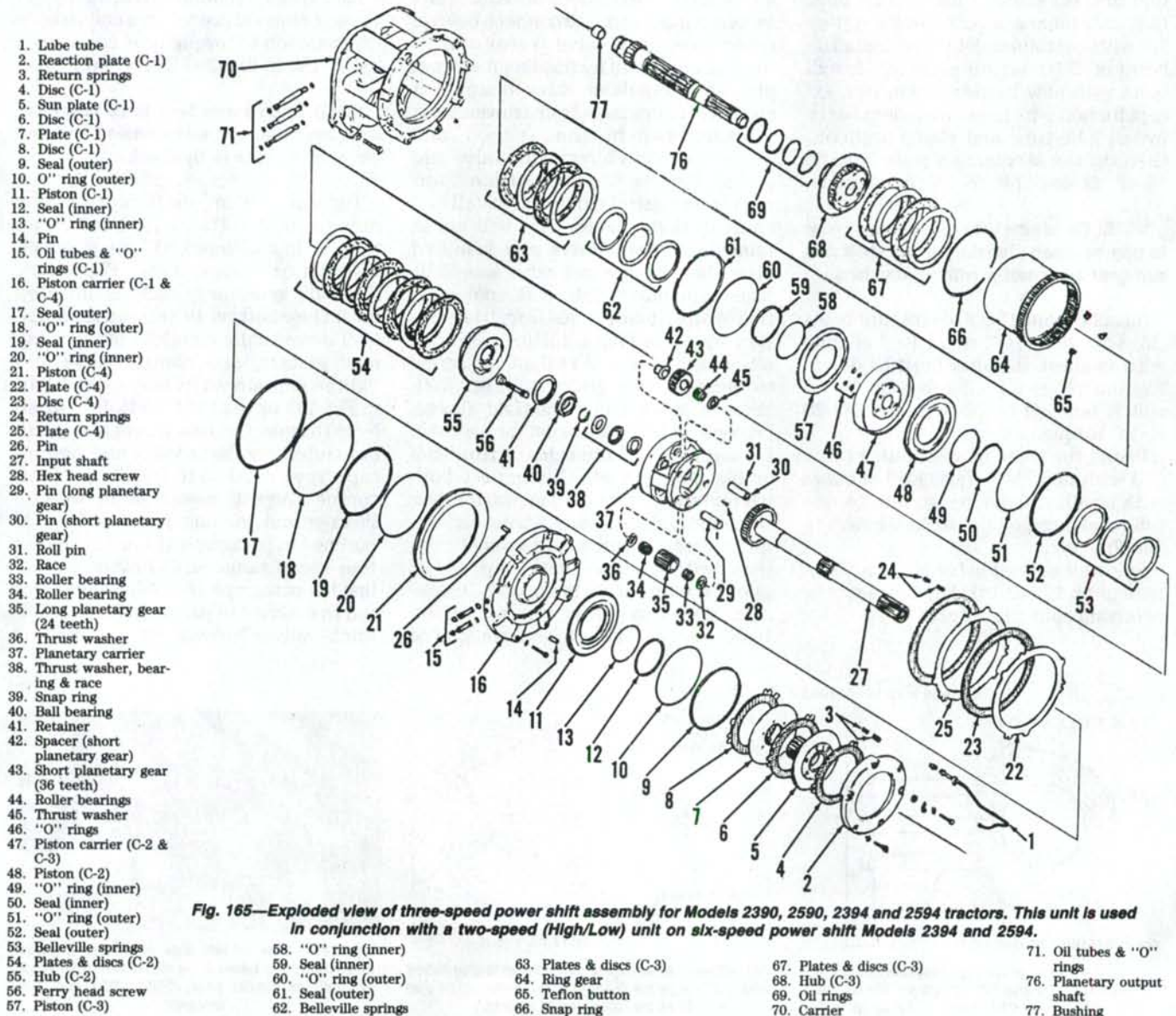


Fig. 165—Exploded view of three-speed power shift assembly for Models 2390, 2590, 2394 and 2594 tractors. This unit is used in conjunction with a two-speed (High/Low) unit on six-speed power shift Models 2394 and 2594.

SERVICE MANUAL

Paragraphs 146-151

165) from hub of ring gear. Remove snap ring (39) retaining bearing (40) to mainshaft. Install three $\frac{1}{4}$ inch 28 x 1-1/2 inch full thread bolts in bearing retainer (40 and 41). Using two levers at rear of ring gear assembly, pry against power shift carrier to remove ring gear assembly from mainshaft (Fig. 166). Inspect oil distributor ring bore in rear of power shift carrier after ring gear assembly is removed. Bore must be smooth and free of grooves or burrs.

146. OUTPUT SHAFT (MAINSHAFT). Removal and repair to output shaft (76—Fig. 165) is outlined in GEAR TRANSMISSION section following Power Shift Overhaul section. Refer to paragraph 164.

147. RING GEAR, C-2 AND C-3 CLUTCH. To disassemble ring gear, C-2 and C-3 clutches, remove the six cap screws (56—Fig. 165) and remove clutch hub (55), clutch plates (54) and Belleville springs (53) from ring gear (64). Lift ring gear from C-3 clutch hub (68) and remove piston carrier (items 46 through 52 and 57 through 61) and Belleville springs (62).

NOTE: C-3 clutch plates and discs (63 and 67) should be counted when removed, so same number can be reinstalled.

NOTE: Model 2390 and 2394 tractors use three Belleville springs on C-2 and C-3 clutches; Models 2590 and 2594 tractors use four Belleville springs on C-2 and C-3 clutches.

Inspect oil distributor rings (69—Fig. 165) and bore in carrier (70).

148. C-2 AND C-3 PISTON CARRIER. Remove the four small "O" rings (46—Fig. 165) from carrier (47). Use compressed air to remove the C-2 and C-3 pistons (48 and 57) from carrier (47). Remove inner and outer seals and "O" rings (items 49 through 52 and 58 through 61) from C-2 and C-3 pistons.

Lubricate new "O" rings (49 and 58) with petroleum jelly and install in both pistons. Lubricate new inner seal rings (50 and 59), install over inner "O" rings in pistons and seat seals using a smooth wooden dowel. Install outer "O" rings and seal rings (51, 52, 60 and 61) in both pistons in same manner. Lubricate edges of both pistons and install flat side inward into piston carrier. Lubricate the

four new "O" rings (46) and install in carrier oil passages.

149. PLANETARY ASSEMBLY. To overhaul the removed planetary assembly (items 27 through 45—Fig. 165), drive pins (31) into planet gear shafts as shown in Fig. 153. This will allow planet shafts (29 and 30—Fig. 165), gears (35 and 43), bearings (33, 34 and 44), thrust washers (32, 36 and 45) and spacers (42) to be removed. Remove input shaft (27). Clean and inspect all parts and renew any that are questionable.

Reassemble by reversing disassembly procedure and observe the following: Needle bearings for the long planetary gears (35—Fig. 165) are different lengths; long bearings (34) are 1-1/4 inches (31.8 mm), short bearings (33) are 1 inch (25.4 mm). Long planetary gears (35) must go in holes of carrier that are closest to outside of planetary shell. Short planetary gears (43) must go in holes next to inside of planetary shell. All thrust races (32, 36 and 45) are 0.030-0.032 inch (0.762-0.813 mm) in thickness. Long needle bearing end of gear (35) must go toward inside splined end of planetary carrier. Install roll pins (31) into carrier until flush or recessed 1/32 inch (0.794 mm).

150. C-1 AND C-4 PISTON CARRIER. To renew seals and "O" rings in C-1 and C-4 clutch pistons (11 and 21—Fig. 165), follow procedure outlined in paragraph 148, and install into C-1 and C-4 clutch carrier (16) as described.

151. REASSEMBLY. To reassemble the power shift unit first install oil distributor rings (69—Fig. 165) on C-3 clutch hub (68) making certain hook ends are engaged. Clean threaded holes in C-3 clutch hub then use Loctite Primer NF in threaded holes. Inspect all friction and steel plates (63 and 67) for wear or warpage and renew as necessary.

Lubricate all discs and plates with clean Hy-Tran Plus fluid. Install one friction disc, one steel plate and one friction disc over C-3 clutch hub (68). Install clutch retaining ring (66) and button bearings (65) into ring gear.

NOTE: Three bearings are used on Model 2390 and 2394 tractors; six bearings on Model 2590 and 2594 tractors. Renew button bearings if head thickness is less than 0.041 inch (1.067 mm) as shown in Fig. 154.

Install ring gear (gear teeth up) on C-3 clutch hub engaging friction disc outside gear teeth in ring gear. Install remaining discs and plates alternating one steel plate and one friction disc on all models.

Check Belleville springs (62—Fig. 165) for wear, rounded corners or scratches and renew as necessary. If free height is less than 0.167 inch (4.242 mm) as shown in Fig. 155, renew Belleville spring.

Install Belleville springs (62—Fig. 165) into recessed area of C-3 clutch hub (68). On Model 2390 and 2394 tractors, put first spring with inside diameter lower than outside diameter. On Model 2590 and 2594 tractors, put first spring with inside diameter higher than outside diameter. Alternate remaining springs as shown in Fig. 167.

Install a 1/2 inch NC x 7 inch stud into bolt hole of C-3 clutch hub which aligns with timing mark as shown in Fig. 157. Use Locquick Primer T and Loctite Epoxy 601 or equivalent on surfaces between C-3 clutch hub and C-2 and C-3 piston carrier assembly (47—Fig. 165).

NOTE: Do not allow Epoxy to enter pressure or lube ports of these parts.

Install C-2 and C-3 piston carrier assembly into ring gear, "O" ring side inward, aligning timing marks on piston carrier with stud in clutch hub.

Install Belleville springs (53) into piston carrier recesses. Install first spring with inside diameter higher than outside diameter. Alternate remaining springs as shown in Fig. 167.

C-2 clutch hub (55—Fig. 165) has a timing mark on inside face which must be transferred to outside face. Use a dab of paint, or other suitable means to make a visibly clear mark. Install discs and plates (54) starting with a friction disc and then steel plate, alternating discs and plates, until a total of eight plates for Model 2390 and 2394 tractors or ten plates for Model 2590 and 2594

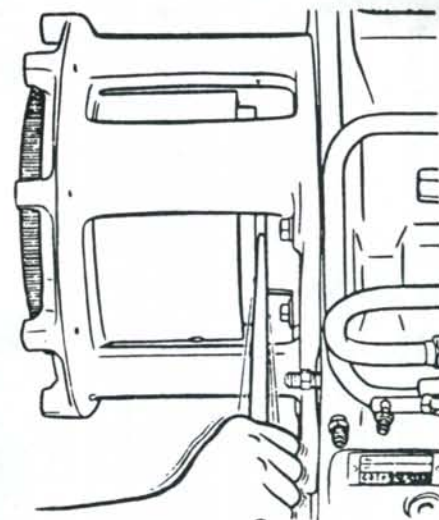


Fig. 166—Pry power shift assembly out of carrier as shown.

Paragraph 152

tractors are installed. Install three clutch plate holders (Fig. 158) to aid assembly. Refer to Fig. 159 and install clutch and hub package, using two ½ inch (12.7 mm) rods as a handle as shown. Be sure timing mark on hub is aligned with stud in C-3 clutch hub. Use Locquick Primer and Loctite 601 or equivalent sealant on surface of C-2 clutch hub surfaces.

NOTE: Do not allow sealant to enter pressure or lube ports on hub.

To be certain C-2 clutch hub is correctly seated, measure gap between C-2 clutch hub and C-2 piston. Gap must be 3/8 inch (9.53 mm) or clutch hub could be held up on Belleville springs or C-2 clutch plates are not flat on hub.

Use a pilot shaft to align assembly as shown in Fig. 160, use Locquick and Loctite sealant on cap screws (56—Fig. 165), install hardened washers under cap screws and tighten cap screws only tight enough to feel Belleville springs starting to compress. Final tightening must be done after ring gear assembly is installed onto transmission mainshaft. Remove clutch plate holder tools and pilot shaft.

Lubricate oil distributor rings (69) on ring gear assembly, install onto transmission mainshaft, then tighten C-2 clutch hub cap screws (previously installed) evenly to 110-130 ft.-lbs. (149-176 N·m) torque.

Install bearing retainer (41), recessed area toward outside. Heat planetary carrier bearing (40) to 250° F (120° C) and install on mainshaft with retaining ring on bearing toward inside, then install snap ring (39). Install thrust washers and needle bearing (38) with 0.092-0.095 inch (2.337-2.413 mm) thick washer against planetary shaft bearing, then needle bearing and 0.030-0.032 inch (0.762-0.813 mm) washer.

To install planetary assembly, first install a 1/4 x 5 inch stud into one of the bearing retainer holes (41—Fig. 165). In-

stall the planetary assembly into ring gear assembly aligning bolt holes in planetary shell with guide stud. Turn ring gear to engage C-2 clutch plates. Pull ring gear forward and when faces of short planet gears are 1/8 inch (3.18 mm) below ring gear face, all clutch plates will be properly engaged. Put Loctite Primer and Loctite 290 or equivalent on threads of new socket head (Jaycock) cap screws (28), then remove guide stud and install and tighten cap screws to 10-14 ft.-lbs. (13.6-19.0 N·m) torque.

To reinstall C-1 and C-4 piston carrier (16—Fig. 165), renew any worn or damaged parts (items 1 through 26). Install seals and "O" rings on C-1 and C-4 pistons (11 and 21) as outlined for C-2 and C-3 pistons in paragraph 148, then install pistons into carrier (16). Lubricate inner and outer return springs (24) with petroleum jelly and install in recessed areas of power shift carrier (70). Install a C-4 friction disc (23) on ring gear, then install a C-4 steel plate (25), aligning notches in plate with "X" mark on power shift carrier, and tabs of plate clockwise from notches, see Fig. 168. Install second C-4 friction disc over steel plate. Install a 3/8 inch NC x 4 inch stud in top hole of power shift carrier to be used as a guide for piston carrier installation. Install second C-4 steel plate on piston carrier aligning notches in plate with dowels (26—Fig. 165) in carrier and tabs on plate clockwise from dowels. Install piston carrier assembly aligning dowel pins with notches on steel plate on ring gear, and two oil distributor holes at left same as oil distributor holes in power shift carrier. Tabs on second steel plate (22) must contact return springs (24) in power shift carrier. Install the nine cap screws with hardened washers and tighten to 35-42 ft.-lbs. (47-57 N·m) torque.

Install C-1 friction disc (8—Fig. 165) on piston carrier with notched tabs on pins (14) and solid tabs clockwise from notches. On Models 2390 and 2394 install a steel plate (7), then a friction disc (6). On Models 2590 and 2594 install a

steel plate (7) and a friction disc (6), another steel plate and friction disc. On all models, install C-1 sun gear (5), engaging splines with solid plate(s) (7) and short planetary gears, then install friction disc (4) aligning notches on pins. Lubricate inner and outer return springs (3) with petroleum jelly and install in holes of C-1 reaction plate (2). Install C-1 reaction plate aligning return springs (3) with tabs on C-1 friction disc(s). Install bolts with hardened washers, except for bolt which secures lube tube (1). Install lube tube and clamp and bolt, then tighten all reaction plate bolts to 47-57 N·m torque.

NOTE: Tip of lube tube (1) must be as near to gap between planetary input shaft and sun gear as possible without touching.

Attach countershaft lube tube to C-1 clutch lube tube.

Rejoin tractor by reversing split procedure outlined in paragraph 142.

HIGH/LOW POWER SHIFT

Some Model 2394 and 2594 tractors are equipped with a two-speed power shift unit located in front of the three-speed power shift unit. This provides six power shift speeds. When used in conjunction with the four-speed gear transmission, tractors have 24 forward speeds.

Models 2394 and 2594 So Equipped

152. R&R AND OVERHAUL. To remove the C-5 and C-6 clutches and planetary assembly, split tractor between torque tube and transmission as outlined in paragraph 142. Unbolt and remove step assembly from cab. Disconnect wires from C-5 and C-6 solenoids and pressure switches. Disconnect hydraulic tubes from hydraulic pump and C-5/C-6 control valve body. Unbolt and remove the C-5/C-6 control valve and the hydraulic pump. Withdraw the hydraulic pump drive shaft. Remove two bolts (5—Fig. 169) and install two 3/8 inch guide studs. Remove remaining bolts and slide oil distribution hub assembly (1 through 9) from torque tube. Remove C-6 friction disc (10) and steel plate (11). Apply air pressure to hole in side of torque tube (Fig. 170) and remove C-6 piston (14—Fig. 169) with seals and "O" rings (12, 13, 15 and 16). Using screwdrivers or small bars, move planetary carrier assembly rearward, then remove assembly from torque tube. Remove cap screws (38) and remove C-5 clutch (17 through 26) and return springs (37). Remove spring plate (27), springs (28) and sun gear (29). Remove

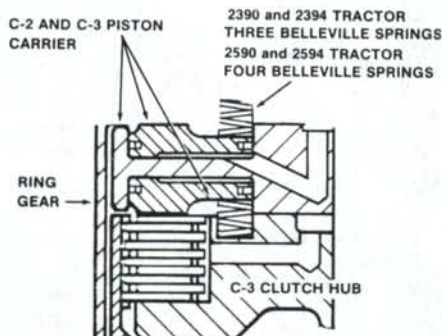


Fig. 167—Cross section showing correct installation position of C-3 clutch Belleville springs. Refer to text.

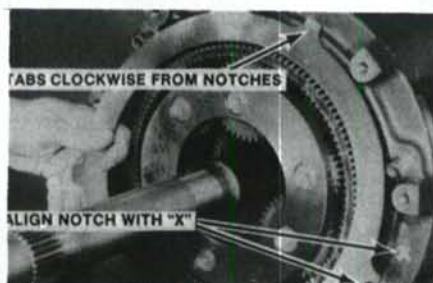


Fig. 168—View showing alignment of notches and tabs on C-4 steel clutch plate with "X" mark on carrier. Refer to text.

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flanged thrust bearing (30), thrust washer (31) and input gear (32). Withdraw input shaft (34), then remove snap ring (33), thrust washers (35) and thrust bearing (36). Drive groove pins (42) into planetary pins (40). Then, remove pins (40), planet gears (45), washers (44), bearing rollers (46) and spacer (47). Using a suitable puller, remove ball bearing (39) from carrier (41).

Remove C-5 piston (21) from piston carrier (17), then remove seals and "O" rings (19, 20, 22 and 23) from piston. If necessary, press needle bearing (18) from carrier (17). Remove seals and "O" rings (12, 13, 15 and 16) from C-6 piston (14). Remove distributor hub (2) from plate (6), then remove seal rings (4) from distributor hub.

Clean and inspect all parts and renew any showing excessive wear or other damage.

When reassembling, press ball bearing (39) on planetary carrier (41) so sealed side of bearing is away from carrier. Assemble planet gears (45), washers (44), bearing rollers (46) and spacers (47), place in carrier (41), insert planetary pins (40) and secure with new

groove pins (42). Install snap ring (33), thrust washers (35) and thrust bearing (36) on input shaft (34). Install input shaft in carrier. Install input gear (32) on input shaft, aligning timing marks on input gear with marks on planet gears (45). Install thrust washer (31) and flanged thrust bearing (30) on input shaft. Using grease to hold springs (28) in place, install sun gear (29), springs and spring plate (27). Place return springs (37) in sockets in planetary carrier. Install steel plate (26) on reaction pins (43), install friction disc (25) on sun gear (29), then install steel plate (24) with tabs against return springs (37). Install outer and inner "O" rings (20 and 23) in C-5 piston (21). Lubricate seal rings (19 and 22) with Hy-Tran Plus fluid and install in piston. Use a wood dowel or plastic pen to work seals into grooves. If removed, press new needle bearing (18) into piston carrier (17). Install C-5 piston into carrier and install piston carrier on planetary carrier. Clean bolt holes in piston carrier with Loctite Safety Solvent and apply Loctite 242 to cap screws (38). Install cap screws and tighten to a torque of 45-54 ft.-lbs. (61-73 N·m). Install planetary and C-5

clutch assembly into torque tube. Install outer and inner "O" rings (13 and 16) in C-6 piston (14). Lubricate seal rings (12 and 15) with Hy-Tran Plus fluid and install in piston. Use a wood dowel or plastic pen to work seals into grooves. Install C-6 piston assembly in torque tube, then install steel plate (11) and friction disc (10). Install new seal rings (4) on oil distributor hub (2) and using new "O" rings (8), install distributor hub on plate (6). Place reaction pins (7) and return springs (9) in sockets in plate (6). Install oil distributor assembly making certain tabs on steel plate are against return springs (9). Install and tighten retaining cap screws to a torque of 45-54 ft.-lbs. (61-73 N·m).

Reassemble tractor by reversing the disassembly procedure. Tighten hydraulic pump retaining nuts to a torque of 80-96 ft.-lbs. (109-130 N·m). Tighten C-5/C-6 control valve bolts to a torque of 17-20 ft.-lbs. (23-27 N·m) using tightening sequence shown in Fig. 144.

GEAR TRANSMISSION (POWER SHIFT MODELS)

ADJUSTMENT

Models 2090, 2290, 2094 and 2294

153. SHIFT LINKAGE. To adjust the four-speed gear transmission shift linkage, disconnect control cable yokes (8—Fig. 171) from shift levers (9 and 10). Place shift quadrants (3 and 4) in neutral position, then place shift levers (9 and 10) in neutral position (20 degrees above horizontal as shown in inset A—Fig. 171). Adjust position of cable yokes (8) so that yoke holes align with shift lever holes. Install yoke pins and secure yokes. Quadrant slots should be closely aligned.

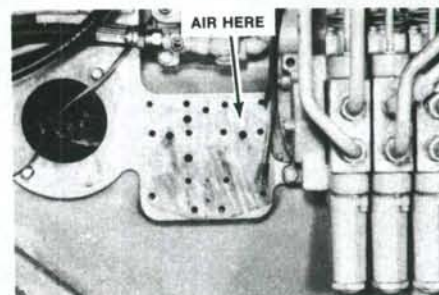


Fig. 170—Apply air pressure to hole indicated to remove C-6 piston.

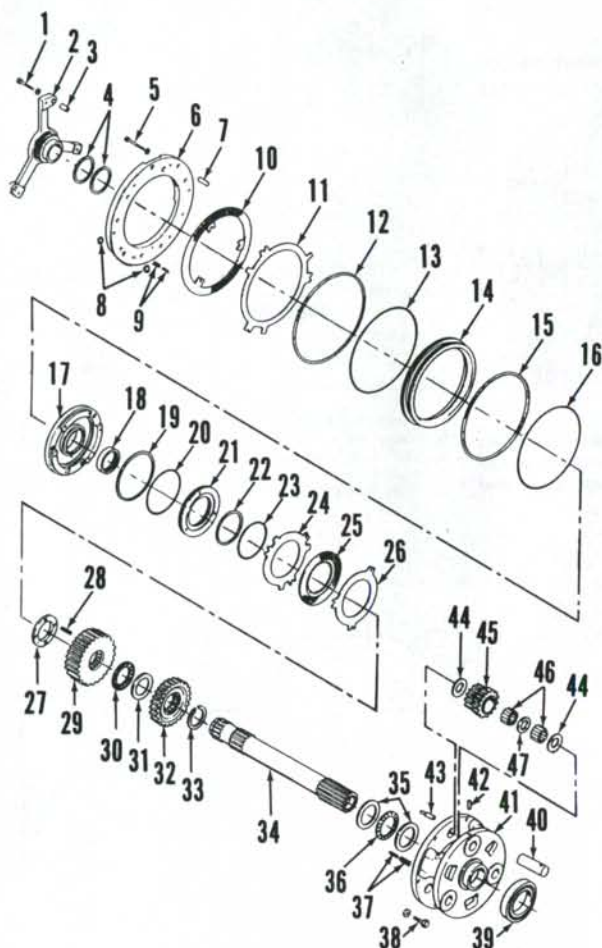


Fig. 169—Exploded view of the High/Low power shift unit used on Models 2394 and 2594 equipped with six-speed power shift.

1. Cap screw
2. Oil distributor hub
3. Tube (3)
4. Seal rings
5. Cap screw
6. Oil distributor plate
7. C-6 reaction pin (3)
8. "O" rings
9. Return springs (6)
10. C-6 friction disc
11. C-6 steel plate
12. Seal ring (outer)
13. "O" ring (outer)
14. C-6 piston
15. Seal ring (inner)
16. "O" ring (inner)
17. C-5 piston carrier
18. Needle bearing
19. Seal ring (outer)
20. "O" ring (outer)
21. C-5 piston
22. Seal ring (inner)
23. "O" ring (inner)
24. Steel plate
25. Friction disc
26. Steel plate
27. Spring plate
28. Spring (4)
29. Sun gear
30. Thrust bearing
31. Thrust washer
32. Input gear
33. Snap ring
34. Input shaft
35. Thrust washers
36. Thrust bearing
37. Return springs (6)
38. Cap screw
39. Ball bearing
40. Planetary pin (3)
41. Planetary carrier
42. Groove pin (3)
43. C-5 reaction pin (3)
44. Washers
45. Planet gear (3)
46. Bearing rollers
47. Spacer

Paragraphs 154-156

On Models 2094 and 2294, reverse lockout linkage (14) should be adjusted to obtain a distance of 3.00 inches (76.2 mm) between center of pins as shown in Fig. 172.

Models 2390, 2590, 2394 and 2594

154. SHIFT LINKAGE. To adjust the four-speed gear transmission shift linkage, disconnect control cable yokes (9—Fig. 173) from levers (10 and 11). Place shift quadrants (2 and 3) in neutral position, then place shift levers (10 and 11) in neutral position (17 degrees below horizontal as shown in inset A—Fig. 173). Adjust position of cable yokes (9) so that holes align with shift lever holes. Install yoke clip pins (12). Quadrant slots should be closely aligned.

On Models 2394 and 2594, reverse lockout linkage (14) should be adjusted to obtain a distance of 3.00 inches (76.2 mm) between center of pins as shown in Fig. 172.

All Models

155. NEUTRAL START SWITCHES.

To adjust the neutral start switches, place the four-speed gear transmission in neutral, disconnect wiring and remove the two switches (Fig. 174). Remove switch shims, then reinstall switches without shims. Using an ohmmeter or suitable continuity light, turn each switch in until light or meter shows continuity. Install shims equal to the gap behind switches. Shims are available in thicknesses of 0.005 and 0.010 inch (0.127 and 0.254 mm).

Recheck switch operation by shifting transmission from neutral to each of the four gear positions. Switch continuity should break with transmission in any gear. Continuity should occur only when transmission is in neutral position. Readjust as necessary.

FOUR-SPEED TRANSMISSION SHIFT FORKS, SHAFTS AND HOUSING

Power Shift Models 2090, 2290, 2094 and 2294

156. REMOVE AND REINSTALL. To remove shifter forks and shafts for service or renewal, first drain transmission oil. Then, disconnect shift control cables from four-speed transmission and park lock levers. Remove neutral start switch wiring. Remove rear side access cover

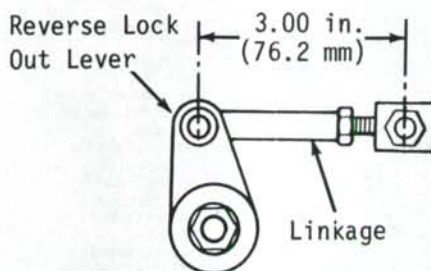


Fig. 172—Adjust reverse lockout linkage to obtain a distance of 3.00 inches (76.2 mm) between center of pins on Models 2094, 2294, 2394 and 2594.

and cable bracket. Refer to Fig. 175 and drive out detent roll pins (17) from both forks (13 and 16), then remove detent springs (19) and balls (18). Engage park lock, fully clockwise, then drive roll pin (20) out of shift rail (21) and shift rail bore in transmission. Disengage park lock, fully counterclockwise, put transmission in first gear by sliding rear shift fork (16) rearward. Rotate shift rail until roll pin (24) can be driven out of shift rail. Separate shift rail and push rear rail section (25) rearward out of shifter fork (16), then remove shifter

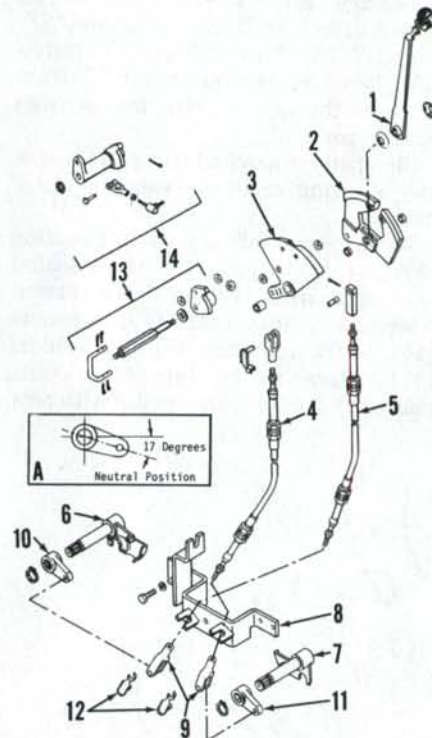


Fig. 173—Exploded view of four-speed gear transmission shift linkage used on Models 2390, 2590, 2394 and 2594.

- | | |
|---------------------------------|---|
| 1. Gear shift lever | 8. Bracket |
| 2. Quadrant (1st & 2nd) | 9. Yokes |
| 3. Quadrant (3rd & 4th) | 10. Shift lever |
| 4. Cable (3rd & 4th) | 11. Shift lever |
| 5. Cable (1st & 2nd) | 12. Clip pins |
| 6. Shift fork lever (1st & 2nd) | 13. Reverse lockout linkage (2390 & 2590) |
| 7. Shift fork lever (3rd & 4th) | 14. Reverse lockout linkage (2394 & 2594) |

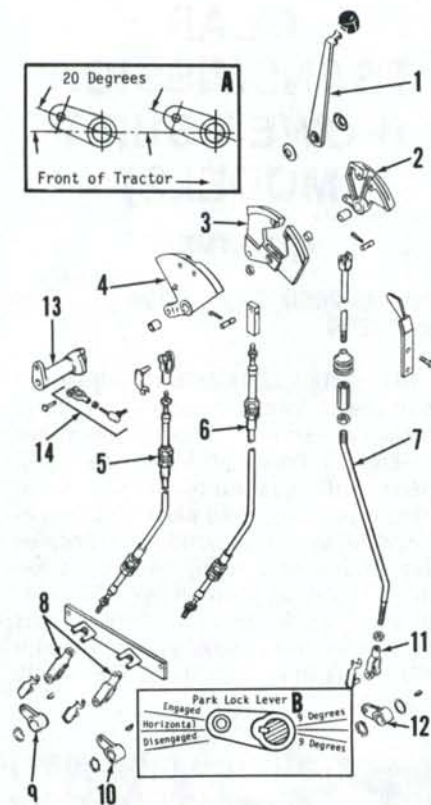
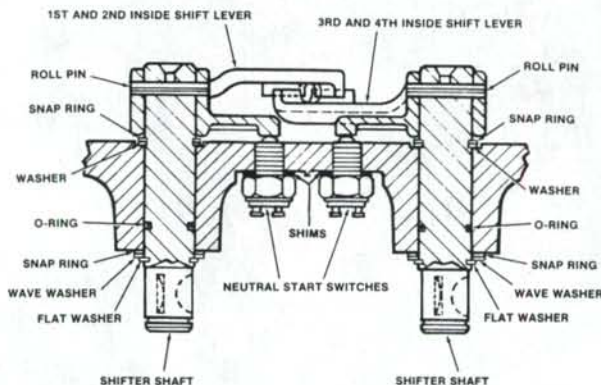


Fig. 171—Exploded view of four-speed gear transmission and park lock linkage used on Models 2094 and 2294. Except for reverse lockout linkage (13 and 14), Models 2090 and 2290 use the same linkage.

- | | |
|----------------------------|-----------------------------|
| 1. Shift lever | 9. Shift lever (1st & 2nd) |
| 2. Park lock quadrant | 10. Shift lever (3rd & 4th) |
| 3. 1st & 2nd gear quadrant | 11. Yoke |
| 4. 3rd & 4th gear quadrant | 12. Shift lever (park lock) |
| 5. Shift cable | 13. Reverse lockout lever |
| 6. Shift cable | 14. Lockout linkage |
| 7. Shift rod (park lock) | |
| 8. Yokes | |

Fig. 174—Top cut-away view showing typical installation of neutral start switches.



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Paragraphs 157-158

fork. Remove shifter fork (13) with shift rail (21) and rail connector (23) as an assembly. Remove rear section of shift rail (25) from bore in transmission.

To remove shifter shafts (items 3 through 12), hydraulic inlet screen must be removed as outlined in paragraph 250. Remove outer shift levers from four-speed transmission. Remove snap ring (3—Fig. 175) from shifter shaft (6). Remove flat washer (4) and wave washer (5). First remove shifter shaft and shift fork lever (12) for third and fourth gear, then remove shifter shaft and shift fork lever (16) for first and sec-

ond gear. Renew "O" rings (7) on shifter shafts when reassembling.

Reassemble by reversing disassembly procedure. Adjust shift linkage as outlined in paragraph 153, neutral start switches as in paragraph 155 and park lock linkage as in paragraph 176.

Models 2390, 2590, 2394 and 2594

157. REMOVE AND REINSTALL SHIFT RAIL AND FORKS. Shift rail (14—Fig. 176) must be removed before shifter forks (16 and 17) can be removed.

Tractor must be split as outlined in paragraph 142 to gain access to shift rail. Remove power shift and mainshaft as an assembly as outlined in paragraph 143. Remove lube line for countershaft. Remove small cap screw (15—Fig. 176) in power shift carrier which holds shift rail, before removing power shift assembly. Drive out pins (18) and remove detent balls and springs. With power shift and mainshaft assembly removed, reinstall cap screw in shift rail, turn rail 90 degrees clockwise and pull out of transmission, using cap screw to extract rail.

When reassembling shifter forks, slip forks into sliding collars on countershaft with long hubs of forks forward and position forks in opening in side of transmission housing. Install shift rail into transmission with tapped hole to front and insert rail through shift forks. Rotate shift rail so that cap screw will align through power shift carrier into tapped hole in rail when power shift is installed. Place shifter forks in neutral, install detent balls and detent springs in bores of shifter forks. Compress springs and install groove pins. Note that groove pins are tapered and are installed small end first. Install power shift and mainshaft assembly in reverse order of disassembly. Make sure the countershaft bearing preload is re-established by aligning marks on retainer nut and countershaft. If rolling torque must be calibrated, refer to procedures outlined in paragraph 165. Rejoin tractor by reversing disassembly procedures as outlined in paragraph 142.

158. GEAR SHIFTER SHAFTS AND HOUSING OVERHAUL.

It is not necessary to split tractor if only shifter shafts and housing are being serviced. Drain transmission and refer to Fig. 176. Disconnect shifter cables from shift levers, disconnect wires from neutral start switches and remove cap screws retaining housing (11). Pull housing and shaft assembly as a unit from transmission.

With shifter housing assembly removed, remove gasket (3) if necessary. Remove neutral start switches and keep shims (5) identified with switches. Punch timing marks on shifter shafts (1 or 1A) and levers and note that levers are installed 17 degrees below horizontal in neutral position. Remove lever retaining snap rings and remove levers. Pry out seals (10). Pull shifter shafts (1 or 1A) from housing (11). Remove shims (12) from shifter shafts.

Reassemble by reversing disassembly procedure and keep the following in mind.

Wave washers must take up all end play in shafts (1); if not, renew washers.

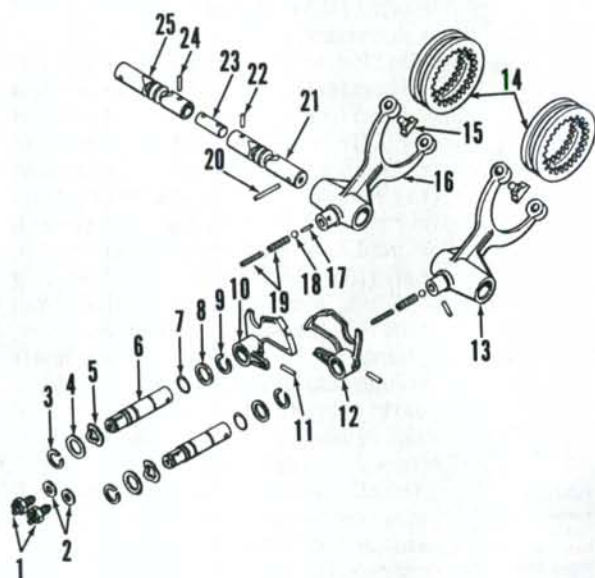


Fig. 175—Exploded view of shifter forks and shafts of gear transmission used on power shift Models 2090, 2290, 2094 and 2294.

1. Neutral start switches
2. Shims
3. Snap ring
4. Washer
5. Wave washer
6. Shifter shaft
7. "O" ring
8. Washer
9. Snap ring
10. Shift fork lever (1st & 2nd)
11. Roll pin
12. Shift fork lever (3rd & 4th)
13. Shifter fork (3rd & 4th)
14. Shift collars
15. Fork finger (4)
16. Shifter fork (1st & 2nd)
17. Roll pin
18. Detent ball
19. Detent springs
20. Roll pin
21. Front rail
22. Roll pin
23. Rail connector
24. Roll pin
25. Rear rail

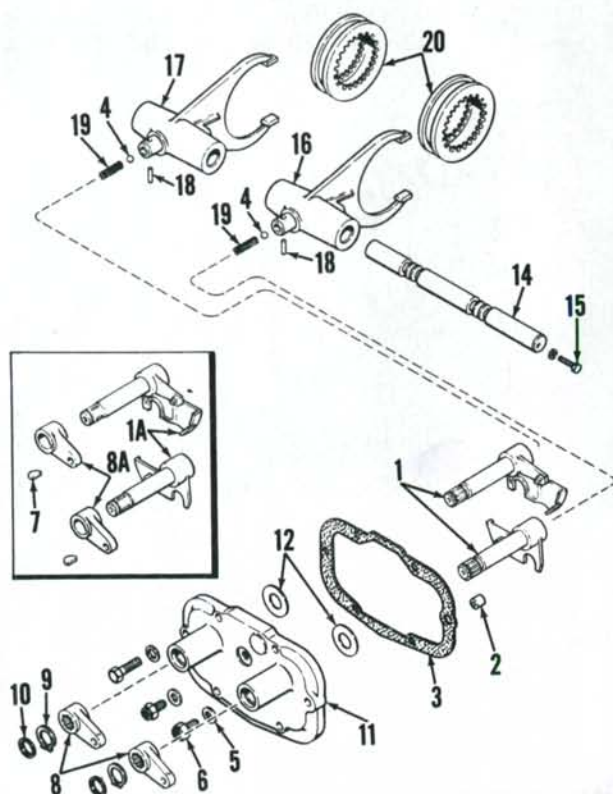


Fig. 176—Exploded view of shifter forks and shafts of gear transmission on Model 2390, 2590, 2394 and 2594 power shift tractors.

1. Shifter shaft (late)
- 1A. Shifter shaft (early)
2. Dowel
3. Gasket
4. Detent ball
5. Shim
6. Neutral start switch
7. Woodruff key
8. Shift levers (late)
- 8A. Shift levers (early)
9. Snap ring
10. Seal
11. Cover
12. Shim
14. Rail
15. Bolt
16. Shift fork
17. Shift fork
18. Pin
19. Spring
20. Shift collars

Paragraphs 159-160

Shims (12) are 0.005 inch (0.127 mm) thick and provide clearance between shifter shafts lugs for neutral switch and housing. If lugs contact boss on housing, add shims until clearance exists. Apply Lubriplate to lips of seals (10) and install flush with housing bores with lip to inside. If neutral start switch (or switches) was removed, be sure to install same number of shims (5) that were removed. Place transmission in neutral and install shifter housing (11) with new gasket and dowel bushing (2). Be sure the shanks on shifter forks engage notches in lugs on shifter shafts when housing is installed. Tighten cap screws to 17-20 ft.-lbs. (23-27 N·m) torque. Align the previously affixed punch marks and install shift levers pointing forward and downward at 17 degrees below horizontal as shown in Fig. 173 and install snap rings. Check and adjust neutral start switches as outlined in paragraph 155.

OVERHAUL GEAR TRANSMISSION

Power Shift Models 2090, 2290, 2094 and 2294

159. GEAR TRANSMISSION INPUT SHAFT. Split tractor between engine and torque tube as outlined in paragraph 41, but do not remove front axle member or radiator assembly. Remove cab or platform. Remove power shift clutch assembly as outlined in paragraph 135. Gear transmission input shaft is also power shift output shaft and overhaul procedure is outlined in paragraph 136 of POWER SHIFT section. Inspect and renew rear input (power shift output) shaft bearing (2—Fig. 177) as necessary by removing retaining rings (1 and 3).

NOTE: Access to rear snap ring (1—Fig. 177) is obtained by removal of top transmission access cover.

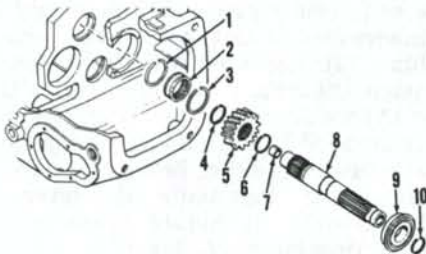


Fig. 177—Exploded view of gear transmission input shaft and related parts on Model 2090, 2290, 2094 and 2294 power shift tractors.

- | | |
|-------------------|----------------|
| 1. Snap ring | 6. Snap ring |
| 2. Roller bearing | 7. Bushing |
| 3. Snap ring | 8. Drive shaft |
| 4. Snap ring | 9. Bearing |
| 5. Output gear | 10. Snap ring |

160. INTERMEDIATE SHAFT. With tractor split and power shift assembly and pto assembly removed, disconnect gear transmission shift control cables and park lock rod. Remove cables from mounting bracket. Disconnect neutral start switch wiring. Unbolt and remove rear transmission side access cover and cable mounting bracket.

On Models 2090 and 2290, refer to Fig. 178 and remove the three Allen head bolts (18), end plate (17) and shims (15

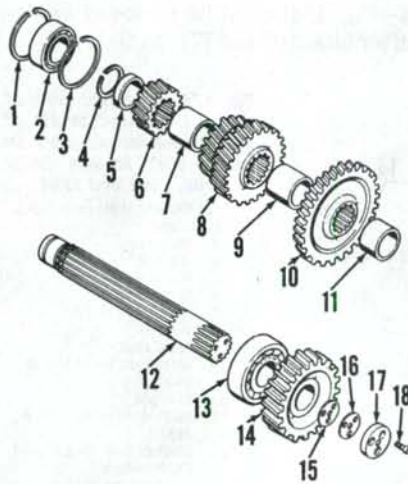


Fig. 178—Exploded view of intermediate shaft of gear transmission used on Model 2090 and 2290 power shift tractors.

- | | |
|---------------------------|---------------------------|
| 1. Snap ring | 10. Gear (4th) |
| 2. Bearing | 11. Spacer |
| 3. Snap ring | 12. Shaft |
| 4. Snap ring | 13. Bearing |
| 5. Spacer | 14. Input gear |
| 6. Gear (1st drive) | 15. Shim |
| 7. Spacer | 16. Shim |
| 8. Gear (2nd & 3rd drive) | 17. End plate |
| 9. Spacer | 18. Allen head cap screws |

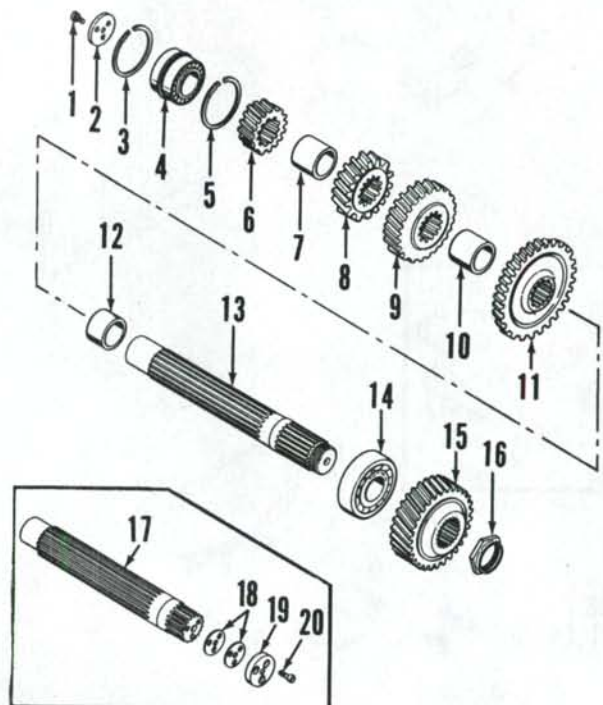
and 16) from front of intermediate shaft, then remove input gear (14). Using a brass drift, drive shaft rearward slightly to aid in removing rear snap ring (4), then remove snap ring from rear of intermediate shaft. Using a long punch or mild steel rod, drive intermediate shaft forward, out of rear bearing (2). Then, while withdrawing shaft from front of transmission remove shaft components (items 5 through 11) from shaft through side access opening, and remove shaft and front bearing (12 and 13) from front of transmission. Remove snap rings (1 and 3) and rear bearing (2) if renewal is necessary. Press front shaft bearing (13) from shaft (12) if renewal is necessary.

On Models 2094 and 2294, refer to Fig. 179 and remove nut (16) on late models or Allen head screws (20), plate (19) and shims (18) on early models, from front end of shaft, then remove input gear (15). Remove Allen head screws (1) and rear plate (2), then using a long punch or mild steel rod, drive intermediate shaft (13 or 17) forward out of bearing (4). Then, while withdrawing shaft from front of transmission, remove components (6 through 12) from shaft through side access opening. Press front bearing (14) from shaft. Remove snap rings (3 and 5) and rear bearing (4) if renewal is indicated.

On all models, clean and inspect all parts for excessive wear or other damage and renew as necessary. Check bearings for free smooth action and renew any bearing having a loose fit or rough action. Heat front bearing (13—Fig. 178 or 14—Fig. 179) to a

Fig. 179—Exploded view of intermediate shaft and components of gear transmission used on Model 2094 and 2294 power shift tractors. Items 17 through 20 in inset are used on early models.

- | | |
|---------------------------|---------------------------|
| 1. Allen head screws | 11. Gear (4th) |
| 2. Rear plate | 12. Shaft |
| 3. Snap ring | 13. Bearing |
| 4. Rear bearing assy. | 14. Input gear |
| 5. Snap ring | 15. Shim |
| 6. Gear (1st) | 16. Shim |
| 7. Spacer | 17. End plate |
| 8. Gear (2nd) | 18. Allen head cap screws |
| 9. Gear (3rd) | |
| 10. Spacer | |
| 11. Gear (4th) | |
| 12. Shaft | |
| 13. Shaft (late) | |
| 14. Front bearing | |
| 15. Input gear | |
| 16. Nut | |
| 17. Shaft (early) | |
| 18. Shims | |
| 19. Front plate | |
| 20. Allen head cap screws | |



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temperature of 250° F (120° C) for ease of assembly. Reinstall shaft, gears and spacers by reversing removal procedures. On Models 2090 and 2290, secure rear of shaft with snap ring (4—Fig. 178). On Models 2094 and 2294, use Loctite 271 on threads of Allen head screws (1—Fig. 179) and install plate (2). Tighten screws to a torque of 40 ft.-lbs. (54.2 N·m). Install input gear on all models. On models equipped with shims and front plate, install plate without shims and tighten Allen screws to a torque of 40 ft.-lbs. (54.2 N·m). Remove Allen screws and front plate. Using a depth gage, measure distance from front face of input gear to end of intermediate shaft. This measurement plus 0.002 inch (0.05 mm) will be correct shim pack thickness to be installed. Shims are available in thicknesses of 0.005 and 0.007 inch (0.127 and 0.178 mm). Install front plate with determined shim pack and using Loctite 271 on threads, tighten Allen screws to a torque of 40 ft.-lbs. (54.2 N·m). On late Model 2094 and 2294, tighten nut (16—Fig. 179) to a torque of 200 ft.-lbs. (271 N·m), then stake flange of nut to slot in shaft.

NOTE: Some late models may be equipped with double taper roller rear bearings in place of double ball bearings.

161. COUNTERSHAFT. For service of countershaft, cab or control platform must be removed from tractor and torque tube must be removed from transmission as follows: With cab or platform removed, unbolt cab or platform side mounts from each side of torque tube. Support torque tube with a suitable hoist or rolling floor jack, then unbolt and remove torque tube from transmission housing.

Remove rear cab or platform mounts. With transmission suitably supported, remove wheels. Remove axle housing and final drive assemblies as outlined in paragraph 166.

Disconnect differential lock oil fitting on right of transmission then remove oil tube. Remove rear pto drive shaft. Disconnect hitch cable and remove oil tube from rear of transmission frame.

Support differential with wood blocks. Remove differential bearing carriers from both sides of transmission. Remove both differential bearing cones, shims and inner halves of brake cylinders from both sides of transmission. Attach a suitable chain or sling and hoist to differential assembly and remove from transmission.

Remove hitch cable upper mount bolts from top of rear transmission access cover, then remove cover. Remove shift rail and shift forks as outlined in paragraph 156.

Bend retainer nut (1—Fig. 180) lip from notch in countershaft and remove nut and thrust washer (2). Remove snap ring (6) from shaft. Using a brass drift, drive countershaft rearward approximately 1/4 inch (6.35 mm) and install a suitable puller and remove front countershaft bearing cone (3). Push countershaft assembly rearward until out of park lock gear (8) and remove Woodruff key (7) (on models equipped with transmission S/N 10237494 and below) from countershaft. Push countershaft rearward while removing items (9 through 18) out top of access opening. Park lock gear cannot be removed until fourth, third and second gears are removed. Remove park lock gear (8), then remove remainder of items (19 through 23) out top of access opening and withdraw countershaft from rear of transmission.

Remove snap ring (5) from behind front bearing cup and drive out cup. Drive out rear bearing cup (25). Press rear bearing cone from countershaft.

Clean and inspect all parts for damage or excessive wear and renew as necessary. Check bearings for free smooth action and renew any bearing having a loose fit or rough action.

Assemble countershaft as follows: If rear pinion bearing cone (26—Fig. 180) was removed, heat bearing cone to a temperature of 250° F (120° C) and install bearing cone on countershaft with large side toward pinion gear. With countershaft standing vertical with pinion gear down, assemble shaft components as follows: Install 1/8 inch (3.18 mm) thick thrust washer from thrust bearing (23), then install needle bearing and cup washer, cup side down. Install first gear (22) hub gear end up. Install thrust bearing (21) cup side up. Install pinion shaft hub (19) with 1/4 inch (6.35 mm) recessed spline side down, then install shift collar (20). Install thrust bearing (18) cup side down; second gear (17) hub gear end down. Install thrust bearing (16) cup side down, then third gear (15) hub gear end up. Install thrust bearing (14) cup side up. Install pinion hub (12) with 1/4 inch (6.35 mm) recessed spline side down then install shift collar (13). Install thrust bearing (11) with 1/8 inch (3.18 mm) thrust washer first and remainder of assembly cup side down. Install fourth gear (10) with hub gear end down. Install thrust bearing (9) with cup side up. Install park lock gear (8) and key (7) (on models equipped with transmission S/N 10237494 and below) on shaft. Tap park lock gear with hammer to make sure there is no clearance between assembled parts. Install a shim type snap ring (6) and measure clearance between snap ring and park lock gear. Install appropriate

thickness snap ring until 0.003-0.011 inch (0.08-0.28 mm) clearance is obtained. Snap rings (6) are available in thicknesses of 0.078, 0.088, 0.098, 0.108, 0.118, 0.128, and 0.138 inch (1.98, 2.24, 2.49, 2.74, 3.0, 3.25 and 3.5 mm). See Fig. 181 for cross-sectional view of assembled countershaft. Remove all parts from countershaft for assembly into transmission.

If front bearing cup was removed, install snap ring (5—Fig. 180) and press cup (4) into bore against snap ring. Install countershaft through rear of transmission case assembling parts in order shown in Fig. 181. Install a bar and bolt as shown in Fig. 182 to hold countershaft rigid and in correct position for installation of front bearing. Heat front bearing cone (3—Fig. 180) and install on front of countershaft, then install thrust washer (2) and retainer nut (1).

162. COUNTERSHAFT BEARING PRELOAD. Remove bar and bolt shown in Fig. 182. Tighten countershaft retainer nut, while rotating countershaft

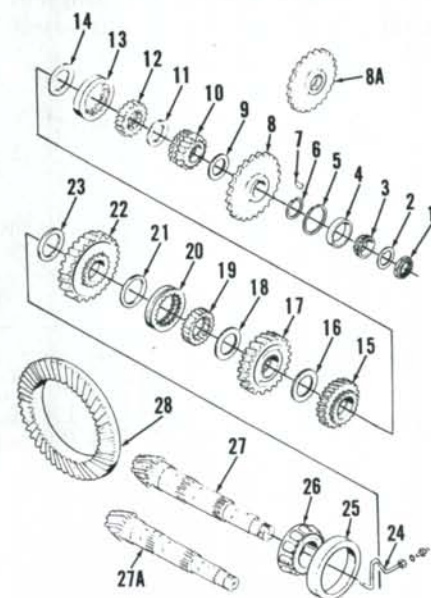


Fig. 180—Exploded view of typical four-speed gear countershaft used on all Model 2090, 2290, 2094 and 2294 tractors.

- | | |
|--|---|
| 1. Locknut | 14. Thrust washer |
| 2. Washer | 15. Gear (3rd driven) |
| 3. Bearing cone | 16. Thrust washer |
| 4. Bearing cup | 17. Gear (2nd driven) |
| 5. Snap ring | 18. Thrust washer |
| 6. Snap ring | 19. Hub (1st & 2nd) |
| 7. Woodruff key (transmission S/N 10237494 & before) | 20. Shift collar |
| 8. Park lock gear (transmission S/N 10237494 & before) | 21. Thrust washer |
| 9. Thrust washer | 22. Gear (1st driven) |
| 10. Gear (4th driven) | 23. Thrust washer |
| 11. Thrust washer | 24. Lube tube |
| 12. Hub (3rd & 4th) | 25. Bearing cup |
| 13. Shift collar | 26. Bearing cone |
| | 27. Pinion shaft (transmission S/N 10237494 & before) |
| | 27A. Pinion shaft (transmission after S/N 10237494) |
| | 28. Ring gear |

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to remove clearance between countershaft bearing cones and cups. Loosen nut, then retighten finger tight. With transmission in neutral, measure rolling torque with a torque wrench. Tighten retainer nut until an additional 25-35 in.-lbs. (2.8-4.0 N·m) rolling torque if obtained for new bearings and 15-25 in.-lbs. (1.7-2.8 N·m) additional rolling torque for original bearings is added to the original measurement. After correct preload is obtained, bend edge of retainer nut into groove in countershaft.

163. Reassemble tractor by reversing disassembly procedure. Install power shift assembly as outlined in paragraph 141. Adjust differential bearing preload and ring gear and pinion backlash as outlined in paragraph 170. Coat all mating surfaces of access cover; axle housings, transmission halves and pto housing assembly with Loctite 504 or equivalent prior to assembly. Fill transmission to proper level with new Hy-Tran Plus fluid. Bleed power steering and brake systems as outlined in paragraphs 25 and 185. Adjust shift linkage as outlined in paragraphs 124, 127 and 153. Adjust hitch control and sensing cables as outlined in paragraph 267.

Models 2390, 2590, 2394 and 2594

To gain access to gear transmission the power shift carrier must be removed from transmission housing. The power shift can be removed as a complete assembly, and will include removal of the four drive gears, which are mounted on the power shift output shaft transmission mainshaft as shown in Fig. 183. If no overhaul of mainshaft or gears is planned, unit may be set aside. Lower shaft removal will require removal of rear axles and differential. If upper mainshaft is to be overhauled, refer to instructions in the following paragraph. If lower (bevel pinion gear) shaft requires service, refer to paragraph 165.

164. GEAR TRANSMISSION MAIN-SHAFT OVERHAUL. Split tractor between torque tube and transmission as outlined in paragraph 142. When power shift carrier is removed for overhaul of mainshaft in gear transmission, the following steps must be taken to preserve countershaft (bevel pinion shaft) bearing preload and rolling torque.

Remove outer retaining nut and lock-washer (43 and 42—Fig. 184) from

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under carrier assembly. Make matching marks on inner retainer nut (41) and countershaft (16). Count the number of turns required to remove nut and make a record of it so preload can be duplicated at the time of reassembly.

NOTE: Failure to observe the above steps will necessitate removal of rear axles and differential to obtain correct pinion preload. Make sure that alignment marks on retainer nut and pinion shaft are matched exactly and exact number of turns are used on retainer nuts when reassembling.

Remove C-1 clutch lube oil line (17—Fig. 184). Remove cap screws retaining C-1 reaction plate (2—Fig. 165), C-1 sun gear (5), springs (3) and plates (4 through 8). Remove cap screws to C-1 and C-4 piston carrier (16) and remove carrier, clutch return springs (24) and C-4 clutch plates (22 through 25).

To remove planet carrier from ring gear, rotate ring gear and planetary until the three holes in rear of carrier and holes in planetary output gear align with three Allen head retainer cap screws (Fig. 151). Insert a 3/16 inch Allen wrench through holes and remove screws. Using two screwdrivers or other suitable levers, pry planetary assembly carefully from ring gear. After planetary is out, remove needle thrust bearing assembly from hub of ring gear. Remove

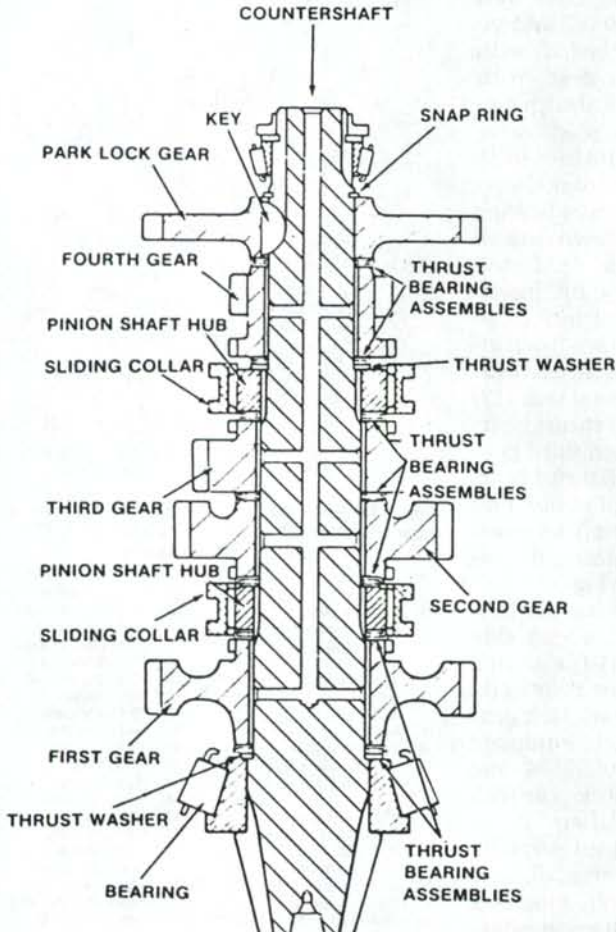


Fig. 181—Cross-sectional view of assembled countershaft and related parts.

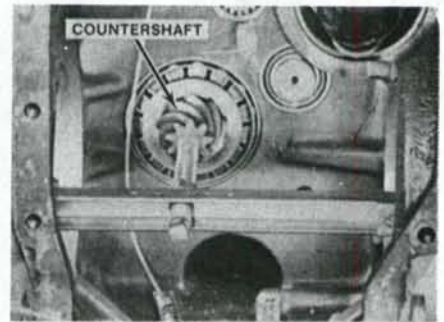


Fig. 182—With differential removed, install jackbolt and bar to support countershaft for reassembly.

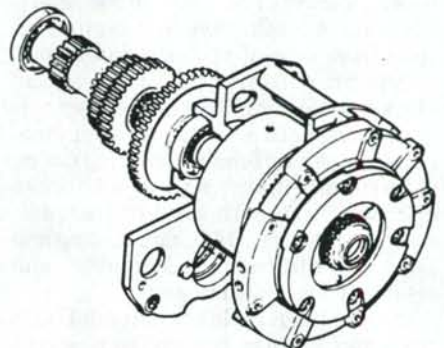


Fig. 183—Illustration showing power shift with intermediate shaft drive gears removed as an assembly from Model 2390, 2590, 2394 or 2594 tractors.

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snap ring (39—Fig. 165) retaining ball bearing (40) to mainshaft. Install three 1/4 inch 28 x 1-1/2 inch cap screws in ball bearing retainer and use cap screws as jackscrews to force bearing from mainshaft. Loosen all six cap screws inside ring gear which retain C-2 clutch hub (55—Fig. 165) but do not remove them. Using two levers at rear of ring gear assembly, pry against power shift carrier to remove ring gear assembly from mainshaft (Fig. 166). Inspect oil distributor ring bore in rear of power shift carrier after ring gear assembly is removed. Bore must be smooth and free of grooves or burrs.

Remove all cap screws holding power shift carrier to transmission case and remove carrier and mainshaft as an assembly. Remove snap ring (14—Fig. 184) and mainshaft assembly can be removed from carrier.

Inspect pto bushing (4—Fig. 184) in rear of mainshaft (5). Renew bushing if ID exceeds 1.382 inches (35.1 mm) and be sure new bushing is reamed to 1.377-1.379 inches (34.97-35.03 mm). Use Loctite 271 or equivalent when installing bushing and install bushing 0.12 inch (3.05 mm) below flush. When reinstalling fourth gear (10), be sure long side of hub goes toward gear (7). Install bearing (13) in rear of power shift carrier and install flat side of retaining ring (12) toward bearing. Insert assembled mainshaft into bearing in power shift

carrier and install snap ring (14). Install power shift carrier and mainshaft into transmission housing and tighten cap screws to 80-96 ft.-lbs. (108-130 N·m) torque. Reassemble retainer nut (41) on countershaft the exact number of turns which were recorded at time of disassembly and match the marks exactly for proper pinion bearing preload.

Reassemble power shift in reverse order of disassembly. Install ring gear assembly (64—Fig. 165) into power shift carrier and then tighten cap screws in rear of ring gear to 110-130 ft.-lbs. (149-176 N·m) torque. Install bearing retainer (41—Fig. 165) with recess to outside and install ball bearing (40) with snap ring toward inside. Install snap ring (39). Install a 1/4 x 5 inch long threaded rod in one of the holes in planet carrier and planetary assembly to align clutches. When planet gears (43) are about 0 to 1/8 inch (0 to 3.18 mm) beyond edge of ring gear, all clutch plates are engaged. Align holes for socket head cap screws (28), install two screws, removing threaded rod and install remaining screw. Tighten socket head screws to 10-14 ft.-lbs. (13.6-19.0 N·m) torque.

Dab a small amount of grease on one end of return springs (24) and install in recesses in power shift carrier. Starting with a C-4 friction disc (23—Fig. 165), install a disc, a steel plate (25) with notch in tab aligned with "X" mark

which is cast into power shift carrier (70) and tab positioned clockwise from notch as shown in Fig. 168. Install the other disc (23—Fig. 165), then install the remaining steel plate (22) onto dowels on rear side of piston carrier (16). Tabs on this steel plate must be clockwise from dowels so that they will contact return springs when installed. These are the only tabs that should contact return springs. Install a 3/8 NC x 4 inch stud into a cap screw hole in power shift carrier. Install piston carrier and last steel plate over stud and install cap screws and hardened washers. Oil supply ports in piston carrier must be in the nine o'clock position when installed. Remove stud and tighten all retaining cap screws on piston carrier to 35-42 ft.-lbs. (47-57 N·m) torque.

Install C-1 friction disc (8—Fig. 165) on piston carrier with notched tabs on pins (14) and solid tabs clockwise from notches. On Models 2390 and 2394 install a steel plate (7) then a friction disc (6). On Models 2590 and 2594 install a steel plate (7) and a friction disc (6), then another steel plate and friction disc. On all models, install C-1 sun gear (5), engaging splines with solid plate(s) (7) and short planetary gears, then install friction disc (4) aligning notches on pins. Lubricate inner and outer return springs (3) with petroleum jelly and install in holes of C-1 reaction plate (2). Install C-1 reaction plate aligning return springs (3) with tabs on C-1 friction disc(s). Install bolts with hardened washers, except for bolt which secures lube tube (1). Install lube tube and clamp and bolt, then tighten all reaction plate bolts to 35-42 ft.-lbs. (47-57 N·m) torque.

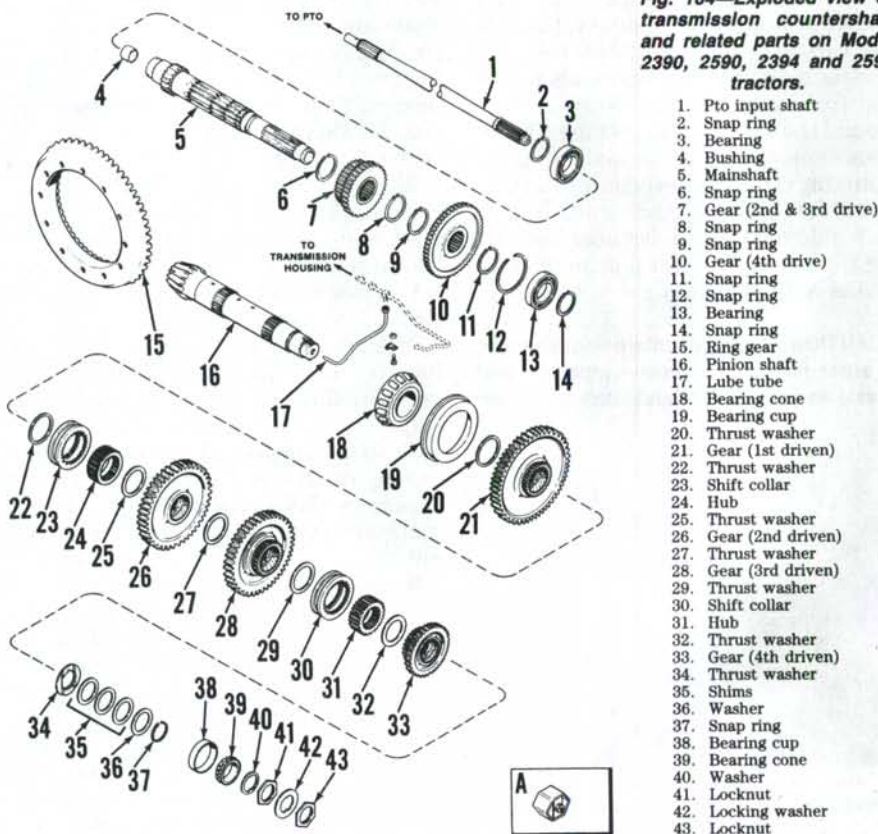
NOTE: Tip of lube tube (1) must be as near to gap between planetary input shaft and sun gear as possible without touching.

Attach countershaft lube tube to C-1 clutch lube tube.

Rejoin tractor by reversing split procedure outlined in paragraph 142.

165. COUNTERSHAFT (BEVEL PINION SHAFT) OVERHAUL. Tractor must first be split between transmission housing and torque tube as outlined in paragraph 142. Remove power shift and mainshaft assembly as a unit, as outlined in paragraph 164. Remove C-1 clutch lube line. Do not disassemble power shift, but be sure the small cap screw in power shift carrier is removed before attempting to remove assembly. The small cap screw holds shift rail in transmission. If any of the following parts are renewed, rolling torque and bearing preload must be recalibrated, which will necessitate removal of rear

Fig. 184—Exploded view of transmission countershaft and related parts on Model 2390, 2590, 2394 and 2594 tractors.



Paragraphs 166-167

axles and differential as outlined in paragraphs 166 and 171. These parts are: Countershaft (16—Fig. 184), rear bearing cone and cup (18 and 19), snap ring (37), front bearing cone and cup (38 and 39), thrust washer (40), retainer nut (41), or power shift carrier (70—Fig. 165).

With power shift and mainshaft assembly out of transmission housing, remove oil filter screen from front of transmission, then remove snap ring (37—Fig. 184) from front of countershaft.

With rear axles and differential removed, gears can be removed from countershaft and countershaft can be removed from rear of transmission housing.

When reassembling, press bearing cup (19—Fig. 184) into transmission case from the rear, press bearing (18) onto countershaft, install part way into transmission and install thrust washer (20) onto shaft. Install gears, thrust washers, splined hubs and sliding collars as shown, making sure splined hubs on gears face toward both sliding collars. Before installing fourth gear (33) and thrust collar (34), install a jackscrew to support countershaft as shown in Fig. 182. Install thrust collar (34—Fig. 184) with oil grooves toward rear of transmission. Install thrust washer (36) and snap ring (37) onto shaft without shim pack (35). Push gears rearward and measure clearance between thrust washer (36) and thrust collar (34). Correct clearance should be 0.017-0.019 inch (0.4318-0.4826 mm). If clearance exceeds 0.019 inch (0.4826 mm), remove snap ring (37) and thrust washer (36) and add correct thickness of shims to obtain desired clearance, then reinstall thrust washer and snap ring. Shims are available in thicknesses of 0.002, 0.006 and 0.010 inch (0.051, 0.152 and 0.254 mm). Install shifter forks and rail as outlined in paragraph 157. Reinstall power shift assembly and install bearing cone (39) in power shift carrier. Install thrust washer (40) and retainer nut (41), making sure that nut is installed exact number of turns as when removed and align marks precisely to obtain proper bearing preload. If any of the aforementioned parts were renewed, socket wrench No. CAS-1082 (A—Fig. 184) can be used to calibrate rolling torque with a torque wrench as shown in Fig. 185. Install retainer nut (41—Fig. 184), tighten nut until zero end play (or no noticeable drag) is obtained, then strike both ends of countershaft with a soft hammer to be sure bearings are seated and recheck free rolling torque. Check and record the no-load rolling torque, then tighten retainer nut until rolling torque is 25-35 in.-lbs. (2.8-4.0 N·m) us-

ing new bearings or 15-25 in.-lbs. (1.7-2.8 N·m) with used bearings, MORE than when first checked. Install locking washer (42), locknut (43) and recheck torque. Bend locking washer (42) over both nuts.

Rejoin tractor by reversing disassembly procedures as outlined in paragraph 142.

DIFFERENTIAL AND FINAL DRIVE

This section covers the differential and ring gear, differential lock, planetary final drive and park lock. Differential can be removed from the rear, but to remove the bevel pinion gear, tractor must be split between transmission and torque tube as outlined in paragraphs 106 or 142.

FINAL DRIVE

All Models

166. REMOVE AND REINSTALL.

Drain transmission housing, jack up rear of tractor and support both sides of tractor with stands under the draft arm mounting brackets. Remove rear tire and wheel assemblies. Loosen both front platform isolation mount nuts, support cab or platform with suitable stands, then remove both rear platform isolation mount retaining bolts and remove the isolation mounts. Remove the cab rear mounting brackets. On models so equipped, disconnect lube line from axle housing. Wrap a chain around the axle housing, attach a hoist, then remove all of the axle housing mounting cap screws except the top one. Install two 5/8 inch guide studs, one on each side of the axle housing, remove the top cap screw and pull final drive assembly from transmission housing.

CAUTION: Hang a counterbalance weight on outer end of axle, or use a pipe over end of axle as a lever to balance unit as it is re-

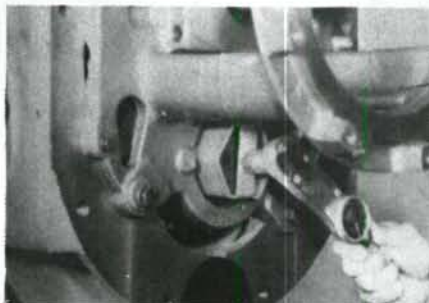


Fig. 185—View showing use of special socket CAS-1082 to aid in setting countershaft rolling torque. Refer to text.

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moved. The planetary end of housing assembly is much heavier than the axle end.

When reassembling unit, use the guide studs to guide unit into mesh with splines. Put Liquid Gasket or Loctite 504 or equivalent on flanges where axles mate to transmission housing prior to assembly. It may be necessary to rotate axle shaft to align splines. Tighten cap screws to 220-264 ft.-lbs. (298-358 N·m) torque.

167. OVERHAUL. Remove axle housing as outlined in paragraph 166. Refer to Fig. 186 or 187 as a guide for disassembly of final drive assembly. On Model 2390, 2590, 2394 and 2594 tractors, remove brake hub and sun gear assembly (items 1 through 3—Fig. 186 or 187) from planetary assembly. On Model 2090, 2290, 2094 and 2294 tractors, remove sun gear shaft from planetary assembly. Lock up planet gears by using a small rod, or other similar object, and loosen cap screw (16) just enough to release lockplate (17). Remove lock plate (use a magnet, if necessary, then remove cap screw (16) and pull planetary assembly from inner end of axle. Remove ring gear (4) from axle housing (10) or transmission housing.

Install a 7/8 inch cap screw into tapped hole in inner end of axle, place a bar across head of cap screw and secure bar with two large "C" clamps. Keep axle from turning and push axle shaft and outer seal from housing by turning cap screw. Remove inner bearing from housing and oil seal and outer bearing from axle shaft. Bearing cups can be driven from axle housing if renewal is required.

To disassemble planet carrier, drive roll pins (5) into planet gear shafts (14), remove shafts and pull planet gears and bearings from carrier. Each planet gear (8) contains 38 roller bearings (7). Remove retaining plate (15).

On Model 2594 and late 2394 tractors, remove snap ring (25—Fig. 187) and remove axle shaft hub (24) from carrier (13).

Clean and inspect all parts for pitting, scoring or undue wear and renew as necessary. Roller bearings for planet gears are available only in kits of 38 rollers.

To reassemble final drive, proceed as follows: If removed, install outer bearing cup (18—Fig. 186 or 187) with taper facing out and inner bearing cup (11) with taper facing in. Heat outer bearing cone (19) and install on axle shaft until it seats against shoulder. Install axle and bearing into housing, then heat inner bearing (12) and install on inner end of axle. Apply Permatex No. 2 or

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equivalent, to outer edge of oil seal (21). Install seal over axle shaft with lip toward inside and drive oil seal in housing until outer face of seal is flush with

outer edge of housing. On Model 2594 and late 2394 tractors, install axle shaft hub (24—Fig. 187) in carrier (13) and secure with snap rings (25 and 26).

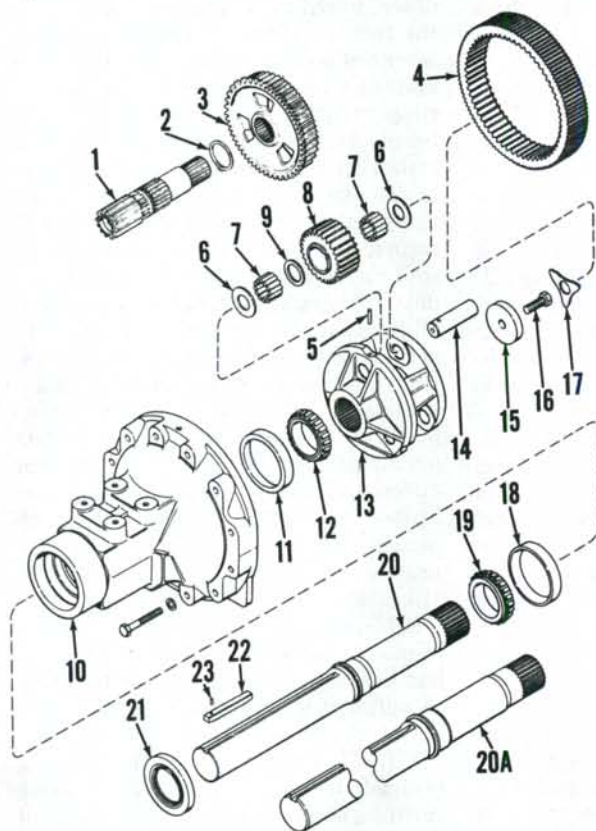


Fig. 186—Exploded view of final drive planetary and associated parts typical of Model 2090, 2290, 2390, 2590, 2094, 2294 and early 2394 tractors. Brake hub (3) is used on Model 2390, 2590 and early 2394 tractors.

1. Sun gear & shaft
2. Snap ring
3. Brake hub (Model 2390, 2590 and 2394 tractors)
4. Ring gear
5. Roll pin
6. Thrust washer
7. Roller bearings
8. Planet gear
9. Spacer
10. Axle housing
11. Bearing cup
12. Bearing cone
13. Carrier
14. Pinion pin
15. Axle retainer
16. Cap screw
17. Lockplate
18. Bearing cup
19. Bearing cone
20. Short axle shaft
- 20A. Long axle shaft
21. Seal
22. Key
23. Pin

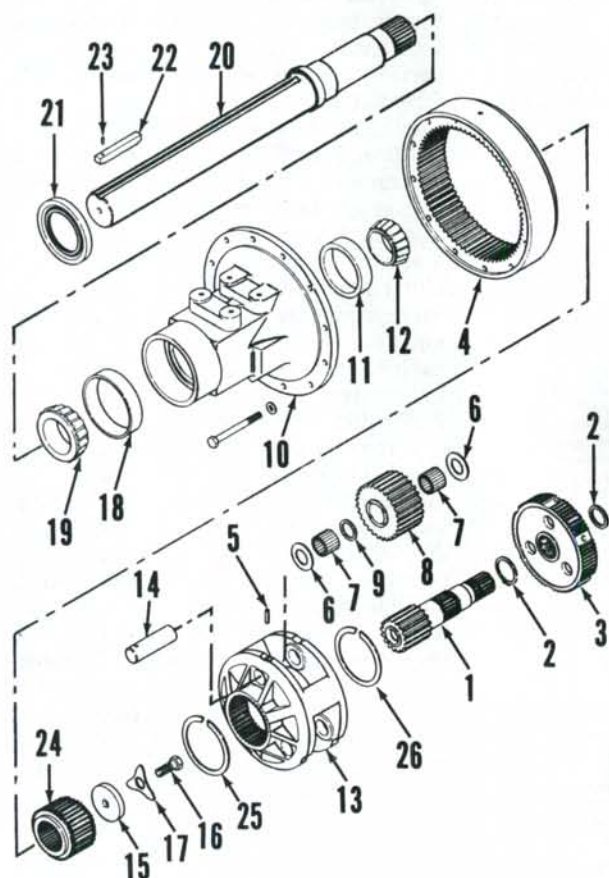


Fig. 187—Exploded view of final drive planetary and related parts used on Model 2594 and late 2394 tractors.

1. Sun gear & shaft
2. Snap ring
3. Brake hub
4. Ring gear
5. Roll pin
6. Thrust washer
7. Roller bearings
8. Planet gear
9. Spacer
10. Axle housing
11. Bearing cup
12. Bearing cone
13. Carrier
14. Pin
15. Axle retainer
16. Cap screw
17. Lockplate
18. Bearing cup
19. Bearing cone
20. Axle shaft
21. Oil seal
22. Key
23. Pin
24. Axle shaft hub
25. Snap ring
26. Snap ring

Paragraph 168

Then, on all models, place planet carrier on bench with splined inner end up. Drive roll pins from planet gear shafts. Use vaseline, or equivalent, and install 38 roller bearings (with spacer between rows of rollers) in planet gears. Place ONE planet gear and bearing assembly in planet carrier, align roll pin hole in planet gear shaft with roll pin hole in carrier and install shaft. Install shaft retaining roll pin flush with carrier surface.

NOTE: The rear axle retainer (15—Fig. 186 or 187) must be installed prior to installing second and third planet gears.

Install retainer with recess away from splined hub of carrier (downward). Install second and third pinion gear assemblies following the procedure already given.

With planet carrier assembled, install splined hub end on the splined inner end of axle and install retaining (adjusting) bolt (16) through retainer (15) and into axle (20). Turn adjusting bolt until it begins to tighten, then bump outer end of axle and planetary carrier to seat bearings. Mount a dial indicator against face of planetary carrier, lightly tap axle and planetary assembly back and forth and turn adjusting bolt as required to obtain axle end play of 0.005-0.015 inch (0.127-0.381 mm). Using a torque wrench, measure and record the no-load rolling torque of axle assembly, then tighten adjusting bolt until the rolling torque is 25 in.-lbs. (2.8-5.6 N·m) greater than the previously recorded no-load rolling torque. Lightly tap axle both ways and recheck bearing preload. If rolling torque (preload) goes above 75 in.-lbs. (8.4 N·m), loosen and bump adjusting bolt only and readjust as already outlined.

Install lockplate (17) and if points of lockplate do not align with points of adjusting bolt head, turn lockplate to another position. If points still do not align, tighten adjusting bolt to the nearest point that will align. However, do not tighten bolt more than necessary as it will affect the preload adjustment.

Reinstall the final drive assembly as outlined in paragraph 166.

DIFFERENTIAL AND BEVEL RING GEAR

Models 2090, 2290, 2094 and 2294

168. REMOVE AND REINSTALL.

Drain transmission and remove pto assembly, final drive housings and brake cylinder assemblies. Remove hitch linkage box oil return tube from inside

Paragraphs 169-170

rear housing. Remove pto input shaft. Disconnect hitch follow up cable or linkage from follow up lever and remove as necessary. Support differential assembly on wood blocks and remove left and right bearing carriers and shims (keeping shims with each bearing). Unbolt and remove left and right inner brake housings. Attach a suitable chain and hoist and remove differential from transmission case.

Reinstall in reverse order of disassembly. Tighten differential brake housing bolts to 220 ft.-lbs. (298 N·m) torque. Install bearing carriers with same shims that were removed. Tighten carrier retainer cap screws to 45 ft.-lbs. (61 N·m) torque. Refer to paragraph 170 for ring gear and pinion backlash adjustment.

169. OVERHAUL. Remove differential as outlined in paragraph 168. Place assembly on a bench and refer to Fig. 188 as a guide to disassembly. Keep shims with bearing carriers from which they were removed. Shims are available in thicknesses of 0.003, 0.007, 0.010 and 0.020 inch (0.08, 0.18, 0.25 and 0.508 mm) for bearing preload adjustment. Put identification mark on pinion pin (10) and ring gear cage (3) to ensure correct reassembly position. Set assembly on bevel ring gear end and remove two differential lock seal rings (25 and 26). Remove differential lock cage retaining cap screws. Remove differential lock cage (24), spring return plate (18), springs (15) and differential lock clutch plates (16 and 17) from differential cage.

Remove reaction plate (14), thrust washer (13) and right side bevel gear (12) from gear cage (3). Drive roll pin (11) out of pinion, then drive out pinion pin (10) and remove pinion gears (9) and washers (8). Remove left side gear (7) and thrust washer (6). Unbolt and remove ring gear (4) from ring gear cage. If ring gear must be renewed, the bevel pinion shaft must also be renewed, which will make it necessary to remove bevel pinion as outlined in paragraph 115 or 161. Drive out bearing cup (2) if renewal is necessary. Using compressed air in oil slot of differential lock cage, remove differential lock piston (19). Remove and discard inner and outer seal rings (items 20 through 23). Use a suitable puller to remove bearing cup (27) if renewal is necessary.

Clean and inspect all parts for wear, nicks and scoring and renew as necessary. Reassemble differential as follows: Install bearing cups (2 and 27—Fig. 188) until they bottom in cage halves (3 and 24). Install bevel ring gear (4) and tighten retaining cap screws with new washers to 220 ft.-lbs. (298 N·m) torque. Install thrust washer (6) and side gear (7) into ring gear cage (3). Install pinion pin (10) through wall of cage while installing pinion gears (9) and thrust washers (8) on pinion pin. Be sure pinion pin is in correct index with ring gear cage. Install new roll pin (11) into pinion pin and ring gear cage until top of roll pin is 1.44 inches (36.58 mm) from top of hole. Lubricate inner and outer piston seal rings (items 20 through 23) with petroleum jelly and install in-

to inner and outer grooves of piston (19). Use a smooth wood dowel or round plastic pen to fit seals into grooves. Lubricate and install piston, flat side down, into differential cage half. Install the two seal rings (25 and 26) onto differential lock cage making sure hook ends of seals are closed. Lubricate seal rings with petroleum jelly. Install right bevel gear (12) into ring gear cage, then install thrust washer (13) over side gear. Install reaction plate (14) flat side up, on ring gear cage aligning bolt holes. Install return springs (15), then alternately install a steel clutch plate (16) and friction disc (17) keeping notches of steel plates aligned with springs. Install with springs. Install piston return plate (18) with tabs on top of return springs. Install two 1/2 NC x 6 inch guide studs opposite each other in reaction plate, then install differential lock cage (24) over differential ring gear cage aligning slots in lock cage with springs and clutch plates. Install retaining bolts with new washers and tighten bolts to a torque of 110 ft.-lbs. (149 N·m).

Reinstall differential by reversing the removal procedure, then check and adjust bearing preload and gear backlash as outlined in paragraph 170.

170. To check differential bearing preload, install left and right bearing carriers, without shims. Tighten bolts of right hand carrier to 45 ft.-lbs. (61 N·m) torque. Install three bolts at 120 degrees from each other into left hand bearing carrier and tighten, while turning differential, to 30 in.-lbs. (3.4 N·m) torque, then tighten, while turning differential, to 50 in.-lbs. (5.6 N·m) torque. Check clearance between left hand bearing carrier and brake housing using a feeler gage at three bolt locations. Assemble a set of shims the same thickness or 0.003 inch (0.076 mm) greater than the average measurement. Divide the shims equally and install one set of shims on each bearing carrier. Install both bearing carriers and tighten all bolts to 45 ft.-lbs. (61 N·m) torque.

With carrier bearing preload adjusted, check and adjust backlash between ring gear and pinion shaft as follows: Locate and record recommended backlash dimension which will be found etched on outside rim of bevel ring gear. Mount a dial indicator so it makes contact with tooth of bevel ring gear and that sufficient pressure is on tip to move indicator needle. Take up slack in gears by holding pinion shaft and rotating differential as far as possible in one direction without moving bevel pinion shaft. Zero the indicator and turn differential in opposite direction as far as possible without moving bevel pinion shaft. Read dial indicator and compare reading to the

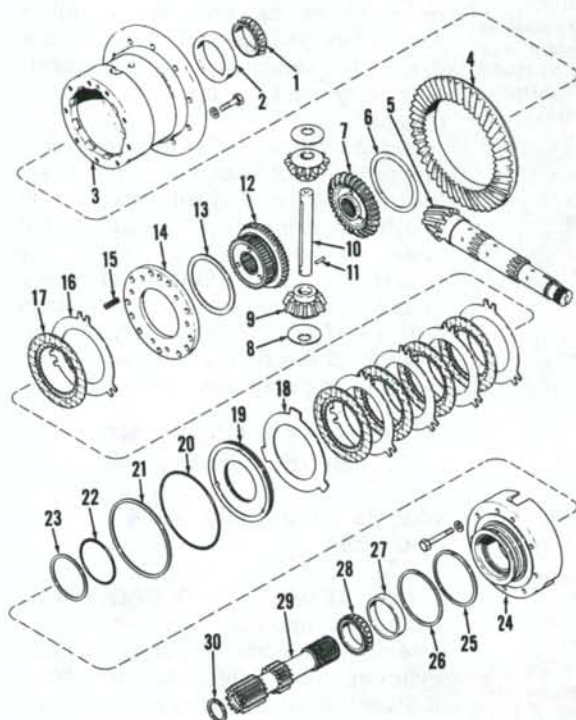


Fig. 188—Exploded view of typical differential and lock clutch assembly used on Models 2090, 2290, 2094 and 2294.

1. Bearing cone
2. Bearing cup
3. Cage
4. Ring gear
5. Pinion shaft
6. Thrust washer
7. Left bevel gear
8. Thrust washer
9. Pinion gear
10. Pinion pin
11. Roll pin
12. Right bevel gear
13. Thrust washer
14. Reaction plate
15. Return spring
16. Steel plate
17. Friction disc
18. Piston return plate
19. Piston
20. "O" ring (outer)
21. Seal (outer)
22. "O" ring (inner)
23. Seal (inner)
24. Differential lock cage
25. Seal ring
26. Seal ring
27. Bearing cup
28. Bearing cone
29. Brake & sun shaft
30. Snap ring

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backlash dimension etched on rim of bevel ring gear. If backlash is too much, remove shims from left hand bearing carrier and put the shims on right hand bearing carrier. If backlash is not enough, remove shims from the right hand bearing carrier and put the shims on the left hand carrier.

NOTE: Backlash will change approximately 0.002 inch (0.051 mm) for every 0.003 inch (0.076 mm) of shims that are added or removed. **DO NOT** change the total amount of shims as it will affect bearing preload.

Recheck backlash with dial indicator after each shim change and when backlash adjustment is complete, tighten all bearing retainer cap screws to 45 ft.-lbs. (61 N·m) torque.

Models 2390, 2590, 2394 and 2594

171. REMOVE AND REINSTALL.

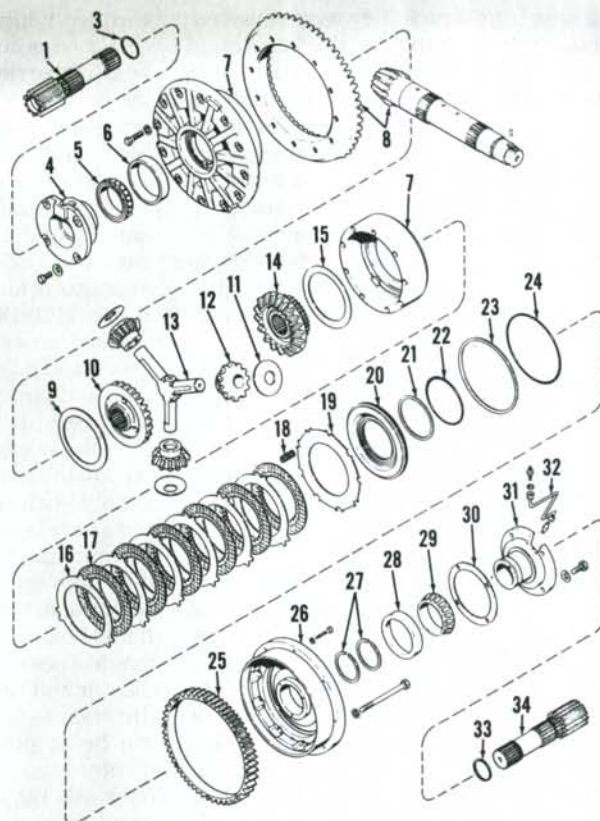
Drain transmission and remove final drive housings as outlined in paragraph 166. Remove three point hitch. Disconnect the three hydraulic oil lines from pto housing. Remove drawbar and drawbar supports. Disconnect transmission temperature sender wire. Support pto assembly with a suitable hoist, then unbolt and remove pto assembly. Remove draft sensing linkage. Remove set screws from both power lift arms inside transmission case. Remove snap rings from both lift arms on sides of tractor. Bump rockshaft out toward right side of tractor while working power lift arms off splines inside case and protecting rockshaft bushings.

Disconnect oil tube from differential lock clutch on left hand side bearing carrier. Support differential assembly on wood blocks, then unbolt and remove both bearing carriers (4 and 31—Figs. 189 and 190). Make certain shims (30) stay with their respective carriers. Roll assembly out far enough to attach a suitable hoist and lift assembly from rear of transmission frame.

Reinstall in reverse order of disassembly. Install bearing carriers (4 and 31—Figs. 189 and 190) with same shims that were removed and make sure oil seal rings (27) have their hooked ends 180 degrees apart. Tighten carrier retaining cap screws to 80-96 ft.-lbs. (109-130 N·m) torque. Refer to paragraph 173 for ring gear to pinion backlash adjustment. Install rockshaft from the right side while working power lift arms onto splines so that set screws align with holes in rockshaft. Protect bushings and seals from damage as rockshaft is installed. Install outer lift arms so that timing marks on arms and rockshaft align; then install snap rings.

Fig. 189—Exploded view of differential and differential lock assembly used on Model 2390 and early 2394 tractors.

1. Brake & sun shaft (right)
3. Snap ring
4. Bearing carrier
5. Bearing cone
6. Bearing cup
7. Differential cage half
8. Ring & pinion gears
9. Thrust washer
10. Side gear
11. Thrust washer
12. Bevel pinion
13. Pinion pin
14. Differential lock side gear
15. Thrust washer
16. Steel plate
17. Friction disc
18. Return spring
19. Spring plate
20. Piston
21. Seal (inner)
22. "O" ring (inner)
23. Seal (outer)
24. "O" ring (outer)
25. Park lock ring gear
26. Differential lock cage
27. Seal rings
28. Bearing cup
29. Bearing cone
30. Shim
31. Bearing carrier
32. Oil tube
33. Snap ring
34. Sun gear shaft



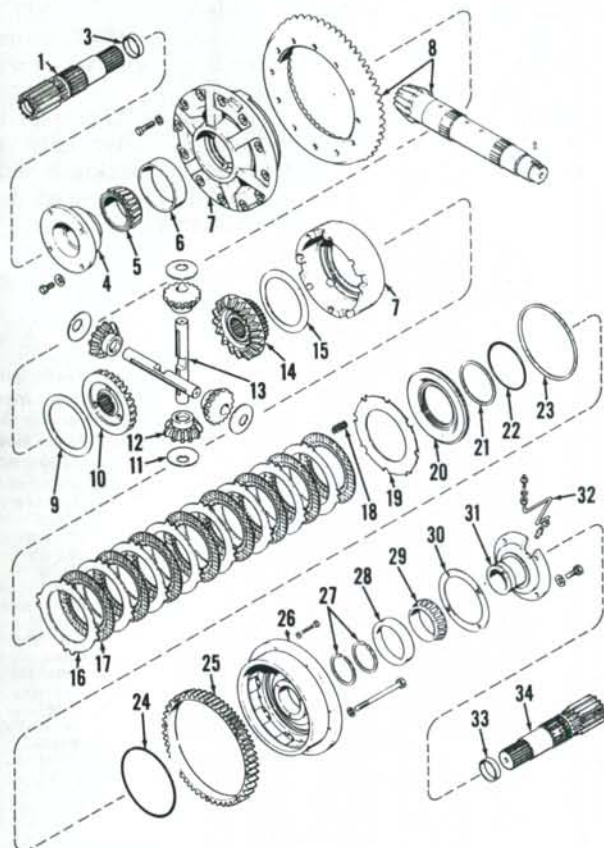
Adjust draft sensing linkage as outlined in paragraph 267.

172. OVERHAUL. Remove differential as outlined in paragraph 171. Place

assembly on a bench and refer to Figs. 189 or 190 as a guide to disassemble. Index pinion pin (s) (13) to ring gear cage (7) to ensure correct reassembly position. Keep shims (30) with the bearing

Fig. 190—Exploded view of differential and differential lock assembly used on Model 2590, 2594 and late 2394 tractors.

1. Sun gear shaft
2. Spacer
4. Bearing carrier
5. Bearing cone
6. Bearing cup
7. Differential cage half
8. Ring & pinion gears
9. Thrust washer
10. Side gear (right)
11. Thrust washer
12. Pinion gear
13. Pinion shaft
14. Side gear (left)
15. Thrust washer
16. Steel plate
17. Friction disc
18. Return spring
19. Spring plate
20. Piston
21. Seal (inner)
22. "O" ring (inner)
23. Seal (outer)
24. "O" ring
25. Park lock ring gear
26. Differential lock cage
27. Seal rings
28. Bearing cup
29. Bearing cone
30. Shim
31. Bearing carrier
32. Oil tube
33. Spacer
34. Sun gear shaft



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carriers from which they were removed. Shims are available in thicknesses of 0.005, 0.007 and 0.015 inch (0.127, 0.178 and 0.381 mm) for bearing preload adjustment. Inspect all parts for wear, nicks and scoring. If ring gear (8) must be renewed, it will be necessary to remove bevel pinion as outlined in paragraph 165. If ring gear was removed, install and tighten retaining cap screws to a torque of 110-125 ft.-lbs. (149-170 N·m). Install items 9 through 15 into large half of differential cage (7). Install steel plates (16) and discs (17) alternately and align tabs on steel plates so three cap screws will align with notches in tabs of steel plates. Model 2390 and early 2394 tractors use a total of 12 plates; Model 2590, 2594 and late 2394 tractors use a total of 16 plates. On Model 2390 and early 2394 tractors, install three springs over bolt holes, 120 degrees between springs and 30 degrees clockwise from tabs with notches. On Model 2590, 2594 and late 2394 tractors install four springs over bolt holes, 90 degrees between springs and 45 degrees clockwise from tabs with notches. Install return spring plate (19), aligning tabs on plate with tabs of clutch plates. Install two 3/8 NC x 6 inch studs in park lock ring gear (25), then install ring gear on differential lock cage, chamfer side toward cage, until it seats. Apply Loctite Primer "T" and Loctite 242 or equivalent, to park lock ring gear cap screws. Remove studs, install and tighten cap screws to 45-54 ft.-lbs. (61-73 N·m) torque.

Lubricate with petroleum jelly and install seal rings (items 21 through 24) into inner and outer grooves of piston (20). Use a smooth dowel or round plastic pen to fit seals and "O" rings into piston grooves. Lubricate and install piston, flat side down, into differential lock cage (26). Install the assembled lock cage and piston (26) onto the assembled differential cage (7) making sure the springs go into the machined recessed areas of the differential lock cage. Remove guide studs and install, then tighten differential lock cage bolts with washers to 220-260 ft.-lbs. (298-358 N·m) torque.

Reinstall differential assembly as outlined in paragraph 171. Adjust ring and pinion bearing preload and gear backlash as outlined in paragraph 173.

173. To check differential bearing preload, install the left hand bearing carrier without shims and tighten the four cap screws to 80-96 ft.-lbs. (109-130 N·m) Install right hand bearing carrier without shims, install two diagonal cap screws and tighten to 30 in.-lbs. (3.4 N·m) torque while rotating differential, then tighten to 50 in.-lbs. (5.6 N·m)

torque while rotating differential. Check clearance between right hand bearing carrier and transmission housing with a feeler gage at both bolt locations and average the readings. Assemble a set of shims the same thickness or 0.003 inch (0.076 mm) greater than the average measurement. Divide the shims equally and install one set of shims on each bearing carrier. Install both bearing carriers and tighten all bolts to 80-96 ft.-lbs. (109-130 N·m) torque.

With carrier bearing preload adjusted, check and adjust backlash between ring gear and pinion shaft as follows: Locate and record recommended backlash dimension which will be found etched on outside rim of bevel ring gear. Mount a dial indicator so that it makes contact with bevel ring gear and that sufficient pressure is on tip to move indicator needle. Take up slack in gears by holding pinion shaft and rotating differential as far as possible in one direction without moving bevel pinion shaft. Zero the indicator and turn differential in opposite direction as far as possible without moving bevel pinion shaft. Read dial indicator and compare reading to the backlash dimension etched on rim of bevel ring gear. If backlash is too much, remove shims from right hand bearing carrier and put the shims on left hand bearing carrier. If backlash is not enough, remove shims from the left hand bearing carrier and put the shims on the right hand carrier.

NOTE: Do not change the total amount of shims as it will affect bearing preload.

Recheck backlash with dial indicator after each shim change and when backlash adjustment is complete, tighten all bearing retainer cap screws

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to 80-96 ft.-lbs. (109-130 N·m) torque. Adjust park lock as outlined in paragraph 180.

DIFFERENTIAL LOCK VALVE

Models 2090, 2290, 2390 and 2590

174. Removal and overhaul of differential lock valve on all models is obvious after examination of unit and referral to Figs. 191 and 192. Use new wiper ring (2), and "O" rings (items 3, 4, 7 and 11) upon reassembly. Examine spool (1) and bore of body (5) for wear, scratches or other damage and renew both items as an assembly if necessary. Replace by reversing removal procedure.

Models 2094, 2294, 2394 and 2594

175. An electric solenoid differential lock control valve is used on all models. Service on the valve consists of renewing solenoid unit (1—Fig. 193), "O" rings (2, 3 and 4) or the complete valve assembly. When installing solenoid (1) in valve body (5), tighten to a torque of 18-20 ft.-lbs. (24-27 N·m).

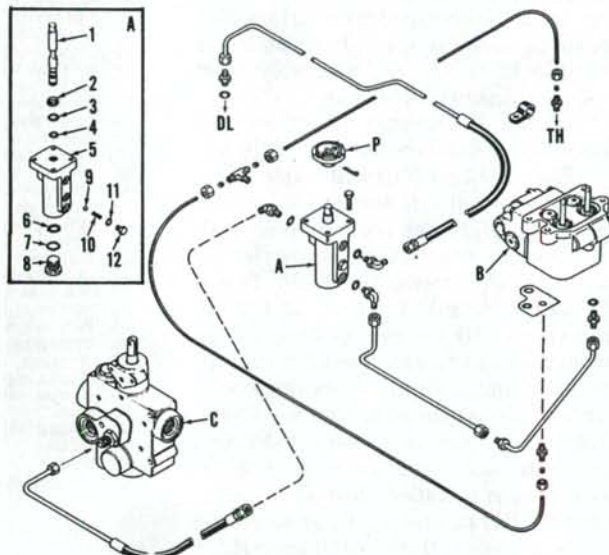
PARK LOCK AND LINKAGE

Models 2090, 2290, 2094 and 2294

176. LINKAGE ADJUSTMENT. To adjust park lock linkage refer to Fig. 194 and disconnect yoke (9) from lever (10). Place gear shift and park lock quadrants on console in neutral position. Place park lock lever (10) in off position approximately 9 degrees below horizontal as shown. Adjust lower yoke (9) so that

Fig. 191—Schematic view of differential lock hydraulic system and exploded view of valve (A) for Model 2090 and 2290 tractors.

- DL. Differential lock
- TH. Transmission housing
- B. Brake valve
- C. Pto control valve/flow divider
- P. Pedal
- 1. Valve spool
- 2. Wiper ring
- 3. "O" ring
- 4. "O" ring
- 5. Body
- 6. Retaining ring
- 7. "O" ring
- 8. Plug
- 9. Detent ball
- 10. Spring
- 11. "O" ring
- 12. Plug



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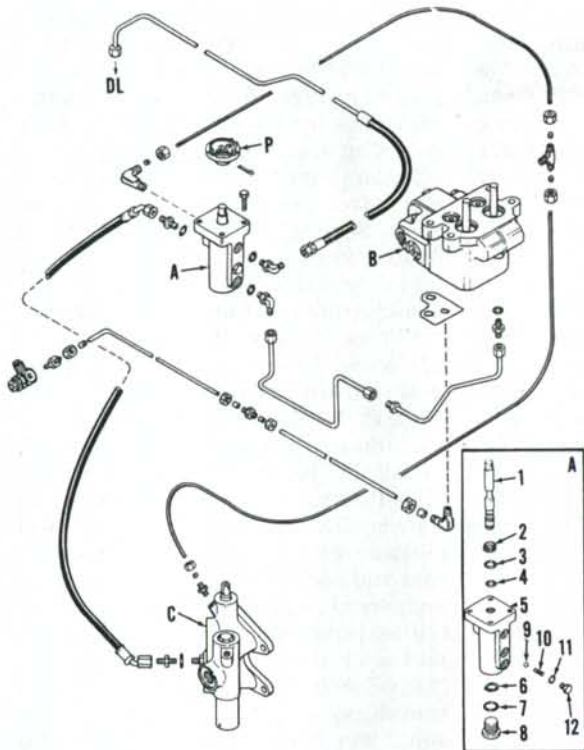


Fig. 192—Schematic view of differential lock hydraulic system and exploded view of valve (A) for Model 2390 and 2590 tractors.

- DL. Differential lock
B. Brake valve
C. Pto control valve/flow divider
P. Pedal
1. Valve spool
2. Wiper ring
3. "O" ring
4. "O" ring
5. Body
6. Retaining ring
7. "O" ring
8. Plug
9. Detent ball
10. Spring
11. "O" ring
12. Plug

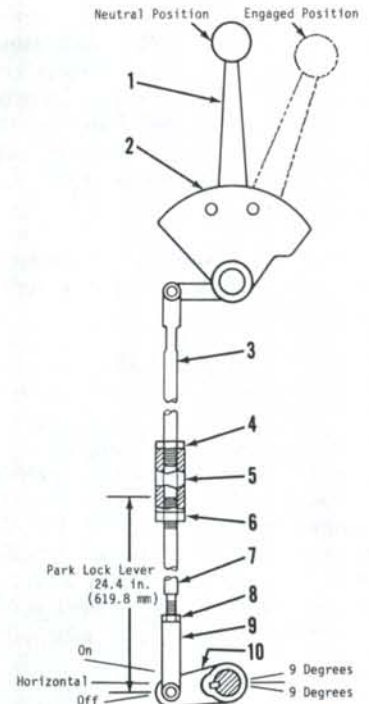


Fig. 194—Illustration showing adjustment dimensions and components for park lock lever on Model 2090, 2290, 2094 and 2294 tractors.

1. Park lock hand lever
2. Quadrant
3. Upper rod
4. Locknut
5. Adjustment sleeve
6. Locknut
7. Lower rod
8. Locknut
9. Yoke
10. Park lock lever

distance between center of hole in yoke is approximately 24.4 inches (619.8 mm) from top end of lower rod, then tighten locknut. Reconnect lower yoke (9) to lever (10). Loosen locknuts on adjustment sleeve (5) and align quadrants on the console by turning adjustment sleeve as necessary. Make sure quadrants on console are exactly in alignment and that shift lever can engage the gear shift quadrants and the park lock quadrant easily when lever is in neutral positions.

177. PARK LOCK. To service park lock first disconnect the two shift cables and park lock rod. Remove cables from mounting bracket. Remove park lock rod, hitch supply tube and hitch control cables. Disconnect electrical wires from neutral start switches. Unbolt and remove right side rear access cover. Place transmission in third gear by sliding front shift fork rearward. Engage

park lock by moving detent lever (15—Fig. 195) forward. Remove snap ring (21), lever (20), key (18) and shims from shaft (17). Remove set screw (6) from gear stop arm. Push roll pin (12)

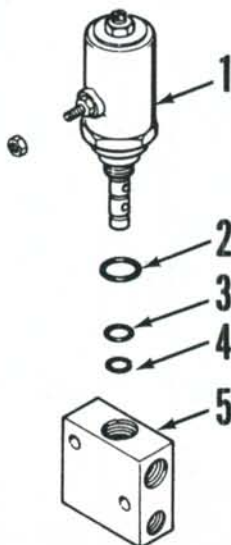
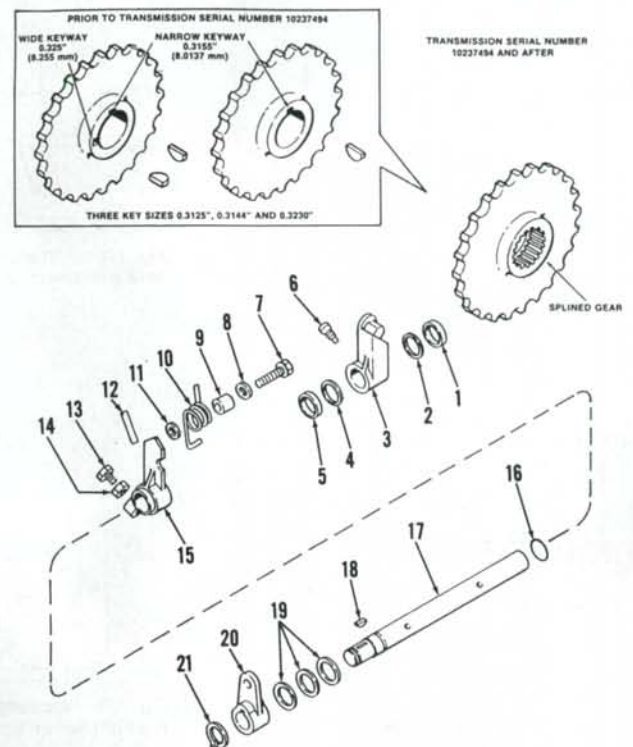


Fig. 193—View of differential lock solenoid control valve used on Models 2094, 2294, 2394 and 2594.

1. Solenoid valve
2. "O" ring
3. "O" ring
4. "O" ring
5. Valve body

Fig. 195—Exploded view of park lock mechanism used on all Model 2090, 2290, 2094 and 2294 tractors.

1. Spacer
2. Shim(s)
3. Gear stop arm
4. Shim(s)
5. Spacer
6. Set screw
7. Bolt
8. Washer
9. Spacer
10. Detent spring
11. Washer
12. Roll pin
13. Stop bolt
14. Locknut
15. Detent lever
16. "O" ring
17. Park lock shaft
18. Woodruff key
19. Shims
20. Lever
21. Snap ring



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out of detent lever as far as possible with an air chisel and CAS-1605 punch tool. Using a hammer and punch, continue pushing pin out of detent lever until shaft can be removed. Pull shaft (17) out far enough to remove spacer (1) and shim(s) (2) on left hand side of gear stop arm.

NOTE: If shaft is pulled out completely, all of the park lock parts will fall to bottom of transmission case.

Carefully withdraw shaft and remove remainder of park lock control items. Unbolt and remove detent spring and related parts (items 7 through 11).

Clean and inspect all parts and renew as necessary. Compare detent spring (10) to dimensions shown in Fig. 196. On tractors with transmission serial number prior to 10237494, equipped with key drive (see insert Fig. 195), check radial movement of park lock gear using a dial indicator.

NOTE: Too much radial movement could cause shearing of key. If radial movement is more than 0.100 inch (2.54 mm), service of park lock gear is required as outlined in paragraphs 115 or 161.

In servicing park lock gear, get the correct radial movement by selecting the tightest key fit possible between the park lock gear and the pinion shaft. Keys are available in thicknesses of 0.3125, 0.3144 and 0.3230 inch (7.938, 7.986 and 8.204 mm). It is not necessary to check radial movement of later model splined gear.

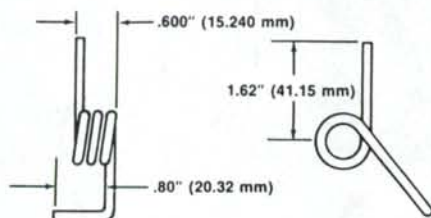


Fig. 196—Illustration showing detent spring dimensions.

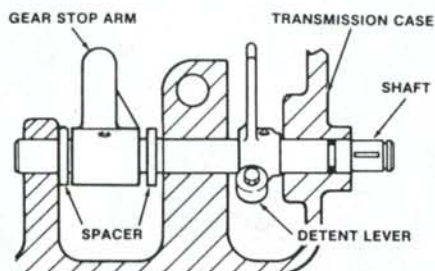


Fig. 197—Illustration showing installation of spacers on park lock shaft. Refer to text.

To reassemble, first clean old Loctite from threads of detent spring bolt (7—Fig. 195) and bolt hole. Assemble washers, spacer and detent spring on bolt making sure straight leg of spring is toward bolt head. Apply Loctite 271 or equivalent to threads of detent spring bolt and install into transmission, tightening bolt to 25-35 ft.-lbs. (34-47 N·m) torque. Insert park lock shaft (17) into bore of transmission case, with keyway toward rear of tractor. Install detent lever (15) on shaft with notch toward front of tractor placing leg of detent spring over detent lever. Install right side spacer (5), gear stop arm (3) and left side spacer (1) onto shaft (17). See Fig. 197. Engage stop arm with park lock gear and install set screw (6—Fig. 195), without Loctite, into stop arm, making sure point of screw enters hole in shaft.

178. ARM SHIM PROCEDURE.

Disengage gear stop arm and push shaft into transmission as far as possible. Install a dial indicator on end of shaft, pull shaft out as far as possible to find and record total end travel. See Fig. 198. Raise right rear tire off the ground engage the gear stop arm with gear, then rotate the right rear tire counterclockwise to remove backlash in drive train. While pushing the shaft in as far as possible and pulling the shaft out as far as possible, record the amount of end travel. See Fig. 199. Subtract

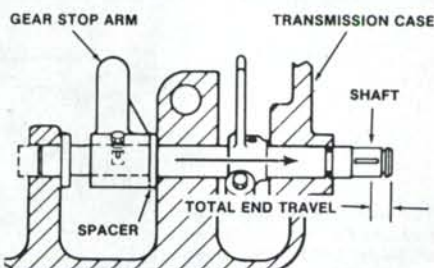


Fig. 198—Pull shaft out as far as possible to find total end travel and record measurement. Refer to text.

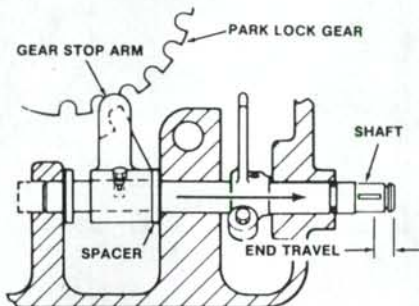


Fig. 199—Illustration showing procedure for finding right hand shim pack of park lock shaft. Refer to text.

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0.150 inch (3.81 mm) from this end travel to obtain correct shim pack thickness (4—Fig. 195) for right side of gear stop arm. To obtain the correct shim pack for the left hand side of the gear stop arm, subtract the right hand side shim pack thickness from the total end travel found in the first measurement. See Fig. 200. Remove shaft and related parts, install proper shim packs for left and right side of gear stop arm, and reinstall shaft and parts with new "O" ring (16—Fig. 195). Apply Loctite 271 or equivalent to set screw (6) on gear stop arm and install and tighten to 15-20 ft.-lbs. (20.4-27.1 N·m) torque. Install roll pin (12) into detent lever (15). Install key (18), lever (20) and snap ring (21). Pull park lock lever away from transmission as far as possible and measure distance between transmission case and back of lever with feeler gage and record measurement. Remove lever (20) and add sufficient shims (19) to obtain a clearance of 0.040-0.100 inch (1.016-2.540 mm) between lever and transmission. Disengage park lock and adjust stop bolt (13) on detent lever (15) until face of gear stop arm is 0.25 inch (6.35 mm) away from park lock gear as shown in Figs. 201 and 202.

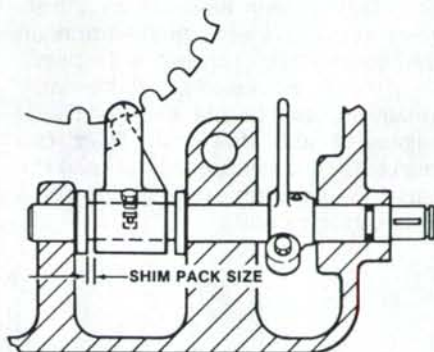


Fig. 200—Illustration showing procedure for finding left hand shim pack of park lock shaft. Refer to text.

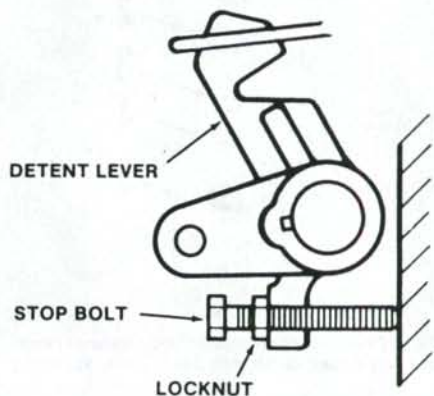


Fig. 201—Illustration showing stop bolt for detent lever travel adjustment. Refer to text.

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Remainder of reassembly is reverse of disassembly. Adjust shift linkage as outlined in paragraph 103 or 153 if necessary. Adjust park lock rod as outlined in paragraph 176.

Models 2390, 2590, 2394 and 2594

179. Model 2390, 2590, 2394 and 2594 tractors are equipped with a mechanical park lock assembly which utilizes a gear on the differential to provide the park locking function. Park lock assembly is controlled by the gear shift lever as shown in Fig. 203. Also refer to Fig. 204 for schematic view of park lock assembly which is located in transmission housing.

Park lock can be serviced by removing the gear shift housing cover and pto assembly.

180. **CONTROL LINKAGE.** To check or adjust control linkage refer to Fig. 203 and place gear shift quadrant and park lock quadrant on console in neutral position, moving hand lever to neutral position and check position of park lock front shaft lever which should be approximately 36 degrees below horizontal. If adjustment is required, disconnect yoke from shaft lever and turn yoke as necessary to align the holes. Reconnect rod to shaft lever. Start tractor and test park lock. Readjust as necessary.

181. **PARK LOCK.** To service park lock, first remove gear shift housing and pto assembly and proceed as follows: Disconnect control rod from front shaft lever (38—Fig. 205), then working through gear shift housing opening, disconnect control rod (28) from lever (30), then remove snap ring (29), lever (30), Woodruff key (37), washer (31), spring (32) and washer (33). Pull shaft (38) with snap ring (36) and washer (35) and if necessary, remove washer and snap ring from shaft. Pry oil seal (34) from bore in transmission housing.

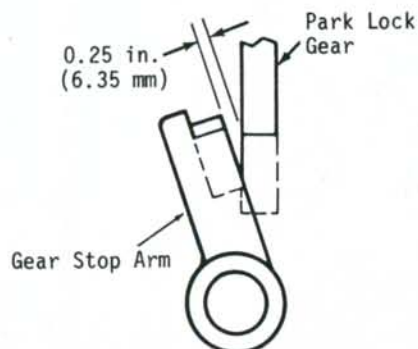


Fig. 202—Adjust stop bolt on detent lever until face of gear stop arm is 0.25 inches (6.35 mm) away from park lock gear. Refer to text.

Paragraphs 179-181

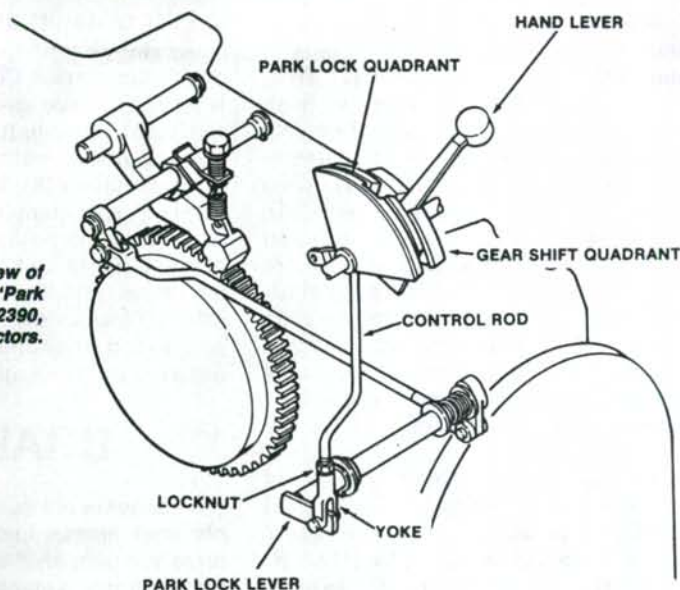


Fig. 203—Schematic view of park lock assembly in "Park On" position on Model 2390, 2590, 2394 and 2594 tractors.

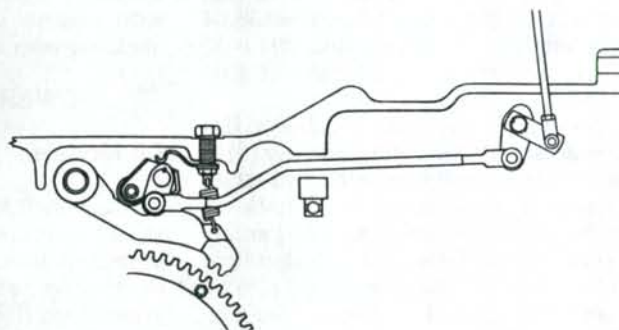
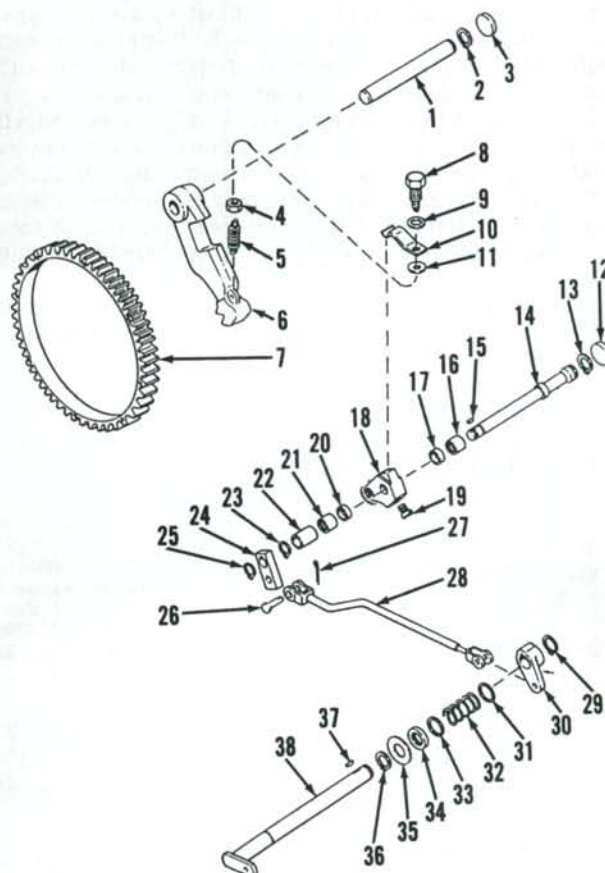


Fig. 204—Cross-sectional view showing internal parts of park lock assembly on Model 2390, 2590, 2394 and 2594 tractors.

Fig. 205—Exploded view of park lock parts and shafts.

1. Rear shaft
2. Snap ring
3. Cup plug
4. Jam nut
5. Spring
6. Engaging lever
7. Park lock ring gear
8. Retainer
9. Gasket
10. Detent spring
11. Washer
12. Cup plug
13. Snap ring
14. Center shaft
15. Woodruff key
16. Needle bearing
17. Spacer
18. Cam lever
19. Screw
20. Spacer
21. Needle bearing
22. Spacer
23. Snap ring
24. Control shaft lever
25. Snap ring
26. Yoke pin
27. Cotter pin
28. Control rod
29. Snap ring
30. Front shaft lever
31. Washer
32. Compression spring
33. Washer
34. Seal
35. Washer
36. Snap ring
37. Woodruff key
38. Front lever & shaft



Paragraphs 182-184

To service rear and center shafts (1 and 14—Fig. 205), remove cup plug (3 and 12), drive rear shaft (1) from transmission housing, then unhook spring (5) from retainer (8) and remove engaging lever (6) and spring. Disconnect rod (28) from lever (24), then remove snap ring (25), lever (24), Woodruff key (15), snap ring (23) and long spacer (22). Remove the square head set screw (19), then bump shaft (14) out of cam carrier (18) and housing and remove cam carrier. Cam roller can be removed after removing snap ring and pin. Remove the short spacer and needle bearing from each bore for the center shaft.

Clean and inspect all parts and renew as necessary. Engaging lever spring (5) has a free length of 1.82 inches (46.2 mm) and should test 25.1 lbs. (111.0 N) when extended to a length of 2.38 inches (60.5 mm). Compression spring (32) has a free length of 2.23 inches (56.64 mm) and should test 64 lbs. (284.0 N) when compressed to a length of 1.60 inches (40.6 mm).

Reassemble park lock as follows: Use new gasket (9) and install retainer (8) in top of transmission housing and when retainer is tightened, index mark on center of bolt (retainer) must be parallel to centerline of rear axle. Drilled hole in lower end of retainer should also be parallel to centerline of axles. See Fig. 206. Install detent spring (10—Fig. 205), washer (11) and nut (4) on retainer but do not tighten nut (4) at this time. Install snap ring (13) on outer end of shaft (14) and start shaft into transmission housing. Install needle bearings (16 and 21) and short spacers (17 and 20) into shaft bore with spacers next to carrier (18), hold cam carrier and following cam in place with detent notch up and push shaft through cam carrier. Install long spacer (22) and snap ring (23). Install Woodruff key (15), lever (24) and snap ring (25). Lever (24) is correctly installed when it faces downward and toward rear of tractor. Use Loctite 242 or equivalent on set screw (19), install set screw and be sure it seats on flat of shaft (14). Tighten set screw to 35-45 ft.-lbs. (47-61 N·m) torque. Remove nut (4) and washer (11), apply Loctite 242 or equivalent to threads of nut (4), then reinstall washer and nut and tighten nut

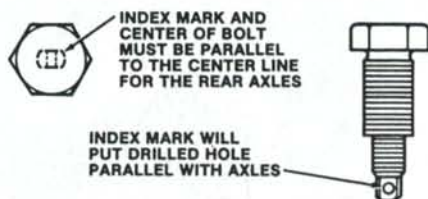


Fig. 206—When installing detent spring retainer the drilled hole faces front and rear of tractor.

to 35-45 ft.-lbs. (47-61 N·m) torque and make sure detent spring seats correctly on cam carrier. Connect rod (28) to lever (24). Place snap ring (2) on rear shaft and start shaft into transmission housing. Attach spring to engaging lever (6) and retainer (8), hold engaging lever in place and complete installation of shaft (1). Apply sealant to outside edges of cup plugs (3 and 12) and drive plugs into bores until they are flush with outside of transmission housing. Adjust park lock control linkage if necessary as outlined in paragraph 180.

BRAKES

All models are equipped with multiple disc brakes located on the final drive sun gear shafts. Brake pedals actuate brake valves, which act as manually operated master cylinders with engine inoperative and power assisted with engine running.

POWER BRAKE VALVE

All Models

182. OPERATION. The power brake valve mounts beneath cab platform and is tapped into the hydrostatic power steering hydraulic circuit. Filtered and pressurized fluid from the 8 gpm (30.3 L/min.) section of main hydraulic pump flows to power brake valve, through pressure regulating spool to steering valve; then through oil cooler back to transmission housing. The return transmission flow lubricates power shift clutch on models so equipped. On Models 2090, 2290, 2390 and 2590, brake valve and regulator valve (cover) are bolted together to form an assembly. On Models 2094, 2294, 2394 and 2594, brake valve and regulator valve are separate units and are connected by hydraulic lines.

Models 2090, 2290, 2390 and 2590

183. LINKAGE ADJUSTMENT. To adjust power brake pedal linkage, refer to Fig. 207 and adjust upper stop bolt on each brake pedal so that centerline of each pedal pad is 7.7 inches (195 mm) from cab floor, then tighten locknuts. Disconnect rod pivots from pedals and pull each rod fully up without compressing springs in brake piston assemblies in brake valve. Push each brake pedal down 0.55 inch (14 mm) and at this position, align hole in each rod pivot with hole in each brake pedal arm by adjusting rod pivots to the brake pedal arms. Push brake pedal down until the pedals are 2.9 inches (74 mm) from the cab floor. Adjust the lower stop bolts to this position and tighten locknut. Pushing down on each brake pedal with 100 lbs. (445 N) of force on each pedal, the pedals must not have more than 0.25 inch (6.35 mm) difference in height from cab floor. If necessary, adjust the highest pedal to the same level as the lower one by adjusting the rod pivot.

Models 2094, 2294, 2394 and 2594

184. LINKAGE ADJUSTMENT. To adjust power brake pedal linkage, refer to Fig. 208 and disconnect brake push rods from brake pedals. Adjust upper stop bolts so that distance between floor mat and corner of each pedal is 6.8 inches (172.72 mm). Reconnect push rods to pedals and adjust length of push rods until upper stop bolts just contact brake and clutch cover. Then, lengthen each push rod one full turn counterclockwise. Tighten locknuts on push rod to a torque of 28-35 ft.-lbs. (38-48 N·m). Push each brake pedal down until push rod travel is 1.25 inches (31.75 mm). At this time, distance between corner of

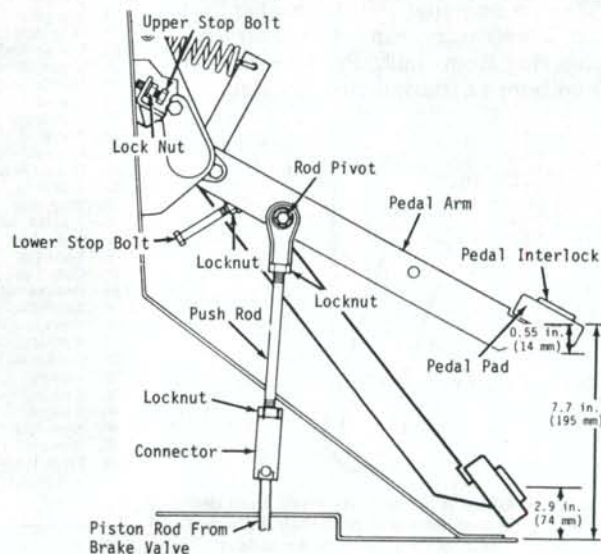


Fig. 207—Illustration showing brake pedal linkage and adjustment dimensions for Model 2090, 2290, 2390 and 2590 tractors. Refer to text.

SERVICE MANUAL

Paragraphs 185-189

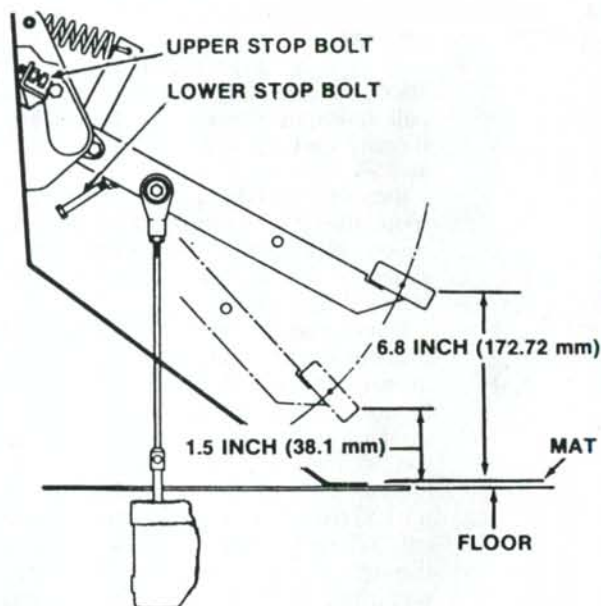


Fig. 208—Illustration showing brake pedal linkage and adjustment dimensions for Model 2094, 2294, 2394 and 2594 tractors.

brake pedal and floor mat should be 1.5 inches (38.1 mm). Adjust lower stop bolts to this position and tighten locknuts.

Push both brake pedals down at the same time and check to see that pedal interlock pin will engage. If not, adjust highest pedal to height of lower pedal by adjusting length of push rod.

All Models

185. BLEEDING. Power brake system bleed screw is located at top of each axle housing as shown in Fig. 209. To bleed brakes, first operate engine at 1000 to 1500 rpm. Turn the steering wheel all the way to the left and right several times to flush the steering system. Open left hand brake bleed screw until fluid flows out. Permit fluid to flow until bubble free, slowly push left hand pedal until pedal is fully down. Close bleed screw while pedal is fully down. Slowly release brake pedal until fully up. Repeat procedure again several times to ensure complete air removal. Repeat operation for right hand brake.

All Models

186. PRESSURE TEST. To check system pressure and flow, refer to paragraph 226 for 8 gpm (30.3 L/min.) pump testing. Using a CAS-10280 flowmeter or equivalent, install outlet hose from flowmeter into transmission filler neck, then install a tee fitting between outlet hose on gear pump and pump. Install inlet hose of flowmeter to the connector on pump. Close load valve on flowmeter, start and run tractor at 2000 rpm until hydraulic fluid reaches operating temperature of approximately 110°-120° F (43°-49° C). Push either left

or right brake pedal down with 110 lbs. (489 N) of force. Pressure on flowmeter pressure gage must be 1600-1800 psi (11032-12411 kPa). If pressure is incorrect, adjustment is accomplished by loosening locknut (17—Fig. 210 or 211) and turning screw (16) clockwise to increase pressure or counterclockwise to decrease pressure. When pressure is correct, tighten locknut.

Models 2090, 2290, 2390 and 2590

187. REMOVE AND REINSTALL. To remove the power brake valve and regulator valve assembly, first disconnect pedal connector from piston rod in brake valve. Disconnect all hydraulic lines leading to valve, then remove mounting bolts and remove valve from cab platform. Install by reversing removal procedure. Bleed power steering system as outlined in paragraph 25 and brake system as outlined in

paragraph 185. Adjust brake linkage if necessary as outlined in paragraph 183.

Models 2094, 2294, 2394 and 2594

188. REMOVE AND REINSTALL. To remove the power brake master valve and pressure regulator valve, disconnect brake push rods from pedals. Disconnect hydraulic lines from brake valve, then unbolt and remove master brake valve.

On Models 2394 and 2594, unbolt and remove left step assembly. On all models, identify and disconnect hydraulic lines as necessary. Then, unbolt and remove pressure regulator valve from left side of torque tube.

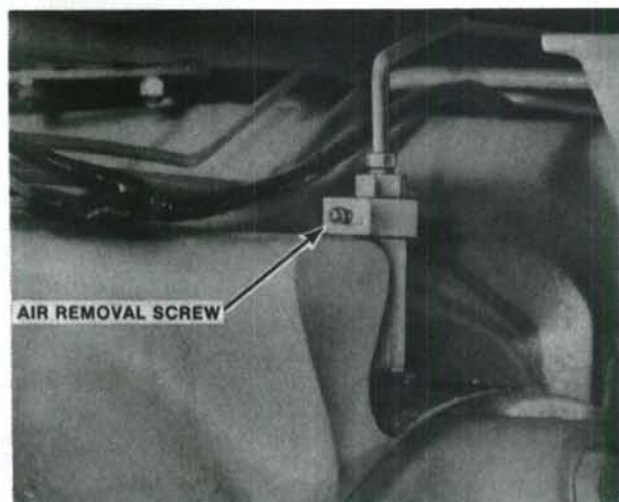
Reinstall by reversing removal procedures. Bleed power steering system as outlined in paragraph 25 and brake system as outlined in paragraph 185. Adjust brake linkage, if necessary, as outlined in paragraph 184.

All Models

189. OVERHAUL REGULATOR ASSEMBLY. Refer to Fig. 210 or 211 for an exploded view of brake valve regulator assembly used on all models and to Fig. 213 or 214 for master brake valve unit. Right and left hand units are identical but used parts should not be intermixed while unit is disassembled. On Models 2090, 2290, 2390 and 2590, with power brake valve removed from tractor, unbolt and remove regulator body (35—Fig. 210). On all models, remove equalizer plug (24—Fig. 210 or 211), "O" ring (25) and piston assembly (items 26 through 34). Remove snap ring (26) and withdraw internal pin assembly (items 27 through 31). Remove clips (27 and 29), spring (28) and "O" ring (31) from pin (30). Remove and discard "O" ring and seal (33 and 34).

Remove plug (48) and "O" ring (47), spring (46) and pressure regulator piston

Fig. 209—View of brake hydraulic air bleed screw (right side shown).



Paragraphs 190-191

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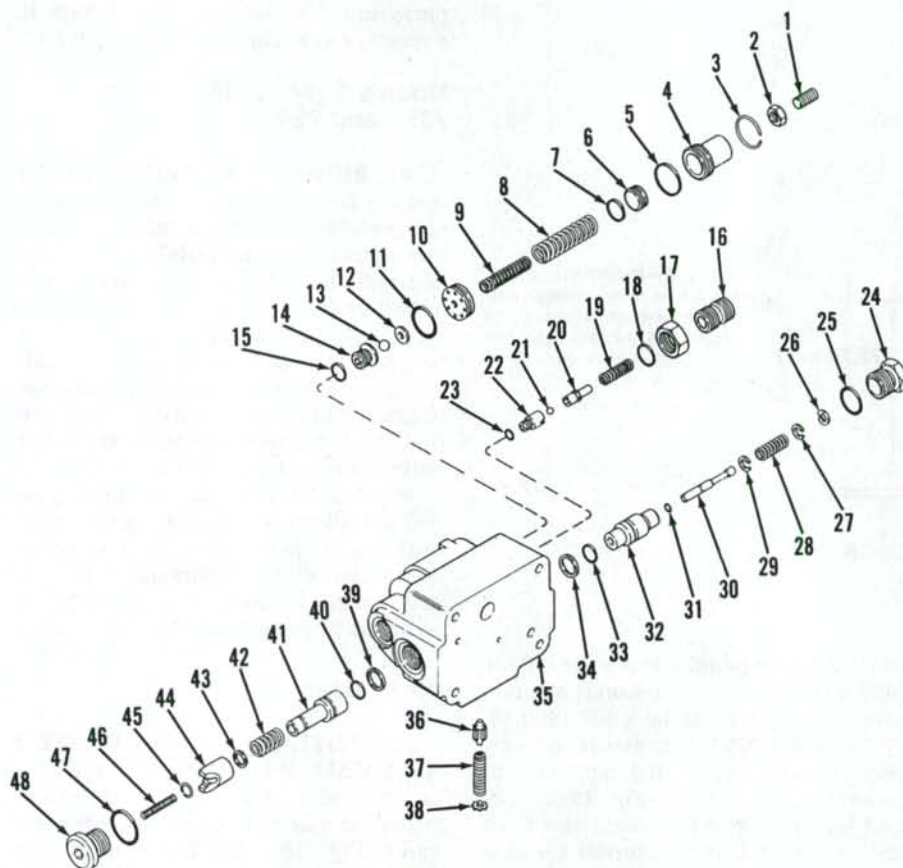


Fig. 210—Exploded view of power brake valve cover (regulator) and associated parts for Model 2090, 2290, 2390 and 2590 tractors.

- | | | | |
|----------------------------|--------------------------|--------------------|--------------------|
| 1. Steering pressure screw | 13. Ball | 24. Plug | 36. Poppet |
| 2. Locknut | 14. Seat | 25. "O" ring | 37. Spring |
| 3. Snap ring | 15. "O" ring | 26. Retaining ring | 38. Retainer |
| 4. Retainer | 16. Brake pressure screw | 27. Washer | 39. Seal ring |
| 5. "O" ring | 17. Locknut | 28. Spring | 40. "O" ring |
| 6. Spring disc | 18. "O" ring | 29. Washer | 41. Piston |
| 7. "O" ring | 19. Spring | 30. Piston pin | 42. Spring |
| 8. Spring (outer) | 20. Guide | 31. "O" ring | 43. Washer |
| 9. Spring (inner) | 21. Ball | 32. Piston | 44. Spool |
| 10. Guide | 22. Seat | 33. "O" ring | 45. Retaining ring |
| 11. "O" ring | 23. "O" ring | 34. Seal ring | 46. Spring |
| 12. Washer | | 35. Valve body | 47. "O" ring |
| | | | 48. Plug |

assembly (items 39 through 45). Remove snap ring (45) and disassemble regulator piston. Remove and discard "O" ring and seal (39 and 40).

Place index marks on locknut (17) and adjustment screw (16) of brake pressure relief valve. Remove locknut and screw together keeping marks aligned. Remove and discard "O" ring (18), then remove spring (19), guide and ball (20 and 21) on Models 2090, 2290, 2390 and 2590 or poppet (20) on Models 2094, 2294, 2394 and 2594 and using a screwdriver, remove relief valve seat (22) and remove and discard "O" ring (23).

Index locknut and adjustment screw (1 and 2) of steering pressure relief valve, and remove screw and locknut together keeping marks aligned. Using a "C" clamp, depress spring housing (4) enough to remove retaining ring (3), then remove spring housing (4), spring disc (6), springs (8 and 9), spring guide (10), washer (12) and relief ball (13). Loosen and remove relief valve seat

(14). Remove and discard "O" rings (5, 7, 11 and 15).

Remove connector for sump hose then remove washer (38), spring (37) and sump poppet (36).

Renew all "O" rings and seals upon reassembly and renew any parts which are worn, scored, or otherwise damaged. Use Loctite 242 or equivalent on threaded seats (14 and 22). Lubricate "O" rings with petroleum jelly upon reassembly. Reassemble by reversing disassembly procedure. On Models 2090, 2290, 2390 and 2590, tighten regulator to valve body cap screws to 17-30 ft.-lbs. (23-41 N·m) torque. On all models, test and adjust steering and brake relief pressures as outlined in paragraphs 27 and 186.

Models 2090, 2290, 2390 and 2590

190. OVERHAUL BRAKE VALVE BODY. With regulator body removed from valve body, remove and discard

"O" rings (2—Fig. 212). Refer to Fig. 213 for exploded view of valve body and remove plug (25) for differential lock check ball assembly, then remove check ball assembly (items 28, 29 and 30). Remove and discard "O" rings (26, 27 and 31).

Remove plug (19) for right hand boost spool, then remove spring (21) and boost spool (22). Remove and discard "O" rings (20 and 23) and seal (24). Repeat removal for left hand boost spool.

Remove snap ring (1) for left hand brake piston assembly and pull assembly (items 2 through 18) from valve body. Remove piston stop and seal assembly (items 2 through 7) from brake piston rod (8). Remove and discard "O" rings (4 and 6) and back-up ring (5). Remove pin (18) from piston rod (8), then remove cup (17), spring (16) and piston (items 13 through 15) from piston rod. Remove snap ring (12) from rod then remove seal washer (10 and 11) from rod. Remove and discard "O" rings (9, 11 and 14) and seal (13).

Remove fitting (34) and remove and discard "O" ring (33).

Renew all "O" rings and seals upon reassembly and renew any parts which are worn, scored or otherwise damaged. Parts (3 and 30) are not serviced separately. Lubricate "O" rings with petroleum jelly upon reassembly. Install seal (2) with lip toward outside. Repeat procedure for right hand brake piston assembly. Install four new "O" rings (2—Fig. 212) between regulator and valve body and tighten regulator to body cap screws to 17-30 ft.-lbs. (23-41 N·m) torque.

Models 2094, 2294, 2394 and 2594

191. OVERHAUL BRAKE VALVE.

With brake valve removed, drive out pins and remove brake push rods from piston rods (8—Fig. 214). Although left and right hand parts are identical, re-used parts should be installed in their original ports. Remove snap ring (1) and pull assembly (2 through 18) from valve body. Remove piston stop and seal assembly (items 2 through 7) from brake piston rod (8). Remove and discard "O" rings (4 and 6) and back-up ring (5). Remove pin (18) from piston rod (8), then remove cup (17), spring (16) and piston (items 13 through 15) from piston rod. Remove snap ring (12) from rod, then remove seal washer (9) and "O" rings (10 and 11) from rod. Remove and discard "O" rings (10, 11 and 15) and seal ring (14).

Remove plug (19), spring (22) and boost spool (23). Remove and discard "O" rings (20 and 25) and seal ring (24).

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Remove plug (27) and discard "O" ring (26).

Repeat the removal operation for opposite side of valve. Clean and inspect all parts and renew any showing excessive wear or other damage.

When reassembling, renew all "O" rings and seal rings. Lubricate all "O" rings with petroleum jelly during installation. Install wiper seals (2) with lip toward outside.

DISC BRAKES

Tractors are equipped with self-adjusting multiple disc brakes, which are located between final drive housing and transmission case. Refer to Figs. 215 and 216. As pressure is applied to brake piston, the lined discs are squeezed between notched steel plates which cannot turn and rotation of discs, hub and/or sun gear shaft is stopped, which prevents planetary gears and axle shafts from turning.

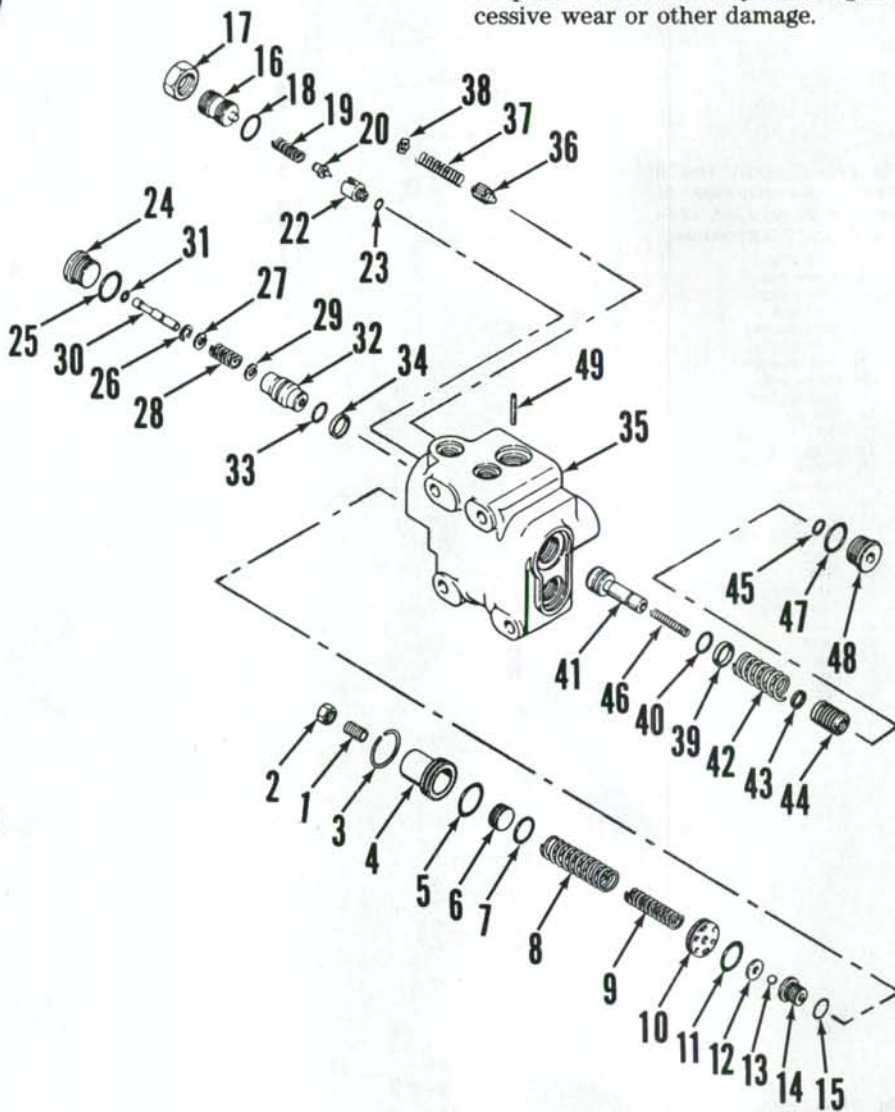


Fig. 211—Exploded view of brake pressure regulator valve and associated parts used on Model 2094, 2294, 2394 and 2594 tractors.

- | | | | |
|----------------------------|--------------------------|----------------------|----------------------|
| 1. Steering pressure screw | 13. Ball | 25. "O" ring | 37. Spring |
| 2. Locknut | 14. Seat | 26. Snap ring | 38. Washer |
| 3. Snap ring | 15. "O" ring | 27. Washer | 39. Seal ring |
| 4. Retainer | 16. Brake pressure screw | 28. Spring | 40. "O" ring |
| 5. "O" ring | 17. Locknut | 29. Washer | 41. Regulator piston |
| 6. Spring disc | 18. "O" ring | 30. Piston pin | 42. Spring |
| 7. "O" ring | 19. Spring | 31. "O" ring | 43. Washer |
| 8. Spring (outer) | 20. Poppet | 32. Equalizer piston | 44. Spool |
| 9. Spring (inner) | 21. Seal ring | 33. "O" ring | 45. Retaining ring |
| 10. Guide | 22. Seat | 34. Seal ring | 46. Spring |
| 11. "O" ring | 23. "O" ring | 35. Valve body | 47. "O" ring |
| 12. Washer | 24. Plug | 36. Sump poppet | 48. Plug |
| | | | 49. Roll pin |

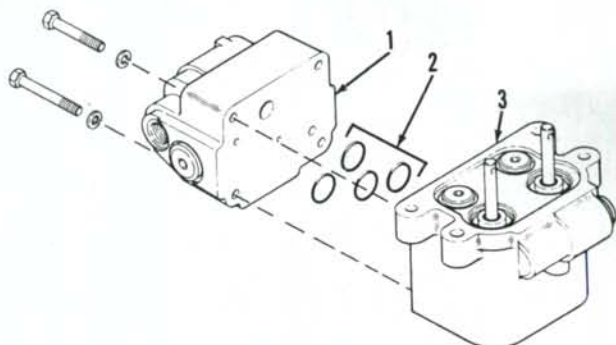


Fig. 212—View of Model 2090, 2290, 2390 and 2590 power brake regulator and valve body separated showing "O" rings (2) between halves.

1. Regulator assy.
2. "O" rings
3. Valve body

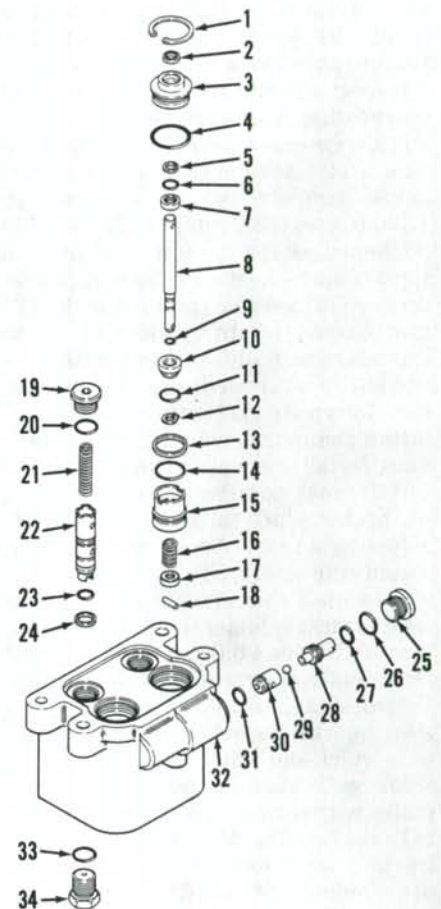


Fig. 213—Exploded view of valve body section and related parts of power brake assembly used on Model 2090, 2290, 2390 and 2590 tractors.

- | | |
|------------------|-----------------|
| 1. Snap ring | 18. Pin |
| 2. Seal | 19. Plug |
| 3. Stop | 20. "O" ring |
| 4. "O" ring | 21. Spring |
| 5. Back-up ring | 22. Spool assy. |
| 6. "O" ring | 23. "O" ring |
| 7. Seal retainer | 24. Seal ring |
| 8. Rod | 25. Plug |
| 9. "O" ring | 26. "O" ring |
| 10. Washer | 27. "O" ring |
| 11. "O" ring | 28. Retainer |
| 12. Snap ring | 29. Ball |
| 13. Seal ring | 30. Seat |
| 14. "O" ring | 31. "O" ring |
| 15. Piston | 32. Body |
| 16. Spring | 33. "O" ring |
| 17. Retainer | 34. Plug |

Paragraph 192

No external service to brakes can be performed, other than bleeding, which is outlined in paragraph 185.

Models 2090, 2290, 2094 and 2294

192. OVERHAUL. Final drive housings must be removed as outlined in paragraph 166. Remove brake fittings (items 6 through 14—Fig. 215 and disconnect and remove the differential lock hydraulic tube (4) on right side only. Unbolt and remove brake cylinder (5), containing piston (items 15 through 18), plates and springs (items 19 through 25). Remove all brake plates (19, 21 and 22), springs (25), self-adjuster screws (24) and adjust retainers (20 and 23). Using compressed air, remove piston (18) from cylinder. Remove and discard "O" rings and seals (15 through 17). Remove small "O" ring (3) from cylinder. Remove air removal screw from cylinder.

Inspect all parts for wear, scoring and overheating. Renew all parts in question and always renew piston "O" rings. Free length of return springs is 1.4 inches (35.56 mm) and should compress to 1.130 inches (28.7 mm) at 171 lbs. (760 N). Renew all springs as a set if any one spring fails to meet specifications. Back-up ring (15) must be installed with "O" ring groove toward cylinder (5). Coat threads of self-adjust screws with Loctite 601 or equivalent prior to installation. Lubricate "O" rings on piston and install piston into cylinder until it bottoms. Install brake plate (19) on cylinder. Install brake adjuster retainer in holes of brake plate aligned with self-adjusting screw holes in cylinder, then install screws (24). Tighten self-adjust screws until retainer (20 and 23) bottoms against cylinder then loosen screw 1/2 turn to give a 0.025 inch (0.635 mm) brake plate clearance. Install differential sun shaft gear into differential, then starting with a steel plate, install alternate steel and friction plates on sun shaft gear aligning notches in steel plates with spring recesses in inner half of brake housing. Model 2090 and 2094 tractors use a total of four plates and discs; Model 2290 and 2294 tractors use a total of six plates and discs. Install springs (25), two 5/8 inch NC x 6 inch studs into inner brake housing, then install cylinder onto studs making sure brake hydraulic fitting hole is at top. Install and tighten all brake cylinder bolts to 220 ft.-lbs. (304 N · m) torque. Install differential lock hydraulic tube with new "O" rings. Install brake fitting through top of transmission housing and into brake cylinder and fill brake cylinder with oil until it flows out top fitting,

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Fig. 214—Exploded view of master brake valve assembly used on Model 2094, 2294, 2394 and 2594 tractors.

1. Snap ring
2. Wiper seal
3. Piston stop
4. "O" ring
5. Back-up ring
6. "O" ring
7. Seal retainer
8. Piston rod
9. Seal washer
10. "O" ring
11. "O" ring
12. Snap ring
13. Piston
14. Seal ring
15. "O" ring
16. Spring
17. Retaining cup
18. Pin
19. Plug
20. "O" ring
21. Valve body
22. Spring
23. Spool
24. Seal ring
25. "O" ring
26. "O" ring
27. Plug

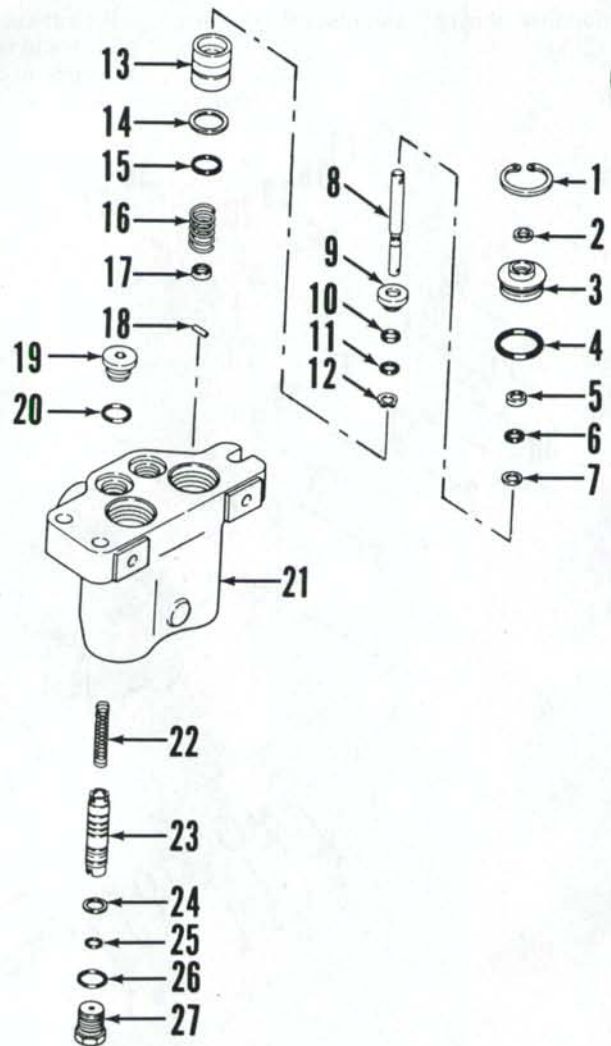
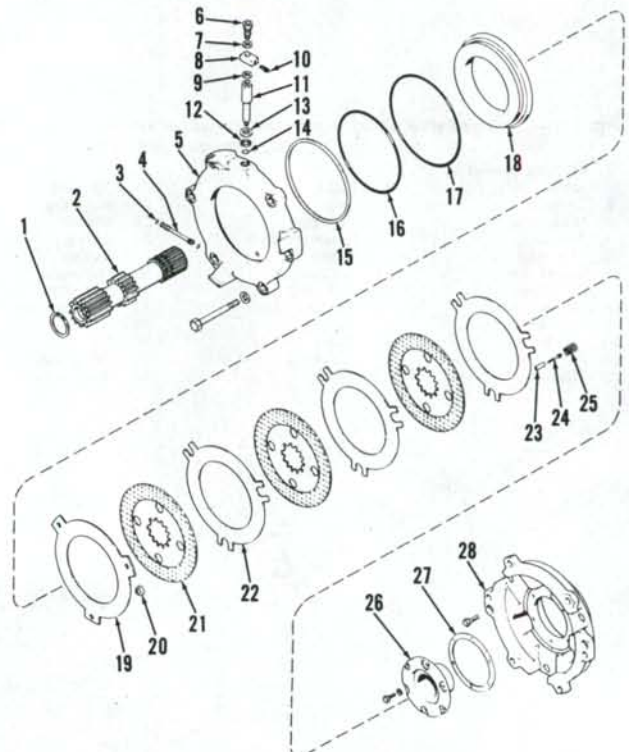


Fig. 215—Exploded view of brake cylinder assembly for Model 2090, 2290, 2094 and 2294 tractors.

1. Snap ring
2. Sun gear shaft
3. "O" ring
4. Differential lock supply tube
5. Cylinder
6. Connector
7. Gasket
8. Fitting
9. Gasket
10. Bleed screw
11. Fitting
12. Grommet
13. Washer
14. "O" ring
15. Back-up ring
16. "O" ring
17. "O" ring
18. Piston
19. Return plate
20. Retainer
21. Friction disc
22. Steel plate
23. Pin
24. Screw
25. Spring
26. Bearing carrier
27. Shim
28. Housing



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then close bottom fitting and connect top fitting to supply line. Remainder of installation is reverse of disassembly. Bleed brakes as outlined in paragraph 185.

Models 2390, 2590, 2394 and 2594

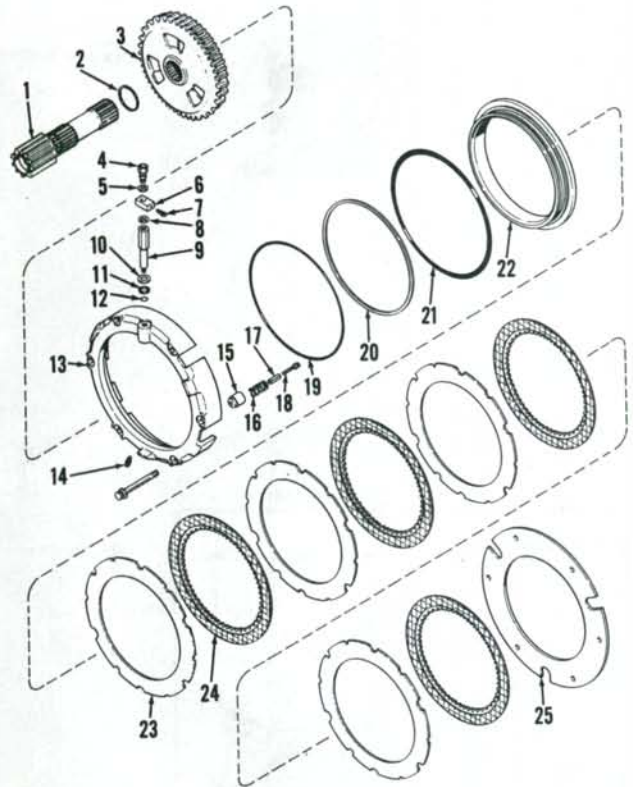
193. OVERHAUL. Final drive housings must first be removed as outlined in paragraph 166. Remove brake fittings (items 4 through 12—Fig. 216). Unbolt and remove brake cylinder (13) which contains piston and seals (items 19 through 22), plates (23 and 24), and springs and adjusters (items 15 through 18). Remove steel plates and friction discs from brake cylinder. Remove brake return springs (16), retaining cap screws (18) and disc pins (15 and 17) from brake cylinder. Using compressed air, remove piston (items 19 through 22) from brake cylinder. Remove and discard "O" rings (19 and 21) and seal ring (20). Remove brake piston return disc (25) from inner housing.

Inspect all parts for wear or scoring and for signs of overheating and renew as necessary. Return springs (16) have a free length of 1.560 inches (39.624 mm) and should compress to 1.28 inches (32.5 mm) at 147 lbs. (654 N). Renew all springs if any one spring fails to meet requirements.

When reassembling, if removed, reinstall bleeder screw in outer edge of brake cylinder. Install "O" rings (19 and 21) on piston (22), then install back-up ring (20) over the small "O" ring (19) so groove in back-up ring is toward small "O" ring. Lubricate "O" rings, back-up ring and lead-in chamfers of brake cylinder and install piston into cylinder until it bottoms. Install brake adjuster retainers in the three 0.470 inch (11.938 mm) radius slots in cylinder. Apply Loctite 601 or equivalent to cap screws (18) and install into retainer and tighten until roll pin in retainer is tight against cylinder, then loosen cap screw ½ turn to give brake clearance of 0.025 inch (0.635 mm). Install springs (16) into disc pins. Starting with a steel plate (23), install into cylinder with the 0.585 inch (14.895 mm) radius slots in plate next to disc pins, then alternately install a friction disc (24) and steel plate. Model 2390 and 2394 tractors use a total of three steel plates and three friction discs; Model 2590 and 2594 tractors use a total of four steel plates and four friction discs. Install brake piston return disc (25) into transmission housing, aligning the 0.625 inch (15.875 mm) slots in disc with disc pins in cylinder and aligning bolt holes in disc with bolt holes in transmission housing. Install brake cylinder assembly and install bolts but

Fig. 216—Exploded view of brake cylinder assembly for Model 2390, 2590, 2394 and 2594 tractors.

1. Sun gear shaft
2. Snap ring
3. Brake hub
4. Fitting
5. Gasket
6. Fitting
7. Bleed valve
8. Gasket
9. Fitting
10. Washer
11. Grommet
12. "O" ring
13. Cylinder
14. Bleed screw
15. Retainer
16. Spring
17. Roll pin
18. Screw
19. "O" ring
20. Back-up ring
21. "O" ring
22. Piston
23. Steel plate
24. Friction disc
25. Reaction plate



do not totally tighten at this time. Install hydraulic fitting (items 4 through 12) through transmission and into cylinder, then tighten brake cylinder mounting bolts to 80-96 ft.-lbs. (108-130 N·m) torque. Loosen air screw (14) at bottom of brake cylinder; connect a hose to fitting and use a hydraulic hand pump to fill brake cylinder with oil. Continue filling cylinder until bubble free oil appears at top hydraulic fitting, then tighten air removal screw (14) and reconnect oil tube at hydraulic fitting. Reassemble tractor by reversing disassembly procedure. Bleed brakes as outlined in paragraph 185.

POWER TAKE-OFF

All models are equipped with an independent power takeoff which is controlled through a cable operated valve to a hydraulically operated multiple disc clutch. All models are powered from a two-piece shaft, coupled at the rear transmission housing and is splined directly to center of flywheel. Model 2090, 2290, 2094 and 2294 tractors are available with a two-speed (540 and 1000 rpm) unit; and Models 2090 and 2094 are also available with a single 1000 rpm unit. Model 2390, 2590, 2394 and 2594 tractors are available with a 1000 rpm unit only. Pto speeds are based on 2100 rpm engine speeds.

Paragraphs 193-194

TESTING AND ADJUSTMENT

Models 2090, 2290, 2390 and 2590

194. LINKAGE ADJUSTMENT. No clutch adjustment is provided. The pto shift lever and cable can be adjusted to provide the correct movement of valve spool. Refer to Fig. 217 and proceed as follows:

Disconnect yoke from bellcrank on valve assembly by removing the retaining pin. Push the pto control knob on console fully down. Pull control spool in valve assembly fully up. Install yoke over bellcrank and make sure holes in yoke align with hole in bellcrank. If holes do not align, loosen locknut on control cable and adjust yoke until holes align with bellcrank. Tighten locknut against yoke to bellcrank and install retaining pin.

With engine running at 750 rpm, and with oil at operating temperature of approximately 120° F (49° C), pull pto control knob to full up position, engaging pto clutch. Take hand off control knob; if control knob does not hold in up position, turn screw (7—Fig. 221 or 223) inward to increase spring pressure on detent in pto control and pressure regulator valve. Stop tractor engine. Pto control knob must automatically return to down position.

Paragraphs 195-196

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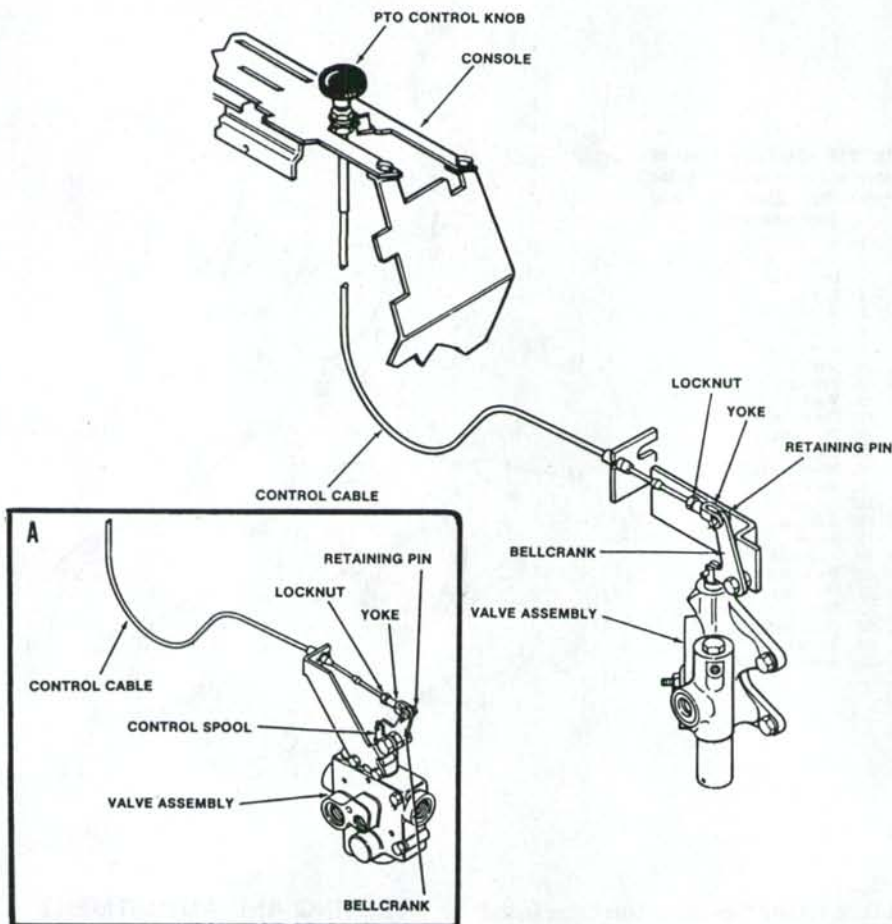


Fig. 217—View of pto linkage and related parts used on Models 2090, 2290, 2390 and 2590. Insert "A" shows Model 2090 and 2290 pto control valve.

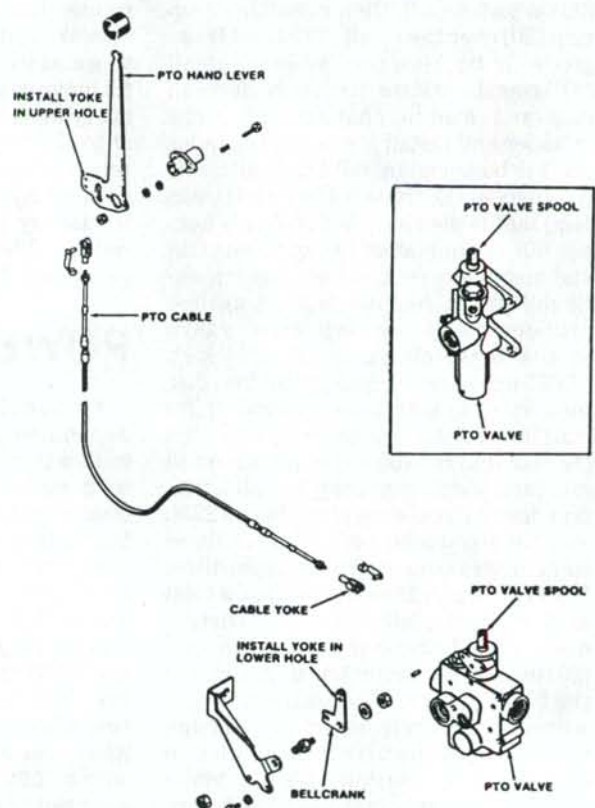
when engine is stopped, screw (7) will have to be backed out from detent spring in pto control and regulator valve or pto control and regulator valve must be overhauled as outlined in paragraphs 198 or 200.

Models 2094, 2294, 2394 and 2594

195. LINKAGE ADJUSTMENT. No clutch adjustment is provided. The pto shift lever and cable can be adjusted to provide the correct movement of control valve spool. Refer to Fig. 218 and proceed as follows: Disconnect control cable yoke from bellcrank on pto control valve. Make certain that upper cable yoke is connected to upper hole in hand lever. Move pto hand lever rearward to the OFF position. Place pto valve spool in the fully lowered position. Check to be sure that bellcrank has 0.004-0.008 inch (0.1016-0.2032 mm) end clearance to prevent binding. Adjust lower yoke on cable so that yoke pin holes align with lower hole in bellcrank. Attach yoke to bellcrank with clip pin.

With engine operating at 750 rpm and oil temperature at approximately 120°

Fig. 218—View of pto control linkage and related parts used on Models 2094, 2294, 2394 and 2594. Insert shows Model 2394 and 2594 control valve.



F (49° C), move hand lever fully forward to pto engaged position. Press and release inching pedal and move hitch lever to actuate the hitch. Pto must remain engaged. If not, turn detent adjusting screw (11—Fig. 222 or 6—Fig. 224) inward to increase detent pressure. Adjust screw a maximum of 1/8 turn at a time.

If pto remains engaged in the preceding test, stop engine. In a short time, pressure will drop and pto handle should return to disengaged position. If not, adjusting screw must be backed out slightly to reduce detent pressure.

All Models

196. TESTING. To connect equipment for testing the pto flow divider, control valve and pto clutch, disconnect the pump outlet tube from the piston pump. Using appropriate fittings, attach flowmeter inlet to the pump outlet. Then, connect flowmeter outlet to piston pump outlet tube. Remove the transmission pressure switch from the flow divider and pto control valve. Install a 600 psi (4100 kPa) test gage and hose to pressure switch port on valve.

To check pto brake or clutch leakage, start engine and operate at 750 rpm. Open load valve and flow valve completely on flowmeter. Make certain that differential lock is disengaged. Move pto control to fully engaged position and observe flow on flowmeter. Flowmeter

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Paragraphs 197-198

Adjust the installed valve if necessary as outlined in paragraph 194 or 195.

Models 2090 and 2290

198. OVERHAUL. Refer to Fig. 221 for exploded view. Remove hydraulic connector (8), set screw (7), spring (6) and ball (9). Remove modulator spool plug (24), spring (23), washer (22), spring (21), poppet (20), return spring (19) and spool (18). Remove relief valve plug (17), spring (16) and relief poppet (15). Place a "C" clamp over pressure regulator plug, then drive out roll pin (5)

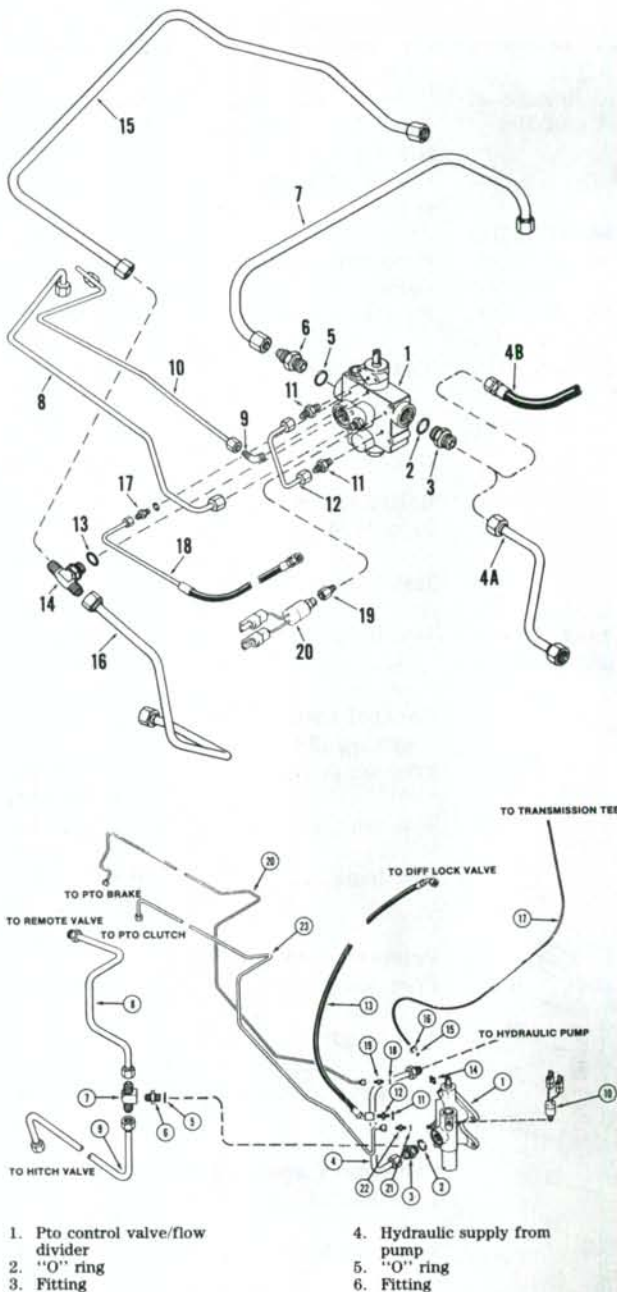


Fig. 219—Schematic view of hydraulic system connecting pto control/flow divider valve. Models 2090 and 2290 are shown. Models 2094 and 2294 are similar.

1. Pto control valve/flow divider
2. "O" ring
3. Fitting
- 4A. To power shift control valve (power shift models)
- 4B. To master clutch (mechanical shift models)
5. "O" ring
6. Fitting
7. From hydraulic pump
8. To pto clutch
9. Elbow
10. To pto brake
11. Fitting
12. Pto brake drain tube
13. "O" ring
14. Tee
15. To remote valve(s)
16. To hitch valve
17. Fitting
18. To differential lock valve
19. Fitting
20. Transmission pressure sensor

Fig. 220—Schematic view of hydraulic system connecting pto control valve/flow divider. Models 2390 and 2590 are shown. Models 2394 and 2594 are similar.

7. Tee
8. To remote valve(s)
9. To hitch valve
10. Transmission pressure sensor
11. "O" ring
12. Fitting
13. To differential lock valve
14. Fitting
15. "O" ring
16. Fitting
17. To transmission tee
18. "O" ring
19. Fitting
20. To pto brake
21. "O" ring
22. Fitting
23. To pto clutch

will indicate a flow as soon as control is engaged. Flow reading will decrease as soon as the engaged pto clutch has filled. A reading of 0-1 gpm (0-3.8 L/min.) is normal. If leakage exceeds 1 gpm (3.8 L/min.), refer to paragraphs 203, 213 and 221 for pto clutch repair procedures.

To check pto control and regulator pressure, start engine and operate at 2100 rpm. Check reading on 600 psi (4100 kPa) test gage. Reading on test gage must be 210 psi (1448 kPa). If not, add or remove shims (13—Fig. 221, 16—Fig. 222, 19—Fig. 223 or 23—Fig. 224) to obtain correct pressure.

Relief valve nominal cracking pressure is 270 psi (1862 kPa). If correct pressure cannot be obtained, refer to paragraphs

198, 199, 200 and 201 for pto control and regulator valve repair procedures.

PTO FLOW DIVIDER CONTROL VALVE

All Models

197. REMOVE AND REINSTALL. To remove the pto control and flow divider valve, disconnect bellcrank to pto spool and electrical connectors. Remove all hydraulic lines from housing and plug or cap all lines to prevent leakage and contamination. Remove cap screws securing valve housing to transmission housing and lift off the valve.

Install by reversing removal procedure, using a new gasket or "O" ring.

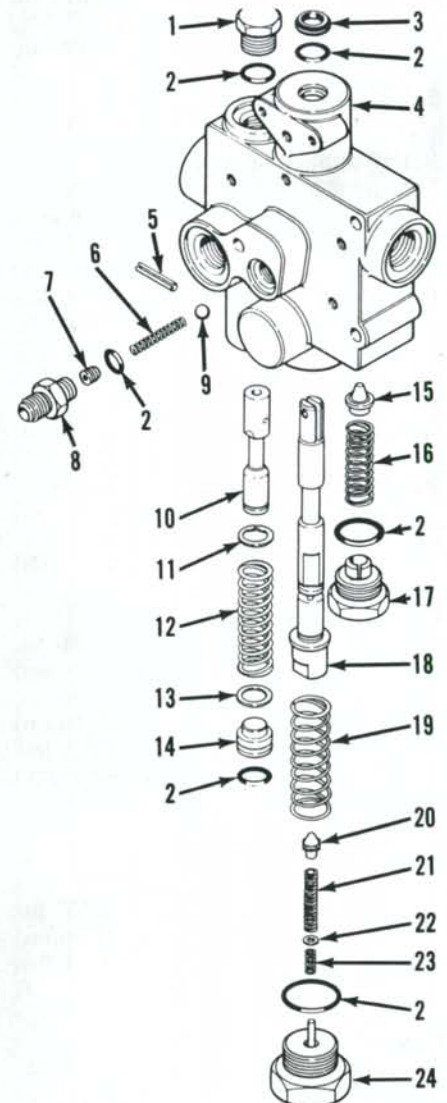


Fig. 221—Exploded view of flow divider and pto control valve for Model 2090 and 2290 tractors.

1. Plug
2. "O" ring
3. Wiper ring
4. Valve body
5. Roll pin
6. Spring
7. Set screw
8. Connector
9. Ball
10. Pressure regulator spool
11. Snap ring
12. Spring
13. Shim
14. Plug
15. Poppet
16. Spring
17. Plug
18. Pto control spool
19. Spring
20. Point
21. Spring
22. Washer
23. Spring
24. Plug

Paragraph 199

and slowly release spring tension on plug (14). Remove shims (13), if any. Remove plug (1) opposite regulator bore and push spool (10) out of bore. Remove snap ring (11) from spool (10). Remove wiper seal (3) from control spool bore. Remove and discard all "O" rings and wiper seal (3).

Renew all "O" rings upon reassembly. Install new wiper seal (3—Fig. 221) with wide end towards the inside of control spool bore. Check springs against following specifications:

Regulator spool spring (12)

Free length 2.874 in.
(73.0 mm)
Test length 1.728 in.
(43.89 mm)
Test load 50.2-61.4 lbs.
(223.4-273.0 N)

Relief poppet spring (16)

Free length 2.189 in.
(55.6 mm)
Test length 1.40 in.
(35.56 mm)
Test load 19.6-24.0 lbs.
(87.3-106.8 N)

Control spool return spring (19)

Free length 3.204 in.
(81.38 mm)
Test length 1.90 in.
(48.26 mm)
Test load 11.1-12.9 lbs.
(49.4-57.4 N)

Primary Spring (21)

Free length 1.86 in.
(47.44 mm)
Test length 1.63 in.
(41.4 mm)
Test load 5.1-6.3 lbs.
(22.8-27.9 N)

Secondary spring (23)

Free length 0.642 in.
(16.31 mm)
Test length 0.437 in.
(11.1 mm)
Test load 0.41-0.51 lbs.
(1.8-2.3 N)

Detent spring (6)

Free length 1.67 in.
(42.42 mm)
Test length 1.0 in.
(25.4 mm)
Test load 19.1-19.7 lbs.
(85-88 N)

Renew any springs which do not meet specifications. Inspect all parts for wear, scoring or other damage and renew as necessary. Valve housing, control spool and regulator spool are available only as a complete assembly. Shims (13) are

available in 1/64 inch (0.397 mm) thickness. Reassemble by reversing disassembly procedure. Adjust overhauled valve assembly and linkage as outlined in paragraphs 194 and 196.

Models 2094 and 2294

199. OVERHAUL. To disassemble the pto control and flow-regulator valve, refer to Fig. 222 and remove connector (12), adjusting screw (11), springs (8 and 9), guide pin (7) and detent ball (6). Remove plug (31) with pin (30) and "O" ring (29), secondary spring (28), washer (27), primary spring (26), modulator poppet (25), return spring (24) and spool (23). Remove relief valve plug (22), spring (20) and relief valve (19). Place a "C" clamp over pressure regulator plug, then drive out roll pin (5). Loosen "C" clamp to release spring pressure from plug (17). Remove plug, shims (16) and spring (15). Remove plug (3) opposite regulator bore and push spool (13)

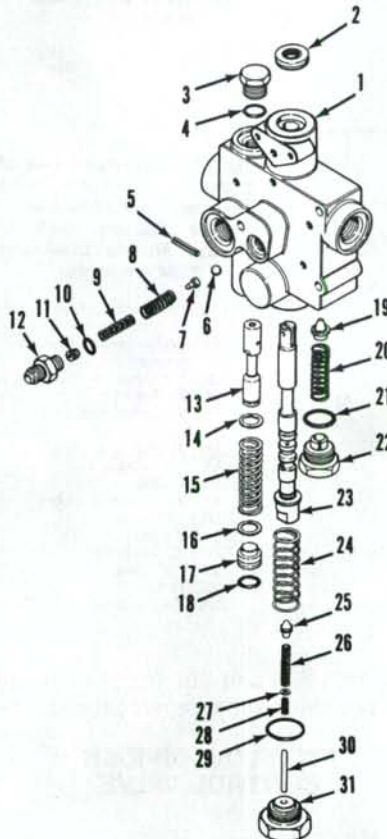


Fig. 222—Exploded view of pto control valve and flow-regulator used on Models 2094 and 2294.

- | | |
|------------------------------|-----------------------|
| 1. Valve body | 16. Shim |
| 2. Oil seal | 17. Plug |
| 3. Plug | 18. "O" ring |
| 4. "O" ring | 19. Relief valve |
| 5. Roll pin | 20. Spring |
| 6. Detent ball | 21. "O" ring |
| 7. Guide pin | 22. Plug |
| 8. Spring (outer) | 23. Pto control spool |
| 9. Spring (inner) | 24. Spring |
| 10. "O" ring | 25. Modulator poppet |
| 11. Adjusting screw | 26. Primary spring |
| 12. Connector | 27. Washer |
| 13. Pressure regulator spool | 28. Secondary spring |
| 14. Snap ring | 29. "O" ring |
| 15. Spring | 30. Pin |
| | 31. Plug |

out bottom of bore. Remove snap ring (14) from spool (13). Remove oil seal (2) from control spool bore.

When reassembling, renew all "O" rings. Install new oil seal (2) with lip toward inside of control spool bore. Check springs against the following specifications:

Pressure regulator spring (15)

Free length 2.989 in.
(72-92 mm)
Test length 1.673 in.
(42.49 mm)
Test load 52.5-64.1 lbs.
(233.4-285.3 N)

Relief valve spring (20)

Free length 2.154 in.
(54.71 mm)
Test length 1.107 in.
(28.12 mm)
Test load 27.0-33.0 lbs.
(120.1-146.8 N)

Control spool return spring (24)

Free length 3.201 in.
(81.31 mm)
Test length 1.90 in.
(48.26 mm)
Test load 10.8-13.2 lbs.
(48.0-58.7 N)

Primary spring (26)

Free length 1.868 in.
(47.45 mm)
Test length 1.40 in.
(35.56 mm)
Test load 7.38-9.02 lbs.
(32.8-40.1 N)

Secondary spring (28)

Free length 0.845 in.
(21.46 mm)
Test length 0.437 in.
(11.1 mm)
Test load 0.41-0.51 lbs.
(1.8-2.3 N)

Detent spring, outer (8)

Free length 1.383 in.
(35.13 mm)
Test length 0.70 in.
(17.78 mm)
Test load 5.4-6.6 lbs.
(24.0-29.4 N)

Detent spring, inner (9)

Free length 1.548 in.
(39.32 mm)
Test length 1.20 in.
(30.48 mm)
Test load 8.1-9.9 lbs.
(36.0-44.0 N)

Renew any springs which do not meet specifications. Inspect all parts for wear,

SERVICE MANUAL

scoring or other damage and renew as necessary. Valve body (1) and regulator spool (13) are not serviced separately. If regulator spool or body is scored or damaged, renew complete valve assembly. Shims (16) are available in thicknesses of 1/64 inch (0.397 mm) and 3/32 inch (2.3 mm). Reassemble by reversing disassembly procedure. Adjust overhauled valve assembly and linkage as outlined in paragraphs 195 and 196.

Models 2390 and 2590

200. OVERHAUL. Refer to Fig. 223 for exploded view. Remove pto clutch fitting (6), late model adjusting screw (7) or early model shims (A) and early model detent plunger (B) or late model detent ball (9). Remove modulator plug (28), pin (27), secondary spring (26), washer (25), primary spring (24), return spring (23) and poppet (22). Remove control spool (3) from bottom to prevent damage to wiper seal (1) and "O" ring (2), then remove wiper seal (1). Using a

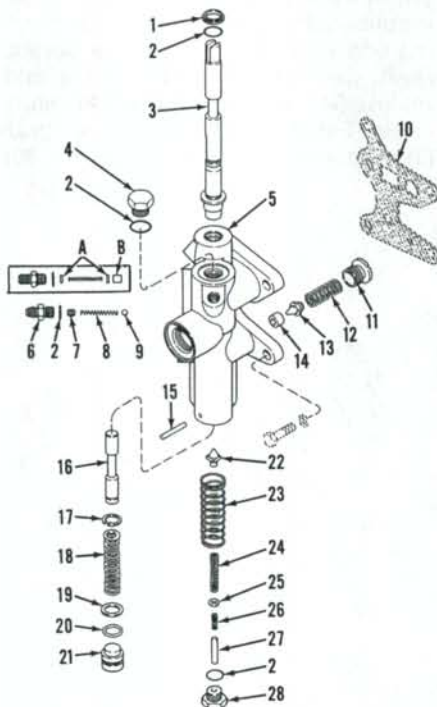


Fig. 223—Exploded view of flow divider and pto control valve for Model 2390 and 2590 tractors. "A" in insert are detent washers; "B" is detent spool.

- | | |
|----------------------|-------------------------|
| 1. Wiper ring | 16. Pressure regulating |
| 2. "O" ring | spool |
| 3. Pto control spool | 17. Snap ring |
| 4. Plug | 18. Spring |
| 5. Valve body | 19. Shim |
| 6. Connector | 20. "O" ring |
| 7. Adjusting screw | 21. Plug |
| 8. Spring | 22. Point |
| 9. Ball | 23. Spring |
| 10. Gasket | 24. Spring |
| 11. Plug | 25. Washer |
| 12. Spring | 26. Spring |
| 13. Poppet | 27. Pin |
| 14. Seat | 28. Plug |
| 15. Roll pin | |

"C" clamp to relieve spring pressure of regulator spool, drive out pin (15), then slowly loosen "C" clamp and remove plug (21), shim(s) (19) and spring (18). Remove plug (4) on opposite side of regulator spool bore and remove spool (16) through large bore of housing. Remove snap ring (17) from spool (16). Remove relief poppet plug (11), spring (12), poppet (13) and seat (14).

Renew all "O" rings upon reassembly. Install new wiper seal (1). Check springs against following specifications:

Regulator spool spring (18)

Free length 2.874 in.
(73.0 mm)
Test length 1.728 in.
(43.89 mm)
Test load 50.2-61.4 lbs.
(223.4-273.0 N)

Relief valve spring (12)

Free length 2.189 in.
(55.6 mm)
Test length 1.40 in.
(35.56 mm)
Test load 19.6-24.0 lbs.
(87.3-106.8 N)

Control spool return spring (23)

Free length 3.204 in.
(81.38 mm)
Test length 1.90 in.
(48.26 mm)
Test load 11.1-12.9 lbs.
(49.4-57.4 N)

Primary spring (24)

Free length 1.86 in.
(47.44 mm)
Test length 1.63 in.
(41.4 mm)
Test load 5.1-6.3 lbs.
(22.8-27.9 N)

Secondary spring (26)

Free length 0.642 in.
(16.31 mm)
Test length 0.437 in.
(11.1 mm)
Test load 0.41-0.51 lbs.
(1.8-2.3 N)

Detent spring (8)

Free length 1.67 in.
(42.42 mm)
Test length 1.0 in.
(25.4 mm)
Test load 19.1-19.7 lbs.
(85-88 N)

Renew any springs which do not meet specifications. Inspect all parts for wear, scoring or other damage and renew as necessary. Valve housing (5), control spool (3) and regulator spool are available only as a complete assembly.

Paragraphs 200-201

Shims (19) are available in thickness of 0.0164 inch (0.42 mm). Reassemble by reversing disassembly procedure. Adjust overhauled valve assembly and linkage as outlined in paragraphs 194 and 196.

Models 2394 and 2594

201. OVERHAUL. To disassemble the pto control and flow-regulator valve, refer to Fig. 224 and remove connector (5), adjusting screw (6), springs (8 and 9), guide pin (10) and detent ball (11). Remove plug (33), with "O" ring (32) and pin (31), secondary spring (30), washer (29), primary spring (28), modulator poppet (26), return spring (27) and control spool (2) from bottom of valve body. Remove relief valve plug (17), spring (16) and relief valve (15). Valve seat (14) can be removed for renewal if necessary. Place a "C" clamp over pressure regulator plug (25), then drive out roll pin (19). Loosen "C" clamp to release spring pressure from plug (25). Remove plug, shims (23) and regulator spring (22). Remove plug (3)

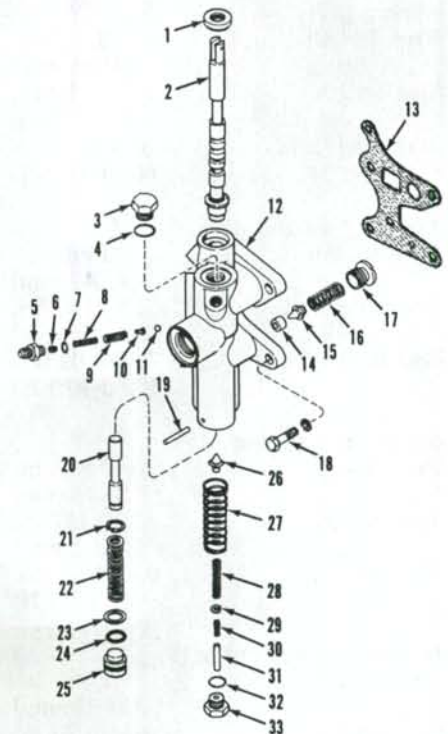


Fig. 224—Exploded view of pto valve and flow-regulator used on Models 2394 and 2594.

- | | |
|----------------------|------------------------|
| 1. Oil seal | 18. Cap screw |
| 2. Pto control spool | 19. Roll pin |
| 3. Plug | 20. Pressure regulator |
| 4. "O" ring | spool |
| 5. Connector | 21. Snap ring |
| 6. Adjusting screw | 22. Spring |
| 7. "O" ring | 23. Shim |
| 8. Spring (inner) | 24. "O" ring |
| 9. Spring (outer) | 25. Plug |
| 10. Guide pin | 26. Modulator poppet |
| 11. Detent ball | 27. Spring |
| 12. Valve body | 28. Primary spring |
| 13. Gasket | 29. Washer |
| 14. Seat | 30. Secondary spring |
| 15. Relief valve | 31. Pin |
| 16. Spring | 32. "O" ring |
| 17. Plug | 33. Plug |

Paragraphs 202-203

opposite regulator bore and push spool (20) out bottom of bore. Remove snap ring (21) from spool (20). Remove oil seal (1) from control spool bore.

When reassembling, renew all "O" rings. Install new oil seal (1) with lip towards inside of control spool bore. Check springs against the following specifications:

Pressure regulator spring (22)

Free length	2.989 in. (72.92 mm)
Test length	1.673 in. (42.49 mm)
Test load	52.5-64.1 lbs. (233.4-285.3 N)

Relief valve spring (16)

Free length	2.154 in. (54.71 mm)
Test length	1.107 in. (28.12 mm)
Test load	27.0-33.0 lbs. (120.1-146.8 N)

Control spool return spring (27)

Free length	3.201 in. (81.31 mm)
Test length	1.90 in. (48.26 mm)
Test load	10.8-13.2 lbs. (48.0-58.7 N)

Primary spring (28)

Free length	1.868 in. (47.45 mm)
Test length	1.40 in. (35.56 mm)
Test load	7.38-9.02 lbs. (32.8-40.1 N)

Secondary spring (30)

Free length	0.845 in. (21.46 mm)
Test length	0.437 in. (11.1 mm)
Test load	0.41-0.51 lbs. (1.8-2.3 N)

Detent spring, outer (9)

Free length	1.383 in. (35.13 mm)
Test length	0.70 in. (17.78 mm)
Test load	5.4-6.6 lbs. (24.0-29.4 N)

Detent spring, inner (8)

Free length	1.548 in. (39.32 mm)
Test length	1.20 in. (30.48 mm)
Test load	8.1-9.9 lbs. (36.0-44.0 N)

Renew any springs which do not meet specifications. Inspect all parts for wear,

scoring or other damage and renew as necessary. Valve body (12), control spool (2) and regulator spool (20) are not serviced separately. If any of the three are not in good condition, renew complete valve assembly. Shims (23) are available in thicknesses of 0.0164 inch (0.42 mm) and 3/32 inch (2.3 mm). Reassemble valve by reversing disassembly procedure. Adjust overhauled valve assembly and linkage as outlined in paragraphs 195 and 196.

PTO HOUSING

Models 2090, 2290, 2094 and 2294 (540 and 1000 rpm)

202. REMOVE AND REINSTALL.

Drain transmission, remove pto shield and remove the two bolts from each side of sway bar bracket, then loosen large third bolt on sway bar bracket. Remove upper lift link pin and remove upper lift link. Reinstall link pin for attachment of hoist. Disconnect pto brake tube, pto clutch tube, pto lube tube and temperature sender wire. Remove two center pto housing bolts, install two 5/8 inch NC studs in bolt holes, remove all remaining nuts and bolts on pto housing. Attach hoist to upper link pin and remove pto housing assembly. Reinstall by reversing removal procedure. Tighten 5/8 inch mounting bolts to 150-180 ft.-

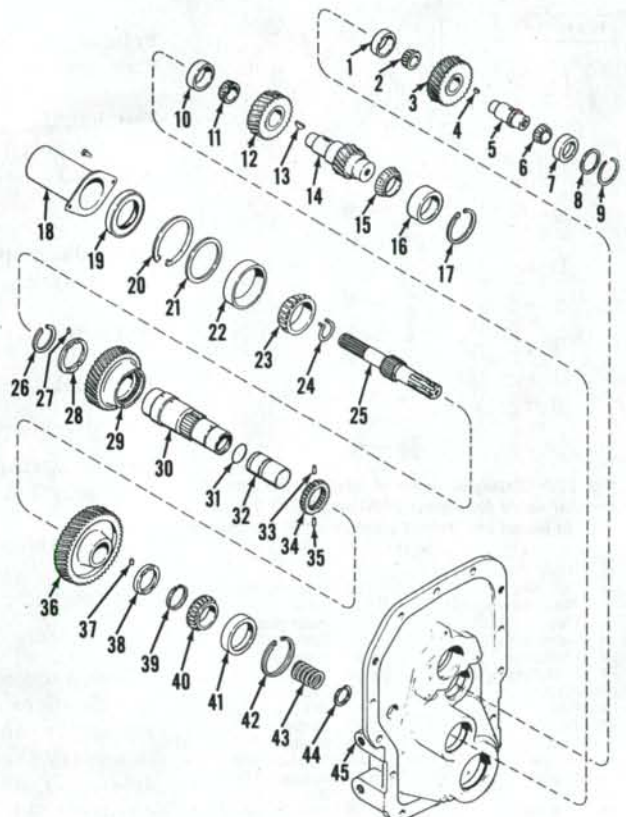
lbs. (203-244 N·m) torque. Tighten 1/2 inch mounting bolts to 80-96 ft.-lbs. (110-130 N·m) torque. Tighten 3/4 inch sway bar bolts to 270-320 ft.-lbs. (366-440 N·m) torque. Tighten 1 inch sway bar bolts to 580-690 ft.-lbs. (786-935 N·m) torque.

203. PTO DRIVE GEAR AND CLUTCH OVERHAUL.

Remove tube guard (18—Fig. 225), shaft retaining ring (24), then remove shaft (25). Pry out shaft oil seal (19), remove snap ring (20) and spacer (21). From front of pto housing, remove snap ring (42), retaining ring (44) and spring (43). Bump rear of output shaft to move bearing (40) and cup (41) out of housing. Remove retaining ring (39) and thrust washer (38). Drive front roll pin (37) through output shaft sleeve (30). Separate gears on output shaft sleeve until shift collar pins (33 and 35) are visible. To remove shift collar pins (33 and 35), install a number 10-24, grade 8, socket head screw with a minimum of 1-1/2 inches (38.1 mm) of thread into shift collar pin. Turn shift collar 180 degrees and remove second pin in same manner. Tap front end of output shaft sleeve to move rear bearing cup (22) out of seat. Pull output shaft sleeve to rear of housing and remove 540 rpm output gear (36), shift collar (34) and 1000 rpm output gear (29). Remove output shaft sleeve (30)

Fig. 225—Exploded view of dual speed pto gear assembly used on some Model 2090 and 2290 and all Model 2094 and 2294 tractors.

1. Bearing cup
2. Bearing cone
3. Idler gear (1st)
4. Woodruff key
5. Idler shaft (1st)
6. Bearing cone
7. Bearing cup
8. Spacer
9. Snap ring
10. Bearing cup
11. Bearing cone
12. Idler gear (2nd)
13. Woodruff key
14. Idler shaft (2nd)
15. Bearing cone
16. Bearing cup
17. Snap ring
18. Guard
19. Seal
20. Snap ring
21. Spacer
22. Bearing cup
23. Bearing cone
24. Snap ring
25. Output shaft
26. Snap ring
27. Roll pin
28. Thrust washer
29. Output gear (1000 rpm)
30. Outer output sleeve
31. "O" ring
32. Inner output sleeve
33. Collar pin
34. Shift collar
35. Collar pin
36. Output gear (540 rpm)
37. Roll pin
38. Thrust washer
39. Snap ring
40. Bearing cone
41. Bearing cup
42. Snap ring
43. Spring
44. Snap ring
45. Pto housing



SERVICE MANUAL

Paragraphs 204-211

from rear of pto housing, then remove inner sleeve (32). Remove and discard "O" ring (31). Press bearing cone (23) from shaft sleeve, then remove retaining ring (26) and thrust washer (28) from output shaft sleeve (30).

204. Remove snap ring (17—Fig. 225) from lower idler shaft (14). Install puller into idler shaft until front bearing cup (16) is removed. Remove idler shaft (14), lower idler gear (12) and rear bearing cone (11). Using a suitable puller, remove rear bearing cup (10). Press front bearing cone (15) from shaft (14).

205. Unbolt and remove pto carrier assembly (items 6 through 37—Fig. 226). Remove needle bearing (29), snap ring (31), then using a suitable puller remove input gear (32) and needle bearing race (30). Remove snap ring (33) and using a suitable puller remove input bearing (34). Remove brake carrier (36) being careful not to lose "O" rings (35) and ball (37). Remove oil control rings (24), retaining back-up ring (6), clutch hub (5) with back-up and friction plate. Remove clutch pack (14). Remove snap ring (13), clutch piston return spring (12), then using compressed air in piston supply port, remove clutch piston (items 7 through 11) from carrier (25). Remove inner and outer seals (8 and 10) and "O" rings or wave springs (7 and 9) from clutch piston (11). Remove and discard support bushing (27) and thrust washer (26) from carrier (25).

Remove brake bolts (23), washers (19 and 22), springs (20) and roll pins (21) from pto brake assembly (items 18 and 36). Remove brake friction plate (18) and using compressed air, remove brake piston (items 15 through 17). Remove two "O" rings (35). Remove and discard inner and outer piston "O" ring seals (15 and 16).

206. Remove snap ring (9—Fig. 225) from upper idler shaft (5) and remove shim (8). Using a suitable puller in idler shaft, pull front bearing cup (7) from housing. Remove idler shaft (5) with bearing (6) attached, rear bearing (2) and idler gear (3). Using a suitable puller, remove rear bearing cup (1) and press bearing cone (6) from shaft (5). Retain Woodruff key (4).

207. Assemble first idler shaft (items 1 through 9—Fig. 225) by reversing disassembly procedure. Inspect and renew any parts showing wear or other damage. Renew bearing cones and cups as necessary. Make certain upper idler gear (3) is positioned with flat side toward front of housing. Measure and install proper width shim (8) between retaining ring (9) and bearing cup (7) to obtain a clearance of 0.000-0.005 inch (0.000-0.127 mm). Shims (8) are available in thicknesses of 0.045 to 0.080 inch (1.14 to 2.03 mm) in 0.005 inch (0.127 mm) increments.

208. Reassemble pto brake (items 15 through 23—Fig. 226) using new "O" rings (15 and 16) on piston (17). Lubricate piston with petroleum jelly and install in carrier (36) flat side up. Install friction plate (18), washers (19) and roll pins (21). Free length of springs (20) is 1.54 inches (39.12 mm) and compressed length at 50 lbs. (68 N) should be 0.500 inch (12.7 mm). Renew all springs if any one spring fails to meet specifications. Install springs (20), then using Loctite 271 or equivalent on bolts (23), install bolts and washers (22) tightening bolts to 18-25 ft.-lbs. (24-34 N·m) torque.

209. Reassemble pto clutch by reversing disassembly procedure. Heat bearing (34—Fig. 226) before installation. Install new thrust washer (26) and press new bushing (27) to a depth of 0.070 inch (1.778 mm) below surface of carrier and ream bushing to an ID of 0.8135-0.8145 inch (20.663-20.688 mm) as shown in Fig. 227. On Models 2090 and 2290, ends of wave springs (7 and 9—Fig. 226) should be toward piston as shown in Fig. 228. On all models, piston return spring (12—Fig. 226) should have a free length of 1.75 inches (44.45 mm) and a compressed length at 78 lbs. (106 N) of 1.25 inches (31.8 mm). Renew spring if specifications are not met. Make certain hooked ends of oil rings (24) connect each other. Install new needle bearing for pto carrier assembly into housing to a depth of 0.094-0.125 inch (2.388-3.175 mm) as shown in Fig. 229. Install two new "O" rings (35—Fig. 226) into brake carrier, then install pto carrier assembly onto pto housing and tighten retaining bolts to 45-54 ft.-lbs. (61-73 N·m) torque.

210. Install lower idler shaft assembly (items 10 through 17—Fig. 225) by reversing disassembly procedure. Inspect and renew any parts showing wear or other damage. Renew bearing cones and cups as necessary. Install lower idler gear (12) with flat side towards front of housing. Measure and install proper width snap ring (17) to obtain a clearance of 0.001-0.005 inch (0.0254-0.127 mm) between bearing cup (16) and snap ring (17). Snap rings (17) are available in thicknesses of 0.070, 0.076, 0.081, 0.086, 0.091, 0.096 and 0.101 inch (1.78, 1.93, 2.06, 2.18, 2.31, 2.44 and 2.57 mm).

211. Assembly of output shaft assembly (items 18 through 44—Fig. 225) is reverse of disassembly procedure. Inspect and renew any parts showing wear or other damage. Renew any bearing cones and cups as necessary. Use new "O" ring (31) on in-

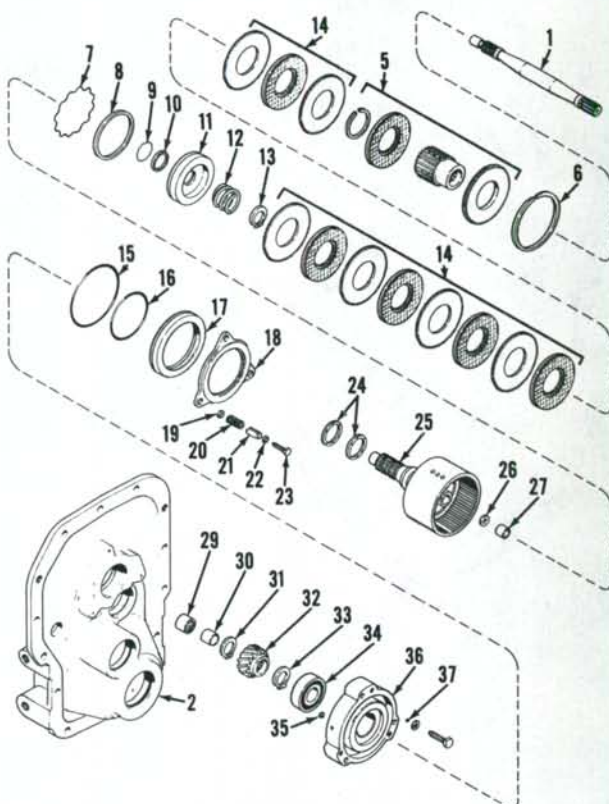


Fig. 226—Exploded view of pto brake and clutch assembly for Model 2090 and 2290 tractors.

1. Pto input shaft
2. Housing
3. Back-up plate, hub & disc Assy.
4. Snap ring
5. Wave spring (large)
6. Piston seal
7. Wave spring (small)
8. Piston seal
9. Pto clutch piston
10. Spring
11. Snap ring
12. Clutch plates & discs
13. "O" ring
14. "O" ring
15. Pto brake piston
16. Brake
17. Washer
18. Spring
19. Roll pin
20. Washer
21. Bolt
22. Seal rings
23. Carrier
24. Thrust washer
25. Bushing
26. Needle bearing
27. Race
28. Snap ring
29. Input gear
30. Snap ring
31. Bearing
32. "O" ring
33. Carrier
34. Ball

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ner sleeve (32). Install rear thrust washer (28) with oil grooves facing away from bearing (23). Install 1000 rpm output gear (29) flat side facing rear of housing. Use new shift collar pins (33 and 35). Shift spring (43) free length is 2.330-2.390 inches (59.182-60.706 mm) and compressed at 41.4 lbs. (56 N) should be 1.277 inches (32.44 mm). Renew spring if specifications are not met. Install front roll pin (27) until pin is 0.12 inch (3.048 mm) above outside diameter of output sleeve. Install front thrust washer (38) with oil grooves to inside of pto housing. Install rear roll pin (37) until pin is 0.12 inch (3.048 mm) above outside diameter of output sleeve. Measure and install proper thickness snap ring (42) to obtain a clearance of 0.001-0.005 inch (0.0254-0.127 mm) between front bearing cup (41) and snap ring (42). Snap rings are available in thicknesses from 0.062 to 0.103 inch (1.57 to 2.62 mm) in 0.005 inch (0.127 mm) increments. Install rear oil seal (19) with lip inward and seal flush with pto housing. Use Loctite 504 or equivalent

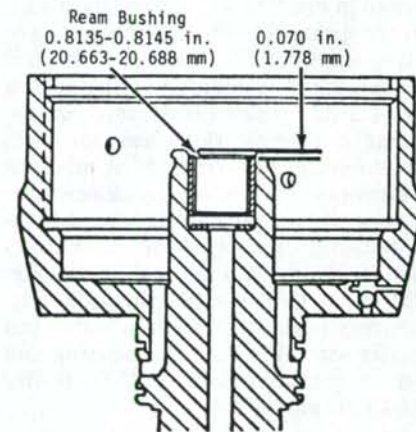


Fig. 227—Install carrier bushing as shown. Refer to text.



Fig. 228—Install the wave springs in clutch piston as shown. Refer to text.

on flange of transmission and reinstall pto assembly as outlined in paragraph 202.

Models 2090 and 2290 (1000 rpm)

212. REMOVE AND REINSTALL. Removal and installation of the single speed 1000 rpm pto housing assembly is identical to procedure outlined in paragraph 202.

213. PTO DRIVE GEAR AND CLUTCH OVERHAUL. Refer to Fig. 230 and remove output shaft guard tube (18). Pry out oil seal (19) and discard. Remove snap ring (20) and spacer (21). Remove front bearing snap ring (30), then bump output shaft to remove front bearing cup and cone (28 and 29) from shaft. Remove gear snap ring (27), then remove shaft (25), gear (26), bearing cone (23) and cup (22).

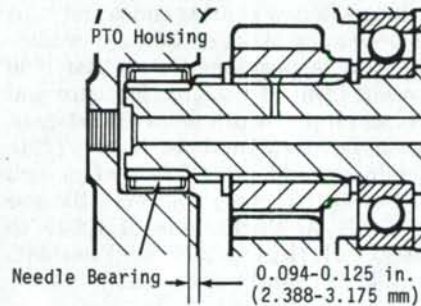
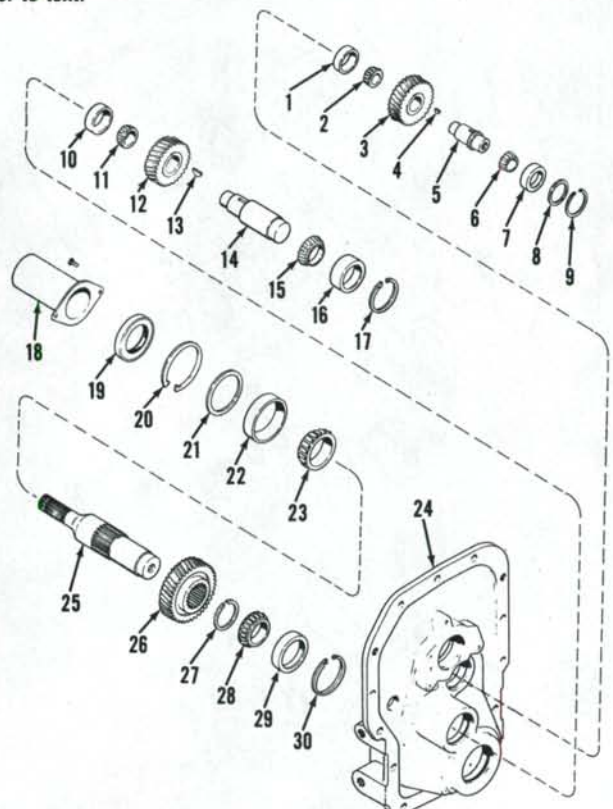


Fig. 229—Install needle bearing into pto housing to dimension shown. Refer to text.

Fig. 230—Exploded view of single speed drive gear assembly used on some Model 2090 and 2290 tractors.

1. Bearing cup
2. Bearing cone
3. Idler gear (1st)
4. Woodruff key
5. Idler shaft (1st)
6. Bearing cone
7. Bearing cup
8. Spacer
9. Snap ring
10. Bearing cup
11. Bearing cone
12. Idler gear (2nd)
13. Woodruff key
14. Idler shaft (2nd)
15. Bearing cone
16. Bearing cup
17. Snap ring
18. Guard
19. Seal
20. Snap ring
21. Spacer
22. Bearing cup
23. Bearing cone
24. Pto housing
25. Output shaft
26. Output gear
27. Snap ring
28. Bearing cone
29. Bearing cup
30. Snap ring



214. Remove lower idler shaft snap ring (17—Fig. 230). Install a suitable puller into end of shaft (14) to pull bearing cup (16) from housing, then remove shaft (14) with bearing cone (15), idler gear (12), Woodruff key (13) and bearing cone (11). Remove rear bearing cup (10) using a suitable puller. Press bearing cone (15) from shaft (14).

215. Remove snap ring (9—Fig. 230) from upper idler shaft (5) and remove shim (8). Using a suitable puller in idler shaft, pull front bearing cup (7) from housing. Remove idler shaft (5) with bearing (6) attached, rear bearing (2) and idler gear (3). Using a suitable puller, remove rear bearing cup (1) and press bearing cone (6) from shaft (5). Retain Woodruff key (4).

216. Assemble first idler shaft (items 1 through 9—Fig. 230) by reversing disassembly procedure. Inspect and renew any parts showing wear or other damage. Renew bearing cones and cups as necessary. Make certain upper idler gear (3) is positioned with flat side toward front of housing. Measure and install proper width shim (8) between retaining ring (9) and bearing cup (7) to obtain a clearance of 0.000-0.005 inch (0.000-0.127 mm). Shims (8) are available in thicknesses of 0.045 to 0.080 inch (1.14 to 2.03 mm) in 0.005 inch (0.127 mm) increments.

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217. Install lower idler shaft assembly (items 10 through 17—Fig. 230) by reversing disassembly procedure. Inspect and renew any parts showing wear or other damage. Renew bearing cones and cups as necessary. Install lower idler gear (12) with flat side toward front of housing. Measure and install proper width snap ring (17) to obtain a clearance of 0.001-0.005 inch (0.0254-0.127 mm) between bearing cup (16) and snap ring (17). Snap rings (17) are available in thicknesses of 0.070, 0.076, 0.081, 0.086, 0.091, 0.096 and 0.101 inch (1.78, 1.93, 2.06, 2.18, 2.31, 2.44 and 2.57 mm).

218. Assembly of output shaft assembly (items 18 through 30—Fig. 230) is reverse of disassembly procedure. Inspect and renew any parts showing wear or other damage. Renew any bearing cones or cups as necessary. Measure and install proper width snap ring (30) to obtain a clearance of 0.001-0.005 inch (0.0254-0.127 mm) between front bearing cup (29) and snap ring (30). Snap rings (30) are available in thicknesses of 0.062 to 0.103 inch (1.57 to 2.62 mm) in increments of 0.005 inch (0.127 mm). Install new oil seal (19) with lip of seal inward and flush with housing. Use Loctite 504 or equivalent on flange of transmission and reinstall pto assembly as outlined in paragraph 202.

219. PTO CLUTCH AND BRAKE CARRIER. Refer to paragraphs 205, 208 and 209 and to Fig. 226 for overhaul procedure of pto clutch and brake carrier.

Models 2390, 2590, 2394 and 2594

220. REMOVE AND REINSTALL. Lower lift arms and drain transmission housing. Remove drawbar, then attach hoist to drawbar support and unbolt support. Pry behind support if necessary to loosen the tapered dowels. Remove upper link brackets and upper link and disconnect the three lube lines from pto housing. Disconnect transmission temperature sender wire. Remove the two center 1/2 inch retaining cap screws and install two 1/2 x 6 inch pilot studs. Remove the two upper retaining cap screws and note that left hand cap screw is a dowel type. Slide pto assembly rearward slightly, then attach a hoist and complete removal of assembly.

Use Loctite 504 or equivalent on transmission flange and reinstall pto assembly by reversing the removal procedure. Tighten the two 1/2 inch cap screws to 80-96 ft.-lbs. (109-130 N·m) torque and the two upper cap screws to

150-180 ft.-lbs. (203-244 N·m) torque. Tighten remaining cap screws and nut to 220-264 ft.-lbs. (298-358 N·m) torque. When installing drawbar hangers and roller, tighten retainer nut to 580 ft.-lbs. (786 N·m) torque.

221. PTO DRIVE GEAR AND CLUTCH OVERHAUL. To disassemble pto, proceed as follows: Remove tubular guard (13—Fig. 231), then pry out oil seal (14). Remove snap ring (15), bump output shaft (18) rearward out of bearing (21) and output gear (20) and remove gear and bearing from housing (12). Drive bearing cup (22) from housing and remove snap ring (19) and bearing cone (17) from output shaft.

Remove retainer (8) and shims (9), pull lower idler shaft (10) with "O" ring (11) rearward and remove idler gear (26) and bearings from housing. Repeat operation for upper idler and note that upper idler gear (4) has an identification groove cut in center of gear teeth. To remove bearing cups (2, 5, 24 and 27) from idler gears, use a punch to drive out one cup, then remove snap rings (3 and 25) and drive out remaining cup.

NOTE: Models 2590 and 2594 use a spacer shown in circled inset, between bearing cups and snap rings.

Remove rear cover (27—Fig. 232) and "O" ring (28) along with shims (29). Unbolt brake piston carrier (39) from pto housing, then drive input shaft (clutch carrier) forward until front bearing cup (35) is free of housing and remove clutch carrier, brake carrier and input gear as

an assembly. Drive rear bearing cup (31) into housing to remove. Place clutch carrier on end and remove snap ring (2), grasp clutch hub (5) and remove clutch hub, back-up plate, first friction plate and steel plate (items 3 and 5). Remove balance of sintered and steel plates from clutch carrier, then remove snap ring (26) and piston return spring (25). Apply air pressure to piston oil supply port to free piston from carrier and remove piston. Inspect bushing (19) and if renewal is indicated, bushing can be collapsed and removed by using a chisel. If bushing is renewed, also renew thrust washer (18). Turn carrier over and remove snap ring (30), then using a knife-edge puller behind gear (33) remove gear and bearing (32).

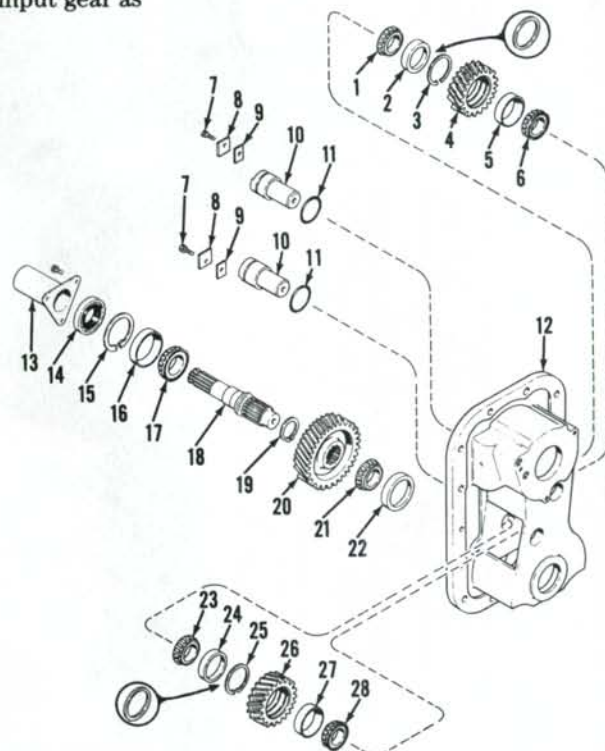
NOTE: Do not press on, or use brake housing for support as damage to brake housing could result.

Use puller between bearing cup (35) and housing (36) to remove bearing (34). Lift brake housing from clutch carrier and remove the two seal rings (14) from carrier shaft. Remove retaining cap screws (13), springs (11) and roll pins (10) and lift brake plate (9) from brake housing. Apply compressed air to piston supply port to remove piston (40) from brake housing.

Clean and inspect all parts and renew as necessary. Clutch return spring (25) has a free length of 1.75 inches (44.4 mm) should test 78 lbs. (347 N) when compressed to a length of 1.25 inches (31.7 mm). Brake return springs (11)

Fig. 231—Exploded view of pto idlers and gear assembly used on Model 2390, 2590, 2394 and 2594 tractors. Insets show spacer used on Model 2590 and 2594 tractors.

1. Bearing cone
2. Bearing cup
3. Snap ring
4. Idler gear (R.H.)
5. Bearing cup
6. Bearing cone
7. Bolt
8. Retainer
9. Shim
10. Gear pin
11. "O" ring
12. Pto housing
13. Guard
14. Seal
15. Snap ring
16. Bearing cup
17. Bearing cone
18. Output shaft
19. Snap ring
20. Output gear
21. Bearing cone
22. Bearing cup
23. Bearing cone
24. Bearing cup
25. Snap ring
26. Idler gear (L.H.)
27. Bearing cup
28. Bearing cone



Paragraph 222

have a free length of 1.54 inches (39.1 mm) and should test 35 lbs. (156 N) when compressed to a length of 1.19 inches (30.2 mm). Renew clutch plates that are worn, scored, warped or show signs of other damage.

222. To reassemble pto assembly, proceed as follows: If installing new bushing (19), first install new thrust washer (18), then press bushing (19) into bore of carrier until it is 0.070 inch (1.778 mm) below flush as shown in Fig. 227. Bushing must be reamed after installation to 0.8135-0.8145 inch (20.663-20.688 mm) ID. Install the wave type seal spring or "O" ring (22—Fig. 232) in groove of piston (24) so that spring ends are toward piston and do not overlap. See Fig. 228. Install seal (23—Fig. 232) over wave spring and work seal into place using a smooth wood dowel or other similar object. Repeat operation to install inner "O" ring or wave spring (21) and seal (20), then lubricate piston assembly and install it in carrier with flat side down. Install piston return spring (25) and retain with snap ring (26). If not already done, remove snap ring (6) from clutch hub (5) and install clutch hub over piston return spring. Lubricate clutch plates, then starting with a steel plate alternately install six steel and six sintered friction plates for Model 2390 and 2394 tractors; and seven steel and seven friction plates for Model 2590 and 2594 tractors.

Remove clutch hub, install snap ring (6), then reinstall clutch hub in clutch plates. Install the last steel plate and sintered friction plate and be sure OD of snap ring fits in ID of last steel plate. Install back-up plate and retaining snap ring (2). Install seal rings (14) and be sure hooked ends are engaged.

Install "O" rings (7 and 41) in grooves of brake piston (40), lubricate "O" rings and install piston flat side up in piston carrier (39). Place brake plate (9) over piston with friction side up, plate roll pins (10) in plate retaining holes and install return springs (11) over roll pins. Use Loctite 271 or equivalent on threads of retainer cap screws (13). Install cap screws with washers (12) and tighten to 18-25 ft.-lbs. (24-34 N·m) torque.

Lubricate seal rings (14), and install brake housing assembly (39) over carrier (15) shaft with brake toward carrier. Place bearing cup (35) over carrier shaft, then heat bearing (34) and install on shaft. Install gear (33) on shaft, then heat bearing (32), install on shaft and install snap ring (30). Install two guide studs in housing (36). Be sure the two square cut "O" rings (37) and the 5/16 inch (8 mm) steel ball (38) are in place, then install carrier and brake assembly on guide studs. Use a soft faced hammer to bump carrier until bearing cup (35) is seated in housing (36), then install

rear bearing cup (31) in housing (36). With no "O" ring on rear cover (27), install cover with original shim pack (29) and tighten the retaining cap screws to 35-42 ft.-lbs. (47-57 N·m) torque. Bump carrier in both directions to ensure that bearings are seated, then check end play of unit which should be 0.001-0.003 inch (0.025-0.076 mm). If end play is incorrect, remove rear cover and vary the number of shims (29) which are available in thicknesses of 0.005, 0.007 and 0.010 inch (0.127, 0.178 and 0.254 mm). When adjustment is correct, remove rear cover and install new "O" ring (28).

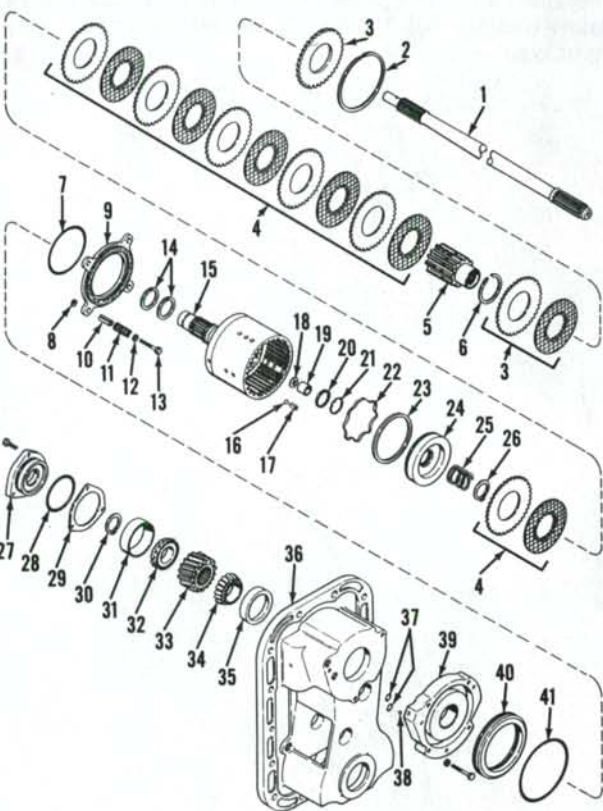
Install snap rings (3 and 25—Fig. 231) in inside groove of idler gears (4 and 26). On Models 2590 and 2594 tractors install shims shown in circled inserts, then drive bearing cups (2, 5, 24 and 27) into idler gears until they bottom. Bearing cup tapers should be facing away from each other (toward sides of gear). Place new "O" ring on upper gear pin (10). Place bearings (6) in upper idler gear (4) which has the identification groove cut in teeth, then place gear assembly in housing (12) and insert gear pin (10). Use original shims (9) and install retainer (8). Tighten retaining cap screw to 35-42 ft.-lbs. (47-57 N·m) torque and check end play of idler gear pin which should be 0.000-0.003 inch (0.000-0.076 mm). If end play is incorrect, vary shims (9) as required. Shims are available in thicknesses of 0.005, 0.007 and 0.010 inch (0.127, 0.178 and 0.254 mm). Repeat above operation for lower idler gear assembly.

NOTE: Lower idler gear (26) has no identification groove.

Heat bearing (17), install on output shaft (18), then install snap ring (19). Install bearing cup (22) in housing (12) with taper toward rear. Place front bearing (21) in cup (22), place output gear (20) in housing from bottom side, insert output shaft through output gear and into front bearing and drive output shaft into bearing. Install rear bearing cup (16) into housing bore and install snap ring (15). Bump output shaft both ways to seat bearings then measure shaft end play which should be 0.000-0.002 inch (0.000-0.051 mm). If shaft end play is incorrect, remove snap ring (15) and install one of the correct thickness. Snap ring (15) is available in thicknesses of 0.074, 0.078, 0.082, 0.086, 0.090, 0.094, 0.098, 0.102, 0.108 and 0.109 inch (1.88, 1.98, 2.08, 2.18, 2.29, 2.39, 2.49, 2.59, 2.74 and 2.77 mm).

Lubricate lip of oil seal (14), place oil seal over output shaft with lip inward and drive seal into bore until outer face

Fig. 232—Exploded view of pto clutch and brake assembly used on Model 2390 and 2590 tractors. Models 2394 and 2594 are similar except "O" rings are used in place of wave springs (21 and 22).



1. Pto input shaft
2. Snap ring
3. Back-up plate & disc assy.
4. Clutch plates & discs
5. Clutch hub
6. Snap ring
7. "O" ring
8. Washer
9. Brake
10. Roll pin
11. Spring
12. Washer
13. Bolt
14. Seal rings
15. Carrier
16. Ball
17. Roll pin
18. Thrust washer
19. Bushing
20. Seal
21. Wave spring (inner)
22. Wave spring (outer)
23. Seal
24. Clutch piston
25. Spring
26. Snap ring
27. Cover
28. "O" ring
29. Shim
30. Snap ring
31. Bearing cup
32. Bearing cone
33. Input gear
34. Bearing cone
35. Bearing cup
36. Pto housing
37. "O" rings
38. Ball
39. Pto brake piston carrier
40. Brake piston
41. "O" ring

SERVICE MANUAL

Paragraph 223

is flush with transmission case. Install tubular guard (13).

HYDRAULIC SYSTEM

The tractor hydraulic system provides power for steering, brakes, pto clutch and brake, differential lock, master hydraulic clutch (models so equipped), power shift clutches and valves (models so equipped), as well as for hydraulic lift and control of carried and towed implements. Refer to Figs. 233, 234, 235, 236 and 237 for schematic views showing location of components.

The dual (gear and piston type) hydraulic pump attaches to left side of torque tube housing and is driven by a shaft extending rearward from engine flywheel to pump drive gear train. Charging pump on Models 2090, 2290, 2094 and 2294 is mounted behind dual hydraulic pump. Charging pump on Models 2390, 2590, 2394 and 2594 is mounted in sump of torque tube. Both charging pumps are driven by gear trains shown in Figs. 241 and 243.

Refer to appropriate following paragraphs for hydraulic pump and system components.

TESTING

All Models

223. PISTON PUMP AND CHARGE PUMP. To test hydraulic pump system, first place outlet hose to a CAS-10280 or other suitable flowmeter into transmission filler neck. Disconnect and plug outlet tube from piston pump, then connect hose from inlet port of flowmeter to outlet port of piston pump. Disconnect and plug compensator tube on pump compensator and install ¼ inch (6.35 mm) hose from flowmeter to pump compensator. Disconnect electrical connector to pressure switch on piston pump inlet tube; remove pressure switch and connect a 100 psi (690 kPa) pressure gage where switch was removed. With engine running at 2100 rpm and with oil at operating temperature of approximately 120° F (49° C) open flow, load and compensator valves on flowmeter. Charge pump pressure on gage should read 30 psi (207 kPa) (maximum) and not less than 15 psi (103 kPa).

NOTE: If charge pump pressure reads less than 15 psi (103 kPa), hydraulic oil filters may be clogged and require renewal or oil inlet screen may also be restricted requiring cleaning. Check inlet tube to pump for restriction or damage. If filters and tube are in satisfactory condition, charge pump will require removal, inspection and/or repair as outlined in paragraphs 236 or 237.

To check piston pump low stand-by pressure, run engine at 750 rpm and with oil at operating temperature of approximately 120° F (49° C) fully open flow valve on flowmeter, and completely close load and compensator valve on flowmeter. Pressure on flowmeter pressure gage should read 325-350 psi (2241-2413 kPa).

NOTE: To adjust low stand-by pressure on Models 2090, 2290, 2390 and 2590, Allen head plug on compensator (Fig. 238) must be removed and shim(s) (15—Fig. 248) be added or removed to correct pressure. Adding shims increases pressure, removing shims decreases pressure.

On Models 2094, 2294, 2394 and 2594, remove plug (18— Fig. 249) and turn adjusting screw (25) in to increase or out to decrease stand-by pressure.

MODELS 2090 AND 2290
TRACTOR HYDRAULIC SYSTEM
Mechanical Shift Tractors
(Neutral Mode)

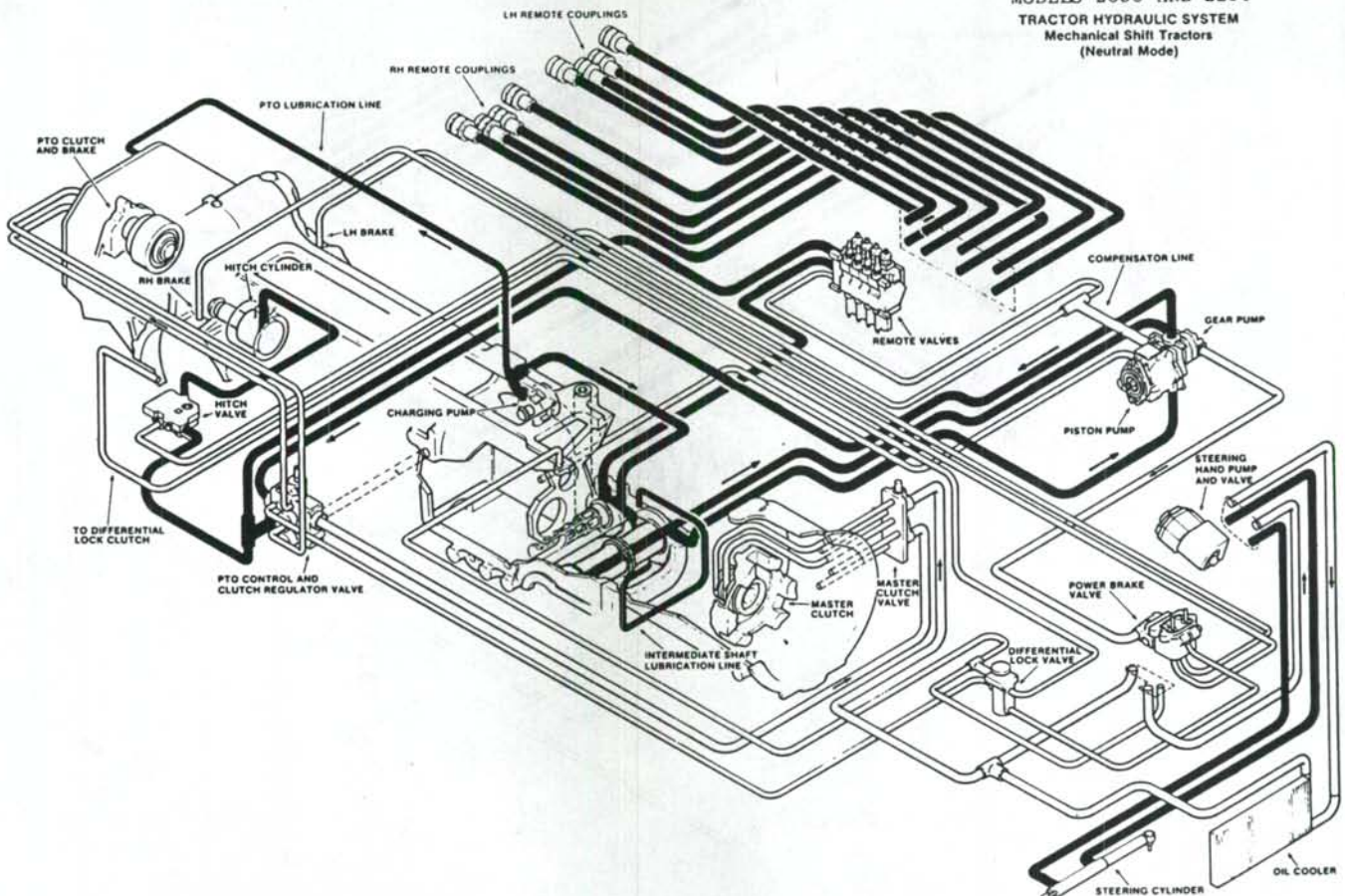


Fig. 233—Schematic view of hydraulic system for Model 2090 and 2290 mechanical shift tractors showing main components.

Paragraphs 224-226

To check piston pump maximum output pressure, run engine at 750 rpm, and with oil at operating temperature of approximately 120° F (49° C) open flow and compensator valves on flowmeter fully and close load valve fully. Reading on flowmeter pressure gage should be 2200-2300 psi (15169-15859 kPa).

NOTE: To adjust piston pump maximum output pressure, turn adjustment screw on compensator (Fig. 238) clockwise to increase pressure, counterclockwise to decrease pressure.

To check piston pump efficiency at maximum flow, with charge pump operating correctly and compensator properly adjusted, run engine at 2100 rpm, and with oil at operating temperature of approximately 120° F (49° C), open flowmeter flow and compensator valves fully. Adjust flowmeter load valve until flowmeter pressure gage reads 400 psi (2758 kPa). Flowmeter flow gage must read 22.5 to 24.2 gpm (85 to 92 L/min.) on Models 2090, 2290, 2094 and 2294 or 25.5 to 29.1 gpm (96.5 to 110.1 L/min.) on Models 2390, 2590, 2394 and 2594. Ad-

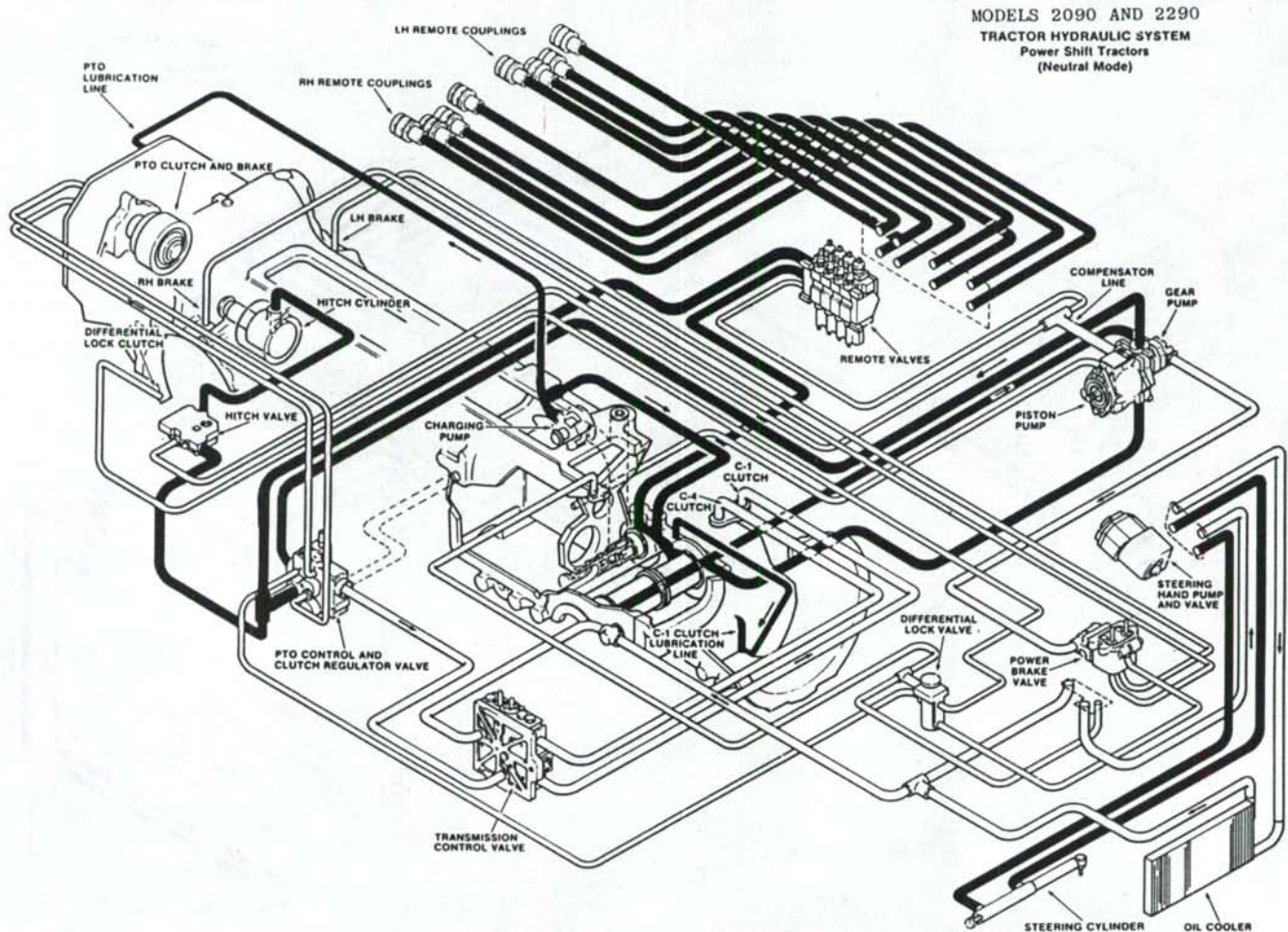
just flowmeter load valve to 2000 psi (13790 kPa). Flow reading must not vary more than 10 percent. If flow reading is less than required, piston pump must be overhauled as outlined in paragraph 239.

224. To check pump flow at 750 (engine) rpm and at 190 psi (1310 kPa) flowmeter load valve setting, run engine at 750 rpm, and with oil at operating temperature of approximately 120° F (49° C), open flowmeter flow valve fully, and with flowmeter load valve adjusted to register 190 psi (1310 kPa) on flowmeter pressure gage, record gpm (L/min.) flow on flowmeter flow gage for comparison use in later tests.

225. PUMP COMPENSATOR. To check pump compensator operation, run engine at 2100 rpm, and with oil at operating temperature of approximately 120° F (49° C), fully open flow and compensator valves on flowmeter. Adjust flowmeter flow valve until flowmeter gage reads 10 gpm (37.85 L/min.). Adjust flowmeter load valve to 500, 1000, 1500 and 2000 psi (3448, 6895, 10342 and 13790 kPa). There must be 9.5 to

10.5 gpm (36.0 to 39.7 L/min.) on flowmeter at each of the four settings. If flow is not in the 9.5 to 10.5 gpm (36.0 to 39.7 L/min.) range, the pump compensator must be overhauled as outlined in paragraph 243 or 244. When testing is finished, remove all test equipment and fittings and reconnect hydraulic tubes, switches and electrical connections.

226. GEAR PUMP. To test the gear pump efficiency, disconnect outlet hose from gear pump. Cap or plug outlet hose. Connect flowmeter inlet hose to gear pump outlet. Insert flowmeter outlet hose in transmission filler neck. Open flowmeter load valve completely, then start engine. With engine operating at 2000 rpm and hydraulic oil temperature at 120° F (49° C), flow reading should be 7.2 gpm (27.3 L/min.) minimum. Adjust load valve until flowmeter pressure gage reads 1750 psi (12066 kPa). At this time, flow reading must be 6.6 gpm (24.8 L/min.) minimum. If not, gear pump must be overhauled as outlined in paragraph 245. Remove flowmeter and hoses and reconnect pump outlet hose.



MODELS 2090 AND 2290
TRACTOR HYDRAULIC SYSTEM
Power Shift Tractors
(Neutral Mode)

Fig. 234—Schematic view of hydraulic system for Model 2090 and 2290 power shift tractors showing main components.

SERVICE MANUAL

Paragraphs 227-232

LEAKAGE TESTS

227. To connect flowmeter for leakage tests, disconnect outlet tube from piston pump. Using appropriate fittings, connect flowmeter inlet hose to pump outlet port. Connect flowmeter outlet hose to piston pump outlet tube.

Models 2090 and 2290 So Equipped

228. MASTER CLUTCH AND CONTROL VALVE. To check master clutch and control valve leakage, operate engine at 750 rpm. With hydraulic oil at operating temperature of approximately 120° F (49° C), fully open flowmeter flow and load valves. With clutch pedal in fully up position, check reading on flowmeter flow gage. If reading is 1 gpm (3.8 L/min.) lower than reading recorded in test in paragraph 224, master clutch or control valve leakage is present. Refer to paragraph 99 for master clutch overhaul and to paragraph 100 for master clutch control valve overhaul.

All Models So Equipped

229. POWER SHIFT CLUTCHES AND CONTROL VALVE. With engine operating at 750 rpm and oil temperature at approximately 120° F (49° C), open flow and load valves on flowmeter completely. Shift power shift lever through all power shift positions. Record flow in each position. Flowmeter will indicate a flow as soon as power shift lever is moved to each position. Flow reading will decrease as soon as the engaged clutches have filled. A flow reading of 0-1 gpm (0-3.8 L/min.) is normal. If leakage exceeds 1 gpm (3.8 L/min.) in one or two of the selected positions, refer to Fig. 239 or 240 and check to see which clutches are applied in the leaking positions. Locate leaking clutch by process of elimination. Refer to paragraphs 129 through 132 for control valve overhaul and to paragraphs 134 through 152 for power shift unit overhaul.

If excessive leakage is indicated in all of the power shift positions, differential

lock, pto, hitch valve or remote valves should be suspected of leakage rather than the power shift.

230. PTO. Check pto for excessive leakage as outlined in paragraph 196.

231. DIFFERENTIAL LOCK. With engine operating at 750 rpm and oil at operating temperature, fully open flow and load valves on flowmeter. Record flow reading in disengaged position and then in engaged position. If difference in flow readings is more than the permitted 1 gpm (3.8 L/min.), isolate differential lock clutch by disconnecting and plugging the differential lock line. Recheck flow readings. If leakage is still present, problem is in differential lock valve. If no leakage is now present, problem is in differential lock clutch or oil distributor tube and "O" rings in right brake carrier.

232. REMOTE VALVE. To test for remote valve leakage in neutral position, fully open flow and load valves on

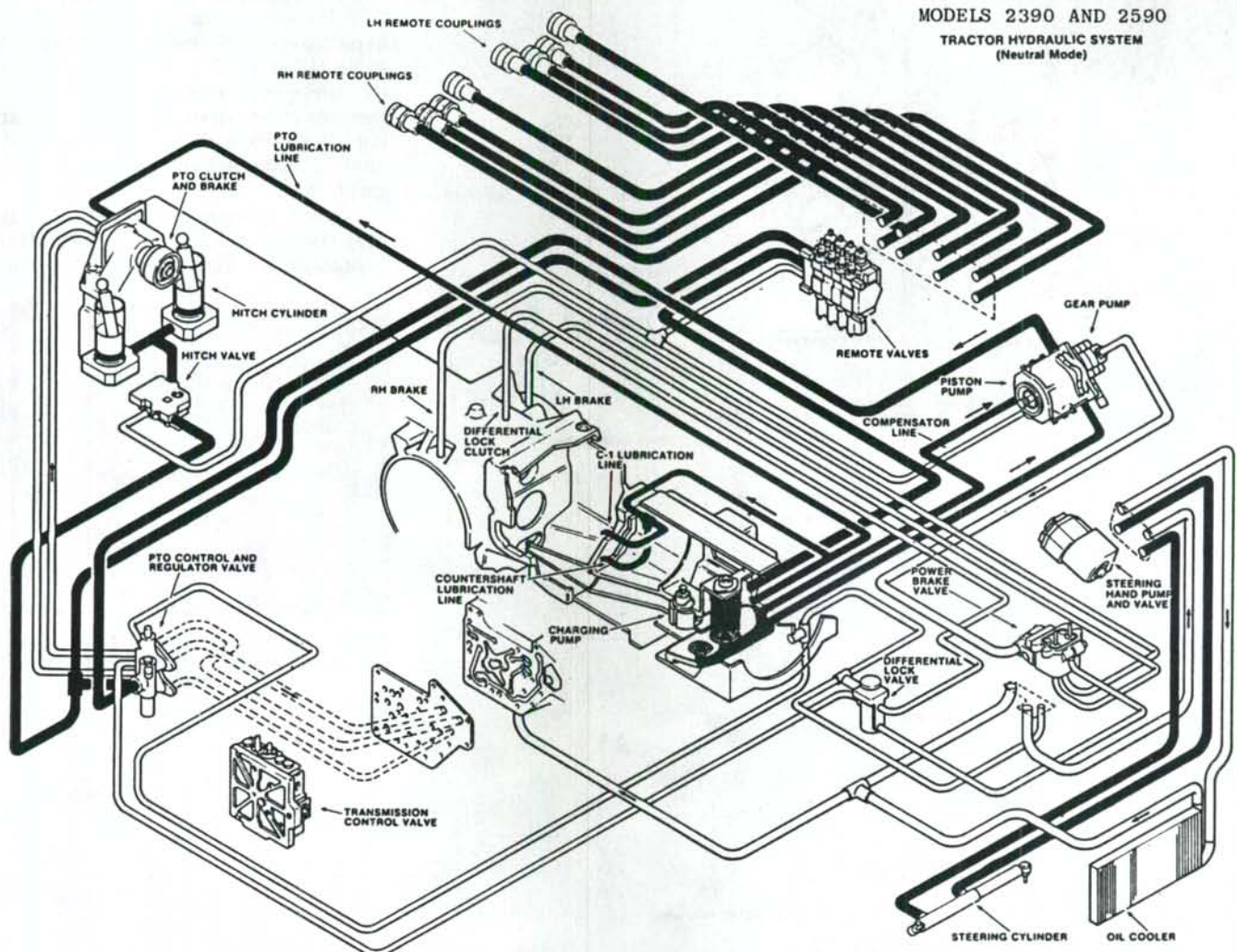


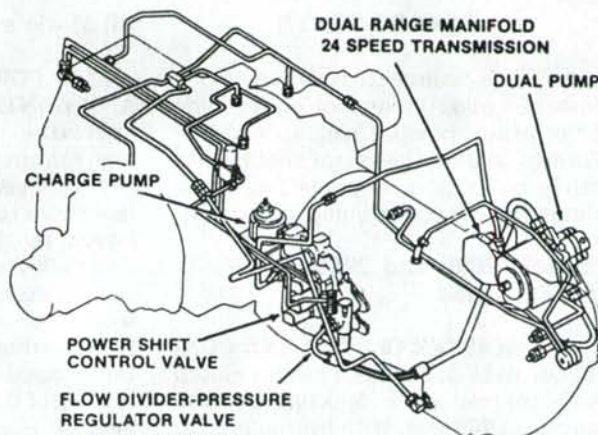
Fig. 235—Schematic view of hydraulic system for Model 2390 and 2590 power shift tractors showing main components.

Paragraphs 233-234

flowmeter. Isolate remote valves by disconnecting and plugging remote supply line. With engine operating at 750 rpm and oil at operating temperature of 120° F (49° C), record flow reading on flowmeter. Reconnect remote supply line, then place all remote levers in neutral position and record flow reading on flowmeter. If flow reading is 0.5 gpm (1.9 L/min.) or more higher than the reading with valves isolated, leakage is present in remote valves. Refer to paragraph 258 for overhaul procedure of remote valves.

233. HITCH VALVE. To test hitch valve for excessive leakage, fully open flow and load valves on flowmeter. Isolate hitch valve by disconnecting and plugging hitch supply line. With engine operating at 750 rpm and oil at operating temperature, record flow

Fig. 237—View showing location of some of the main hydraulic components on Models 2394 and 2594. Location of other hydraulic components is similar to Fig. 236.



reading on flowmeter. Reconnect high valve supply line and again check flow reading on flowmeter. If flow reading is 0.5 gpm (1.9 L/min.) or more higher than the reading with hitch valve isolated, leakage is present in hitch valve.

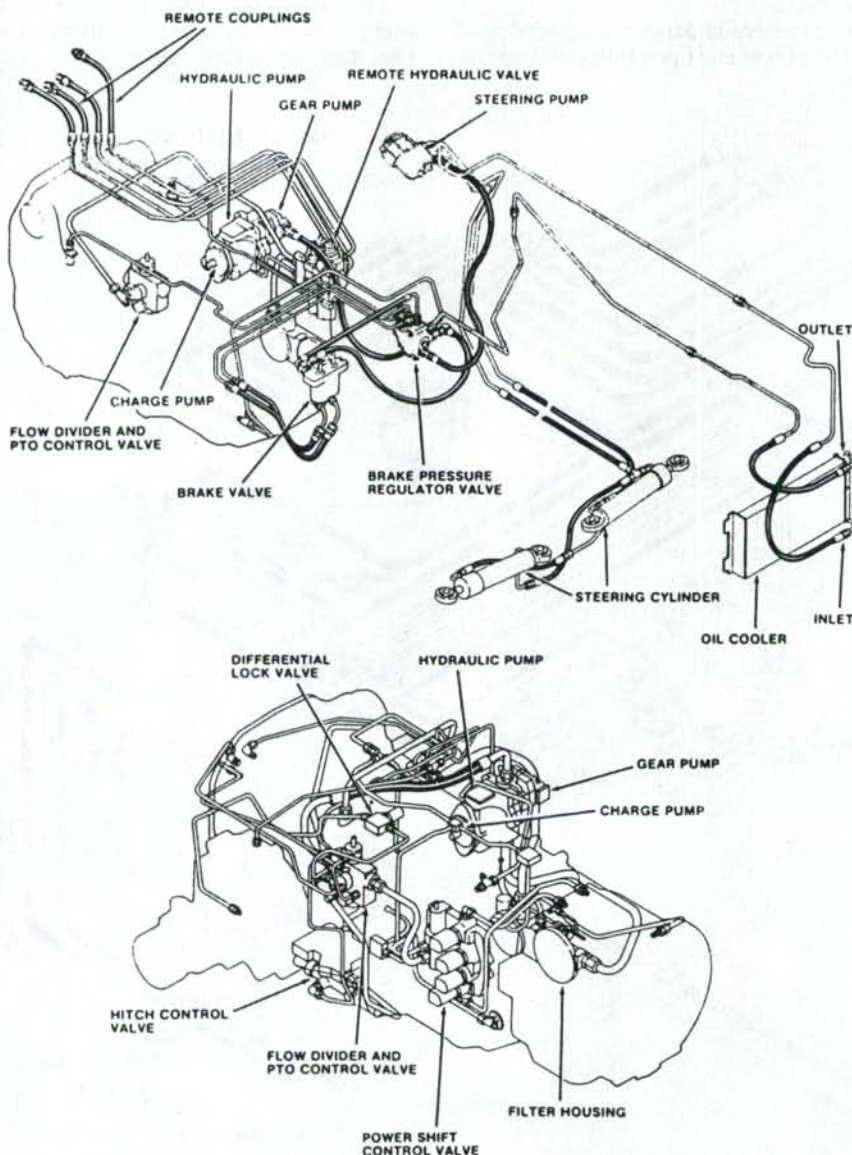


Fig. 236—View showing location of main hydraulic components on Models 2094 and 2294.

CASE/INTERNATIONAL

PUMP DRIVE

Model 2090, 2290, 2094 and 2294

234. REMOVE AND REINSTALL. To remove hydraulic pump drive, first remove pto assembly as outlined in paragraph 202. Remove rear pto drive shaft. Remove tractor cab. Remove rear transmission top access cover. Remove hydraulic pump as outlined in paragraph 238. Remove charge pump as outlined in paragraph 236. Remove charge pump shims (13—Fig. 241), noting number and thickness of shims for reinstallation. Remove outer drive shaft needle bearing (7) if necessary and renew as outlined in charge pump overhaul paragraph 236.

To remove pump driven gear (25—Fig. 241), tractor must be split as outlined in paragraph 106. Remove shim type snap

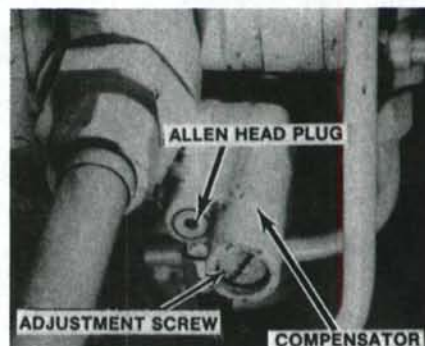


Fig. 238—View of pump compensator showing adjusting screw and plug for shim adjustment. Refer to text.

POWER SHIFT HAND LEVER POSITION	APPLIED CLUTCHES			
	C1	C2	C3	C4
1 LOW	X	X		
2 INTERMEDIATE	X		X	
3 HIGH		X	X	
R REVERSE		X		X

Fig. 239—Chart identifying clutches applied for various speeds on three-speed power shift unit.

SERVICE MANUAL

Paragraph 235

POWER SHIFT HAND LEVER POSITION	APPLIED CLUTCHES					
	C1	C2	C3	C4	C5	C6
1 FIRST	X	X				X
2 SECOND	X	X			X	
3 THIRD	X		X			X
4 FOURTH	X		X		X	
5 FIFTH		X	X			X
6 SIXTH		X	X		X	
R REVERSE		X		X		X

Fig. 240—Chart showing which clutches are applied for each speed on six-speed power shift unit.

Models 2390, 2590, 2394 and 2594

235. REMOVE AND REINSTALL. To remove hydraulic pump drive, first remove charge pump as outlined in paragraph 237 and dual hydraulic pump as outlined in paragraph 238. To gain access to pump drive assembly shown in exploded view in Fig. 243, tractor must be split between transmission and torque tube as outlined in paragraph 142.

Unbolt and remove pump drive assembly (items 3 through 20—Fig. 243) from torque tube. Remove snap ring (17) for charge pump drive, then remove retaining washer (16), outer and inner thrust washers and thrust bearing (items 14 and 15). Remove snap ring (10) for dual pump drive, outer and inner thrust washers and thrust bearing (items 7 through 9). Remove snap ring (18) and input gear with bearing (19 and 20). Remove charge pump drive gear (3) and dual pump drive gear (4). Remove needle bearings (5, 6 and 13) and input gear bearing (19) if renewal is necessary.

Inspect gears and bearings and renew as necessary. Install pump needle bearings until edges are flush with pump drive housing.

NOTE: Charge pump shaft needle bearings are same width; dual pump shaft needle bearings are different widths. Install narrow bearing toward outside of housing as shown in Fig. 244.

Assembly is reverse of disassembly. Select correct width snap ring (10—Fig. 243) that will give correct backlash between input gear (20) and dual pump drive gear (4); or snap ring (17) that will give correct backlash between input gear (20) and charge pump drive gear (3). Correct backlash for all gears should be 0.002-0.006 inch (0.051-0.153 mm) when measured with a dial indicator. Snap rings (10 and 17) are available in

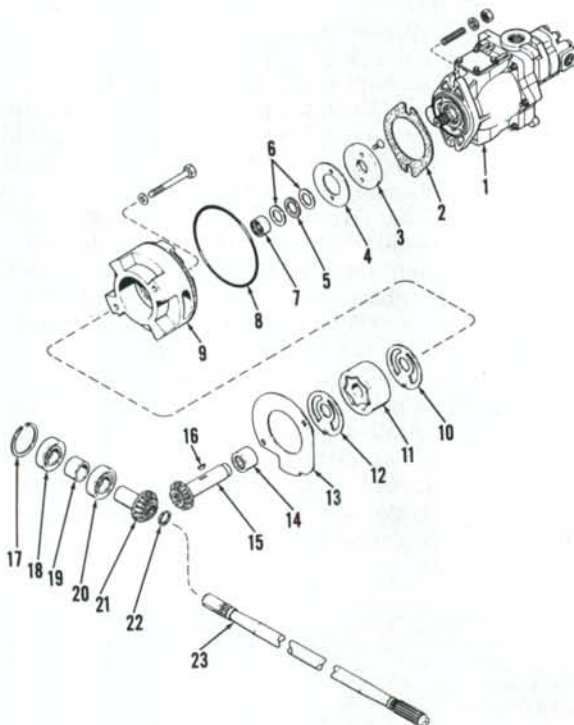


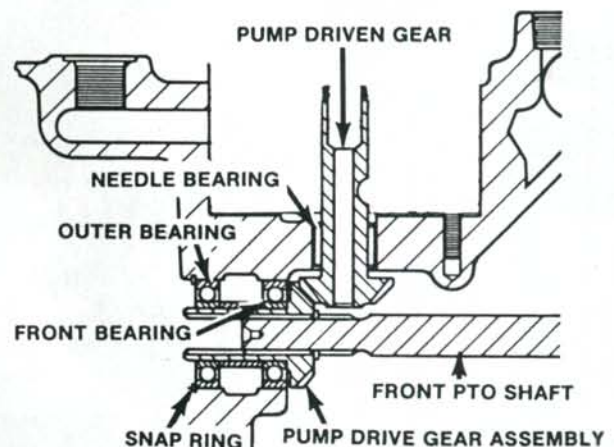
Fig. 241—Exploded view of hydraulic charge pump and drive for both charge and dual hydraulic pumps on Model 2090, 2290, 2094 and 2294 tractors.

1. Dual pump
2. Gasket
3. Retainer
4. Shim
5. Needle thrust bearing
6. Thrust washers
7. Needle bearing
8. "O" ring
9. Pump cover
10. Wear plate
11. Gerotor assy.
12. Wear plate
13. Shim
14. Needle bearing
15. Pump drive shaft
16. Woodruff key
17. Snap ring
18. Bearing
19. Spacer
20. Bearing
21. Bevel gear
22. Snap ring
23. Pto & pump input shaft

ring (17—Fig. 241) from behind outer bearing (18). Push pump gear drive assembly (items 21 through 18) rearward and remove from transmission case by driving front pto shaft (23) rearward, then pull pto front drive shaft forward from transmission case. Remove Woodruff key and pump driven gear (15 and 16) from inside transmission case. Drive needle bearing (14) from transmission.

Inspect gears and bearings for wear or other damage and renew as necessary. Reassembly by reversing disassembly procedure. Install needle bearing (14) until bearing is approximately 1/16 to 1/8 inch (1.59 to 3.18 mm) below inside surface of transmission case. Numbers on bearing must face outside of transmission case. Install original pump shim(s), but if original number and size of shim(s) is not known, refer to charge pump overhaul paragraph 236 for checking and adjusting gear backlash.

Fig. 242—Cross-sectional view of pump drive showing relative parts on Model 2090, 2290, 2094 and 2294 tractors.



Paragraph 236

thicknesses of 0.074, 0.084 and 0.094 inch (1.88, 2.13 and 2.39 mm).

CHARGE PUMP

Models 2090, 2290, 2094 and 2294

236. R&R AND OVERHAUL. To remove charge pump, first remove dual hydraulic pump as outlined in paragraph 238. Refer to Fig. 241, unbolt and remove charge pump body (items 3 through 10) from transmission cavity. Remove two-piece gerotor (11) from drive shaft. Remove shim(s), Woodruff key (16) and wear plate (12) from cavity. Remove wear plate (10) from pump body (9). Remove and discard "O" ring (8). Remove screws and remove retainer plate (3), shim(s) (4), outer and inner thrust washers (6) and thrust bearing (5).

Inspect wear plates (10 and 12) for scoring, bending or other damage. Also renew plates if wear thickness measures less than 0.025 inch (0.635 mm). Renew gerotor (11) if clearance between inner and outer apex tips exceeds 0.008 inch (0.203 mm). Inspect and renew needle bearing (7) as necessary. Install bearing with numbers toward outside of pump body.

Clean old sealant from outside of pump body, lightly rough outside surface of pump body with emery cloth and apply Loctite Accelerator or equivalent to pump body and let dry. Repeat procedure to inner surfaces of pump cavity in transmission. Lubricate new "O" ring (8—Fig. 241) and install in groove of pump body. Install inner wear plate (10) with tab on plate fitting in hole of pump body. Install gerotor assembly into pump body.

To select proper shim pack (13), place outer wear plate (12) on gerotor, tab of plate facing up. Place a straightedge across top face of wear plate, measure gap between straightedge and top face of pump body with a feeler gage and add 0.0015-0.003 inch (0.038-0.076 mm) to measurement to obtain correct total gap. Select number of shims (13) to fill gap correctly. Blue shims are 0.005 inch (0.127 mm) thick; red shims are 0.003 inch (0.076 mm) thick. At least one shim must be installed. Remove plates and

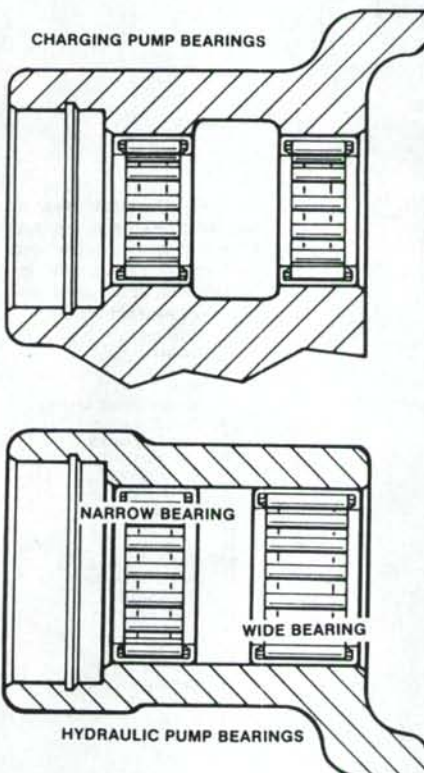


Fig. 244—Cross section showing correct placement of needle bearings.

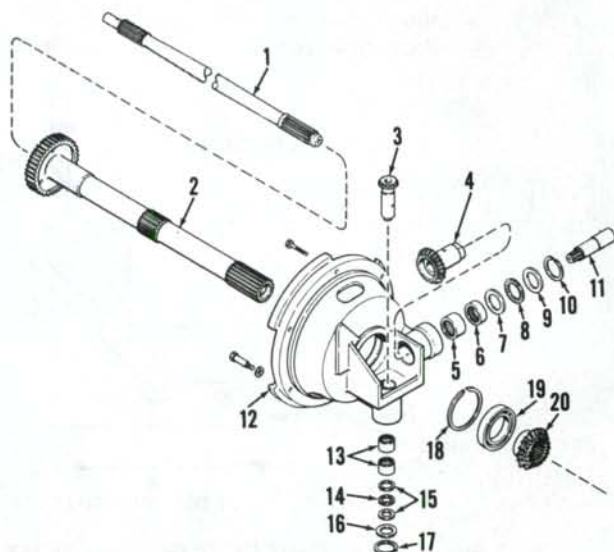


Fig. 243—Exploded view of hydraulic pump drive assembly on Model 2390, 2590, 2394 and 2594 tractors.

1. Pto & pump input shaft
2. Planetary input shaft
3. Charge pump bevel gear (22 teeth)
4. Piston pump bevel gear (13 teeth)
5. Needle bearing
6. Needle bearing
7. Thrust washer
8. Thrust bearing
9. Thrust washer
10. Snap ring
11. Pump drive coupling
12. Housing
13. Needle bearings
14. Thrust bearing
15. Thrust washers
16. Race
17. Snap ring
18. Snap ring
19. Bearing
20. Drive gear (33 & 47 teeth)

CASE/INTERNATIONAL

gerotor from pump body. Lubricate "O" ring (8) with petroleum jelly and install in groove of pump body. Install inner wear plate (12) with tab in hole of pump body. Install gerotor assembly (11) in pump body. Install outer wear plate (12) over drive shaft and with tab in plate in hole of transmission housing. With groove in drive shaft up, install Woodruff key (16). Place two pilot studs in transmission housing and install shim pack (13). Apply suitable Loctite or equivalent sealant to four contact areas of pump housing and transmission housing, then aligning Woodruff key and slot in inner gerotor set, install pump body into transmission housing. One at a time, remove pilot stud and install retaining bolt, and tighten bolts to 75-89 ft.-lbs. (102-121 N·m) torque. Install thrust washers and bearing (5 and 6), install two 3/8 inch bolts with flat washers to secure thrust assembly tightly in mesh with drive gear and using a depth micrometer, measure distance from outer thrust washer to bottom of counterbore of pump body. Add sufficient shims (4) to fill measured gap and to obtain drive gear backlash of 0.003 to 0.005 inch (0.076-0.127 mm). Shims are available in 0.003 and 0.010 inch (0.076 and 0.254 mm) thicknesses. Remove 3/8 inch bolts and washers and install desired shim pack (4) and retainer plate (3). Use Loctite 242 or equivalent on retaining plate screws and tighten screws to 25-30 ft.-lbs. (34-41 N·m) torque.

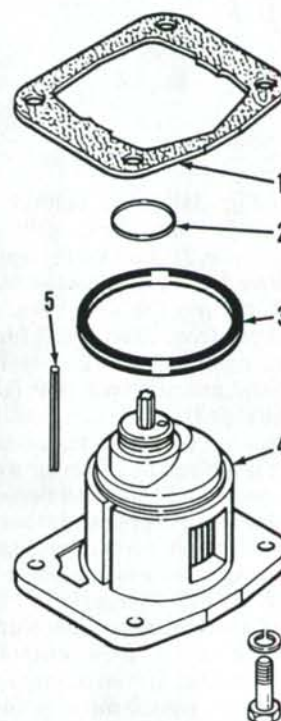


Fig. 245—View of Model 2390, 2590, 2394 and 2594 tractor charge pump, "O" rings, seals and gasket.

SERVICE MANUAL

Balance of reassembly is reverse of disassembly.

Models 2390, 2590, 2394 and 2594

237. R&R AND OVERHAUL. Before removing charging pump, remove all three drain plugs to drain transmission and twin filter cavity. Remove the four pump mounting cap screws and work pump straight down and out bottom of torque tube. When reinstalling, renew "O" ring, square cut seal and two "X" section side seals. See Fig. 245. Coat all seals and pump cavity with Lubriplate or similar lubricant and very carefully install pump into the torque tube. Be sure gasket is in place and do not allow "X" section side seals to buckle or be cut as pump is worked into place. Tighten mounting cap screws to 80-96 ft.-lbs. (109-130 N·m) torque.

To disassemble removed charging pump, refer to Fig. 246. Bushings (2) are

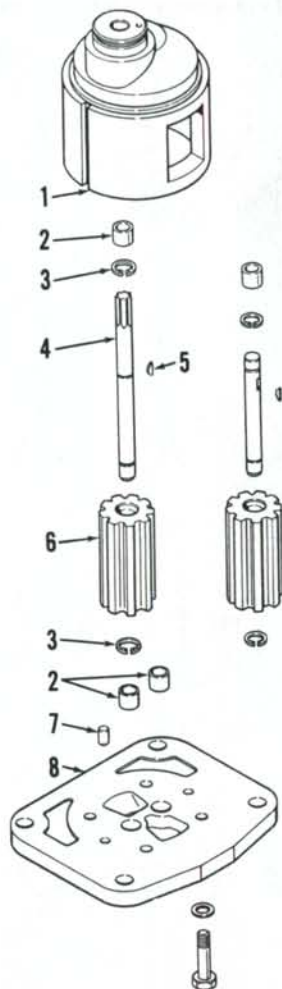


Fig. 246—Exploded view of charge pump used on Model 2390, 2590, 2394 and 2594 tractors.

- | | |
|----------------|-----------------|
| 1. Body | 5. Woodruff key |
| 2. Bushing | 6. Drive gear |
| 3. Snap ring | 7. Dowel |
| 4. Drive shaft | 8. Cover |

renewable in cover (8) and in pump body (1). Press bushings into body until they bottom. Ream new bushings to 0.4930-0.4938 inch (12.522-12.543 mm) after installation. If pump body or cover is renewed, bushings in new part will be proper size. Dowel pins (7) should be pressed into pump body approximately 1/2 their length. Inspect parts for scoring and gears for nicks. Renew any questionable parts. Tighten cover retaining cap screws finger tight, make sure pump turns freely, then tighten to 20-25 ft.-lbs. (27-34 N·m) torque, using a criss-cross pattern.

DUAL HYDRAULIC PUMP

All Models

238. REMOVE AND REINSTALL. To remove dual hydraulic pump on all models, remove inlet and outlet tubes and hoses from piston and gear pumps. Remove outlet tube for charge pump. Remove drain tube for piston pump. Remove both tubes from tee fitting on pump compensator, then remove nuts and washers securing pump to transmission and remove pump.

Reinstall by reversing removal procedure and tighten nuts to 80-96 ft.-lbs. (108-130 N·m) torque.

239. OVERHAUL PISTON PUMP. Unbolt gear pump, "O" ring and splined coupler (items 2, 3 and 4—Fig. 250) from

piston pump. Unbolt and remove pump compensator, "O" ring and gasket (1, 2 and 3—Fig. 248 or 249) from piston pump. Refer to Fig. 247 and remove "O" ring (44) from control piston guide. Unbolt and remove valve block (42) from pump housing (9). Remove gasket (32). Remove rear bearing (29) and spacer (28). Remove cylinder block assembly (items 19 through 27) from pump housing being careful not to allow pistons (19) to fall out. Unbolt and remove both side bearing covers (3) and shims (4), keeping shims with respective covers of each side, "O" rings (5), spacers (6), bearing cups and cones (7 and 8), then remove cam plate (18) from pump housing. Remove pump shaft (15) with bearing (14), pressing off bearing cone and renew cup (13) and cone together if necessary. Remove spring (11) and pivot (12).

Remove control piston and limit washer (33 and 34) from guide (35).

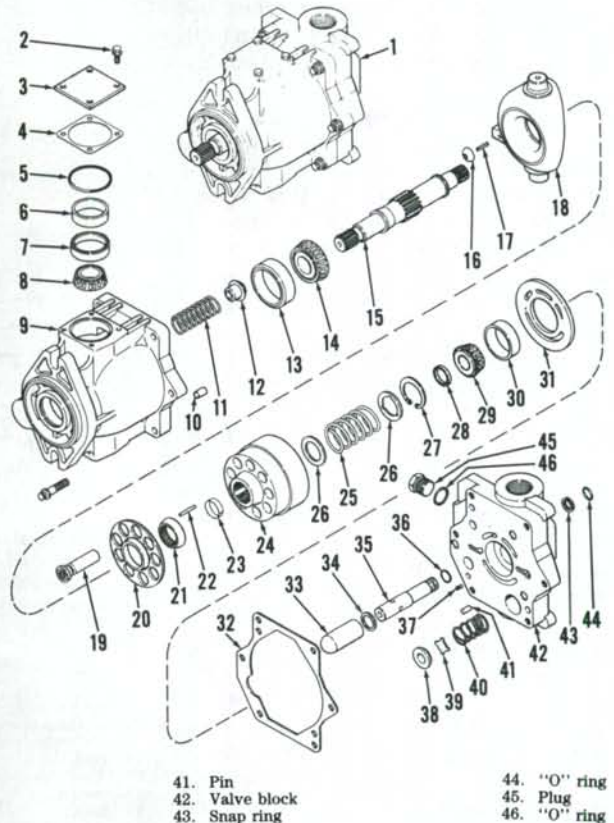
NOTE: Limit washer (34) is used on Models 2090, 2290, 2094 and 2294 only.

Remove wear plate (31) from valve block (42), remove snap ring (43), then remove control piston guide (35) from valve block (42).

240. CYLINDER BLOCK. Remove shoe plate and pistons (19 and 20—Fig. 247) from block (24). Remove pivot washer (21) and three guide pins (22)

Fig. 247—Exploded view of piston type pump used on all models. Piston limiter ring (34) is used only on Models 2090, 2290, 2094 and 2294.

1. Pump Assy.
2. Whizlock screw
3. Cover
4. Shim
5. "O" ring
6. Spacer
7. Bearing cup
8. Bearing cone
9. Housing
10. Dowel
11. Spring
12. Seat
13. Bearing cup
14. Bearing cone
15. Shaft
16. Seat
17. Roll pin
18. Yoke
19. Piston
20. Shoe plate
21. Washer
22. Pin
23. Retainer
24. Cylinder block
25. Spring
26. Washer
27. Snap ring
28. Spacer
29. Bearing cone
30. Bearing cup
31. Wafer plate
32. Gasket
33. Piston
34. Limiter ring
35. Rod
36. "O" ring
37. Plug
38. Seat
39. Valve
40. Spring



- | | |
|-----------------|--------------|
| 41. Pin | 44. "O" ring |
| 42. Valve block | 45. Plug |
| 43. Snap ring | 46. "O" ring |

Paragraphs 241-243

from block (24). Check each piston (19) for wear or damage. Looseness between ball and socket of piston must not exceed 0.005 inch (0.127 mm). Shoe thickness of piston must not vary more than 0.001 inch (0.0254 mm) between all piston shoes. Check shoe plate (20) for excessive wear or cracks and pivot washer (21) for excessive wear or scratches and renew shoe plate and pivot washer together if necessary. Check the three pins (22) for bending and equal length and renew as necessary. Check each bore of cylinder block (24) for excessive wear and smoothness of piston travel or excessive looseness in piston travel. Check face of cylinder block for excessive wear between ports and for surface scratches.

NOTE: Do not try to remove spring (25), washers (24 and 26) or snap ring because spring is under high tension, but inspect parts for any possible damage and renew cylinder block assembly (Items 24 through 27) if necessary.

241. Check wafer plate for excessive wear, scratches or cracks and renew as necessary. Check piston shoe surface of cam plate (18) for wear, grooves or scoring and renew as necessary. Make certain pivot (16) on cam plate is not damaged and is securely fastened by roll pin (17). Check cam plate spring (11) for free length of 2.125 inches (53.985 mm) and compression length of 1.4 inches (36.1 mm) at 65.7 to 80.3 lbs. (292-357 N). Check guide (35) for scratches and smooth action with control piston (33). Renew guide and piston as an assembly.

242. Reassemble by reversing disassembly procedure. Lubricate all moving parts with clean hydraulic oil. Use new "O" rings upon reassembly. If new bearings, or cam plate have been renewed, adjust cam plate bearing preload as follows: Using a depth micrometer, measure distance between top edge of spacer (6—Fig. 247) and flat face of pump housing at two points 180 degrees apart and average measurement. Subtract correct preload of 0.008 inch (0.203 mm) from averaged depth to obtain correct shim pack. Shims (4) are available in thicknesses of 0.003, 0.005 and 0.010 inch (0.076, 0.127 and 0.254 mm). Upper and lower shim packs must not differ more than 0.020 inch (0.508 mm). Install correct shim pack and new "O" ring (5) and tighten cover (3) bolts to 175-185 in.-lbs. (20-21 N·m) torque.

If any shaft bearings, shaft, valve block or housing has been renewed, adjust shaft bearing preload as follows: Without installation of valve block, measure thickness of rear bearing spacer (28) and install, chamfered side

toward inside of housing, on pump shaft. Install rear bearing (29), tapered end toward outside of housing, on shaft. Install valve block (42), without gasket (32) and install and evenly tighten valve block bolts to 2 in.-lbs. (0.23 N·m) torque while turning shaft to remove any bearing clearance. Measure gap between pump housing and valve block with feeler gage at four areas 90 degrees apart and average measurement. Subtract thickness of gasket (32) which is 0.020 inch (0.508 mm), from averaged measurement. This will give shaft bearing preload using original spacer (28). Shaft bearing preload should be 0.001-0.003 inch (0.025-0.076 mm). If preload exceeds or is not enough, add or subtract correct preload to measured preload, and select correct thickness spacer (28) to obtain desired preload. Spacers (28) are available in thicknesses ranging from 0.139 to 0.169 inch (3.54 to 4.29 mm) in increments of 0.003 inch (0.076 mm). After correct spacer is obtained, disassemble pump housing and valve block then reassemble pump assembly. Make certain dowel (41) is

pushed fully into valve block so that wafer plate (31) is completely flat against valve block face. Tighten valve block to pump housing bolts to 23-26 ft.-lbs. (31-34 N·m) torque.

243. OVERHAUL PUMP COMPENSATOR (MODELS 2090, 2290, 2390 AND 2590). To disassemble pump compensator, remove seal wire from end of compensator. Refer to Fig. 248. Index high pressure adjustment plug with compensator body so number of turns needed to remove plug can be recorded for reassembly aid. Remove adjustment plug (23), spring (21), seat (20) and spool (19). Remove plug (18), shim cup (16), shim(s) noting size and quantity, disc (14), spring (13), seat (12) and stand-by pressure spool (11). Remove cover plug (10), orifice plug (6) and orifice (7). Remove plugs (4) if necessary.

Check orifice for obstructions or dirt. Clean all parts and inspect spools and bores for wear, scoring or other damage. If renewal is necessary, body and spools must be renewed as an assembly. Free length of stand-by pressure spring (13)

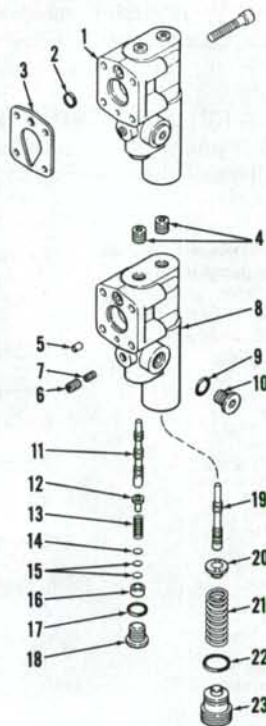


Fig. 248—Exploded view of pump compensator section of dual hydraulic pump used on Model 2090, 2290, 2390 and 2590 tractors.

- | | |
|-------------------------------|------------------------------|
| 1. Compensator assy. | 13. Spring |
| 2. "O" ring | 14. Disc |
| 3. Gasket | 15. Shims |
| 4. Plugs | 16. Cup |
| 5. Plug | 17. "O" ring |
| 6. Plug | 18. Hex socket plug |
| 7. Orifice | 19. Spool (pressure limiter) |
| 8. Compensator body | 20. Seat |
| 9. "O" ring | 21. Spring |
| 10. Plug | 22. "O" ring |
| 11. Spool (stand-by pressure) | 23. Adjusting plug |
| 12. Seat | |

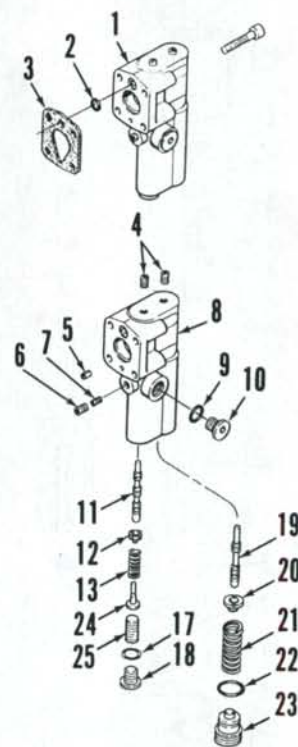


Fig. 249—Exploded view of pump compensator section of dual hydraulic pump used on Models 2094, 2294, 2394 and 2594.

- | | |
|-------------------------------|------------------------------|
| 1. Compensator assy. | 12. Seat |
| 2. "O" ring | 13. Spring |
| 3. Gasket | 14. "O" ring |
| 4. Plugs | 15. Hex socket plug |
| 5. Plug | 16. Spool (pressure limiter) |
| 6. Plug | 17. Seat |
| 7. Orifice | 18. Spring |
| 8. Body | 19. "O" ring |
| 9. "O" ring | 20. Adjusting plug |
| 10. Plug | 21. Spring seat |
| 11. Spool (stand-by pressure) | 22. Adjusting screw |

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should be 0.600 inch (15.24 mm) and compressed length should be 0.570 inch (14.478 mm) at 7.5-9.2 lbs. (33.4-40.9 N). Free length of high pressure spring (21) should be 1.402 inches (35.611 mm) and compressed length should be 1.178 inches (30 mm) at 123.3-150.7 lbs. (548.5-670.3 N).

Reassemble by reversing disassembly. Tighten orifice (7) to 20-25 in.-lbs. (2.3-2.8 N·m) torque. Use all new "O" rings. Lubricate all moving parts with clean hydraulic oil. Install shim cup with bore toward inside. Install high pressure flow spool plug (23) to previously indexed position. Use new "O" ring (2) and gasket (3) when reinstalling on piston pump. Tighten compensator to pump bolts to 60-70 in.-lbs. (6.8-7.9 N·m) torque.

244. OVERHAUL PUMP COMPENSATOR (2094, 2294, 2394 and 2594). To disassemble pump compensator, remove seal wire from end of compensator. Refer to Fig. 249. Index high pressure adjustment plug (23) with body (8) so number of turns needed to remove plug can be recorded for aid in reassembly. Remove adjustment plug (23), spring (21), seat (20) and high pressure spool (19). Remove plug (18) with "O" ring (17) and index screw (25) with body (8). Count and record number of turns needed to remove adjusting screw (25). Remove spring seat (24), spring (13), seat (12) and stand-by pressure spool (11). Remove cover plug (10), orifice plug (6) and orifice (7). Remove plugs (4) if necessary.

Check orifice for obstructions or dirt. Clean all parts and inspect spools and bores for wear, scoring or other damage. If renewal is necessary, body and spools must be renewed as an assembly. Free length of stand-by pressure spring (13) should be 0.966 inch (24.536 mm) and compressed length should be 0.930 inch (22.860 mm) at 8.8-10.8 lbs. (39.1-48.0 N). Free length of high pressure spring (21) should be 1.402 inches (35.611 mm) and compressed length should be 1.178 inches (30.0 mm) at 123.3-150.7 lbs. (548.5-670.3 N).

Reassemble by reversing disassembly procedure. Tighten orifice (7) to 20-25 in.-lbs. (2.3-2.8 N·m) torque. Use all new "O" rings and lubricate all moving parts with clean Hy-Tran Plus oil. Install adjusting screw (25) and adjusting plug (23) exact number of turns recorded during removal. Use new "O" ring (2) and gasket (3) when installing on piston pump. Tighten compensator to pump bolts to a torque of 60-70 in.-lbs. (6.8-7.9 N·m).

245. OVERHAUL GEAR PUMP. Place index marks across the three sec-

tions of pump to aid in reassembly. Unbolt and remove rear cover (17—Fig. 250). Index gear teeth (13 and 14) to retain wear pattern, then remove drive (13) and driven (14) gear. Remove pump body (12) from front cover (5). Remove wear plate (11), Teflon seal (10) and rubber seal (9) from front cover (5).

Check gears for excessive wear or damage. Check bushing contact surfaces of gear shafts for excessive wear and check inside surface of pump body (12) where gears rotate, for scratches or excessive wear. Check wear plate (11) and surface of rear cover where gears contact. If any excessive wear or damage is found, pump must be renewed as a complete assembly.

Reassemble by reversing disassembly procedure. Use new "O" rings, rubber seal and Teflon seal upon reassembly. Install wear plate (11) with oil grooves toward top. Make sure gear index marks and pump sections align. Tighten retaining bolts (1) to 16-18 ft.-lbs. (22-24 N·m) torque. Install splined coupler (3) on piston pump and use new "O" ring (4) when reassembling gear pump to piston pump and tighten mounting bolts to 16-18 ft.-lbs. (22-24 N·m) torque.

246. After reinstallation of dual pump on tractor, run pressure checks

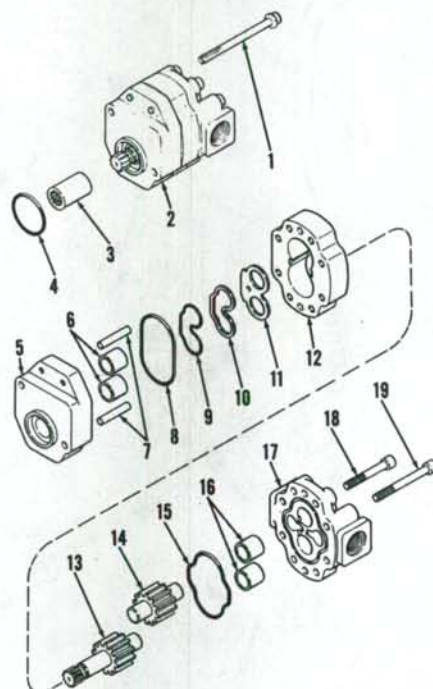


Fig. 250—Exploded view of gear type hydraulic pump section of dual pump.

- | | |
|---------------------|-----------------|
| 1. Ferry head screw | 11. Wear plate |
| 2. Pump assy. | 12. Pump body |
| 3. Coupler | 13. Drive gear |
| 4. "O" ring | 14. Driven gear |
| 5. Front cover | 15. "O" ring |
| 6. Bushings | 16. Bushings |
| 7. Dowels | 17. Rear cover |
| 8. "O" ring | 18. Short screw |
| 9. Rubber seal | 19. Long screw |
| 10. Teflon seal | |

Paragraphs 244-251

and adjustments as outlined in TEST section, paragraphs 223 through 226.

HYDRAULIC SYSTEM FILTER

Models 2090, 2290, 2094 and 2294

247. DUAL FILTERS. To service hydraulic filters on Model 2090, 2290, 2094 and 2294 tractors, refer to paragraph 25 in POWER STEERING SYSTEM section.

248. BYPASS RELIEF VALVE. To renew the hydraulic filter bypass relief valve (12—Fig. 251), refer to paragraph 25 in POWER STEERING SYSTEM section.

249. CHARGE SYSTEM REGULATOR. To remove the charge system pressure regulator valve, first drain transmission oil. Refer to Fig. 251 and remove steering pump tube (6). Unbolt and remove manifold cover (1) and gasket (2), then unbolt and remove charge regulator valve and gasket (3 and 4).

Reverse the removal procedure and install new charge regulator valve using new gaskets. Tighten regulator valve retaining cap screws to a torque of 35-42 ft.-lbs. (48-57 N·m). Tighten manifold cover bolts to a torque of 35-42 ft.-lbs. (48-57 N·m). Refill transmission with Hy-Tran Plus oil and bleed system as outlined in paragraph 25.

250. TRANSMISSION HYDRAULIC OIL SCREEN. To clean or renew transmission hydraulic oil screen, first drain transmission and remove charge system relief valve as outlined in paragraph 249. Disconnect gear and piston pump supply tube, reverse idler lube tube (15—Fig. 251), if so equipped, or master clutch lube tube (16), if so equipped. Disconnect transmission lube tube (5), charge pump supply tube and remote valve supply tube. Unbolt and remove manifold (7) and gaskets (8) along with dual filter assembly (items 10 through 12). Remove transmission hydraulic oil screen (9).

Clean or renew screen and install assembly by reversing removal procedure. Use new gaskets and tighten manifold bolts to 35-42 ft.-lbs. (48-57 N·m) torque. Fill transmission with new Hy-Tran Plus fluid and bleed power steering and brake systems as outlined in paragraphs 25 and 185. Check for leaks.

Models 2390, 2590, 2394 and 2594

251. DUAL FILTERS. To service or renew hydraulic filters on Model 2390,

Paragraphs 252-255

2590, 2394 and 2594 tractors, refer to paragraph 25 in POWER STEERING SYSTEM section.

252. BYPASS RELIEF VALVE. To renew the hydraulic filter bypass relief valve (4—Fig. 252), refer to paragraph 25 in POWER STEERING SYSTEM section.

253. CHARGE SYSTEM PRESSURE REGULATOR. If filters look flattened because of excess pressure in transmission cavity, hydraulic controls feel soft or operate erratically or pressure flow compensated pump makes noise, charge system pressure relief valve (10—Fig. 252) must be renewed.

With dual hydraulic filters removed, unbolt and remove relief valve in bore of transmission above filters. Renew valve and install filter assembly as outlined in paragraph 251.

254. TRANSMISSION OIL SCREEN. To clean or renew transmission oil screen (2—Fig. 253), tractor must be split between torque tube and transmission housing as outlined in paragraph 142. Clean or renew oil screen (2) and reconnect tractor halves using new gasket (3).

REMOTE HYDRAULIC VALVES

All model tractors may be equipped with one to four remote valve circuits, located on the left hand side of the tractor. The following removal, installation and overhaul procedures pertain to a single remote valve circuit. Multiple circuit procedures are identical. See Figs. 254 and 255 for linkage and schematic flow diagram of remote hydraulic valve system. Some models may be equipped with a variable flow control for each remote valve circuit. The control increases or decreases hydraulic flow to the remote couplings from 24 gpm to 3.5 gpm (90.8 to 13.2 L/min.).

255. REMOTE VALVES DETENT RELEASE. Before proceeding with test, disconnect all remote valve control cables at bellcranks on valves and make certain all cables move freely and smoothly, then reconnect control cables to bellcranks. Move stops on control levers away from lever slots to allow levers to move completely forward into float position.

Move each lever to forward detent position, connect a spring scale to lever.

Force required to move lever to float position must be 16 to 18 lbs. (71 to 80 N). If force is not correct, see Fig. 256, loosen locknut on adjustment screw and turn adjustment screw clockwise to increase force; counterclockwise to decrease force. When adjustment is made, tighten locknut. Repeat test and adjustment for each remote lever.

To check and adjust remote lever release pressure, connect inlet hose of flowmeter to bottom breakaway coupling on circuit to be tested. Connect outlet hose of flowmeter to breakaway coupling on same circuit. Run engine at 2100 rpm, and with oil at operating temperature of approximately 120° F (49° C), fully open flow valve on flowmeter. Move remote lever, on circuit being tested, to forward detent position. Turn flow control on circuit being tested fully counterclockwise (maximum flow position). Turn load valve on flowmeter clockwise while observing flowmeter pressure gage, until remote lever on console automatically returns to neutral position. Lever should automatically return to neutral position at 1900 psi (13100 kPa). If lever does not return to neutral at this pressure, loosen small

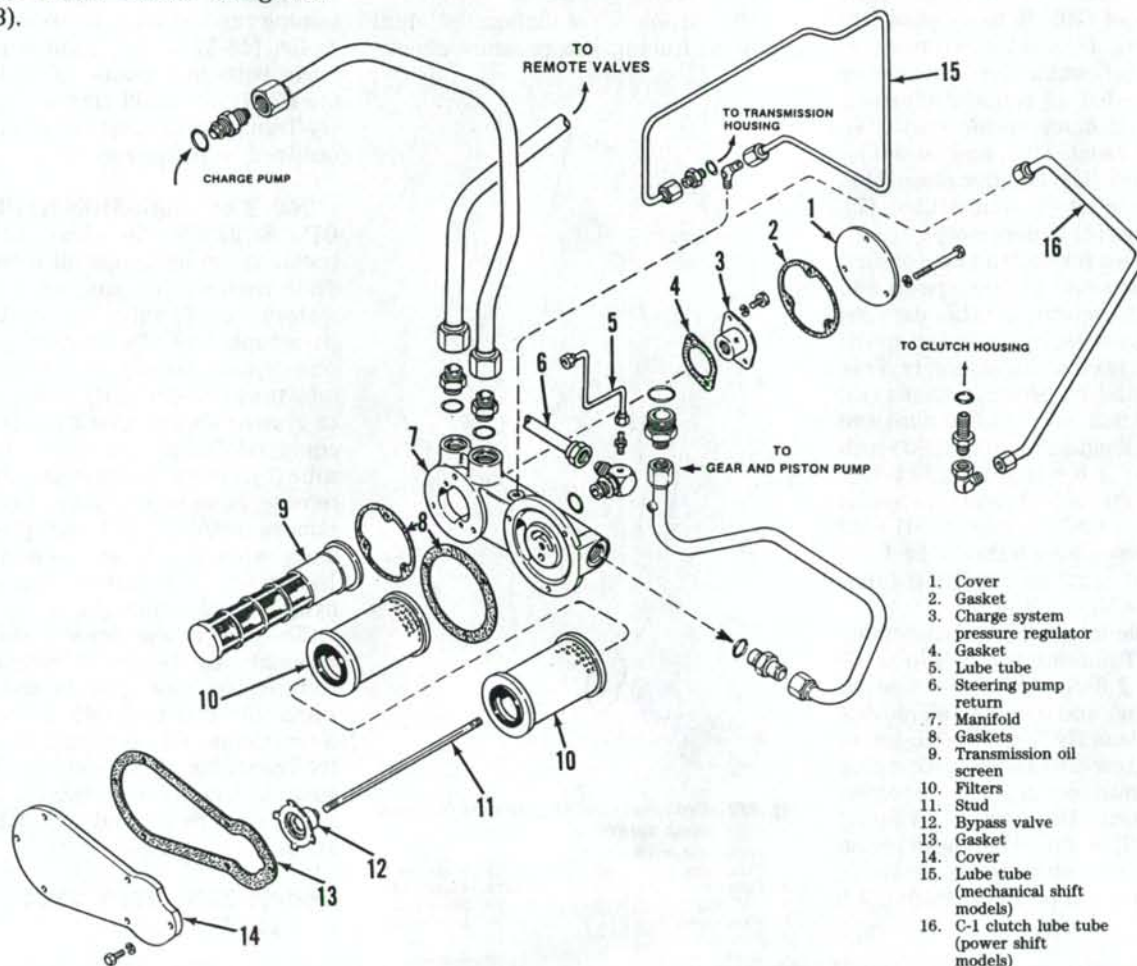


Fig. 251—Schematic and exploded view of hydraulic filter system on Model 2090 and 2290 tractors. Except for cover and gasket (1 and 2) Models 2094 and 2294 are similar.

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Paragraphs 256-258

locknut on adjustment screw (Fig. 257) and turn adjustment screw clockwise to increase return pressure; counterclockwise to decrease return pressure. When correct pressure is obtained, tighten locknut. Repeat test and adjustments, if necessary, on all remote levers.

wise to decrease return pressure. When correct pressure is obtained, tighten locknut. Repeat test and adjustments, if necessary, on all remote levers.

256. REMOTE FLOW CONTROLS.

With all previous pump pressures, valve operations and control adjustments in acceptable conditions, run engine at 2100 rpm, and with oil at operating temperature of approximately 120° F (49° C), turn flow control valve on circuit being tested, fully counterclockwise (maximum flow position). Move and hold remote lever on same circuit to forward detent position. Adjust load valve on flowmeter to 1700 psi (11720 kPa). Flow on flowmeter must not be

less than 20 gpm (75.7 L/min.) for Model 2090, 2290, 2094 and 2294 tractors; 23 gpm (87.1 L/min.) for Model 2390, 2590, 2394 and 2594 tractors. If flow is less than specified, check and/or overhaul remote valve as outlined in paragraph 258.

257. R&R REMOTE VALVE. To remove remote valve, place a container below valve to catch any oil drainage. Disconnect all hydraulic oil tubes from valve. Remove hydraulic tube from pump compensator to remote valve (2—Fig. 255) for valve removal convenience. Disconnect lever control linkage by removing pins (7—Fig. 254) connecting lever cables to spool bellcrank. If equipped, disconnect cables connecting flow control knob (19). Unbolt and remove remote valve.

Install by reversing removal procedure. Use new "O" rings on all hydraulic fittings. Tighten mounting bolts to 18-20 ft.-lbs. (24-27 N·m) torque.

258. OVERHAUL. With valve removed from tractor as outlined in paragraph 257, remove inlet and outlet connectors and "O" rings from inlet cover (5—Fig. 258). Remove compensator inlet fitting (1), "O" ring (2), retainer (3), spring (4) and ball (6). Remove nuts and washers and remove inlet cover (5) from body. Remove the three metal shims (9) and four "O" rings (8) from cover. Remove valve seat (7), if necessary, pushing from outside of cover.

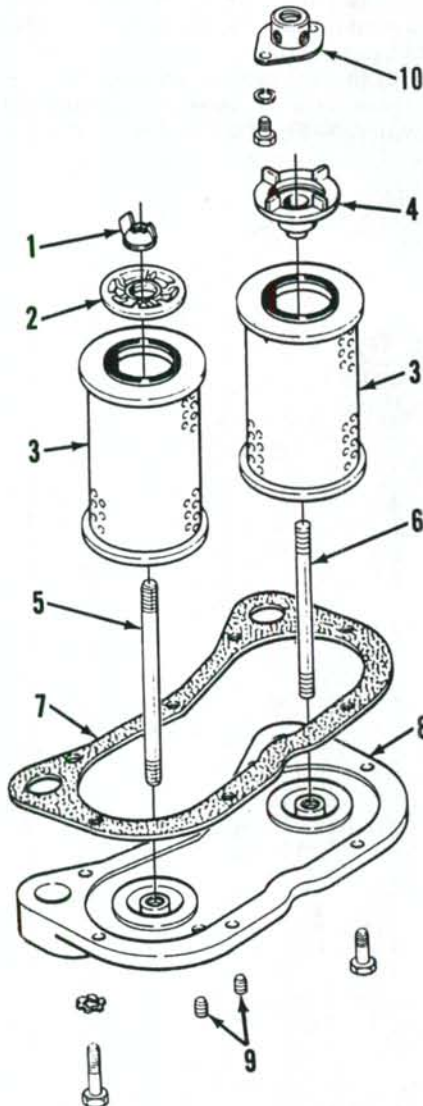


Fig. 252—Exploded view of dual hydraulic system filters on Model 2390, 2590, 2394 and 2594 tractors.

- | | |
|-----------------|--------------------------------------|
| 1. Wing nut | 7. Gasket |
| 2. Washer | 8. Cover |
| 3. Filters | 9. Plugs |
| 4. Bypass valve | 10. Charge system pressure regulator |
| 5. Stud | |
| 6. Stud | |

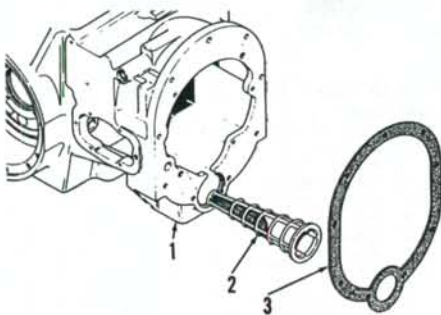


Fig. 253—View of transmission hydraulic oil screen on Model 2390, 2590, 2394 and 2594 tractors.

- | | |
|----------------------|-----------|
| 1. Transmission case | 3. Gasket |
| 2. Oil screen | |

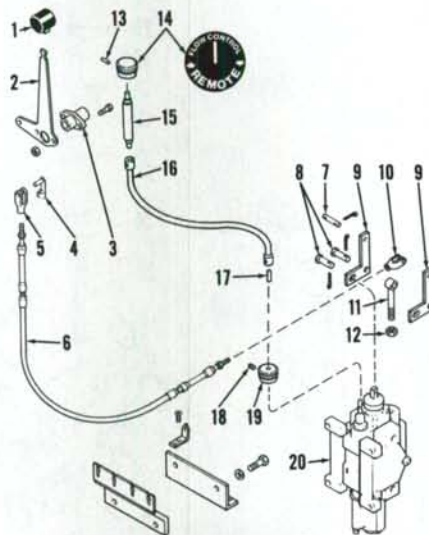
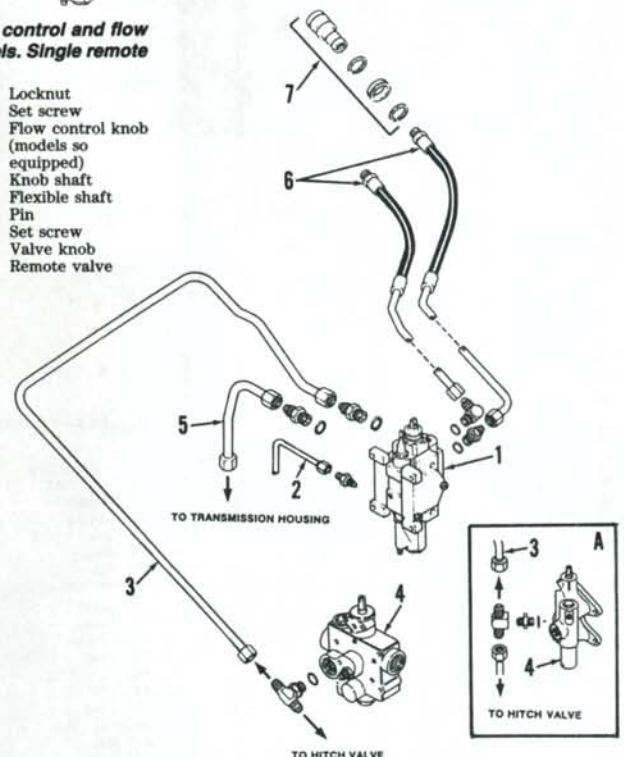


Fig. 254—View of remote valve control and flow control linkage used on all models. Single remote valve shown.

- | | |
|-----------------------|--|
| 1. Knob | 12. Locknut |
| 2. Remote valve lever | 13. Set screw |
| 3. Bearing | 14. Flow control knob (models so equipped) |
| 4. Clip | 15. Knob shaft |
| 5. Yoke | 16. Flexible shaft |
| 6. Cable | 17. Pin |
| 7. Pin | 18. Set screw |
| 8. Pins | 19. Valve knob |
| 9. Bellcrank | 20. Remote valve |
| 10. Yoke | |
| 11. Eyebolt | |

Fig. 255—Schematic view of remote valve hydraulic component parts. Insert "A" is for Model 2390, 2590, 2394 and 2594 tractors. Single remote valve shown.

- | |
|-----------------------------------|
| 1. Remote valve |
| 2. Tube from compensator |
| 3. Remote valve supply tube |
| 4. Regulator/flow divider |
| 5. Return tube |
| 6. Coupling supply & return hoses |
| 7. Coupling |



Paragraph 258 Cont.

NOTE: If multiple remote valves are being overhauled, separate valves and remove shims (9) and "O" rings (8) from between each valve.

Remove end cover (23) and remove shims (9) and "O" rings (8) from end cover. Remove linkage pins (8—Fig. 254) and bellcrank (9) from eyebolt (11). Index eyebolt depth in valve body, loosen locknut (12) and remove eyebolt (11). Unbolt and remove dust cover (36—Fig. 258), retainer (37) and filter (38) from body. If equipped, loosen set screw (18—Fig. 254) and remove flow control knob (19). Remove flow control housing (items 24 through 32—Fig. 258), spool (33) and springs (34 and 35) from body.

Remove set screw (32), roll pin (28) and disassemble flow control housing (items 24 through 31). Index and remove detent plug (70 and 71), spring washers (69), then unbolt and remove detent plug housing (A). Remove the seven detent balls (63) from housing, then push out piston (items 64 through 68), toward outside of housing using a 7/16 x 6 inch (11 x 152 mm) nylon or equivalent rod. Remove ball retainer (62), spring washers (61) and spacer (60) from housing. Remove the two small "O" rings (46) and large "O" ring (49) from housing.

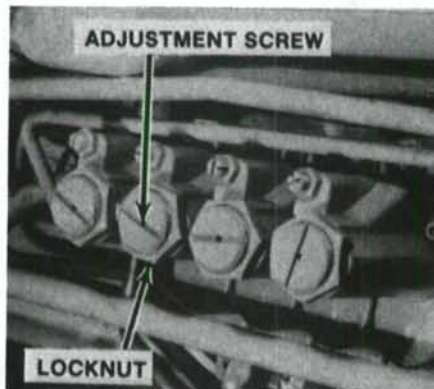


Fig. 256—View of remote valves showing adjustment screws for setting float detent force. Refer to text.

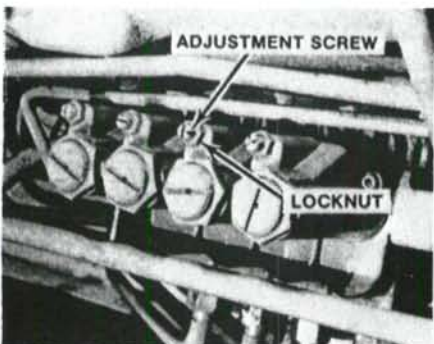


Fig. 257—View of remote valves showing adjustment screw to set neutral return release pressure. Refer to text.

Press on spring retainer (44) and remove shaft detent (59). Keeping spool (39) from turning, place a small punch through hole in coupler (45) and unscrew coupler out of spool (39), removing coupler (45), spring retainers (41 and 44), spring (42) and spacer (43). Remove "O" rings (40) and (22) and slide spool out towards bottom of body.

Remove primary shuttle housing (items 16 through 21). Remove secondary shuttle and ball (items 12 through 15). Remove adjusting screw and locknut (57 and 58), spring (56), pin (55) and poppet (52).

Clean and inspect all parts for excessive wear or other damage. Inspect spool (39—Fig. 258) and bore of valve

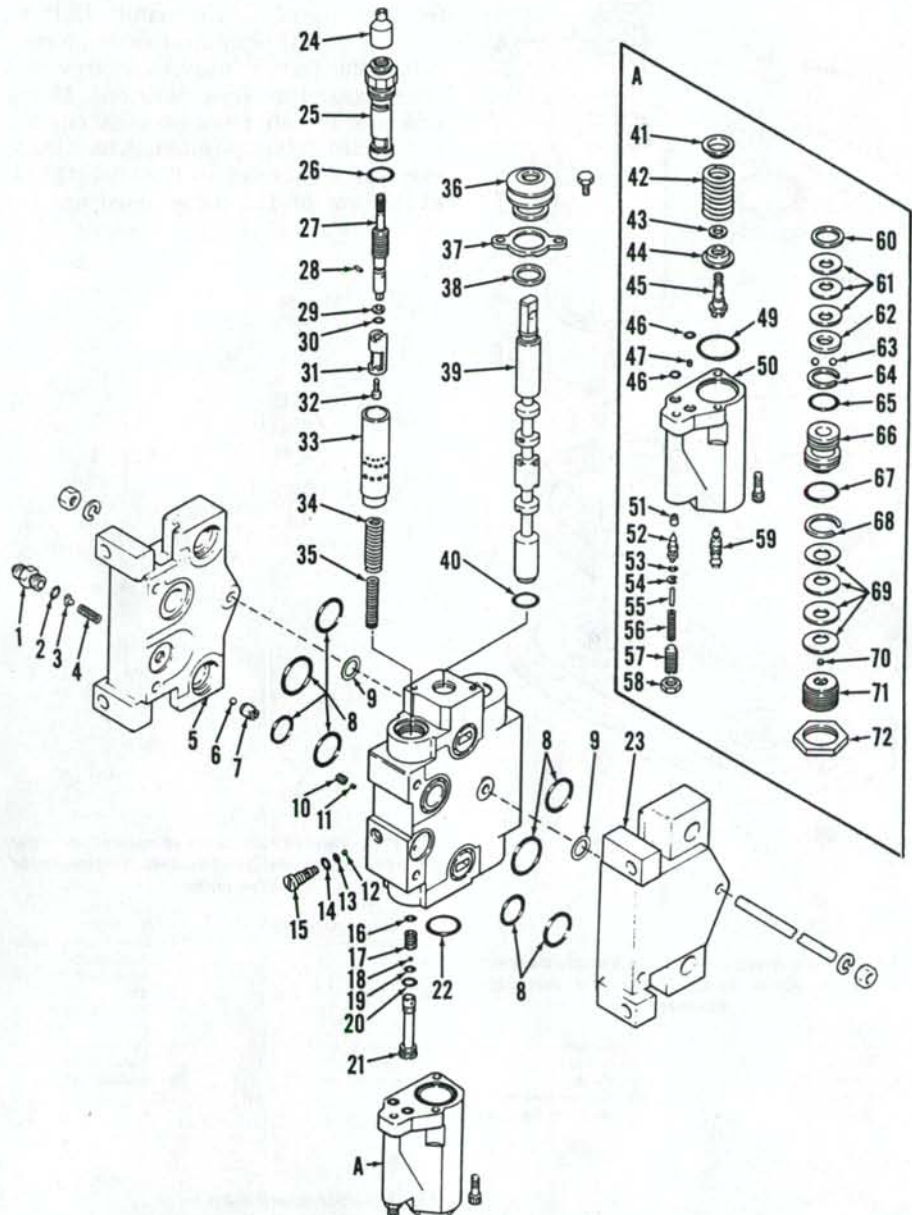


Fig. 258—Exploded view of typical remote valve used on all models. Insert "A" is exploded view of detent housing components.

- | | | | |
|------------------|--------------------------|--------------------|--------------------|
| 1. Inlet fitting | 19. "O" ring | 36. Dust cover | 55. Pin |
| 2. "O" ring | 20. "O" ring | 37. Retainer | 56. Spring |
| 3. Retainer | 21. Housing | 38. Filter | 57. Screw |
| 4. Spring | 22. "O" ring | 39. Valve spool | 58. Locknut |
| 5. Inlet cover | 23. Front cover | 40. "O" ring | 59. Pivot shaft |
| 6. Ball | 24. Dust cover | 41. Retainer | 60. Washer |
| 7. Seat | 25. Flow control housing | 42. Spring | 61. Spring washers |
| 8. "O" rings | 26. "O" ring | 43. Spacer | 62. Ball retainer |
| 9. Shim (3) | 27. Adjusting shaft | 44. Retainer | 63. Balls (7) |
| 10. Plug | 28. Pin | 45. Coupler | 64. Back-up ring |
| 11. Orifice | 29. Teflon ring | 46. "O" ring (2) | 65. "O" ring |
| 12. Ball | 30. "O" ring | 47. Plug | 66. Piston |
| 13. "O" ring | 31. Control tube | 48. "O" ring | 67. "O" ring |
| 14. "O" ring | 32. Screw | 49. "O" ring | 68. Back-up ring |
| 15. Plug | 33. Flow control spool | 50. Detent housing | 69. Spring washers |
| 16. "O" ring | 34. Spring (outer) | 51. Pilot seat | 70. Filter |
| 17. Seat | 35. Spring (inner) | 52. Poppet | 71. Adjusting plug |
| 18. Ball | | 53. "O" ring | 72. Locknut |
| | | 54. Back-up ring | |

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body for wear, scratches, scoring or nicks and burrs. If damage is present, spool and valve body are not available separately. Renew other parts as necessary. Use new "O" rings, seals and filter (38) upon reassembly. Lubricate "O" rings with petroleum jelly and all moving parts with clean hydraulic oil.

Reassemble by reversing disassembly procedure, paying attention to the following: Tighten primary shuttle housing in valve body to 3-6 ft.-lbs. (4-8 N·m) torque. Free length of centering spring (42) is 2.50 inches (63.50 mm) and compressed length is 1.375 inches (34.925 mm) at 18-22 lbs. (80-98 N). Use Loctite 271 or equivalent on detent pivot coupling (45) and tighten to 6-10 ft.-lbs. (8-14 N·m) torque. Tighten detent housing to valve body cap screws to 6-10 ft.-lbs. (8-14 N·m) torque. Install hardened washer (60) over detent pivot shaft. Install a spring washer (61), concave side against hardened washer (60), then second spring washer with convex side against first washer and third spring washer with concave side against second spring washer. See Fig. 259. Install ball retainer (62—Fig. 258), flat side against spring washer and install the seven balls (63) on retainer (62). Install piston (66) with new rings (64, 65, 67 and 68).

NOTE: Teflon rings (64 and 68) must be on outside ends of piston.

Concave surface of piston (66) must seat against detent balls. Install concave springs (69) with first spring concave surface against piston, then alternating as previously described and referring to Fig. 259. Install indexed detent plug and locknut (70, 71 and 72—Fig. 258). Install poppet assembly (items 51 through 58). Poppet spring free length is 1.050 inch (26.670 mm) and compressed length should be 1.000 inch (25.40 mm) at 8.5 to 10.5 lbs. (38-47 N).

NOTE: Preload on relief poppet will have to be adjusted for neutral return of control lever as outlined in paragraph 255.

Install and tighten shuttle seat assembly (items 12 through 15) to 3-5 ft.-lbs. (4-7 N·m) torque.

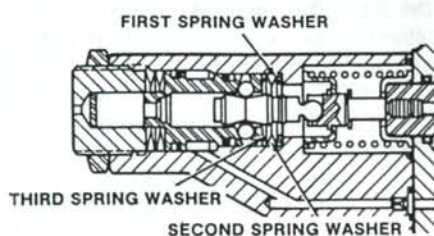


Fig. 259—Cross-sectional view of detent housing showing spring washer placement. Refer to text.

Install "O" ring and Teflon seal on flow adjusting shaft (27) with Teflon seal toward top of shaft. Lubricate rings with petroleum jelly and install shaft with screw hole end into threaded end of housing (25). Align roll pin hole of shaft with center of top slot in housing. Install pin (28) until it bottoms. Shaft must turn freely from stop to stop without pin hitting side wall of housing. Remove pin if it hits side, rotate shaft one turn and reinstall and center pin. Turn shaft counterclockwise until pin hits housing, install flow control tube (31) in housing, flat groove end first, and align groove with matched flats of adjusting shaft. See Fig. 260.

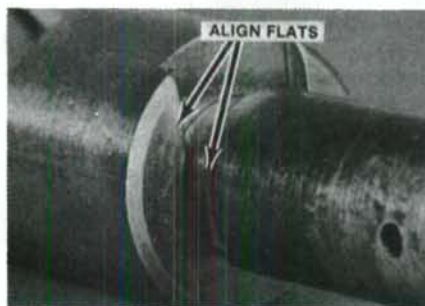


Fig. 260—View of flow control adjusting shaft showing proper alignment of flats on shafts. Refer to text.

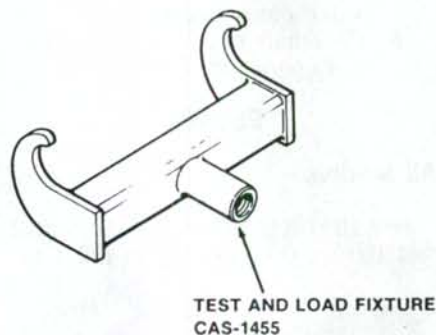
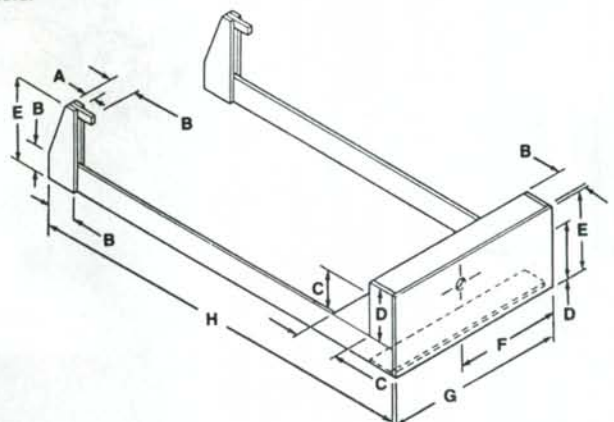


Fig. 261—Illustration of CAS-1455 load test fixture used for hydraulic hitch tests on Model 2090, 2290, 2094 and 2294 tractors.

Fig. 262—Test fixture for Models 2390, 2590, 2394 and 2594 can be fabricated from 5/16 inch (7.94 mm) flat stock using dimensions listed. Weld all seams inside and outside with a minimum of 1/4 inch (6.35 mm) fillet weld.

- A. 1.0 in. (25.4 mm)
- B. 2.5 in. (63.5 mm)
- C. 4.0 in. (101.6 mm)
- D. 5.5 in. (139.7 mm)
- E. 8.0 in. (203.2 mm)
- F. 10.5 in. (266.7 mm)
- G. 18.0 in. (457.2 mm)
- H. 39.0 in. (990.6 mm)



Paragraph 258 Cont.

NOTE: It is possible to install flow control tube in housing 180 degrees out. The opening in the flow control tube must be aligned with opening in shaft housing.

Use Loctite 271 or equivalent on cap screw (32—Fig. 258), install and tighten to 6-10 ft.-lbs. (8-14 N·m) torque while securing shaft in a vise to prevent bending roll pin. Outer flow control spring (34) free length is 2.401 inches (60.985 mm) and compressed length should be 1.01 inches (25.654 mm) at 30.6 to 34.9 lbs. (136-155 N). Inner flow control spring (35) free length is 2.218 inches (56.337 mm) and compressed length should be 1.01 inches (25.654 mm) at 15.6 to 18 lbs. (70-80 N). Install flow control spool, small end first into valve body. Install flow control assembly and tighten to 18-22 ft.-lbs. (24-30 N·m) torque. Balance of reassembly is reverse of disassembly.

HYDRAULIC HITCH SYSTEM

All tractors may be equipped with a hydraulic 3-point hitch system. Model 2090, 2290, 2094 and 2294 tractors are equipped with a single cylinder operated rockshaft arm, see Fig. 278 or 279; Model 2390, 2590, 2394 and 2594 tractors are equipped with a dual cylinder operated rockshaft arm, see Fig. 280. Hydraulic hitch systems on all models receive hydraulic power from the piston type pump after passing through the regulator/flow divider valve. All models so equipped have both position and sensing controls. The hitch position control is used to lift and lower implements and to select the working depth of soil entering implements. The sensing control is used to find sensitivity of implements control of load or draft on implement due to keep implement at a constant working depth through variable field conditions.

Paragraphs 259-260

CASE/INTERNATIONAL

TROUBLESHOOTING
HITCH SYSTEM

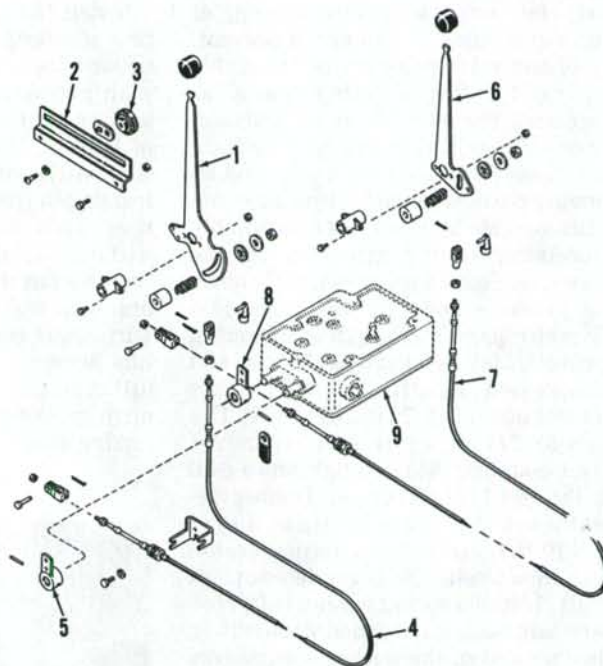
All Models

259. The following are symptoms which may occur during operation of hydraulic hitch system. By using this information in conjunction with the Adjustment, R&R and Overhaul information, no trouble should be encountered in servicing the hydraulic hitch system.

1. Draft arms will raise and lower but sensing does not work.
 - A. Operating procedure incorrect (see Operators Manual).
 - B. Incorrect tire pressure.
 - C. Draft arm height adjustment incorrect.
 - D. Incorrect amount of front or wheel weights installed.
 - E. Sensing linkage not adjusted correctly.
 - F. Draft spring tension incorrect.
2. Draft arms will raise but do not cancel.
 - A. Valve lockout linkage incorrectly adjusted.
 - B. Follow-up linkage incorrectly adjusted.
3. Oscillation of draft arms with engine running or draft arms lower when engine is stopped.
 - A. Hitch control valve or rockshaft cylinder not operating correctly.
4. Draft arms will not raise.
 - A. Tractor hydraulic system not operating correctly.
 - B. Hitch control cables disconnected or incorrectly adjusted.
 - C. Hitch control valve lowering piston not operating correctly.

Fig. 264—View of hydraulic hitch position and draft sensing control linkage used on all models.

1. Position control hand lever
2. Quadrant
3. Quadrant stop knob
4. Cable
5. Position control valve lever
6. Draft sensing hand lever
7. Cable
8. Sensing control valve lever
9. Draft control housing



- D. Rockshaft piston and cylinder not operating correctly.
5. Draft arms will not lower.
 - A. Hitch control cables disconnected or incorrectly adjusted.
 - B. Hitch control valve spool control linkage broken or disconnected.
 - C. Rockshaft cylinder(s) or hitch control valve not operating correctly.
 - D. Lowering piston of hitch control valve not operating correctly.
 - E. Rockshaft piston and cylinder not operating correctly.

TESTING

All Models

260. **HITCH SYSTEM CHECK.** Install test fixture (Fig. 261) (CAS-1455) for

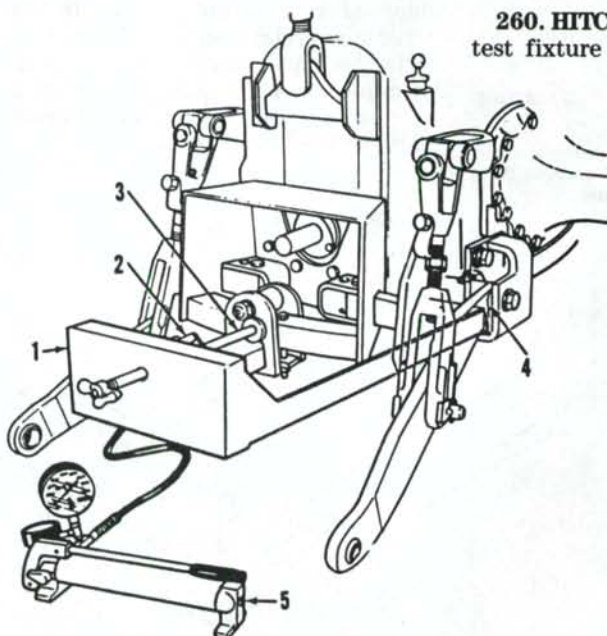


Fig. 263—Test fixture for Model 2390, 2590, 2394 and 2594 tractors mounts under crossbar and pulls rearward, stretching wishbone springs. Pressure gage is No. CAS-10117.

Model 2090, 2290, 2094 and 2294 tractors or test fixture shown in Figs. 262 and 263 for Model 2390, 2590, 2394 and 2594 tractors. Install an Owatonna 17-1/2 ton (158.7 Mg) ram and 0-3000 psi (0-20625 kPa) pressure gage (CAS-10117) to testing fixture. Lower draft arms and pull sensing lever (6—Fig. 264) to rear for maximum sensing position. Start engine and pull hitch lever (1) toward rear until draft arms just start to raise. At the moment the draft arms move up, hitch lever (1) should be near center position on console between full raise and full lower. Slowly pull hitch lever (1) to rear; lever and draft arms should reach full raise position simultaneously. If not, adjust hitch lever cable (4) length (paragraph 267) until correct operation is obtained.

To check pounds of pull needed to operate the sensing mechanism of the hitch, use test fixtures to pull sensing cross shaft to rear.

NOTE: Model 2090, 2290, 2094 and 2294 tractors have an 800-1000 lbs. (3559-4448 N) spring preload that will need 1000-1200 lbs. (4448-5338 N) of pull to actuate hitch; Model 2390, 2590, 2394 and 2594 tractors have a 1300-1500 lbs. (5783-6672 N) spring preload that will need 1500-1700 lbs. (6672-7562 N) of pull to actuate the hitch. Using the Owatonna 17-1/2 ton (158.7 Mg) ram, 900 lbs. (4003 N) of pull is equal to 255 psi (1758 kPa) on gage for Models 2090, 2290, 2094 and 2294; 1400 lbs. (6228 N) of pull is equal to 390 psi (2689 kPa) on gage on Models 2390, 2590, 2394 and 2594.

Start engine, lower draft arms and put sensing lever to maximum sensing position. Slowly pull the hitch lever to rear until draft arms just start to raise. With

SERVICE MANUAL

Paragraphs 261-263

sensing cross shaft pulled to rear with fixture, hitch must sense between 227-283 psi (1565-1592 kPa) for Model 2090, 2290, 2094 and 2294 tractors or 365-420 psi (2517-2895 kPa) for Model 2390, 2590, 2394 and 2594 tractors. If draft arms raise slightly then stop, increase tension on sensing crossbar using fixture. Draft arms must raise slightly and stop each time pressure is increased. When pressure is released, draft arms must lower. If specified pressures did not obtain acceptable operation, sensing linkage will have to be adjusted as outlined in paragraph 263.

ADJUSTMENTS

Models 2090, 2290, 2094 and 2294

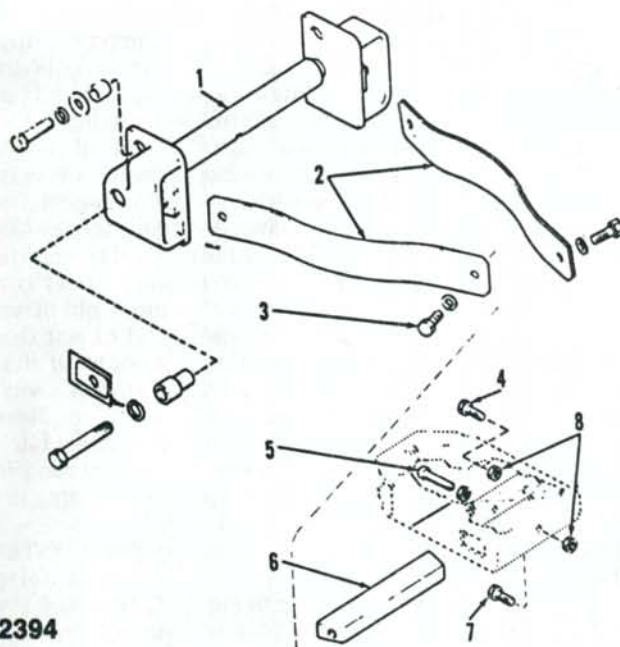
261. SENSING SPRING PRELOAD.

Set correct tire pressures. Lower draft arms fully. Distance from ground to center of draft arm balls should be 8 inches (203.2 mm). Adjust if necessary by turning turnbuckle(s) on lifting links. Remove drawbar. Loosen nuts on both spring adjusting eyebolts (4—Fig. 265) or U-bolts (4A). With test fixture (CAS-1455), hydraulic ram assembly and gage installed, operate ram until 255 psi (1785 kPa) registers on gage. On Models 2090 and 2290, pull eyebolts rearward until they contact cross bar; tighten outer nut (2), then tighten inner nut (3) to 120-150 ft.-lbs. (163-203 N·m) torque while maintaining 255 psi (1758 kPa) reading on gage.

On Models 2094 and 2294, pull U-bolts (4A) rearward until they contact cross shaft (1). Tighten flange nuts evenly until U-bolts are snug against cross shaft. Then, tighten locknuts on each U-bolt to a torque of 200-250 ft.-lbs. (271-339 N·m) while maintaining 255 psi (1758 kPa) reading on gage.

Fig. 266—Exploded view of wishbone spring mounting brackets and adjusting screws used on Model 2390, 2590, 2394 and 2594 tractors.

1. Crossbar
2. Wishbone springs
3. Mounting bolts (2)
4. Outer bolt (2)
5. Set screw
6. Spring bar
7. Lock bolt
8. Locknuts (4)



Models 2390, 2590, 2394 and 2594

262. SENSING SPRING PRELOAD.

Set correct tire pressures. Lower draft arms fully. Distance from ground to center of draft arm balls should be 8 inches (203.2 mm). Adjust if necessary by turning turnbuckle (3) on lifting links. Loosen all lock bolts in drawbar bracket (see Fig. 266). Tighten wishbone spring to spring bar bolts (3) to 580-696 ft.-lbs. (787-944 N) torque. With testing fixture, Owatonna 17-1/2 ton (158.7 Mg) ram and 0-3000 psi (0-20625 kPa) pressure gage (CAS-10117) installed as outlined in paragraph 260, turn set screw (5—Fig. 266) against spring bar (6) until cross plate (1) is against axle housing stop. Loosen set screw (5) until a 0.005 inch (0.127 mm) clearance is obtained between cross shaft plate and axle housing stop. Correct sensing spring preload is 1300-1500 lbs. (5783-6672 N) which registers as 390 psi (2689 kPa) on

pressure gage. Adjust set screw (5) with 390 psi (2689 kPa) pressure applied to fixture until 0.005 inch (0.127 mm) clearance between cross shaft plate and axle housing stop is obtained. Turn outer lock bolts (4) until finger tight, then tighten locknuts. Turn center lock bolt (7) until finger tight and tighten locknut. Tighten center set screw locknut.

All Models

263. SENSING LINKAGE. Place sensing control hand lever in maximum sensing position. Drain oil from cover of draft control housing which should be approximately 1 gallon (3.78 L), then remove cover and adjust set screw on sensing shaft (1—Fig. 277) until signal amplifier link in draft housing is parallel with front of draft control housing. See Fig. 267.

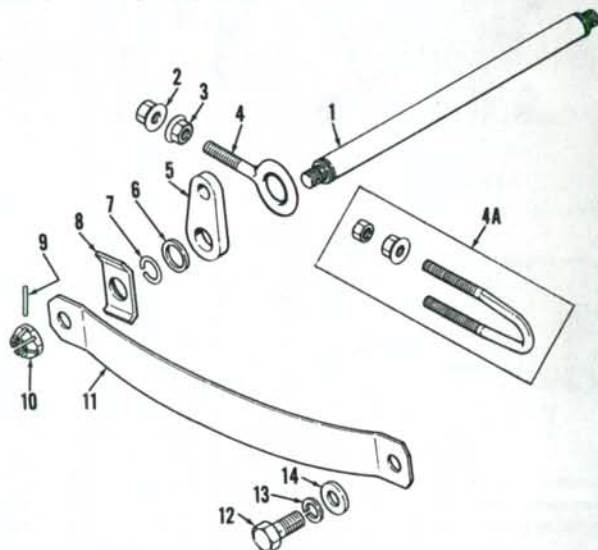


Fig. 265—Exploded view of sensing spring mounting brackets and adjusting eyebolt used on Model 2090 and 2290 tractors. One half shown. Models 2094 and 2294 are similar except U-bolts (4A) are used in place of eyebolts.

1. Cross shaft
2. Adjusting nut
3. Locknut
4. Eyebolt
- 4A. U-bolt
5. Link
6. Washer
7. Snap ring
8. Spacer
9. Pin
10. Nut
11. Sensing spring
12. Bolt
13. Lockwasher
14. Spacer

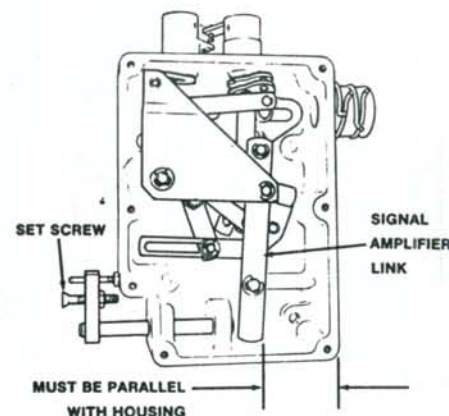


Fig. 267—With sensing lever in maximum position, adjust set screw to place signal amplifier arm parallel to front edge of box.

Paragraphs 264-266

264. DRAFT ARM FULL RAISE. To adjust the draft arm full raise position, place sensing hand control to full sensing position, disconnect the hitch control cable (4—Fig. 264) from control lever (1) on draft control console. Refer to Fig. 268 and make certain timing marks on follow-up cam align with timing mark on housing. If timing marks do not align, follow-up linkage inside transmission housing must be adjusted by first removing pto assembly as outlined in paragraph 202 or 220. On Model 2090 and 2290 tractors check position on sensing linkage follow-up lever and adjust if necessary so that yoke pin hole is 6.56 inches (166.62 mm) from end of transmission case (see Fig. 269). Disconnect lower cable yoke from follow-up lever and adjust follow-up lever until timing marks in draft control housing align and reconnect cable.

On Models 2094 and 2294, refer to Fig. 270 and loosen jam nuts on adjusting rod for the follow-up lever. Disconnect lower rod bearing from outer sensing lever. Move outer sensing lever until timing marks on follow-up cam and draft control housing are aligned. Adjust lower rod bearing on adjusting rod as required and reconnect to outer sensing lever.

On Model 2390, 2590, 2394 and 2594 tractors refer to Fig. 271 and check length of lower follow-up rod. Length must be 8.5 inches (215.9 mm) from

center to center of rod ends. Disconnect and adjust upper rod length until timing marks in draft control housing align. Tighten all jam nuts. Reinstall pto assembly.

On all models, start engine, raising draft arms to fully raised position, then stop engine. Draft arms must have 1-1/2 to 2 inches (38-51 mm) additional upward travel when lifted by hand. If not, turn offset trunnion (see Fig. 272) to move pin of valve lockout link toward end of slot (rearward) to increase the amount of draft arm travel; or move trunnion away from end of slot (forward) to decrease draft arm travel. Reconnect hitch control cable to control lever on console and reinstall draft control housing cover.

265. CONTROL SPOOL STROKE. To adjust control spool stroke, refer to Figs. 273 and 274, start engine and raise draft arms fully, then lower arms about 3/4 the way downward and stop engine. On models without cover cap screw (19—Fig. 273), remove spring cover (15) and using a depth micrometer, measure length of valve spool from end of spool to flange of valve body and record measurement (see Fig. 274). Start engine, move hitch control lever slowly toward raise position until draft arms just start to raise, then stop arm movement and stop engine. Remeasure spool length. Subtract first measurement from

second measurement. Difference should be 0.007-0.015 inch (0.178-0.381 mm). If specifications are not correct, support draft arms in raise position, remove cover (30—Fig. 276), and remove lowering piston assembly (25 through 29). Refer to Fig. 275 and adjust lowering piston screw (25—Fig. 276) to increase or decrease lowering spool travel.

266. On models with control spool cover equipped with cap screw (see insert Fig. 273), start engine. Fully raise draft arms, then lower them to center position. Remove cap screw (19) from spool cover, install a 1/4-20 x 3 inch full thread bolt until it just contacts the valve spool. Set up a dial indicator on the bolt installed, preload and then zero indicator. Turn bolt clockwise until draft arms just start to lower and record reading on dial indicator. Readjust dial indicator to zero and move hitch control hand lever one inch (25.4 mm) toward raise position. Turn installed bolt counterclockwise until draft arms just start to raise and record reading on dial indicator. Subtract first reading from second. Difference must not be more than 0.007-0.015 inch (0.178-0.381 mm). If specifications are not correct, adjust lowering piston screw (25—Fig. 276) as previously outlined in paragraph 265. Recheck and adjust as necessary until correct control spool travel is obtained. On models with cap screw in spool



Fig. 268—Timing marks in linkage box should align as shown. Refer to text.

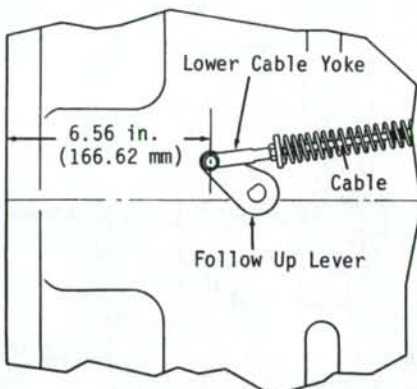


Fig. 269—Set follow-up lever to dimension shown to correctly adjust cable length on Models 2090 and 2290 tractors.

Fig. 270—View showing sensing linkage on Models 2094 and 2294.

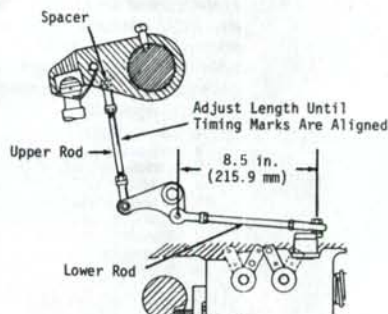
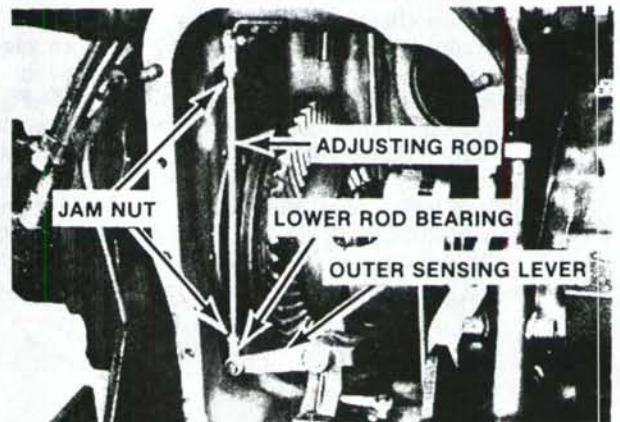


Fig. 271—Horizontal rod center-to-center length must be 8-1/2 inches (215.9 mm), then vertical rod must be adjusted to align timing marks, as shown in Fig. 268.

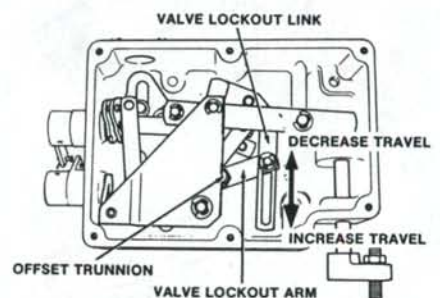


Fig. 272—Adjust eccentric nut to change upper limit of draft arm height. Refer to text for procedure.

SERVICE MANUAL

Paragraphs 267-270

cover, renew seal (18—Fig. 273) upon reassembly.

267. CONTROL CABLES. Put hitch control hand lever (1—Fig. 264) to full raise position. Disconnect clevis pin at draft housing control lever (5). With control lever (5) in full raise position (fully counterclockwise), adjust cable length until clevis pin hole in cable aligns with control lever (5). Install cotter pins and tighten jam nuts.

To adjust draft cable, lower draft arms fully, disconnect sensing cable clevis pin from draft control housing lever (8). Turn draft lever (8) counterclockwise against the stop, put sensing hand control lever (6) in fully forward position and adjust cable (7) length until clevis pin hole aligns with draft control lever (8). Install clevis pin, cotter pins and tighten jam nuts.

268. LEVER FRICTION DISCS. Refer to Fig. 264 and tighten locknut on hitch control lever (1) disc until an ef-

fort of 12-15 ft.-lbs. (56-67 N) of force is needed to move lever. Tighten locknut on draft control lever (6) disc until an effort of 3-7 lbs. (13-31 N) of force is needed to move lever.

HITCH CONTROL VALVE

All Models

269. REMOVE AND REINSTALL. Refer to Fig. 273, drain transmission oil, disconnect all hydraulic tubes from manifold (5) and valve (13). Remove clamps (10) and tube (11) and disconnect spool from valve to draft control housing. Unbolt manifold (5) and separate from hitch valve body (13).

Reinstall by reversing removal procedure. Use new "O" rings (12) between manifold and valve. Check oil return ball and seat for dirt and free action. Tighten valve to manifold cap screws to 17-20 ft.-lbs. (23-27 N·m) torque. Use new gasket (4). Tighten control valve and manifold mounting cap screws to 35-42 ft.-lbs. (48-57 N·m) torque. Use new "O" rings on hydraulic fittings. Fill transmission with new Hy-Tran Plus fluid.

270. OVERHAUL CONTROL VALVE. With control valve removed and separated from manifold, disassembly of valve will be obvious after removal of spool cover (15 and 17—Fig. 273) and examination of unit and referral to exploded view of valve in Fig. 276.

Clean and inspect all parts for scratches, burrs or other damage. Spool (8) and body (1) are not serviced separately. Use new "O" rings and seals upon assembly. Free length of spool return spring should be 6.36 inches (161.5 mm) and a compressed length of 4.05 inches (102.9 mm) at 13.5-16.5 lbs. (60-73 N). Lowering poppet piston spring (29) free length is 1.90 inches (48.26 mm) with a compressed length of 1.63 inches (41.4 mm) at 31-39 lbs. (138-174 N). Load check spring (14) free length is 1.25 inches (31.8 mm) with a compressed length of 0.750 inch (19.1 mm) at 7.7-9.4 lbs. (34-42 N). Ball return spring (17) free length is 0.654 inch (16.6 mm) with a compressed length of 0.450 inch (11.4 mm) at 1.1-1.4 lbs. (5-6 N). Lubricate all moving parts with clean Hy-Tran Plus fluid upon reassembly. Check and adjust control spool travel as outlined in paragraph 265.

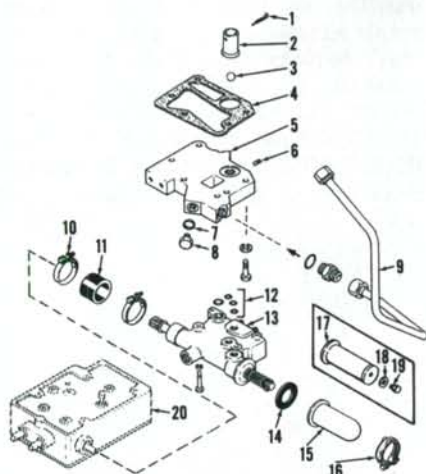


Fig. 273—Exploded and schematic view of hydraulic hitch control valve and related components.

- | | |
|---------------|-------------------|
| 1. Cotter pin | 11. Hose |
| 2. Tube | 12. "O" ring |
| 3. Ball | 13. Control valve |
| 4. Gasket | 14. Gasket |
| 5. Manifold | 15. Cover |
| 6. Plug | 16. Clamp |
| 7. "O" ring | 17. Cover |
| 8. Plug | 18. Washer |
| 9. Oil tube | 19. Bolt |
| 10. Clamp | |

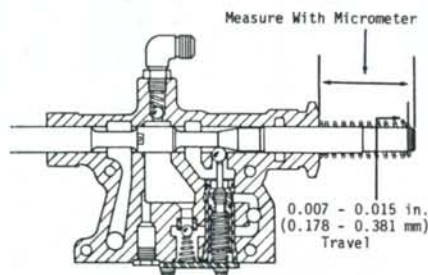


Fig. 274—Measure control valve spool travel with an accurate instrument as shown. Remove lower cover and lowering piston to measure overall length. Refer to text for procedure and Fig. 275 for dimensions.

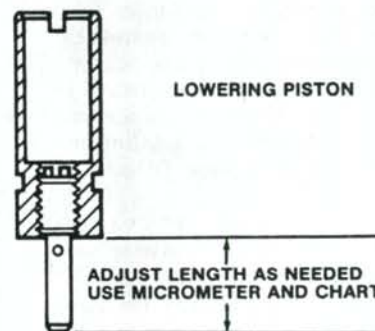
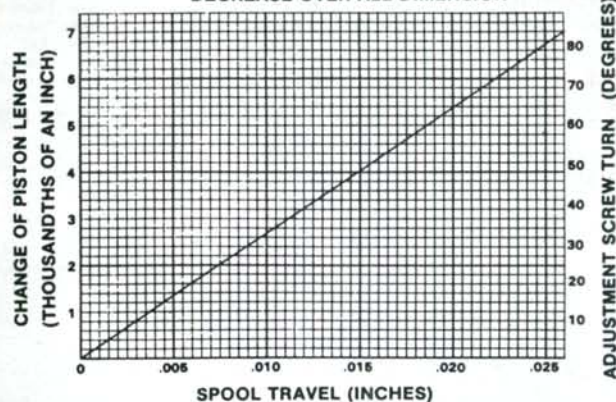


Fig. 275—Illustration and graph showing correct adjustment length of lower piston. Refer to text for procedure.

IF SPOOL STROKE IS TOO LONG
INCREASE OVER ALL DIMENSION

IF SPOOL STROKE IS TOO SHORT
DECREASE OVER ALL DIMENSION



Paragraphs 271-272

CASE/INTERNATIONAL

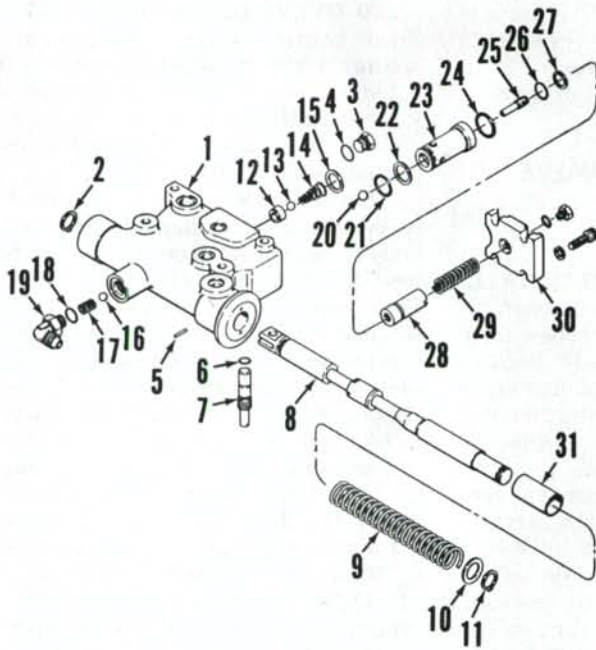


Fig. 276—Exploded view of hitch control valve used on all models.

1. Valve body
2. Snap ring
3. Plug
4. "O" ring
5. Pin
6. "O" ring
7. Throttle screw
8. Control spool
9. Spring
10. Washer
11. Snap ring
12. Seat
13. Ball
14. Spring
15. Seal ring
16. Ball
17. Spring
18. "O" ring
19. Connector
20. Ball
21. "O" ring
22. Back-up washer
23. Sleeve
24. "O" ring
25. Adjusting screw
26. Back-up ring
27. "O" ring
28. Piston
29. Spring
30. Cover
31. Spacer

All Models

271. OVERHAUL LOWER SENSING LINKAGE. Figure 277 shows relative positions of sensing linkage in linkage box. Approximately 1 gallon (3.78 L) of fluid is contained in box. To drain box, remove plug in bottom cover, then remove cover for access to linkage. Most of the linkage can be examined for damage or wear without removal. Disassemble only far enough to renew damaged parts. Valve lockout arm (7) should not have excessive clearance on eccentric pivot nut (9). Cam follower roller (14) should be a good fit on its pivot pin.

For ease of disassembly, remove retaining clip from pin (12) in valve spool end (11). Spring on control valve spool will pull spool end forward and release tension on linkage. Retaining clips on studs and links can then be removed as necessary. Seals (2) should be renewed if leaking, or when shafts are removed. Install seals flush, with lips to inside of box.

When reassembling, be sure linkage is free from binding and does not interfere with free movement of other linkage. Refer to paragraphs 263 and 264 for adjustment procedure before bottom cover is reinstalled.

ROCKSHAFT AND CYLINDER

Models 2090 and 2290

272. R&R AND OVERHAUL. To gain access to hydraulic hitch rockshaft and work cylinder assembly, first disconnect lift links from upper lift arm (2—Fig. 278), then remove pto assembly as

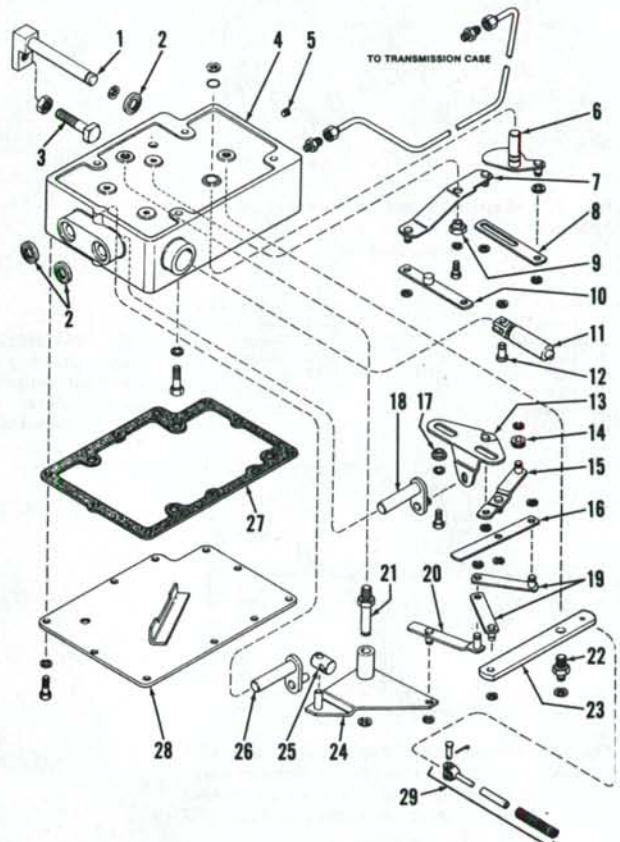
outlined in paragraph 202. Remove rear pto shaft. Disconnect draft sensing follow-up cable link (insert A) from rockshaft (5). Remove snap rings (1 and 13) from rockshaft ends. Note timing marks on rockshaft ends and lift arms (2) and remove lift arms. Remove set screws (6) from power arm (7), unbolt

and remove retainer (10), then drive rockshaft out toward left of transmission housing and remove power arm (7). Remove piston rod from piston, then remove snap ring (15) and remove piston and cylinder liner (items 16 through 23) from transmission cavity.

Clean and inspect all parts for excessive wear, scoring, scratches or other damage and renew as necessary. If renewing bushings (4 and 11—Fig. 278), small ID 2.379-2.382 inch (60.427-60.503 mm) bushing (11) installs in right side of transmission housing; large ID 2.754-2.758 inch (69.952-70.053 mm) bushing (4) installs in left side of transmission housing. Install new "O" ring (19) on piston (16) and the two back-up rings (18 and 20) with concave sides toward "O" ring (19). Install new wear rings (17 and 21) on piston. Use new "O" ring (23) and install cylinder liner (22), small OD first, into transmission cavity, and secure with snap ring (15). Install new seals (3 and 12) with lips toward inside. Reinstall rockshaft (5), small end first, through left side bushing. Make certain all timing marks align on power arm (7) to rockshaft and lift arms (2) and rockshaft. Reinstall draft sensing follow-up cable and adjust as outlined in ADJUSTMENTS paragraphs of HYDRAULIC HITCH SYSTEM if necessary. Balance of reassembly is reverse of removal.

Fig. 277—Exploded view of sensing linkage in linkage box.

1. Sensing shaft
2. Seals
3. Adjusting screw
4. Linkage box
5. Plug
6. Follow-up cam
7. Valve lockout arm
8. Valve lockout link
9. Eccentric pivot nut
10. Valve spool link
11. Valve spool end
12. Pin
13. Manual lever slide
14. Cam follower roller
15. Cam follower link
16. Pivot link
17. Slide trunnion
18. Manual shaft
19. Pivot block
20. Sensing pivot link
21. Stud
22. Link pivot stud
23. Amplifier arm
24. Sensing arm link
25. Pivot block
26. Sensing arm shaft
27. Gasket
28. Cover
29. Yoke, guide & spring



SERVICE MANUAL

Paragraphs 273-274

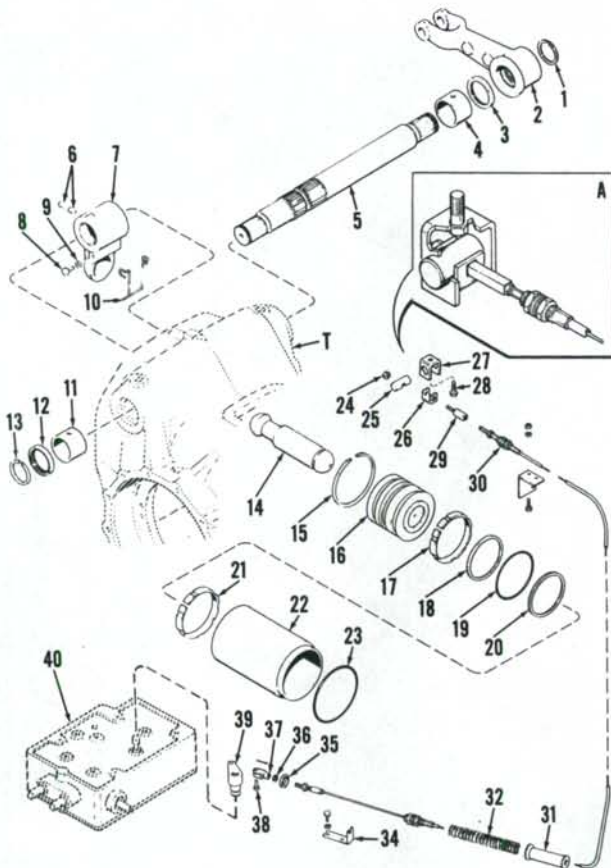


Fig. 278—Exploded view of rockshaft and associated parts contained within transmission housing on Model 2090 and 2290 tractors.

1. Snap ring
2. Lift arm
3. Seal
4. Bushing
5. Rockshaft
6. Set screws
7. Power arm
8. Bolt
9. Washer
10. Retainer
11. Bushing
12. Seal
13. Snap ring
14. Piston rod
15. Snap ring
16. Piston
17. Wear ring
18. Back-up ring
19. "O" ring
20. Back-up ring
21. Wear ring
22. Cylinder liner
23. "O" ring
24. Adjusting nut
25. Swivel pin
26. Clip
27. Clip
28. Lock bolt
29. Adjusting end
30. Sensing cable
31. Guide
32. Spring
33. Bracket
34. Washer
35. Jam nut
36. Pin
37. Yoke
38. Sensing lever
39. Sensing lever
40. Draft sensing assy.

and 21) on piston. Use new "O" ring (23) and install cylinder liner (22), small ID first, into transmission cavity and secure with snap ring (15). Install new seals (3 and 12) with lips toward inside. Reinstall rockshaft (5), small end first, through left side bushing. Make certain all timing marks align on power arm (7) to rockshaft and lifter arms (2) to rockshaft. Reinstall draft sensing linkage and adjust as outlined in ADJUSTMENTS paragraphs of HYDRAULIC HITCH SYSTEM if necessary. Balance of reassembly is reverse of removal procedure.

Models 2390, 2590, 2394 and 2594

274. R&R AND OVERHAUL ROCK-SHAFT CYLINDERS. Figure 280 shows parts encased inside rear of transmission housing. Drain fluid from transmission and final drive. Cylinder caps (20) and pressure lines can be removed separately, from the bottom. A drain pan should be placed under cap to catch residual fluid. With cap off, cylinder liner (16) with piston (12), wear rings (13 and 15) and "U" cap seal (14) can be removed out the bottom of housing. Push-rod (11) will stay up inside housing, since clip (10) will retain it in power arm (9). Piston can be removed from cylinder liner after liner is removed. Check all parts for wear or scoring and renew any parts in question. Renew "O" rings, wear rings and "U" cup seals, making sure open part of "U" on seal is installed on piston facing downward. In-

Models 2094 and 2294

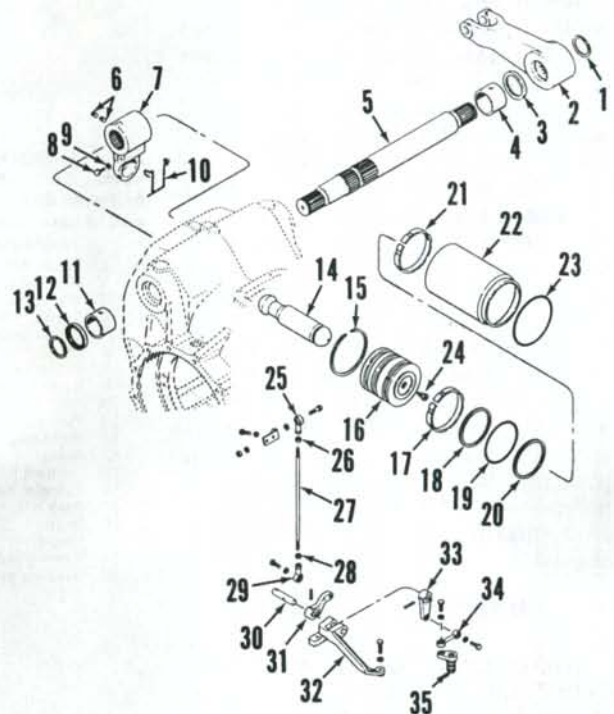
273. R&R AND OVERHAUL. To remove the hydraulic hitch rockshaft and work cylinder assembly, first disconnect lift links from upper lift arms and remove pto assembly as outlined in paragraph 202. Remove rear pto shaft. Disconnect draft sensing linkage bracket from rockshaft (5—Fig. 279). Remove snap rings (1 and 13) from rockshaft ends. Note timing marks on rockshaft ends and lift arms (2) and remove lift arms. Remove set screws (6) from power arm (7), unbolt and remove retainer (10), then drive rockshaft out toward left side of transmission housing, removing power arm (7). Remove piston rod from piston, then remove snap ring (15) and remove piston and cylinder liner (items 16 through 23) from transmission cavity.

Clean and inspect all parts for excessive wear, scoring or other damage and renew as necessary. When renewing bushings (4 and 11), small ID 2.3805-2.3845 inches (60.465-60.566 mm) bushing (11) installs in right side of transmission housing. Large ID 2.756-2.760 inches (70.002-70.104 mm) bushing installs in left side of transmission housing. Install new "O" ring (19)

on piston (16) and the two back-up rings (18 and 20) with concave sides toward "O" ring (19). Install new wear rings (17

Fig. 279—Exploded view of rockshaft, cylinder and sensing linkage contained in transmission housing on Models 2094 and 2294.

1. Snap ring
2. Lift arm
3. Seal
4. Bushing
5. Rockshaft
6. Set screws
7. Power arm
8. Cap screw
9. Washer
10. Retainer
11. Bushing
12. Seal
13. Snap ring
14. Piston rod
15. Snap ring
16. Piston
17. Wear ring
18. Back-up ring
19. "O" ring
20. Back-up ring
21. Wear ring
22. Cylinder
23. "O" ring
24. Thermal safety valve
25. Upper rod bearing
26. Locknut
27. Adjusting rod
28. Locknut
29. Lower rod bearing
30. Shaft
31. Outer sensing lever
32. Support
33. Inner sensing lever
34. Link
35. Follow-up lever



Paragraphs 275-276

sert piston into cylinder liner, being careful not to damage wear rings or seal. A ring compressor will aid in installing piston. Lubricate "O" rings on OD of liner and install assembly carefully into housing until snap ring (18) makes contact. Install "O" ring in cylinder cap, lubricate "O" ring and OD of cylinder and carefully install cap. Tighten cap screws to 150-180 ft.-lbs. (203-244 N·m) torque. Lower draft arms to force pistons to their lowest point in cylinders, which will remove most of the air from cylinders. Renew "O" ring at fluid line to cap connection and tighten cap screws to 17-20 ft.-lbs. (23-27 N·m) torque.

275. R&R AND OVERHAUL ROCK-SHAFT AND FOLLOW-UP LINKAGE.

Lift arms can be removed by removing snap rings from ends of rockshaft. Notice timing marks on arms and shaft, which must be aligned when arms are reinstalled. In order to gain access to rockshaft or follow-up linkage, the pto housing must be removed as outlined in paragraph 220. With pto housing removed, the cap screws and spacer (21—Fig. 280) which attach vertical follow-up rod (22) to right power arm should be removed next. Set screws (8) in top of power arms (9) must be removed before bumping rockshaft toward right side of tractor. Catch power arms as rockshaft is removed. Inspect bushings (2 and 5) and if renewed, be sure oil hole in bushing is aligned with hole in transmission case. Install lip of seals (3 and 4) toward inside. Inspect pushrod seats (7) in power arms and renew if necessary. Check assembled center-to-center length of horizontal rod (23), which should be 8-1/2 inches (215.9 mm). If necessary to remove pivot bolt for bellcrank (28), be sure copper washer is installed against head of bolt when reinstalling. Install rockshaft from right side of tractor, being careful not to damage bushings or seals. As power arms are assembled on splines, holes for set screws (8) must be aligned. Spacer (21) should be reinstalled under upper end of vertical follow-up rod (22). Length of vertical rod aligns timing marks of follow-up cam in lower linkage box, so it should be changed only if timing marks are being adjusted with draft arms fully lowered, as outlined in paragraph 264. Reinstall pto housing in reverse order of removal and install lift arms, making sure timing marks are aligned.

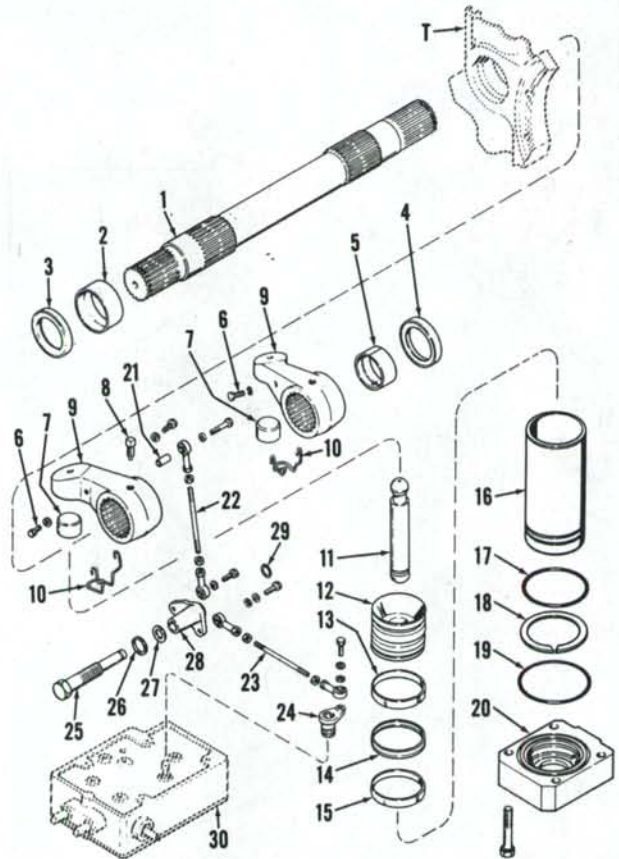
REMOTE CYLINDER

276. OVERHAUL REMOTE WORK CYLINDER. Refer to Fig. 281 for exploded view of one of the commonly

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Fig. 280—Exploded view of rockshaft and associated parts contained within transmission housing on Model 2390, 2590, 2394 and 2594 tractors.

1. Rockshaft
2. Bushing
3. Seal
4. Seal
5. Bushing
6. Retainer screw
7. Push rod seat
8. Set screw
9. Power arm
10. Retainer
11. Push rod
12. Piston
13. Wear ring
14. "U" cup seal
15. Wear ring
16. Cylinder liner
17. "O" ring
18. Snap ring
19. "O" ring
20. Cylinder cap
21. Spacer
22. Vertical rod
23. Horizontal rod
24. Follow-up sensing lever
25. Stud
26. Washer
27. Washer
28. Bellcrank
29. Snap ring
30. Draft sensing assy.

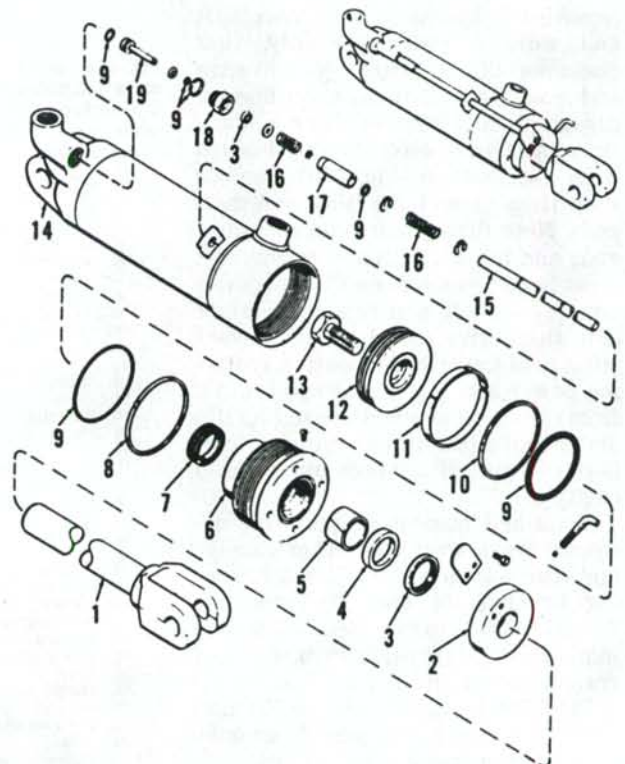


used cylinders, which may have center bearing (5) renewable separately, or as an integral part of gland (6). Wiper seal

(3) is installed with lip toward outside. Tighten valve gland (18) to 33-42 ft.-lbs. (44.7-56.9 N·m) torque. Back-up ring

Fig. 281—Exploded view of work cylinder with collar type hydraulic limit stop. Items 4 and 6 are not available separately.

1. Piston rod
2. Stop collar
3. Wiper seal
4. Bearing ring
5. Center bearing
6. Gland
7. Piston rod seal
8. Back-up ring
9. "O" ring
10. Piston seal ring
11. Wear ring
12. Piston
13. 3/4 inch bolt
14. Cylinder barrel
15. Push rod
16. Spring
17. Sleeve
18. Valve gland
19. Blocking piston



SERVICE MANUAL

Paragraph 277

(8) goes over OD of gland (6), with "O" ring beneath it. Piston seal ring (10) goes on piston (12) with "O" ring installed under it. Install $\frac{3}{4}$ inch bolt (13) in piston rod (if removed) and tighten to 200-220 ft.-lbs. (271-298 N·m) torque. Gland (6) should be tightened with a spanner wrench to at least 100-200 ft.-lbs. (136-271 N·m) torque.

CAB

REMOVE AND REINSTALL

All Models So Equipped

277. To remove the cab assembly, first disconnect battery cables and remove batteries and carrier. Disconnect throttle cable from injection pump, shut off fuel supply valve and disconnect fuel supply line and return line. Shut off heater valve and disconnect heater hoses. If so equipped, disconnect cable from ground speed sensor. Disconnect air conditioner hoses at quick couplers. Identify and disconnect the four power steering tubes from steering hand pump. Disconnect brake drain line and supply line. Disconnect front-wheel drive shift cable, power shift wiring and differential lock wires, if so equipped. Disconnect gear shift cables and park lock rod. Disconnect remote valve cables and hitch control cables. Identify and disconnect remote outlets from cab panel. Disconnect clutch control cable or inching pedal cable. Disconnect pto control cable and left and right brake lines. Disconnect engine wiring harness from cab wiring harness at front of cab. Attach a cab lifting bracket and hoist as shown in Fig. 282. Lifting bracket can be fabricated using dimensions shown in Fig. 283. Remove bolts from left and right rear cab mounts and from left and right front cab mounts. Slowly raise the cab and check to be sure all wiring,

tubes and cables have been disconnected. Lift off cab assembly.

Reinstall by reversing removal procedures. Install and tighten rear cab mount bolts to a torque of 80-96 ft.-lbs.

(108-130 N·m). Install front cab mount bolts. Tighten all $\frac{1}{2}$ inch bolts to a torque of 80-96 ft.-lbs. (108-130 N·m) and all $\frac{5}{8}$ inch bolts to a torque of 150-180 ft.-lbs. (203-224 N·m).

Fig. 282—View showing cab lifting bracket and hoist installed for cab removal.

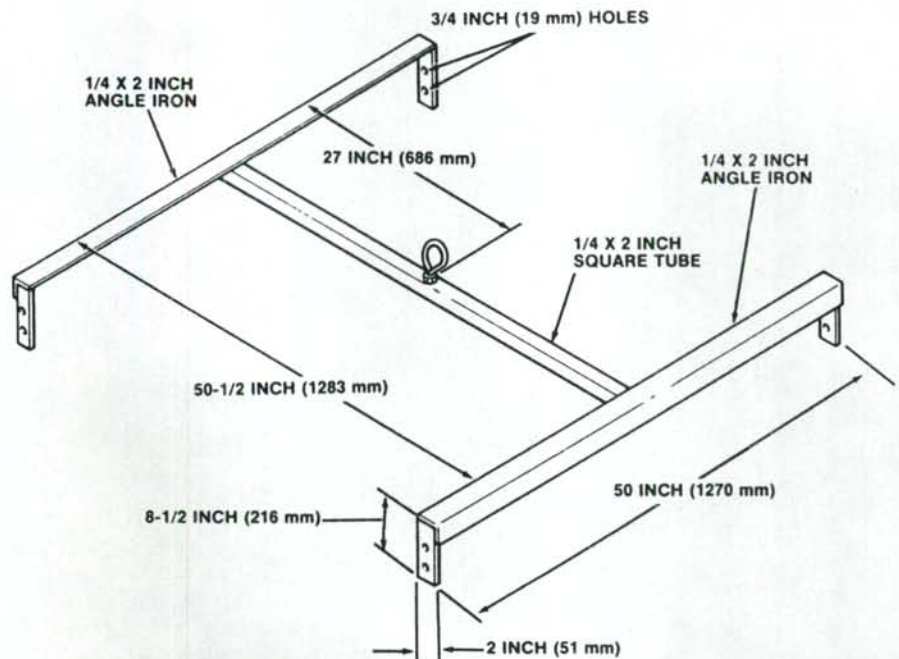
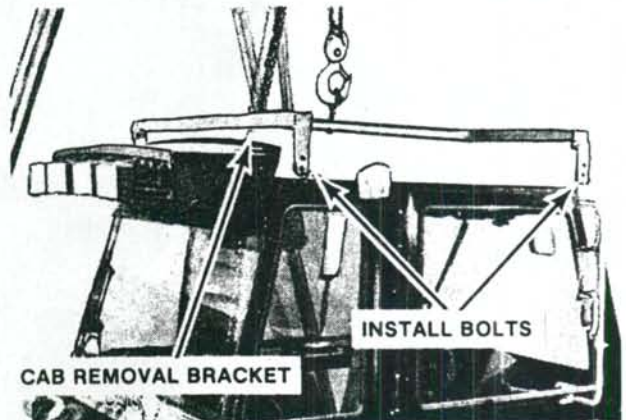


Fig. 283—Cab lifting bracket can be fabricated using dimensions shown.